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UNDP

THE ECONOMIC, SOCIAL, AND ENVIRONMENTAL BENEFITS OF A CIRCULAR ECONOMY IN INDONESIA

JANUARY, 2021

Contents

Foreword

Entering a decade towards the sustainable development goals and the target of reducing greenhouse gas (GHG) emissions of Paris Agreement by 2030, the Government of Indonesia is further strengthening its commitments and efforts in overcoming economic, social and environmental problems through a low carbon development and circular economy.

Circular economy is a closed loop economy system approach in which raw materials, components, and products are maintained as useful and valuable as possible so as to reduce the amount of waste material that is not reused and disposed of to landfills. The Circular Economy encourages higher green economic growth compared to the business as usual (BAU) scenario by designing systems and products that require fewer resources, ensuring that the extracted raw materials are used as efficiently and maximize its lifespan. The circular economy is one of the instruments that can support the achievements of the Sustainable Development Goals. The circular economy is also one of the drivers for Indonesia towards economic transformation, in particular supporting the green economy and low-carbon development strategies.

Indonesia has adopted the Circular Economy concepts into its vision and development strategies. Vision Indonesia 2045 has elaborated on the Circular Economy concepts as the policy going forward. As an initial step in implementing the circular economy concept, the Government of Indonesia in collaboration with the United Nations Development Program (UNDP) with the support of the Danish Government has established an analysis study of the environmental, economic, and social potential for the implementation of a circular economy in Indonesia in 5 (five) industrial sectors, namely food and beverages, construction, electronics, textiles, and plastics. This circular economy development study will be followed by further development stages, such as developing the National Action Plan and including the circular economy in the next National Medium Term Development Plan (RPJMN) 2025-2029.

The challenges and gaps with the current actual conditions will certainly be shared big work together. However, with comprehensive strategy development and collaboration of stakeholders, the implementation of a circular economy will be a concrete solution to the problems we face today. We also express our appreciation to Ministries/Institutions, Regional Governments, Academia, and development partners who have supported the preparation of the study.

Hopefully, this document can become a common reference and provide an overview of the Indonesian Government's efforts in implementing a circular economy that supports low carbon development and its contribution to achieving development targets, both at the national and global levels.

Suharso Monoarfa

Minister of National Planning and Development Indonesia/Bappenas

We initiated the study on Circular Economy in the beginning of 2020. A lot has happened since then. The corona pandemic has changed the world. Including how we see our economy and the way we produce and consume. We now see Green Recovery and Building Back Better as smart ways to get through the pandemic. The Pandemic has shown that we can change the way we live. We know it remains more important than ever to ease the burden on our common environment, and the current rethinking of value chains and economic restart after the pandemic presents clear, green opportunities.

The Circular Economy puts a framework around this change. It is a change that requires huge efforts from not only producers and consumers, but from every entity in the entire value chain.

Investing in a more Circular Economy is not only necessary seen from an environmental point of view, but also a sound investment for the economy! It helps our economy, boosts our employment rates and reduces our carbon footprint. And that is exactly what we need after the corona pandemic. In Denmark, we estimate that the transition to a Circular Economy will increase GDP by more than 7 billion USD, increase the net export with 3-6% and reduce CO2 emissions by 3-7%. The report you are about to read will show some of the Indonesian potentials of circular Economy in five key economic sectors of Indonesia – and the conclusions are no less stunning. Investing in Circular Economy is a smart way for recovery after COVID – and with a positive return on the investment, in contrary to seeking to uphold the old ways of consuming and producing.

I am happy that Denmark has been able to support this study as part of the long-term Danish-Indonesian environmental cooperation.

I believe this study provides a good foundation to develop a National Strategy and Action Plan for Circular Economy in Indonesia. Formulating such a National Strategy and Action Plan for Circular Economy is a big task involving a lot of support from both public and private, national and international institutions. I call for further action by our Indonesian and international colleagues and partners.

Let me end by thanking BAPPENAS, UNDP and the consultant team for their outstanding engagement in this study. I express a hope that it will form the basis of a Strategy and Action Plan for Circular Economy in Indonesia.

Lars Bo Larsen

Ambassador of Denmark to Indonesia

This Report on the circular economy comes at an opportune moment as we enter the 'decade of action' to fast-track the achievement of the Sustainable Development Goals (SDGs). Furthermore, Indonesia currently stands at a critical juncture, where more resources and energy may be needed, to reinvigorate its post COVID-19 economy. As the clock ticks towards 2030, a key question remains as to how a resource-rich country like Indonesia strives to improve people's lives, whilst at the same time reduce its carbon emissions and waste. Balancing energy use and resource utilization to sustain growth is indeed a tricky question that could lead to setbacks, if not handled strategically. Under the circular economy, companies and manufacturers can be successful by producing zero waste and re-use any by-products from their production. Consumers value such products and services, and new technologies and techniques generate jobs. Hence, with its massive potential in cost efficiency, a circular economy is a win-win model for all stakeholders in Indonesia to boost growth, address climate change and create new jobs at the same time.

The analysis and policy recommendations in this report are focusing on five sectors: food and beverages, textiles, wholesale and retail trade (with focus on plastic packaging), construction, and electronics. I am pleased to note that some encouraging findings have transpired: Indonesia's GDP stands to increase by IDR 593 - 638 trillion (USD 42– 45 billion) in 2030, if those five sectors fully adopted the circular economy model.

The COVID-19 pandemic has forced Indonesia to refocus its national budget on cushioning the impacts of the pandemic, including budget for climate change mitigation, where health and economic sectors become the priority. This is where the circular economy model can come in to provide an alternative for Indonesia to accelerate its efforts to meet emission reduction target and to achieve green and sustainable recovery from COVID-19 crisis.

UNDP Indonesia stands ready to support Indonesia in realizing a circular economy, by providing evidence-based studies, and policy advocacy, including this Report. Our sincere gratitude goes to the Government of Indonesia, in particular the Ministry for Development Planning, BAPPENAS, for their solid commitment to advocate for the adoption of circular economy in Indonesia. We thank the Government of Denmark for its generous contribution without which this Report would not have been completed.

As you study the Report, I encourage you to assume a more active role in our joint effort to advocate for the implementation of circular economy. It is my sincere hope that all stakeholders work together to unleash the massive potential of the circular economy to create a greener and more prosperous Indonesia and improve the lives of millions of people in Indonesia.

Norimasa Shimomura

UNDP Indonesia Resident Representative

Several experts provided valuable input on the approach and findings throughout the development of this report. The experts include Dr Tammara Soma (Food & Beverage), Maria Chahboune (Textiles), Prasetyo Adi (Construction), Arthur Neeteson (Wholesale & retail trade), and Dr M Akbar Rhamdhani (Electrical and electronic equipment). Apart from sector-specific experts, valuable feedback was also provided by local and international circular economy experts, including Maria Dian Nurani, Lydia Napitupulu, Helga Vanthournout, and Jelmer Hoogzaad. The team is grateful for all the experts' immense contribution to this report.

SUPPORTED BY

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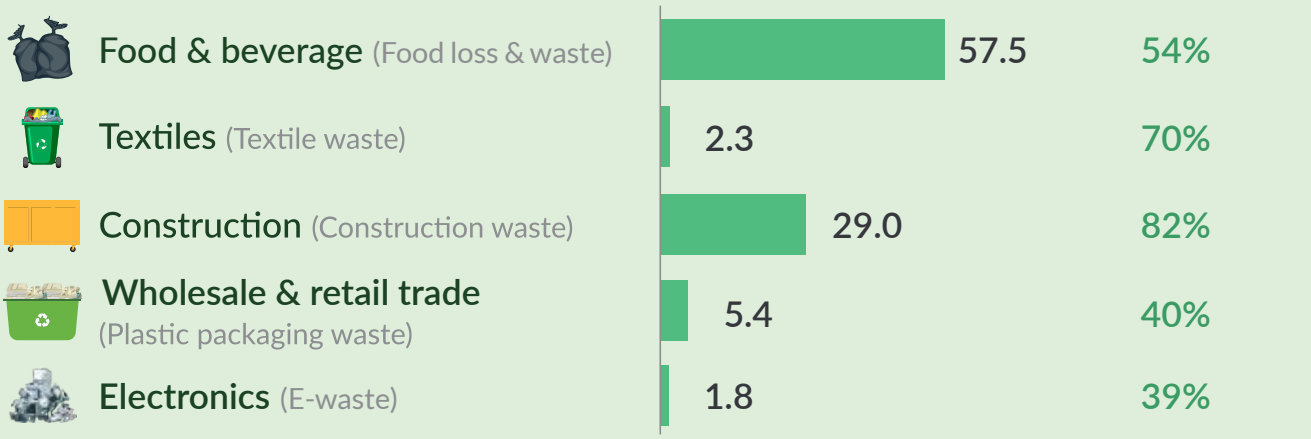
The circular economy opportunity for Indonesia

5 SECTORS IN INDONESIA HAVE LARGE POTENTIAL TO ADOPT A CIRCULAR APPROACH

FOOD & BEVERAGE | **TEXTILES** | **CONSTRUCTION** | **WHOLESALE & RETAIL TRADE** | **ELECTRICAL & ELECTRONIC EQUIPMENT**

These five sectors represent **1/3** of Indonesia's GDP and employed **>43 million** people in 2019

CURRENT PRACTICES IN THESE SECTORS ARE INFFICIENT AND GENERATE LARGE AMOUNTS OF WASTE



A CIRCULAR APPROACH COULD GENERATE MEANINGFUL ECONOMIC, ENVIRONMENTAL AND SOCIAL BENEFITS BY 2030 COMPARED TO A "BUSINESS AS USUAL" SCENARIO

Economic benefits

Potential to generate an additional economy-wide GDP of **IDR593 - 638 trillion** in 2030; the direct GDP impact on the 5 sectors could vary from **IDR -1,563 trillion** to **IDR312 trillion** based on different scenarios

Environmental benefits

Reduce waste in each sector by **~18-52%** in 2030
Reduce CO_2e emissions by **126 million tonnes** and water use by **6.3 billion cubic metres** in 2030

Social benefits

Create **4.4 million** net cumulative jobs by 2030
Create annual household savings of almost **9%** of their budgets (IDR4.9 million annually)[1] in 2030

[1] Based on IO methodology.

SOURCE: BPS; Ministry of Environment and Forestry; World Economic Forum (see Annex)

Glossary

Term	Full form / Description
3PL	Third-Party Logistics
AC	Air-Conditioner
AI	Artificial Intelligence
B2B	Business-To-Business
Bappenas	The Ministry of National Development Planning in Indonesia
BAU	Business-As-Usual
BIM	Building Information Management
BSDC	Business and Sustainable Development Commission
BPS	Badan Pusat Statistik
CAD	Computer-Aided Design
C&D	Construction and demolition
CE	Circular Economy
CO_2e	Carbon dioxide-equivalent
CMT	Cut-Make-Trim
DOA	Dead On Arrival
EMF	Ellen MacArthur Foundation
EPR	Extended Producer Responsibility
EU	European Union
FAO	Food and Agriculture Organization
F&B	Food and Beverage
GBCI	Green Building Council Indonesia
GDP	Gross Domestic Product
GHG	Greenhouse gas(es)
GHP	Good Handling Practices
GPAP	Global Plastic Action Partnership
GVA	Gross Value Added
ICOR	Incremental Capital Output Ratio
IEA	International Energy Agency
IoT	Internet of Things
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IBCSD	Indonesia Business Council for Sustainable Development
ICEF	Indonesia Circular Economy Forum
IPLC	Indigenous Peoples and Local Communities
IRP	International Resources Panel
JAKSTRANAS	Policies referring to the Presidential Regulation No.97/2017 concerning household and household-related waste
LCDI	Low Carbon Development Indonesia
LFPR	Labour Force Participation Rate
MBOE	Million Barrels of Oil Equivalent
MoEF	Ministry of Environment and Forestry
MSME	Micro, Small, and Medium Enterprises

MSW	Municipal Solid Waste
MT	Metric Tonnes
re-PSF	Recycled Polyester Staple Fibre
P2F	Plastic-to-Fuel
PCB	Printed Circuit Boards
PPE	Personal Protective Equipment
PRO	Packaging Recovery Organisation
RCA	Recycled Concrete Aggregate
SEZ	Special Economic Zone
Sqm	Square metres
UNDP	United Nations Development Programme
UN SDG	UN Sustainable Development Goals
WRI	World Resources Institute

Executive Summary

A circular economy is more than just an opportunity for Indonesia to reduce waste and improve the environment. Like governments around the world, Indonesian policymakers are seeking to support the economic recovery from the COVID-19 pandemic. However, a key question remains as to whether these recovery policies reinforce the existing "business-as-usual" economic structures with their associated negative impacts on the environment, or whether there is an opportunity to "build back better" where efforts are placed to maximise the shared benefits between the economy and the environment. This analysis shows that fully adopting circularity opportunities in five key sectors of the economy (food & beverage, textiles, construction, wholesale and retail trade, and electrical and electronic equipment) could be a key component of the economic recovery, helping to strengthen the economy, create new jobs, lower household costs, and preserve the environment. By adopting circular economy opportunities in these sectors, Indonesia's GDP could increase by IDR593 to 638 trillion (USD42 to 45 billion) in 2030 (than it would under a "business-as-usual" approach) in 2030; 4.4 million cumulative net jobs could be created economy-wide between 2021 and 2030, out of which 75 percent could be for women; CO2e emissions and water use could be reduced by 126 million tonnes and 6.3 billion m^3 in 2030, respectively (equivalent to 9 percent of the current emissions and 3 percent of the current water usage); and the average Indonesian household could save IDR4.9 million (USD344) annually, representing almost nine percent of the current yearly household expenditure. By creating new job opportunities, making supply chains more resilient, and providing business opportunities (particularly for Micro, Small and Medium Enterprises), a circular economy can be a key component of Indonesia's economic recovery. However, this analysis also highlights some challenges, including potential job losses and reduced demand for upstream production in the five focus sectors (under some scenarios). A robust multi-stakeholder roadmap is envisaged as the next step in this work and will be crucial for tackling these concerns and addressing the barriers for capturing the circular economy opportunities.

RETHINKING VALUE CREATION

A circular economy aims to generate economic growth by maintaining the value of products, materials, and resources in the economy as long as possible, thereby minimising the social and environmental damage caused by a linear economic approach. It is not just a better form of waste management with more recycling. A circular economy embraces a broad set of interventions across all economic sectors, and activities focused on the 5Rs: Reduce, Reuse, Recycle, Refurbish, and Renew (Exhibit E1). The good news is that many Indonesian businesses are already adopting elements of the 5R principles in their operations. For instance, Danone has made a 100 percent recyclable bottle for its packaged drinking water brand, Aqua.[1] CupKita, a start-up based in Jakarta, provides a reusable container service in an attempt to eliminate the use of single-use plastic cups.[2] PT Sigin Interactive Indonesia provides repair and refurbishing services for used electronics and home appliances, dead-on-arrival (DOA) products, and printed circuit boards.[3] The informal sector also plays a substantial role in the adoption of the 5Rs in Indonesia.[4] For example, in the electrical and electronic equipment sector, the reuse and recycling of electronic products are dominated by small and informal players.[5] Elsewhere, around seven percent or nearly 500,000 tonnes of Indonesia's plastic waste is collected informally.[6] A circular economy could build upon the progress made by the informal sector. For example, upskilling of informal workers could substantially increase the economic value associated with end-of-life electronic products and e-waste recovery.

1 Aqua. Available at: https://aqua.co.id/en/brand/aqua-100-recycled-1
2 Eco-business (2020), "Indonesia's first reusable cup rental service launches in Jakarta." Available at: https://www.eco-business.com/news/indonesias-first-reuseable-cup-rental-service-launches-in-jakarta/
3 Sigin Interaction Indonesia, "Services". Available at: http://sigininteractive.co.id/index.php/sigin-greetings/capability-competence/repair-electronic-and-telecommunication-devices/
4 Enri Damanhuri (2012), *Post-Consumer Waste Recycling and Optimal Production.*
5 Fauziah F. Rochman et al (2016), *E-waste, money and power: Mapping electronic waste flows in Yogyakarta, Indonesia.*
6 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership.* Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf

Exhibit E1

A circular approach comprises the 5Rs

REDUCE	▪ Remove waste in production and supply chain (e.g., 3D printing) ▪ Virtualise products and services (e.g., electronic books) ▪ Reduce energy usage (e.g., improving energy efficiency) ▪ Redesign products to require less resource inputs (e.g., high strength steel in construction)
REUSE	▪ Share assets (e.g., cars, rooms, appliances) ▪ Use of secondhand products ▪ Improve asset utility by offering products as a service
RECYCLE	▪ Recycle materials ▪ Anaerobic digestion and extracting biochemicals from organic waste
REFURBISH	▪ Remanufacture products or components ▪ Prolong life through maintenance of products
RENEW	▪ Prioritise renewable energy and materials (e.g., substituting plastic packaging with paper based packaging)

SOURCE: Ellen MacArthur Foundation; expert interviews

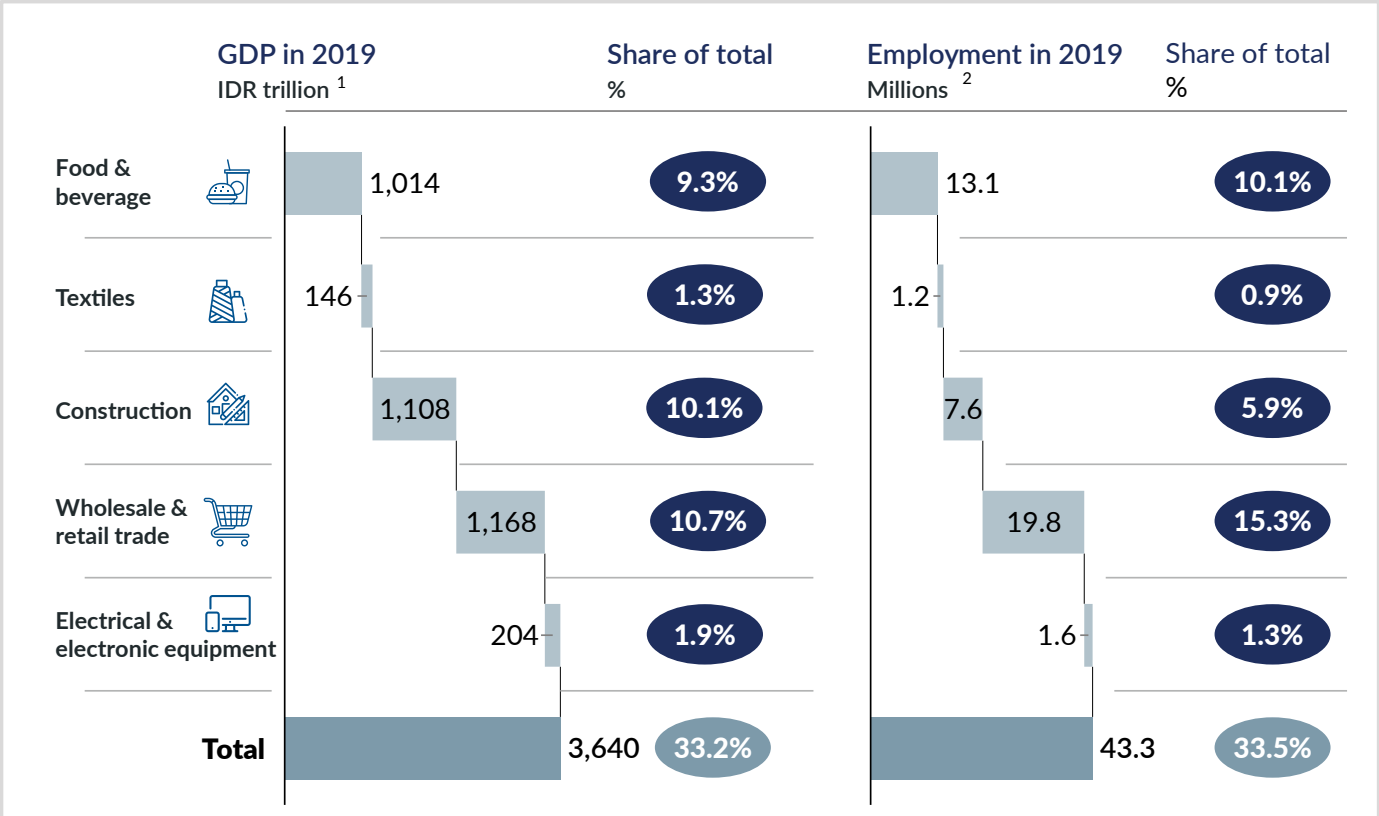
FIVE KEY SECTORS OFFER LARGE OPPORTUNITIES FOR A CIRCULAR APPROACH IN INDONESIA

This analysis identified five sectors with high potential to create a circular economy approach in Indonesia: food & beverage, textiles, construction, wholesale and retail trade (focused on plastic packaging), and electrical and electronic equipment. The high potential was driven by each sector's economic importance (e.g., five-year average Gross Value Added), the amenability of its production systems to a circular approach (e.g., material intensity), and the level of stakeholder support, both private and public, in advancing circularity within the sector (e.g., government priority based on whether the sector was mentioned in important government plans). More details about the sector prioritisation approach are available in the Annex.

These sectors play a pivotal role in Indonesia's economy. Based on data published by Badan Pusat Statistik (BPS), the five sectors contributed over 30 percent to Indonesia's current GDP and employed more than 43 million people or one-third of Indonesia's workforce in 2019 (Exhibit E2).

Exhibit E2

The five focus sectors account for ~33% of GDP and employ over 43 million people



1. GDP figures are in 2010 prices
2. The employment for the focus sectors was estimated using the sector employment data published by BPS. Due to the limited data availability on sub - sector employment, it was assumed that the labour productivity is constant across the sub-sectors

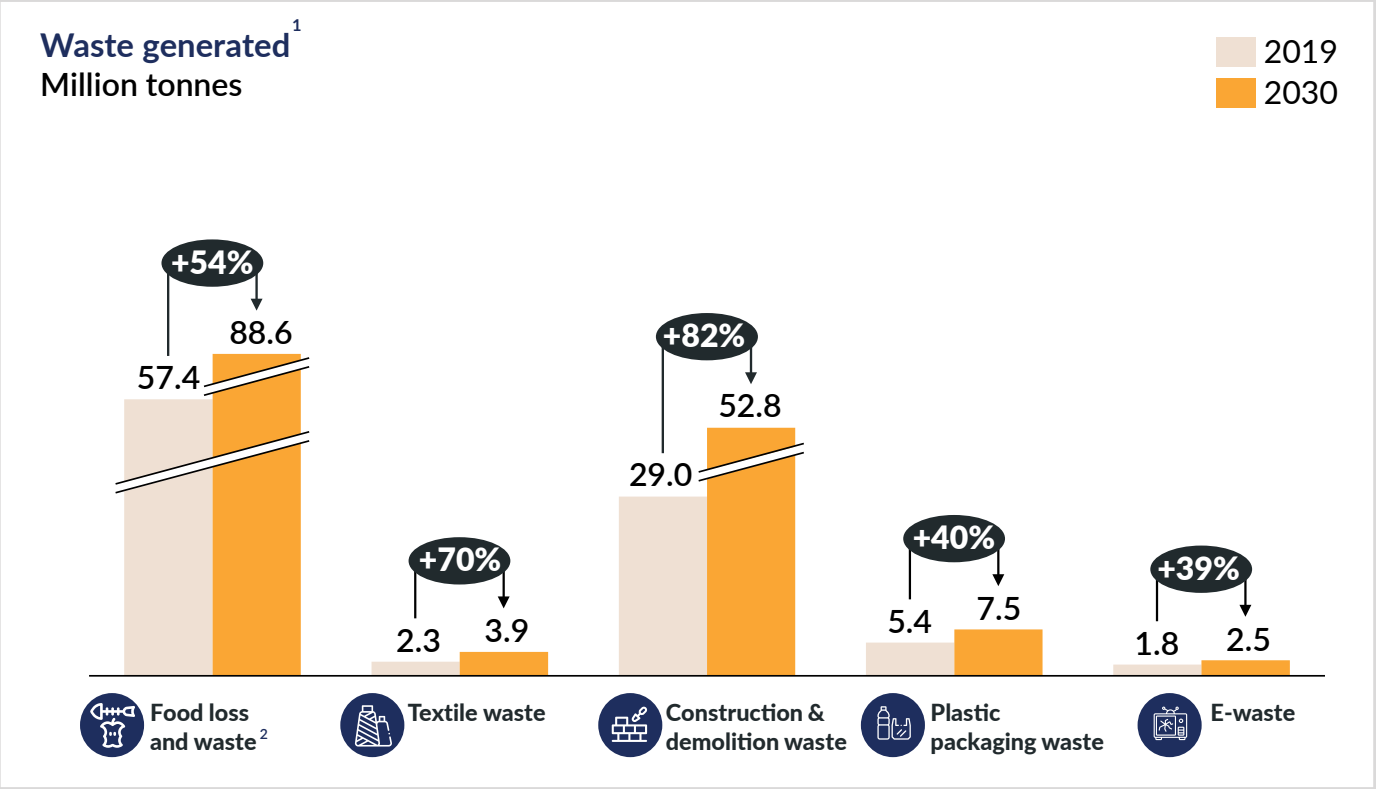
SOURCE: Bank Indonesia; BPS

Based on estimates calculated from data and inputs shared by the Government of Indonesia (e.g., Ministry of Environment and Forestry), academics, and civil society representatives, these sectors generated a significant amount of waste in 2019 (e.g., the food loss and waste, excluding food loss at production, was nearly 57.4 million tonnes). The volume of waste could increase by up to 82 percent by 2030 in some sectors (Exhibit E3). The growth in waste is not just physical waste, such as food waste or textile waste, but also structural waste, such as unoccupied office space or inefficient energy use in the built environment. Two key factors could drive the growth of waste generation over the next decade. First, more than 90 million Indonesians could join the consuming class by 2030,[7] fuelling demand for consumer staples (e.g., packaged food) and discretionary consumer products (e.g., electronics and clothing). Second, more than 35 million people could move to cities in Indonesia between 2019 and 2030.[8] According to government estimates, 67 percent of Indonesia's population could live in urban areas in 2045.[9] Urbanisation drives not only the demand for consumer products but also the construction of homes and other public infrastructure, generating associated waste in the process.

7 McKinsey Global Institute (2012), *The archipelago economy: Unleashing Indonesia's potential*. Available at: https://www.mckinsey.com/~/media/mckinsey/featured%20insights/asia%20pacific/the%20archipelago%20economy/mgi_unleashing_indonesia_potential_executive_summary.ashx.
8 United Nations Department of Economic and Social Affairs, *World Urbanization Prospects 2018*. Available at: https://population.un.org/wup/Download/
9 Minister of National Development Planning. "General Statements: Urban Development to Decrease Disparity, Alleviate Poverty and Create Jobs." Available at: https://www.bappenas.go.id/files/4315/1814/3479/180205a_General_Statements_Menteri_PPN_Bappenas_WUF9.pdf

Exhibit E3

Under a "business-as-usual" approach, waste generated by the 5 key sectors could increase by up to 82% in 2030



1. Percentages are rounded to the nearest percent
2. Excludes food loss generated at the production stage

SOURCE: BPS; WRI ; Ellen Macarthur Foundation; World Economic Forum ; ITU (see annex for more details)

THE WASTE FOOTPRINT IN THE FIVE FOCUS SECTORS COULD BE TRANSFORMED BY CIRCULAR ECONOMY OPPORTUNITIES

Based on the circularity potential of the 5Rs for each sector, sector-specific circular opportunities were prioritised (Exhibit E4). These opportunities were identified based on the available evidence on which opportunities were likely to generate the largest impact in the sector and were revised based on stakeholder consultations. For instance, for the food & beverage sector, "Reduce" and "Recycle" were found to have the highest potential. Hence, four opportunities were prioritised: i) Reduce post-harvest food loss; ii) Reduce supply chain food loss and waste; iii) Reduce consumer food waste; and iv) Process food loss and waste.

To understand the impact of each prioritised opportunity, the current adoption rates in Indonesia were estimated. For example, the current e-waste recycling rate in Indonesia is estimated to be five percent.[10] Based on local and international benchmarks, the potential for each circular economy opportunity was assessed for Indonesia in 2030. For example, based on stakeholder consultations, it was assessed that Indonesia could increase its current e-waste recycling rate and match India's recycling rate of 21 percent by 2030.[11] Elsewhere, case studies were used to understand this potential. For instance, pilot efforts in Benin, Cape Verde, India, and Rwanda have documented reductions of food loss by more than 50 percent during field trials of a variety of low-cost storage techniques and handling practices.[12] Hence, it was assumed that if Indonesia were to invest in improved infrastructure and food handling (e.g., temperature control during storage), it could reduce its post-harvest food loss by 50 percent by 2030.

10 Mairizal et al, *Electronic Waste Generation, Distribution Map, and Possible Recycling Routes in Indonesia*. Forthcoming.
11 The Hindu (2017)," E-waste recycling has doubled, says Centre". Available at: https://www.thehindu.com/news/national/e-waste-recycling-has-doubled-says-centre/article30983383.ece
12 World Food Logistic Organization (2010), *Identification of appropriate postharvest technologies for improving market access and incomes for small horticultural farmers in Sub-Saharan Africa and South Asia. Part 2: Postharvest Loss Assessments.*

Exhibit E4

Sector-specific opportunities were selected based on the circularity potential of the 5Rs

THIS TABLE IS NOT EXHAUSTIVE OF ALL CIRCULAR ECONOMY OPPORTUNITIES

High potential
Moderate potential
Low potential

Circular economy opportunities prioritised for each sector based on the 5Rs

5R	F&B	Textile	Construction	Wholesale & Retail Trade	Electrical and electronics equipment
REDUCE	Reduce post-harvest food loss	Reduce waste in production	Generate less C&D waste through existing processes	Reduce plastic packaging	Virtualise and dematerialise physical goods
	Reduce supply chain food loss and waste		Generate less C&D waste through new processes		
	Reduce consumer food waste		Optimise building usage		
REUSE		Reuse products	Reuse materials	Reuse plastic packaging	Reuse products
RECYCLE	Process food loss and waste	Recycle materials	Recycle materials	Redesign plastic packaging for improved recyclability	Recycle materials
				Increase recycling rate of recyclable packaging	
REFURBISH					Increase product lifespan and reduce obsolescence
					Refurbish products
RENEW		Use more sustainable materials	Use more sustainable materials	Replace with more sustainable packaging	
			Design and build more resource-efficient buildings		

SOURCE: Expert interviews; focus group discussions

To estimate the current volumes of household and household-related waste, and industrial waste, both local and international sources were used (Exhibit E5). More details can be found in the Annex.

Exhibit E5

A variety of data sources were used to estimate the current waste volumes and recycling rates in Indonesia

- Based on local data
- Estimated based on local proxies
- Estimated based on international proxies
- Not relevant / out of scope

Sector	Household and household-related waste [1]	Industrial waste	Recycling rates [2]
F&B	Ministry of Environment & Forestry (2018)	World Resources Institute (2019) using the South and Southeast Asia average	Ministry of Environment & Forestry (2018) using the share of waste used to compost and for biogas production
Textile	Ministry of Environment & Forestry (2018)	Ellen MacArthur Foundation (2017) using a global average	Ministry of Environment & Forestry (2018) using the overall household waste recycling rate
Construction		Nguyen (2018) using Vietnam's C&D waste, which was scaled up to estimate Indonesia's waste	Esaet al (2017) using Malaysia's C&D waste recycling rate as aproxy
Wholesale & Retail Trade	NPAP (2020) using the estimates for plastic MSW and adjusting the estimates for plastic packaging		NPAP (2020) using the overall plastic waste recycling rates as proxy
Electrical and electronics equipment	Mairizal et al (forthcoming)		

1. Household-related waste includes waste generated by traditional markets, commercial centres, offices, and other establishments. It does not include industrial waste
2. Reuse rates or refurbish rates are not included in this exhibit

Box 1. ***Data limitations in this analysis***

This analysis leveraged local data published by the Government of Indonesia, local organisations, and academics to the extent that this information was available. For example, data published by the National Plastic Action Partnership (NPAP) was used to calculate plastic packaging waste volumes and the estimates from a working paper by Mairizal et al. (forthcoming) were used to calculate e-waste volumes. However, for some indicators, data availability was found to be limited after consultations with government and non-government stakeholders. Where data was unavailable, data from comparable countries were used as proxies. For example, to calculate Indonesia's construction and demolition (C&D) waste, Vietnam's C&D waste was used as a proxy and adjusted to Indonesia's context based on the relative Gross Value Added of the construction sector in the two countries. In the absence of suitable comparable proxies, regional or global averages were used. For example, due to the lack of robust data on the share of food loss and waste generated across the different stages of the value chain, the averages published by the World Resources Institute (WRI) for South and Southeast Asia were used as proxies.

Representatives from the textile sector highlighted that the lack of data on pre-consumer textile waste is one of the key barriers hampering the capture of circular opportunities in the textile sector. To accelerate the adoption of circular opportunities and to strengthen the analysis presented in the report, the Government of Indonesia and other stakeholders could develop sector-specific taskforces that undertake research to improve data availability.

There are ongoing initiatives in Indonesia that are addressing this data gap. For example, a joint study by UK Aid, Waste4Change, WRI, Low Carbon Development Institute, and Bappenas intends to estimate current and future food loss and waste and propose national policies to reduce food loss and waste and achieve Indonesia's greenhouse gas emissions reduction target.

In addition, this analysis used the Input-Output (IO) table published by the OECD for Indonesia in 2015 to estimate the economic impact since the latest IO table published by the Government of Indonesia was published in 2010. While the analysis of supply chain linkages showed that these relationships are structurally robust over time – in other words, they do not change significantly over the short and medium terms – this analysis could be more robust if a more recent IO table published by the Government was available. More details on the use of the IO table and the checks carried out by the team are available in the Annex.

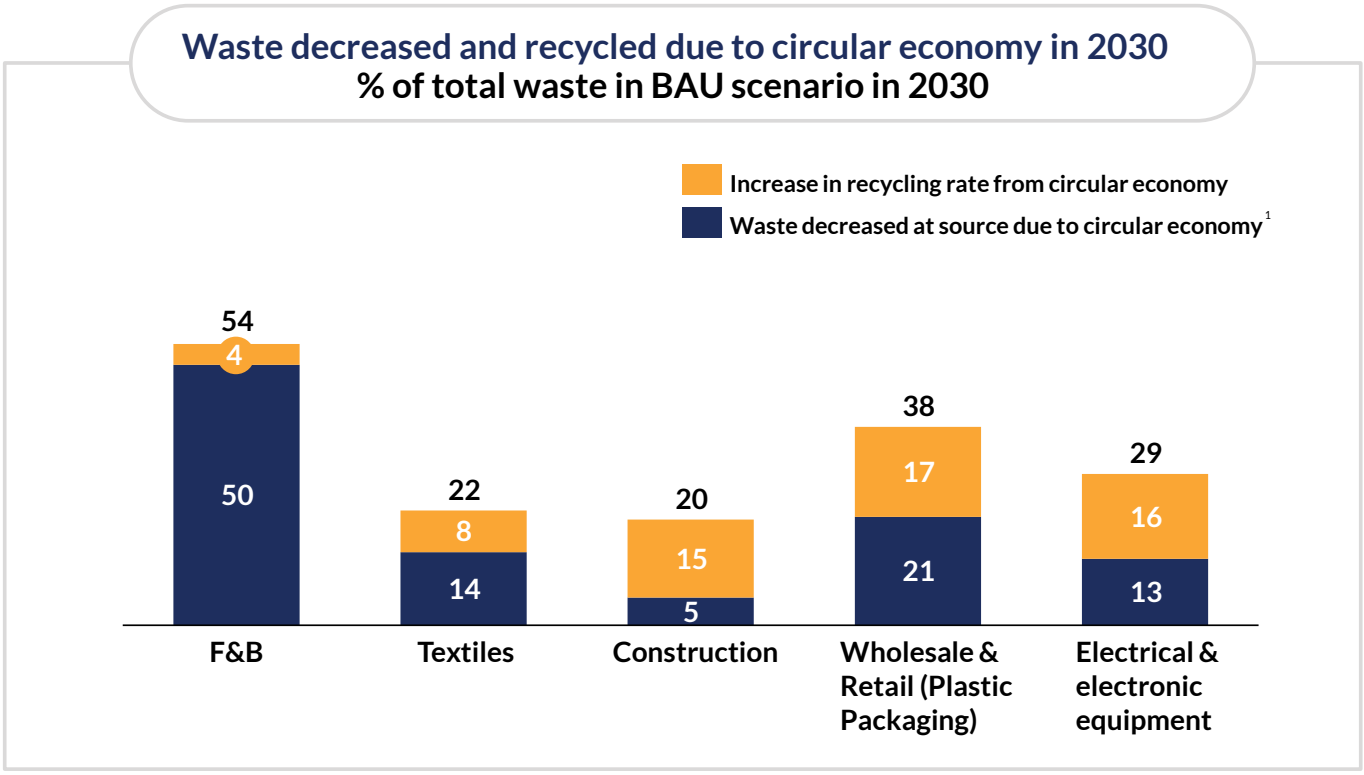
A successful transition towards the circular economy could help Indonesia reduce its waste generation at source and increase its waste recycling rates. A circular economy could reduce waste by up to 50 percent in 2030 (compared to a BAU scenario). Depending on the sector, it could also add between 4- 17 percent to the BAU recycling rates. This analysis shows that a circular economy could significantly contribute to the Government's efforts to reduce waste across the five sectors (Exhibit E6):

- **Food loss and waste.**[13] Indonesia could reduce food loss and waste by 50 percent and recycle an additional four percent of the remaining food loss and waste, relative to a BAU scenario.
- **Textile waste.** Indonesia could reduce textile waste by 14 percent and recycle an additional eight percent of the remaining textile waste.
- **Construction and demolition (C&D) waste.** Indonesia could reduce C&D waste by 5 percent and recycle an additional 15 percent of the remaining C&D waste.
- **Plastic packaging waste.** Indonesia could reduce plastic packaging waste by 21 percent and recycle an additional 17 percent of the remaining plastic packaging waste.
- **E-waste.** Indonesia could reduce e-waste by 13 percent and recycle an additional 16 percent of the remaining e-waste.

13 The FAO differentiates between food loss and food waste. Food loss is defined as all the crop, livestock and fish human-edible commodity quantities that, directly or indirectly, completely exit the post-harvest slaughter/catch supply chain by being discarded, incinerated or otherwise disposed of, and do not re-enter in any other utilization (such as animal feed, industrial use, etc.), up to, and excluding, the retail level. Losses that occur during storage, transportation and processing, as well as imported products, are therefore all included. Food waste occurs from retail to the final consumption/ demand stages.

Exhibit E6

A circular economy in Indonesia could make significant contributions in decreasing waste generation at source and recycling waste



1. The decrease in waste generation at source takes into account the impact of reduction, reuse, and refurbishment circular economy opportunities

SOURCE: BPS; Bank Indonesia; Ministry of Environment and Forestry; WRI; World Economic Forum; ITU; Ellen MacArthur Foundation; expert interviews (see annex for more details)

THE ECONOMIC IMPACTS OF A CIRCULAR APPROACH COULD BE SIGNIFICANT

Generating less and recycling more waste could impact the Indonesian economy significantly (Exhibit E7). Based on two methodologies (Input-Output Table modelling and Incremental Capital Output Ratio modelling), transitioning towards a circular economy could help create an additional IDR593-638 trillion (USD42-45 billion) GDP for Indonesia in 2030 (equivalent to 2.3 to 2.5 percent of its projected GDP in 2030).[14] This additional economic value would be above the BAU scenario where Indonesia does not actively pursue circular economy opportunities. Two aspects of this analysis are important to note:

- **COVID impact.** These estimates were not adjusted for the COVID-19 crisis due to a lack of clarity on the long-term impact of COVID-19 on Indonesia's economy and waste volumes. Based on the latest government estimates, Indonesia's GDP is expected to shrink by 1.6 to 2.2 percent in 2020.[15] The International Monetary Fund (IMF) projects that Indonesia's GDP could rebound to 6.1 percent growth in 2021.[16] However, the link between GDP growth and waste volumes for the five prioritised sectors is not straightforward, and COVID-19 could have impacts on waste and circularity opportunities (which are hard to quantify) beyond its impact on the economy. For example, a fall in household income could lead to lower demand for consumer electronics, thereby, decreasing the generation of e-waste. However, a greater share of formal workers working from home and an accompanying shift toward digitisation could increase e-waste volumes.[17] It is unclear whether the fall in e-waste due to lower incomes could offset the expected rise in e-waste due to greater digitisation. More details

14 Further details on these methodologies are provided in the Annex.
15 The Jakarta Post (2020), "Govt again revises down 2020 GDP amid year-end surge of COVID-19 cases." Available at: https://www.thejakartapost.com/news/2020/12/22/govt-again-revises-down-2020-gdp-amid-year-end-surge-of-covid-19-cases.html
16 IMF (2020), *A Crisis Like No Other, An Uncertain Recovery*. Available at: https://www.imf.org/en/Publications/WEO/Issues/2020/06/24/WEOUpdateJune2020
17 The Rising (2020), "Will Social Distancing Increase E-Waste? Here's How This IT CEO Is Preparing For The Possibility." Available at: https://therising.co/2020/04/23/social-distancing-increase-e-waste-sagent-ceo-preparing-for-possibility/

can be found in the Annex. Hence, it is important that these numbers are updated once there is greater clarity on the impact that COVID-19 could have on Indonesia's economy and waste volumes to better understand the potential of a circular economy in a post-COVID environment.

- **Economy-wide benefits versus sector-specific benefits.** The economic impact represents the economy-wide gains derived from the adoption of circular economy opportunities in the five sectors (not equal to the net impact in these sectors). The economic benefits were derived from reducing waste in the key sectors, with the resulting savings spent in other sectors (e.g., healthcare, education, recreation services, etc.). This is important to note because even though the overall economy may benefit significantly from circular economy adoption, this does not necessarily mean that the economic output in the five sectors will be higher. Understanding the exact economic impact for the focus sectors is difficult as it depends on where the resultant savings from business and consumer adoption of circular opportunities are spent. For example, if consumers reducing their food waste (and hence needing less quantity of food) decide to spend the resultant savings on higher-value food, then the impact on the food & beverage sector could be positive. But if those savings are spent in other sectors, then the impact could be negative. System dynamics analysis was conducted to better understand these sector-specific impacts (see Box 2 for further details). The Causal Loop Diagram and the detailed methodology related to system dynamics can found be in the Annex. The system dynamics analysis focused only on the direct impact of the five focus sectors. According to the analysis, the adoption of the business efficiency opportunities related to a circular economy could create significant benefits to GDP growth and jobs in the focus sectors. However, if the adoption of a circular economy opportunity leads to reduced consumer demand, it could lead to slower growth than under business-as-usual. These findings must be caveated given that they exclude the economy-wide multipliers from the spending of savings from a circular economy, but nonetheless, they reinforce the importance of understanding that there will be potential winners and losers from a transition to a circular economy, and businesses and policymakers must prepare accordingly to ensure that the transition does not adversely impact certain sections of the Indonesian economy and society.

Box 2. System dynamics approach

System dynamics takes a systems approach to policy analysis and design, which can be applied to problems arising in social, managerial, economic, or ecological systems.[18] This approach begins by defining problems and then proceeds by mapping and modelling the different stages of the system, which are often dynamic and interconnected. System dynamics approach differs from the linear modelling processes since it takes into account the (often lagged) feedback loops that arise in complex systems.[19] The system dynamics approach was used in this analysis to complement the analysis shown earlier, ensuring that any potential feedback loops and other linkages between interconnected factors (e.g., waste and GDP growth) were fully incorporated. The findings from the system dynamics approach are broadly consistent with the findings estimated from the Input-Output and ICOR methodologies, showing the potential for stronger GDP and employment growth, and better environmental outcomes from a circular economy. However, it also notes the potential future growth challenges for certain sectors due to the reduction in waste.

A key finding from the system dynamics approach is that supply-wide circular economy adoption focused on reducing waste in production systems could support higher economic growth. However, reductions in waste from consumers could have a negative impact on growth and employment due to the lower demand. The analysis shows that a consumer-centric approach could lead to a negative GDP impact of IDR1,563 trillion on the five focus sectors relative to a BAU scenario in 2030 (Exhibit E8).[20] In contrast, a producer-centric approach could generate a positive GDP impact of IDR312 trillion in 2030. A combined consumer and producer-centric approach could lead to a modest economic impact of IDR21 trillion. Hence, an important takeaway is that the Government of Indonesia should consider prioritising efforts to encourage producers to adopt circular economy opportunities.

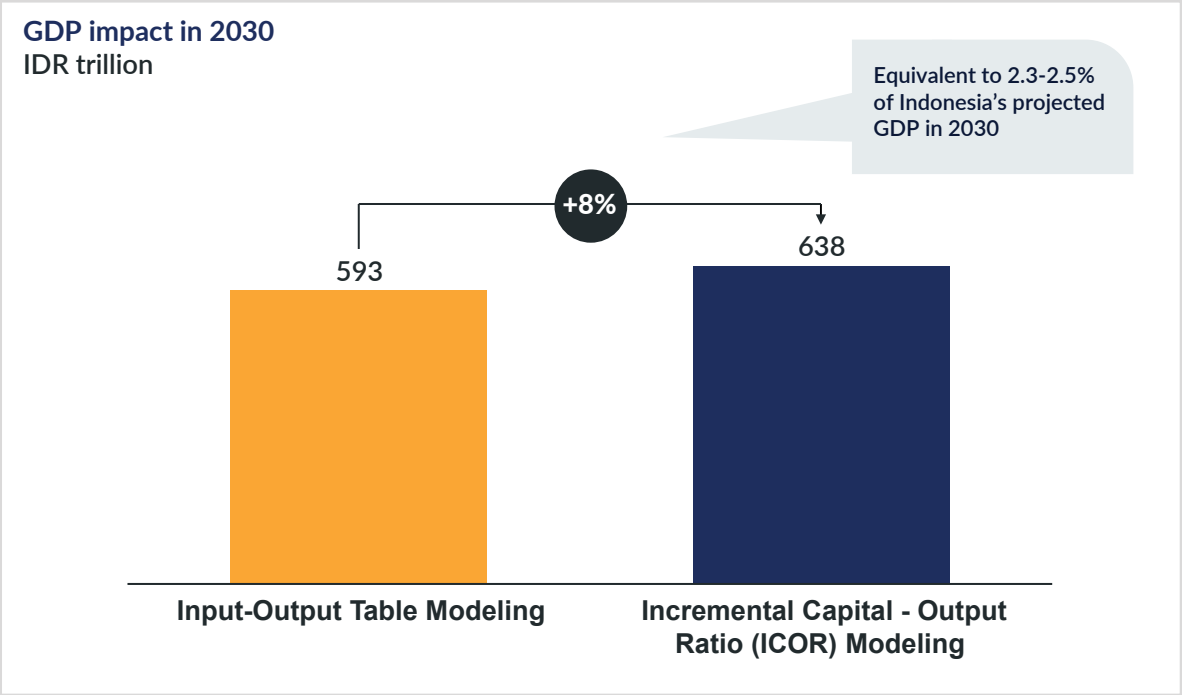
A key reason for the differences in the system dynamic results from the earlier findings is that the system dynamics approach in this analysis only focused on the GDP impact in the five focus sectors, whereas the economic impact analysis shown in the main report accounts for the spillover effects into other sectors (beyond the five focus sectors). This is particularly important for reduction opportunities which could lead to lower demand in the focus sectors, but the savings could be spent in other sectors, helping to drive their demand. For example, reductions in consumer food waste may lead to lower demand for the food & beverage sector. However, savings from reduced food purchases could be spent elsewhere in the economy (e.g., on health, education, recreation, etc.) contributing to growth in those sectors. Further details on the system dynamics approach can be found in the Annex.

Indonesia's MSMEs could also play a key role in supporting the economic transition. In 2018, there were close to 64 million MSMEs in Indonesia, employing approximately 61 million people (representing nearly 90 percent of all employment).[21] MSMEs also contributed nearly 60 percent to Indonesia's GDP in 2017.[22] A circular economy could enable cost savings for MSMEs from greater resources efficiency and waste reduction, and lead to the development of new business models, such as those focusing on recovery and recycling, which could provide significant opportunities to MSMEs.[23] Furthermore, MSMEs could be better placed than large enterprises to adopt circular economy practices. Since MSMEs are more likely to be closer to the end-consumer than large enterprises, they are better positioned to adopt circular business models that require decentralised production systems, such as business models focused on reusing, recycling, or repurposing resources locally.[24] However, in Indonesia, most enterprises within MSMEs are micro or small. According to the BPS, micro and small enterprises accounted for close to 98 percent of all MSMEs in 2016.[25] The micro and small firms could lack the knowledge and capital to adopt circular opportunities. Hence, the Government would need to draft policies that are cognizant of the variation within the MSMEs. To support micro and small firms, the Government could consider helping such firms become members of supply chain partnerships that have shown to be effective in Europe.[26]

18 System Dynamics Society. "Introduction to system dynamics." Available at: https://www.systemdynamics.org/what-is-sd
19 Francesca Ricciardi et al (2020), *System dynamics modeling as a circular process: The smart commons approach to impact management*. Available at: https://www.sciencedirect.com/science/article/pii/S0040162519310923
20 The estimates in the system dynamics analysis are in constant 2010 prices
21 TNP2K (2020), The Mechanism of Micro, Small, and Medium Enterprise's Data Integration in Indonesia for Targeting Social Assistance and Empowerment Programs. Available at: http://tnp2k.go.id/download/43209The%20Mechanism%20of%20Micro,%20Small,%20and%20Medium%20Enterprise's%20Data%20Integration%20in%20Indonesia%20for%20Targeting%20Social%20Assistance%20and%20Empowerment%20Programs.pdf; Badan Pusat Statistik Republik Indonesia (2016), Results of Establishment Listing Economic Census 2016. Available at: https://se2016.bps.go.id/Lanjutan/files/buku/00_Indonesia.pdf
22 Tulus Tambunan (2019), *Recent evidence of the development of micro, small and medium enterprises in Indonesia*. Available at: https://link.springer.com/article/10.1186/s40497-018-0140-4
23 Plant Chicago (2020), *The circular economy toolkit for small business*. Available at: https://www.swalco.org/DocumentCenter/View/2322/Plant-Chicago_Circular-Economy-Toolkit-for-Small-Business_Feb2020
24 Oliver Wyman (2017), *Supporting the circular economy transition*. Available at: https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2017/sep/CircularEconomy_print.pdf
25 BPS (2016), *Result of establishment listing economic census 2016*. Available at: https://se2016.bps.go.id/Lanjutan/files/buku/00_Indonesia.pdf
26 Rizos et al (2016), *Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers*. Available at: https://www.mdpi.com/2071-1050/8/11/1212

Exhibit E7

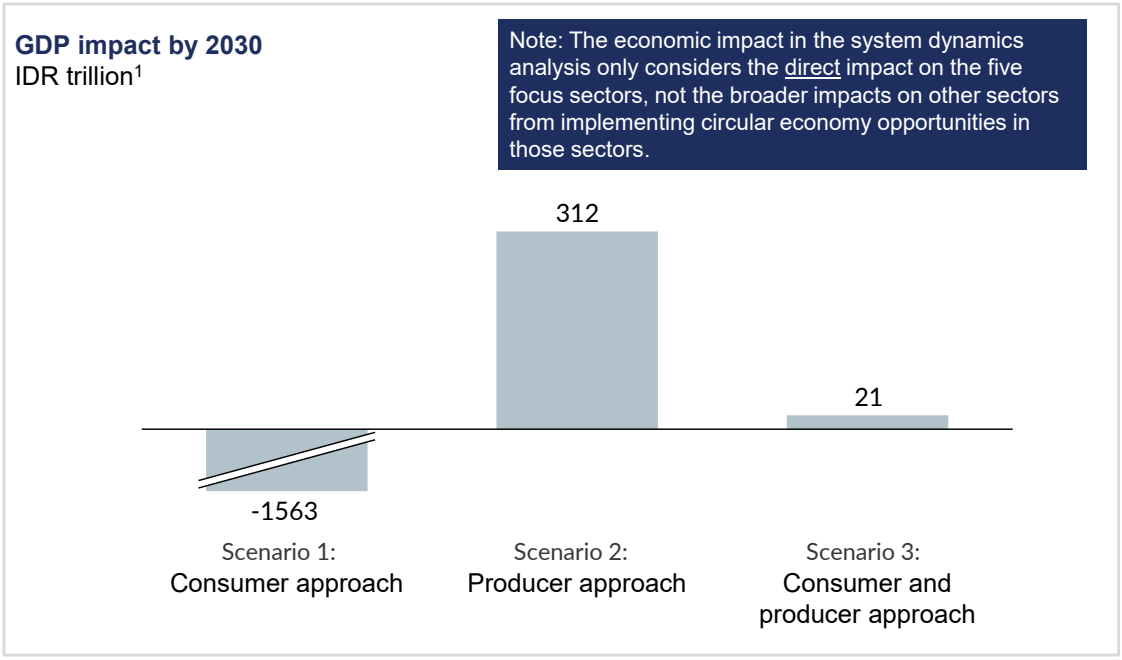
A circular economy could generate an additional economy-wide GDP impact of IDR593-638 trillion in 2030



SOURCE: BPS; Bank Indonesia; Ministry of Environment and Forestry; ADB; WRI; ITU; expert interviews (see annex for more details)

Exhibit E8

Based on the system dynamics analysis, the additional GDP impact on the 5 focus sectors could be up to IDR312 trillion by 2030



1. All figures in this exhibit are in constant 2010 prices

SOURCE: Ministry of Environment and Forestry ; WRI; World Economic Forum; Ellen MacArthur Foundation; ITU; expert interviews (see annex for more details)

A CIRCULAR APPROACH COULD ALSO SIGNIFICANTLY REDUCE CARBON EMISSIONS AND WATER USE

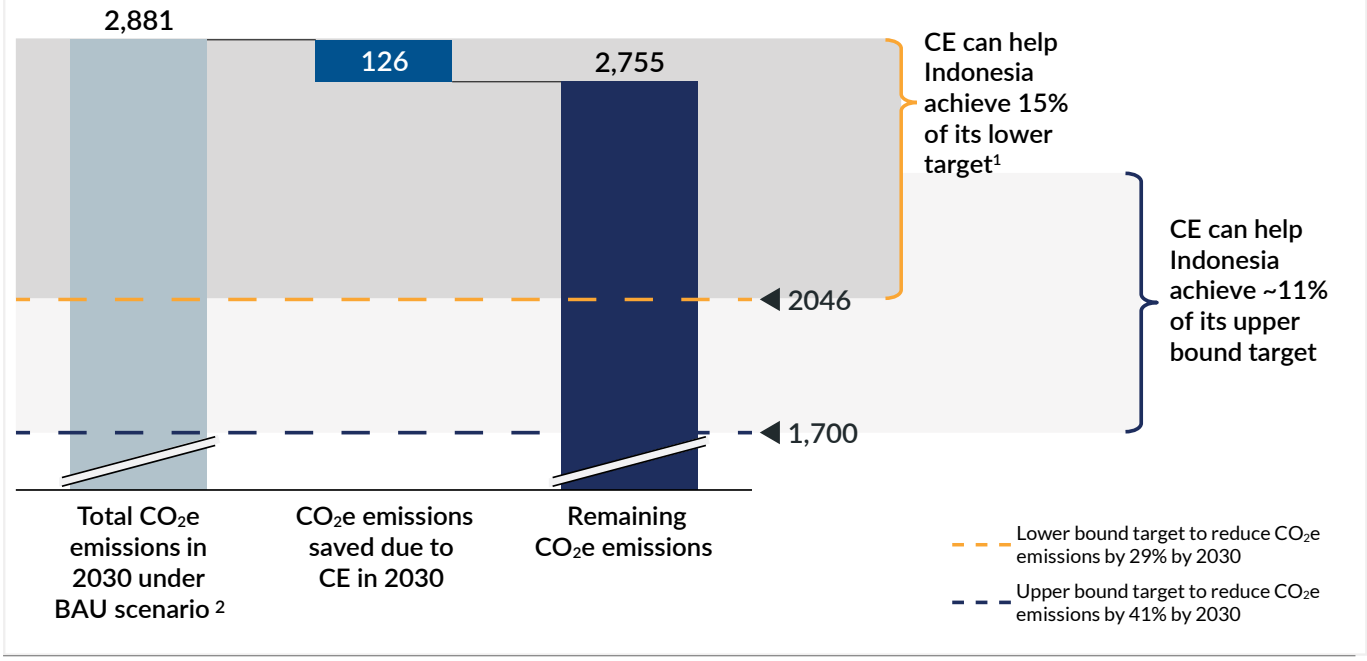
There is also substantial potential to avoid the generation of CO_2e emissions and water use, which could help Indonesia reach its national targets. For example, based on the Government of Indonesia's submissions to the United Nations Framework Convention on Climate Change, Indonesia targets to reduce its CO_2e emissions by 29 percent against a business-as-usual baseline scenario, and up to 41 percent subject to international assistance and financial support by 2030. Based on this analysis, a circular economy could help Indonesia achieve around 15 percent of its lower bound target of reducing CO_2e emissions and around 11 percent of its upper bound target of reducing CO_2e emissions by 2030 relative to the BAU scenario (Exhibit E9). The reduction in CO_2e emissions is driven by several factors, including lower waste generation (e.g., decrease in consumer food waste due to improved consumer awareness, which could decrease food production), use of more energy-efficient alternatives (e.g., greater use of wood and timber-based constructions over concrete), and increasing the lifespan of resources (e.g., greater reuse of garments and increased recycling of electronic parts). The emissions released during the production of various products related to the five focus sectors (e.g., food, textiles, plastic) were estimated to calculate the emissions that could be avoided if Indonesia were to adopt circular opportunities.

Apart from avoiding carbon emissions, a circular economy could also offer several other environmental benefits. For example, the increased reuse of textile products could reduce the production of virgin textiles and the associated negative impact of wastewater discharge from the factories. Increased food waste recycling through composting could help avoid land degradation and thereby reduce the need to clear land in pursuit of new fertile agricultural land to counter the loss of soil fertility elsewhere.[27]

Exhibit E9

A circular economy could make a significant contribution in helping Indonesia achieve its CO_2e emissions reduction targets in 2030

CO_2e emissions, millions of tonnes



1. The lower bound target requires a reduction of nearly 835 million tonnes in CO_2e emissions and the upper bound target requires a reduction of nearly 1,181 million tonnes
2. Based on Indonesia's estimate given in its UNFCCC submission that its BAU CO_2 emissions in 2030 will be 2,881 million tonnes

SOURCE: United Nations Framework Convention on Climate Change; WRI; World Economic Forum; Ellen MacArthur Foundation; International Energy Agency (see annex for more details)

27 FAO (2015), "Composting: let's give the soil something back." Available at: http://www.fao.org/soils-2015/news/news-detail/en/c/280674/

4.4 MILLION CUMULATIVE NET JOBS COULD BE CREATED BY A CIRCULAR APPROACH, WITH SIGNIFICANT SAVINGS IN HOUSEHOLD EXPENDITURE

Social benefits in terms of job creation may also be reaped (Exhibit E10). Circular economy opportunities in the five sectors could generate a cumulative total of 4.4 million net jobs between 2021 and 2030 in Indonesia. The additional jobs created from a circular economy could contribute to Indonesia's target of generating three million jobs every year, as set out in the omnibus bill.[28]

It is important to note there will be winners and losers in this jobs transition. For instance, some upstream jobs (e.g., in the manufacturing sector) are likely to be displaced, but these could be offset by the new jobs created in the downstream sectors (e.g., services sector). According to the system dynamics analysis, the direct jobs impact in the five focus sectors could vary between -13.9 to 2.5 million jobs based on different scenarios (The details about the scenarios can be found in the Annex). What is clear is that policies must be in place to support the transition of jobs by retraining displaced workers to fill new roles created by the circular transition. This policy response required will be assessed in detail in the next phase of this project.

Apart from its impact on jobs, a circular economy that limits carbon emissions and reduces environmental pollution is an investment in human capital, health, and productivity. The Pollution and Health Metrics report by the Global Alliance on Health and Pollution revealed that there were 232,974 recorded pollution-related deaths in Indonesia.[29] By lowering the demand for virgin materials, a circular economy could potentially reduce such pollution-related deaths.

Moreover, a circular economy could also contribute to reducing gender disparity in Indonesia. According to the Organisation for Economic Co-operation and Development (OECD), poor labour conditions facing the female workforce and greater involuntary exposure to harmful products and chemicals among women are examples of reasons why women are environmentally disadvantaged in a linear economy.[30] Even plastic pollution has a disproportionate impact on women. Women are more likely to be exposed to the negative effects of plastic pollution than men, such as through direct exposure to emissions from waste burning or dumping since they are more likely to be responsible for domestic tasks that expose them to waste pollution. Moreover, female workers in the informal sector waste system are often exposed to health and safety risks and face workplace violence and discrimination.[31]

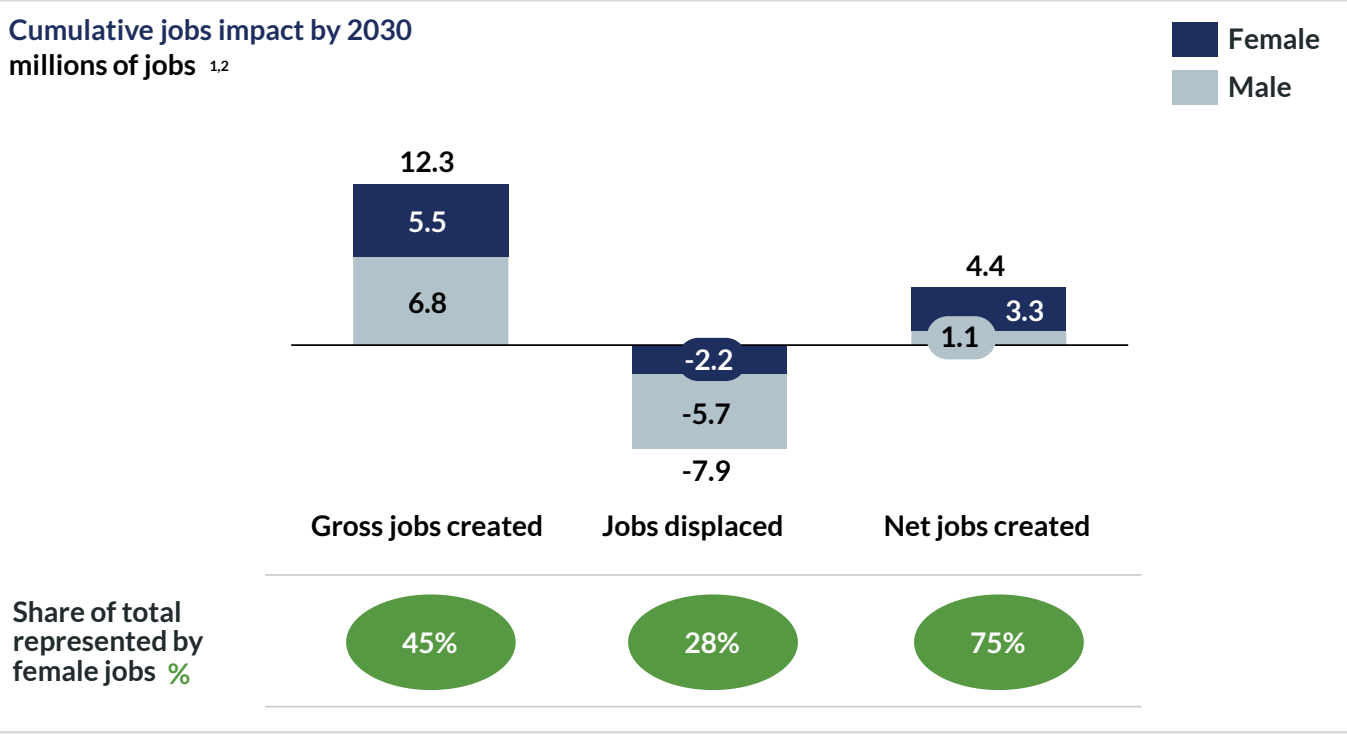
A circular economy could also create significant economic opportunities for Indonesia's women. According to the International Labour Organization (ILO), the rise of "green jobs" could offer an opportunity to empower women.[32] This could be especially relevant for the textiles sector in Indonesia, where women account for 58 percent of the jobs.[33] This underlines the importance of a circular economy for creating benefits to gender equality in Indonesia and the necessity of a proactive women-centric approach to policy development.

Based on this analysis, 75 percent of the total net jobs created by a circular economy in Indonesia in 2030 could potentially be for women. This is driven by the potential job displacement in male-dominant sectors (e.g., construction, where women make up only two percent of the total jobs) from a circular economy and the likely job creation in female-dominant sectors (e.g., education, human health and social work, where households could reinvest their savings according to the analysis).

28 The Jakarta Post (2020), "Indonesia hopes to attract $87b investment, create 3m jobs through omnibus bill: Airlangga." Available at: https://www.thejakartapost.com/news/2020/02/24/omnibus-bill-to-attract-87b-investment-open-3m-jobs-airlangga.html
29 Global Alliance on Health and Pollution (2019), *Pollution and health metrics: Global, Regional, and Country Analysis*. Available at: https://gahp.net/wp-content/uploads/2019/12/PollutionandHealthMetrics-final-12_18_2019.pdf
30 OCED (2020), *Gender-specific consumption patterns, behavioural insights, and circular economy*. Available at: http://www.oecd.org/env/GFE-Gender-Issues-Note-Session-5.pdf
31 WIEGO (2018), *Violence and Informal Work*. Available at: https://www.wiego.org/sites/default/files/publications/files/ILC_WIEGO_Briefing%20Note%20Violence%20in%20the%20workplace%20EN%20for%20web.pdf
32 ILO (2015), *Gender equality and green jobs*. Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_360572.pdf
33 ILO (2017), *Indonesia garment and footwear bulletin*. Available at: https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-jakarta/documents/publication/wcms_625195.pdf

Exhibit E10

The circular economy could create 4.4 million net jobs by 2030, of which three-quarters could be for women



1. The total jobs in 2030 were calculated by growing the total jobs in Indonesia in 2019 with Indonesia's BAU labour force growth rate of 1.3% till 2030. The total jobs in 2030 are inclusive of the net jobs created by the circular economy in 2030
2. To estimate the jobs created for women in 2030, it was assumed that the gender share of jobs in each sector in 2018 would remain unchanged till 2030. The data from the Labour Force Situation report published by BPS in February 2018 on the gender share of jobs in each of the 17 sectors of Indonesia's economy was used

SOURCE: Bank Indonesia; BPS; World Bank; UN Population Division (see annex for more details)

There could also be significant monetary savings for households, either through direct savings from a reduction in consumer demand (due to less wastage), or in the form of a pass-through of savings from producers.[34] An average Indonesian household could save around IDR4.9 million (USD344) annually or nine percent of its annual household expenditure due to the savings derived from the circular transition (Exhibit E11). These savings are particularly impactful for lower-income households. For example, the savings from a circular economy could represent 9.8 percent of the annual household expenditure of a household in the lowest expenditure class (those that spend less than IDR7.2 million annually).

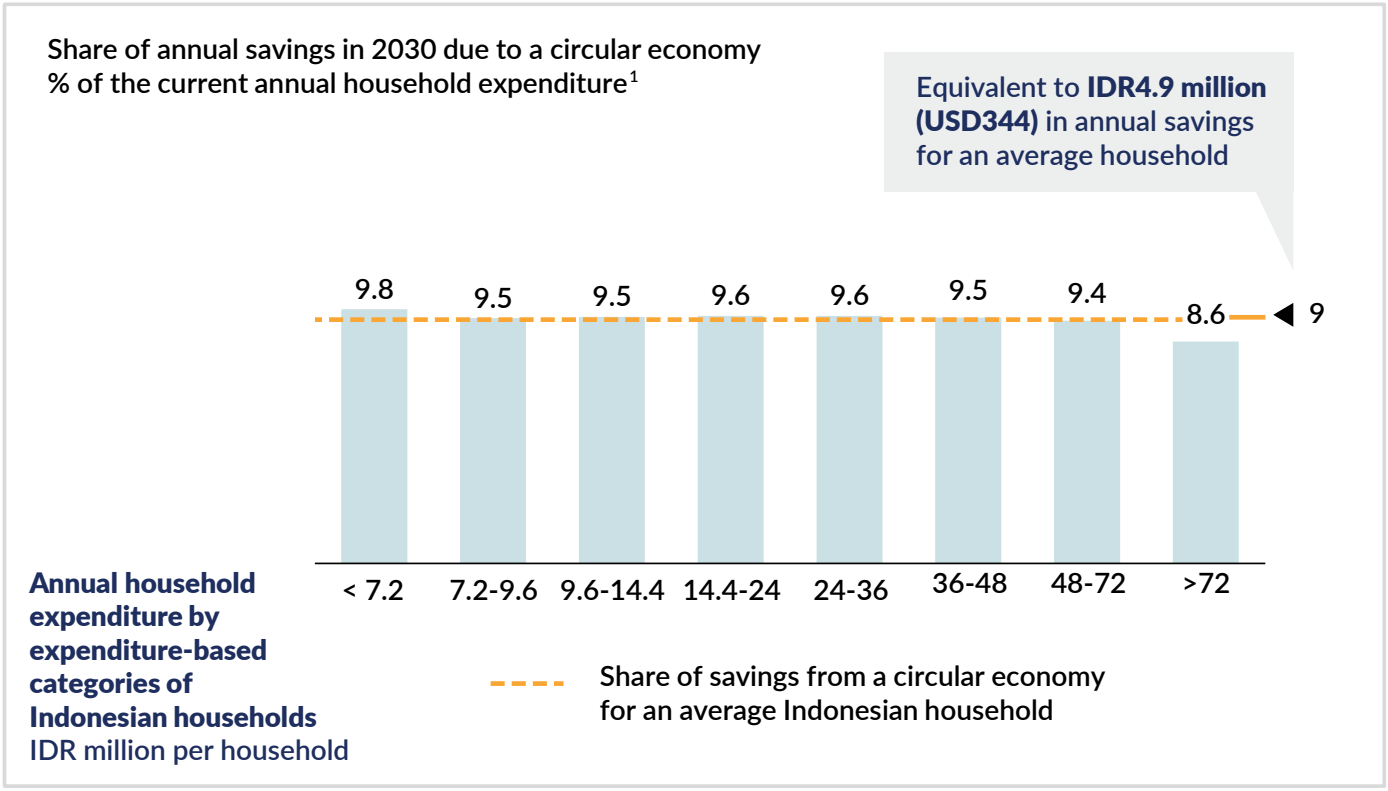
It is important to note that these household savings are likely to be reinvested since a circular economy could lead to a shift in consumer demand. The demand is likely to move away from production-oriented activities to service-oriented economic activities. For example, an increase in the lifespan of electronics could decrease the demand for new consumer electronics and increase the demand for refurbishing and reusing electronics. Thus, the initial household savings created due to a circular economy could either be reinvested in the same sector or in other sectors (e.g., education, health, and recreation).

It is also important to stress that the annual household savings could be lower than IDR4.9 million (USD344) subject to the specific implementation arrangements. For example, the introduction of Extended Producer Responsibility (EPR) could increase costs for businesses, some of which could be passed down to consumers. Calculating the impact of such implementation costs on household savings is challenging since the impact would depend on the sector-specific policy responses, which would be assessed in the next phase of work.

34 The exact pass-through depends on the relative price elasticities of products.

Exhibit E11

A circular economy could generate annual savings worth 9% of the total expenditure for an average household in Indonesia in 2030



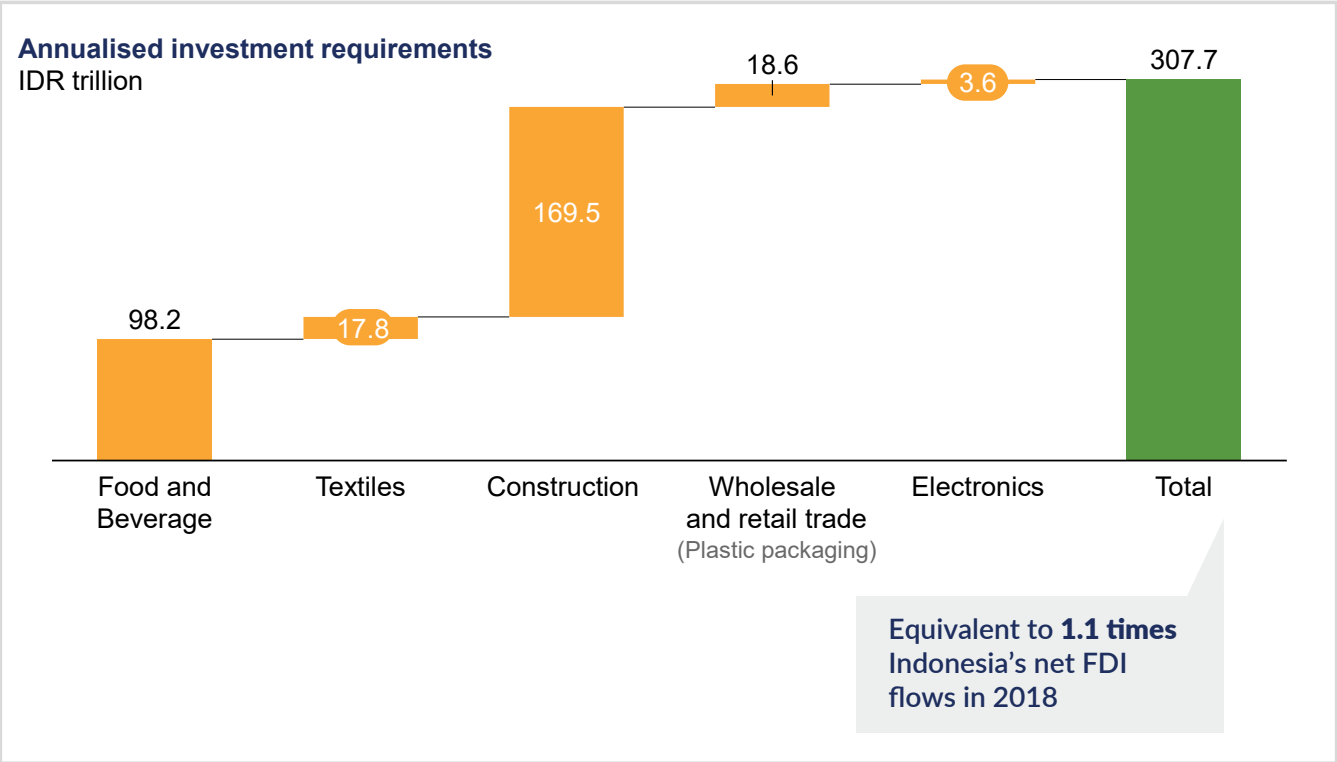
1. BPS data for an average household from 2018 was used for this purpose. The data for different expenditure-based categories of households was only available for 2016. This data was used to project household spending by item in 2018 for the different household categories. The items listed by BPS in its data were matched to the 5 focus sectors: food and beverage ("total food"); textiles ("clothing, footwear, and headgear"); construction ("housing and household facilities"); plastic packaging ("goods and services"); and electronics ("durable goods")

REALISING THE POTENTIAL OF A CIRCULAR ECONOMY

Significant investment is needed to address the infrastructure gaps and create business models that can unlock the circular economy opportunities outlined in this study. Indonesia could need IDR308 trillion (USD21.6 billion) of annual investment across the five focus sectors between now and 2030 (Exhibit E12), more than 50 percent of which would be required in the construction sector. Indonesia would need to deploy these capital investments in a variety of channels. For example, in construction, to facilitate the development of more energy-efficient buildings, the investment would be required on on-site energy generation, distribution systems, controls technologies, space heating, lighting, amongst others.[35]

Exhibit E12

Annual capital investment required to capture circular opportunities could be IDR308 trillion (USD21.6 billion) or 1.1 times Indonesia's net FDI flows in 2018



SOURCE: World Bank; Ellen MacArthur Foundation; Business & Sustainable Development Commission; WRI; FAO; World Economic Forum (see annex for more details)

Existing government policies could also play a crucial role in creating a favourable environment for a circular economy in Indonesia. For example, Ministry of Environment and Forestry issued the Ministerial Regulation No. 75/2019 (MR 75/2019), which sets strict targets for businesses to achieve by 2029 – it obliges businesses to reduce plastic, aluminium, glass, and paper waste by 30 percent between 2020 and 2029. The Presidential Regulation No. 97 of 2017 (also known as JAKSTRANAS), aims to reduce waste by 30 percent and manage the remaining 70 percent of the waste by 2025. Moreover, the Presidential Decree No.83/2018, aims to reduce marine plastic debris by 70 percent by 2025 and has paved the way for Indonesia's National Plastic Action Partnership (NPAP).

Despite the existing policy landscape, several barriers are preventing firms from capturing circular economy opportunities. A survey of 57 Indonesian firms revealed that key barriers included the need to overcome existing habits and customs, the unintended consequences of existing regulations, and lack of infrastructure (Exhibit E13). Another

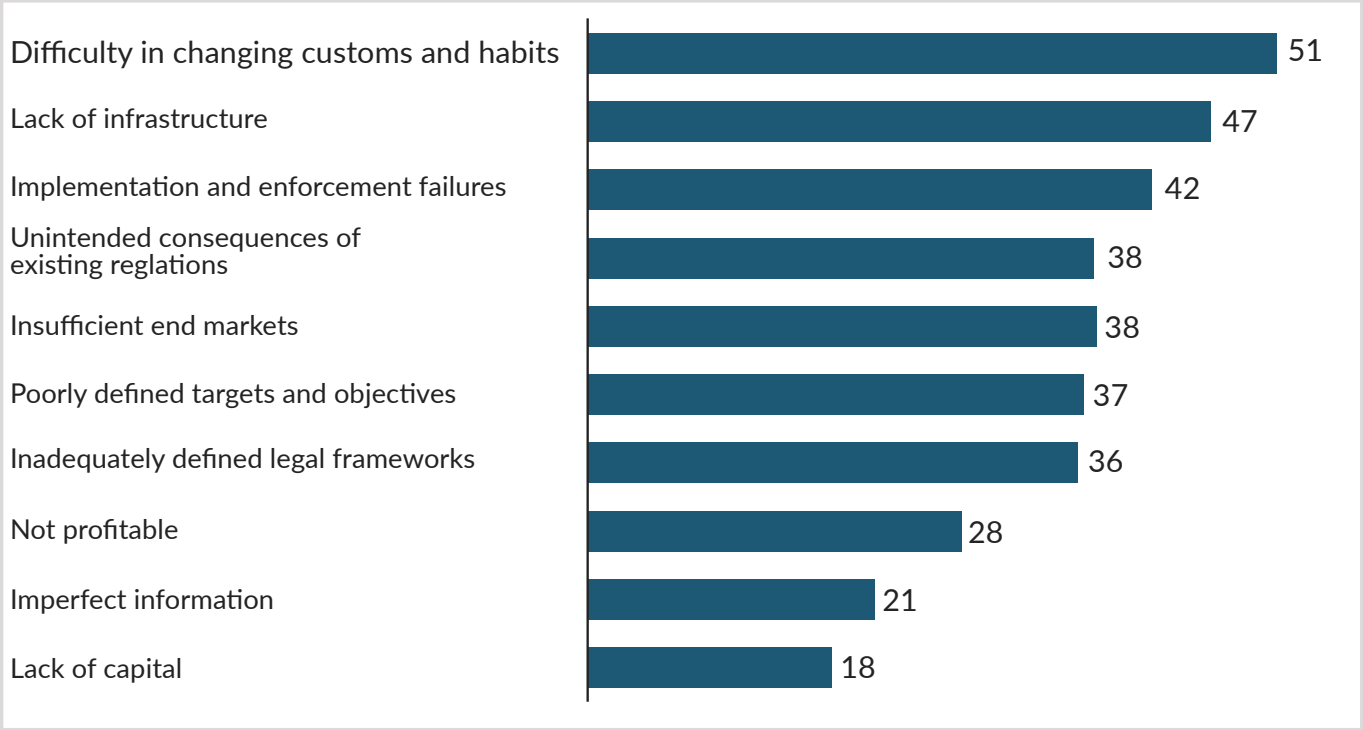
35 Build up (2019), "Overview. Financing energy efficiency in buildings". Available at: https://www.buildup.eu/en/news/overview-financing-energy-efficiency-buildings

survey of 53 respondents conducted by the Indonesia Circular Economy Forum (ICEF) highlighted that commitment and collaboration among critical stakeholders, along with government regulations, are key challenges in implementing a circular economy in Indonesia.[36] Micro, Small, and Medium Enterprises (MSMEs) will be particularly important to engage in circular economy efforts. They represented around 90 percent of employment and close to 60 percent of Indonesia's GDP in 2019. MSMEs often face barriers to implementing changes due to skill gaps, lack of information, and capital requirements, but international research also shows that MSMEs can be some of the potential biggest beneficiaries from a circular economy if these challenges are overcome.[37] As such, ensuring MSMEs are at the heart of the circular economy roadmap development will be crucial. Based on consultations with sector-specific experts and discussions with private sector representatives, an initial list of policy solutions to overcome the barriers are outlined in this report. The next phase of this work will develop a detailed multi-stakeholder roadmap for addressing the barriers and capturing the opportunities identified in this report.

Exhibit E13

A sample of firms in Indonesia highlighted top 10 barriers to adopting circularity actions

Share of firms highlighting barrier as very relevant
(tick all that apply) % of firms



SOURCE: Online survey of firms in Indonesia carried out in February and June 2020 (sample size = 57)

36 ICEF (2019), "The 3rd Indonesia Circular Economy Forum 2019."
37 Oliver Wyman (2017), *Supporting the circular economy transition.* Available at: https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2017/sep/CircularEconomy_print.pdf

1. Rethinking value creation: The circular perspective

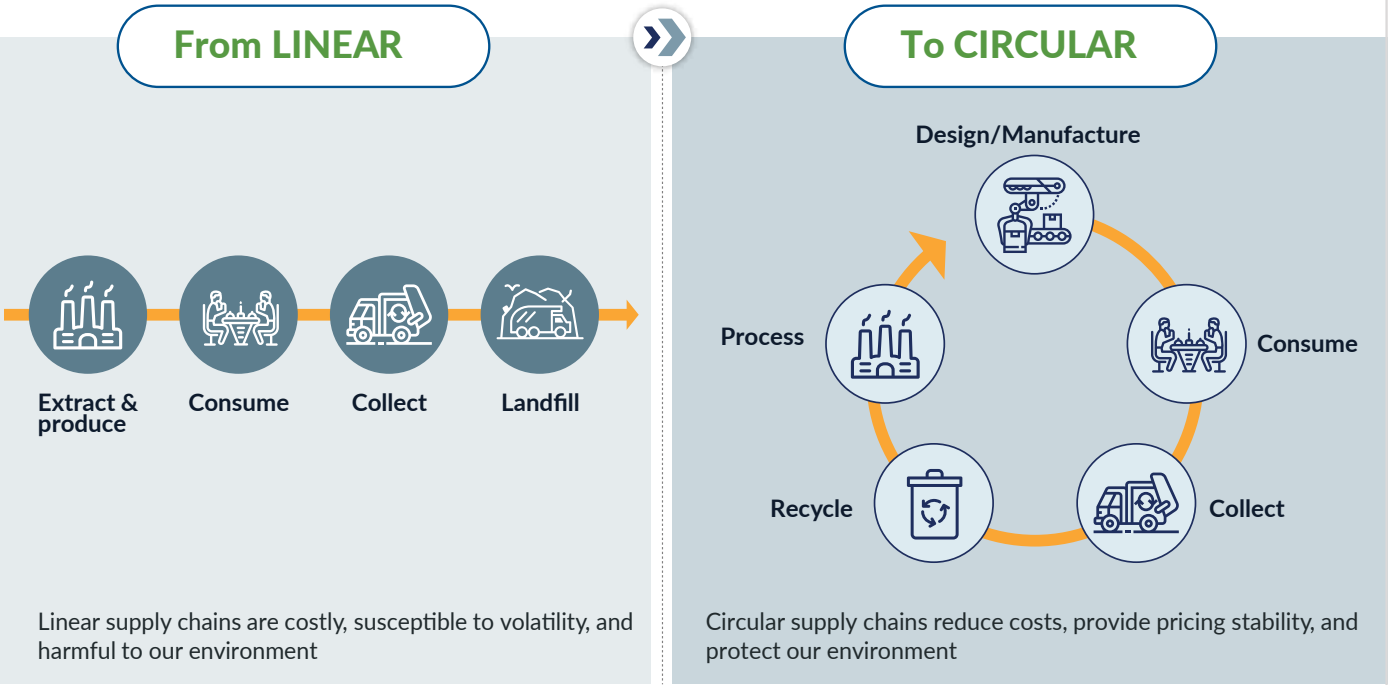
This chapter introduces the circular economy concept, why it is important for Indonesia and for the objectives of the National Circular Economy Roadmap for Indonesia. A circular economy is a fundamental shift from Indonesia's current linear production approach and could create significant potential benefits for the country. To expedite the implementation of the circular economy, the Ministry of National Development Planning (Bappenas) in cooperation with United Nations Development Programme (UNDP) and supported by the Kingdom of Denmark have launched a partnership to develop a circular economy roadmap for Indonesia.

A CIRCULAR ECONOMY IS A FUNDAMENTAL SHIFT FROM THE CURRENT LINEAR APPROACH

A circular economy aims to generate sustainable economic growth by maintaining the value of products, materials, and resources for as long as possible. By rethinking how to manage resources, how to make and use products, and what to do with the materials afterwards, societies can look beyond the current linear "take, make, and dispose" extractive industrial model towards a "make, use, and return" model (Exhibit 1).

Exhibit 1

A circular economy is one that maintains the value of products, materials, and resources in the economy as long as possible



A circular economy is an economic system of closed loops in which a) raw materials, components, and products retain their value as much as possible, b) renewable energy sources are used, and c) systems thinking is at the core

SOURCE: Ellen MacArthur Foundation

According to the Ellen MacArthur Foundation, a circular economy is based on three key principles: i) Designing out waste and pollution; ii) Keeping products and materials in use; and iii) Regenerating natural systems.[38] These principles help preserve and enhance natural capital; optimise resource yields by circulating products, components, and materials within the system; and minimise negative externalities.

A CIRCULAR ECONOMY GOES FAR BEYOND MORE RECYCLING OR BETTER WASTE MANAGEMENT

A circular economy is not just a better form of waste management with more recycling. A circular economy embraces a broad set of interventions across all relevant economic sectors, and activities focused on 5Rs: Reducing, Reusing, Recycling, Refurbishing, and Renewing (Exhibit 2). This 5R framework is helpful in systematically identifying relevant circular opportunities. While the 5R framework encourages reusing, recycling, and refurbishing resources, the focus of stakeholders involved in a circular economy should be on reducing waste generation at source or "designing out waste." For example, when technical components of a product, such as a mobile phone, are designed for disassembly and refurbishment, it increases the value gained from resources and decreases waste generation at source. Minimising over-specification can similarly reduce waste generation. By eliminating pigments and replacing labels by embossed text, plastic packaging can be made more recyclable.[39] "Designing out waste" in a circular economy differentiates it from safe disposal of resources and recycling, where large amounts of embedded energy and labour are lost.[40]

A circular economy not only ensures that it retains as much value from resources as possible, but it could also help prioritise human capital over the exploitation of primary resources as a driver for economic growth.[41] A circular economy relies on collaboration across different steps of the value chain to adopt circular economy opportunities, thereby encouraging a people-centric approach over a resource-centric approach.

Exhibit 2

A circular approach comprises the 5Rs

REDUCE	▪ Remove waste in production and supply chain (e.g., 3D printing) ▪ Virtualise products and services (e.g., electronic books) ▪ Reduce energy usage (e.g., improving energy efficiency) ▪ Redesign products to require less resource inputs (e.g., high strength steel in construction)
REUSE	▪ Share assets (e.g., cars, rooms, appliances) ▪ Use of secondhand products ▪ Improve asset utility by offering products as a service
RECYCLE	▪ Recycle materials ▪ Anaerobic digestion and extracting biochemicals from organic waste
REFURBISH	▪ Remanufacture products or components ▪ Prolong life through maintenance of products
RENEW	▪ Prioritise renewable energy and materials (e.g., substituting plastic packaging with paper based packaging)

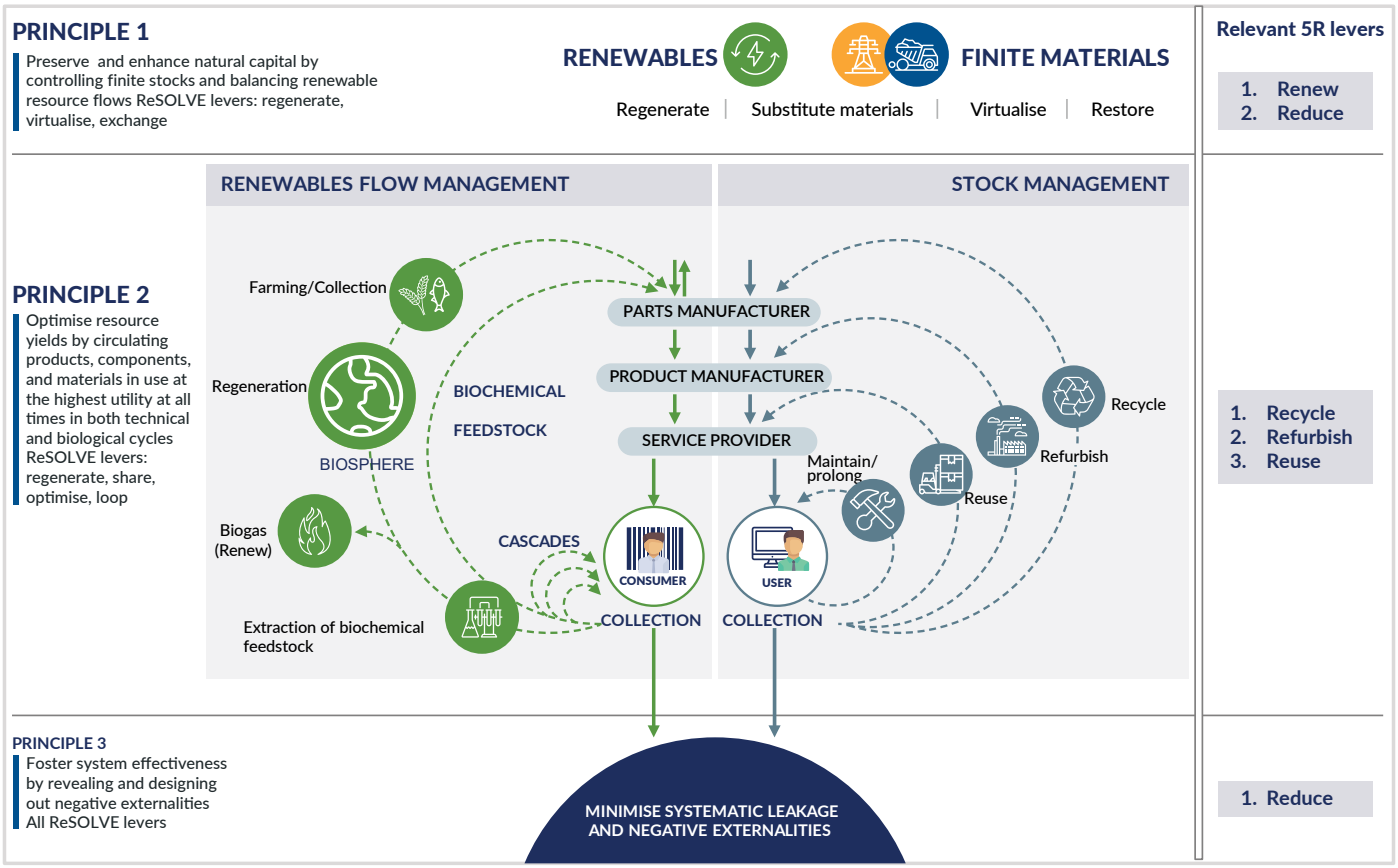
SOURCE: Ellen MacArthur Foundation; expert interviews

38 Ellen MacArthur Foundation, "Circular economy concept." Available at: https://www.ellenmacarthurfoundation.org/circular-economy/concept
39 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership.* Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
40 World Economic Forum (2014), *Towards the Circular Economy: Accelerating the scale-up across global supply chains.* Available at: http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf
41 Circle Economy, "The seven elements of the circular economy." Available at: https://www.circle-economy.com/circular-economy/7-key-elements

The 5R framework used in this study was adapted from the Ellen MacArthur Foundation's three circular economy principles and its ReSOLVE framework (Exhibit 3). The first principle corresponds to the "Reduce" and "Renew" levers by promoting virtualisation and use of renewable resources. The second principle corresponds to the "Recycle", "Refurbish", and "Reuse" levers by optimising resource use by increasing resource lifespan. The third principle corresponds to the "Reduce" lever, which minimises negative externalities (e.g., pollution). The framework was tested during stakeholder engagements and was found to be comprehensive and easy to understand.

Exhibit 3

The 5R framework was adapted from Ellen MacArthur Foundation's 3 circular economy principles



SOURCE: Ellen MacArthur Foundation

Below are some examples of how organisations in Indonesia are going circular using the 5Rs:

- **Reduce.** A growing number of companies in Indonesia are attempting the reduce the waste generation in their sectors. For example, Limakilo, Sayurbox, and Tanihub have established online marketplaces that allow consumers to purchase fresh produce directly from farmers and potentially reduce food loss and waste generated in the supply chain in Indonesia. In the construction sector, the use of emerging technologies such as 3D printing, modular construction, and Building Information Systems (BIM) have significant potential to reduce the generation of construction and demolition waste. Global case studies have shown that 3D printing, modular construction, and BIM can reduce construction waste by 30 percent,[42] 50 percent,[43] and 45 percent,[44] respectively. Construction companies in Indonesia have demonstrated the application of these technologies. For example, PT. Bondor

42Ghaffar, et al (2018), *Additive manufacturing technology and its implementation in construction as an eco-innovative solution*. Available at: https://www.sciencedirect.com/science/article/pii/S0926580517309731
43WRAP, *Waste Reduction Potential of Offsite Volumetric*. Available at: https://www.wrap.org.uk/sites/files/wrap/VOLUMETRIC%20-%20Full%20case%20study.pdf
44McKinsey & Company (2019), *Modular construction: From projects to products*. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/modular-construction-from-projects-to-products

Indonesia has developed modular buildings in Merauke and Timika (Papua) and Muara Tuhup (Kalimantan).[45] The Green Building Council Indonesia (GBCI) has also demonstrated how the GREENSHIP certified buildings have managed to reduce their energy consumption in Indonesia through appropriate site development and improved building management, among other measures.[46,47]

- **Reuse.** The potential benefits of reuse are substantial. Rentique, Style Theory, and Tinkerlust are examples of businesses that provide garment rental services to consumers in Indonesia, utilising the reuse potential of garments. In the electronics sector, platforms that rent products also encourage the reuse of products. For example, Asani is an Indonesian B2B electronic rental (PC, printers, monitors) platform.[48] BelanjaBekas.com is an online marketplace that allows users to buy and sell second-hand goods. CupKita, a start-up based in Jakarta, provides a reusable container service in an attempt to reduce the use of single-use plastic cups.[49]

- **Recycle.** A range of recycling opportunities exist across sectors, covering both biological nutrients and extracted or manufactured materials. For example, anaerobic digesters, operationalised in Jambi city in South Sumatra, Malang Regency in East Java, and Bandung city, process food waste and help extract biogas, used as a fuel, and bio-slurry, used as a fertiliser.[50,51] Pilot efforts in Indonesia have also shown the potential to upcycle textile waste like batik remnants to manufacture women's wear products.[52]

- **Refurbish.** Many companies globally are shifting from offering products to offering services and retaining control of key resources. For instance, PT Sigin Interactive Indonesia provides repair and refurbishing services for used electronics and home appliances, dead-on-arrival (DOA) products, and printed circuit boards.

- **Renew.** This involves shifting to more renewable energy and materials. For example, Cinta Bumi, a fashion brand based in Bali, uses barkcloth, a sustainable material created from paper mulberry and Ficus tree barks from Central Sulawesi, to manufacture its garments. Nusantara Fabrics and H&M (in collaboration with Kahatex) use recycled PET from plastic bottles to produce garments. In the construction sector, Indonesians are also substituting bricks and concrete with more sustainable materials. For example, villagers in Lombok reconstructed their houses from bamboo and wood following the August 2018 earthquake since such regenerative building materials can improve earthquake-resilience of buildings.[53] In the plastic packaging sector, the Indonesian start-up Evoware makes cups from farmed seaweed and also designs food wrappings and sachets made out of edible seaweed-based material, thus replacing plastic packaging with a more sustainable alternative. Some companies in Indonesia, like Danone, have demonstrated their commitment to using recycled waste as a sustainable alternative. For example, Danone's bottled water brand, Aqua, uses bottles made of 100 percent recycled plastic.[54]

45 Bondor, "Modular & Transportable Building." Available at:
https://bondor.co.id/applications/modular-transportable-building.html
46 Njo Anastasia (2013), *The Way to Encourage Green Building in Indonesia*. Available at:
https://www.researchgate.net/publication/301557863_The_Way_to_Encourage_Green_Building_in_Indonesia
47 Green Building Council Indonesia, "Conference on sustainable buildings Southeast Asia: New opportunities and challenges." Available at:
http://www.mgbc.org.my/Resources/Day%202/GBC%20Indonesia%20Presentations/Country%20Paper%20-%20GBC%20Indonesia%20Presentation.pdf
48 Information available from:
https://www.asani.co.id/
49 Eco-business (2020), "Indonesia's first reuseable cup rental service launches in Jakarta." Available at:
https://www.eco-business.com/news/indonesias-first-reuseable-cup-rental-service-launches-in-jakarta/
50 Mohammad Helmy (2015), *Promoting anaerobic digestion of municipal solid waste in Indonesia*. Available at:
https://www.unescap.org/sites/default/files/Indonesia%20Solid%20Waste%20Association%2C%20Indonesia.pdf
51 Encep Amit et al (2016), *Socio-Economic Considerations of Converting Food Waste into Biogas on a Household Level in Indonesia: The Case of the City of Bandung*
52 Novita (2012), *Utilization of textile waste (batik remnants) for womenswear in Yogyakarta, Indonesia*. Available at:
https://pdfs.semanticscholar.org/cd75/6a680a7c51762fef18babe333d3ffd947811.pdf?_ga=2.184216290.594119853.1593663908-1003791673.1585896863
53VOA News (2018), "Indonesians Discover Bamboo and Wood Beat Concrete and Steel". Available at:
https://www.voanews.com/east-asia-pacific/indonesians-discover-bamboo-and-wood-beat-concrete-and-steel
54 Aqua. Available at:
https://aqua.co.id/en/brand/aqua-100-recycled-1

EIGHT TRENDS MAKE A CIRCULAR ECONOMY MORE IMPORTANT THAN EVER FOR INDONESIA

Eight trends make the circular economy concept particularly relevant today (Exhibit 4).

Exhibit 4

Eight important trends are contributing to the increasing importance of a circular economy for Indonesia

SOURCE: ADB; Circulate Capital; Ellen MacArthur Foundation; McKinsey Global Institute; World Bank; World Economic Forum

1. **Degradation of natural resources.** A fundamental challenge to the global economy is the set of negative environmental consequences related to the linear economic model. According to the latest report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the most comprehensive global biodiversity assessment to date, nature is declining globally at rates unprecedented in human history and its decline is accelerating, with grave impacts on the foundations of our societies and economies.[55] The World Economic Forum's 2020 Global Risks Report ranks biodiversity loss and ecosystem collapse as one of the top five threats humanity will face in the next ten years.[56] Recent research shows that USD44 trillion of economic value generation – over half the world's total Gross Domestic Product (GDP) – is moderately or highly dependent on nature and its services.[57] Loss of biodiversity could impact business operations, supply chains, and markets. For instance, overfishing is a major concern in many parts of Indonesia.[58] In Asia, the economic cost due to overfishing is estimated to be USD54 billion.[59]

   This is especially relevant for Indonesia since the share of its natural capital in its overall wealth is higher than the global average.[60] 52 percent of its exports between 2010 and 2017 were based on natural resources (e.g., palm oil exports). Activities that depend on natural resources contribute around 20 percent to its GDP (e.g., mining and

55 Intergovernmental Panel of Biodiversity and Ecosystem Services [IPBES] (2019), *Global Assessment Report.* Available at: https://www.ipbes.net/global-assessment-report-biodiversity-ecosystem-services
56 World Economic Forum (2020), *The Global Risks Report 2020.* Available at: https://www.weforum.org/reports/the-global-risks-report-2020
57 World Economic Forum (2020), *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy.* Available at: https://www.weforum.org/reports/nature-risk-rising-why-the-crisis-engulfing-nature-matters-for-business-and-the-economy
58 Kementerian Kelautan Dan Perikanan Republik Indonesia, "FAQ Kebijakan Perikanan Di Indonesia."
59 World Bank (2017), *The Sunken Billions Revisited: Progress and Challenges in Global Marine Fisheries.* Available at: https://openknowledge.worldbank.org/handle/10986/24056
60 Bappenas (2019), *Low carbon development: A paradigm shift towards a green economy in Indonesia. Available at:* https://drive.bappenas.go.id/owncloud/index.php/s/ZgL7fHeVguMi8rG#pdfviewer

quarrying contributed 7.4 percent to Indonesia's GDP in 2019).[61] Moreover, since 2000, reductions in natural capital have decreased the gross national income by 7.2 percent each year.[62] A circular economy approach can help businesses build resilience to impacts associated with the degradation of natural systems. Indonesia is not the only resource-rich developing country that is considering adopting a circular economy. In Nigeria, its government, private sector, and NGOs are forging alliances to adopt circular economy practices.[63,64] A study focused on Brazil has also shown that the circular economy holds significant economic and environmental promise.[65]

2. **Increasing price volatility and supply chain risks.** Commodity prices have been highly volatile in recent years. For example, prices for non-renewable resources, such as oil, gas, and coal, have more than doubled and then halved in recent decades.[66] The past three decades have witnessed as many price shocks across a range of commodities as the preceding seven decades.[67] This price volatility is driven by a combination of factors, including geopolitics, increasing interlinkage of resources, and degradation of natural systems.[68] Higher price volatility can dampen economic growth and investment in supply by increasing uncertainty and hampering long-term decision making.[69] Linked to this price volatility are rising concerns over resource security. The world is not running out of natural resources, but the remaining reserves are increasingly difficult to extract and in more risky locations. For example, over half of the remaining arable land is in places with limited infrastructure or high political risk.[70] The increasingly challenging environment around resource extraction not only increases the risk of disruptions to supply but also makes supply even more inelastic.

   Indonesia has witnessed significant price volatility in agricultural and non-agricultural products. Being a net importer of rice, Indonesia is particularly vulnerable to changes in the price of rice.[71,72] Volatility in other agricultural products has also shown to have an impact on Indonesia's economy, politics, and society. For example, price volatility in chillies was a sensitive political issue in 2015.[73] Price volatility has also been witnessed in Indonesia for beef and milk.[74,75] Such price variation can have an adverse economic impact. For example, since chillies are an essential commodity for many Indonesians, its inelastic demand has contributed to inflation.[76] This inflation can erode the purchasing power of Indonesian households.

   For non-agricultural products, such as crude oil, the Government has also found it difficult to manage domestic prices due to the volatility in international prices.[77] A circular economy approach could create net material savings and minimise exposure to international markets by reducing import requirements. This is particularly relevant for Indonesia, given the large volume of imports of certain commodities and currency volatility – the Rupiah was rated the most volatile Asian currency in 2018.[78] Indonesia imported USD8.5 billion worth of food from 134 countries in 2018.[79] A supply shock caused by trade wars, geopolitical events, or epidemics (as recently seen in the case of COVID-19), could hamper Indonesia's ability to fulfil the demands of its population.

   By reducing waste and optimising the use of resources, a circular economy can help Indonesia reduce its dependence on imports and cushion the country from supply shocks. A circular economy could complement other policy responses that address price volatility in commodities, such as, developing policy monitoring and reaction systems; improving social safety net programs; improving infrastructure; improving legal systems and information networks, establishing standards and certifications; reducing trade restrictions; prudent fiscal management; and the developing price stabilisation mechanisms for the benefit of smallholder farmers.[80]

61 Bank Indonesia (2019). "Economic data." Available at:
https://www.bi.go.id/en/iru/economic-data/real-sector
62 Bappenas (2019), *Low carbon development: A paradigm shift towards a green economy in Indonesia. Available at:*
https://drive.bappenas.go.id/owncloud/index.php/s/ZgL7fHeVguMi8rG#pdfviewer
63 LafargeHolcim (2019), "Geocycle Nigeria lays foundations for a circular economy." Available at:
https://www.lafargeholcim.com/geocycle-nigeria-circular-economy-waste-management
64 International Institute for Sustainable Development (2019), "Nigerian Project Tackles E-Waste, Promotes Circular Economy." Available at:
https://sdg.iisd.org/news/nigerian-project-tackles-e-waste-promotes-circular-economy/
65 Ellen MacArthur Foundation (2017), *A circular economy in Brazil: An initial exploration.* Available at:
https://www.ellenmacarthurfoundation.org/assets/downloads/A-Circular-Economy-in-Brazil-An-initial-exploration.pdf
66 James Hansen and Isaac Gross (2017), *Commodity Price Volatility With Endogenous Natural Resources.* Available at:
https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=EEAESEM2017&paper_id=2161
67 Oil Brown, et al (2008), *Boom or bust: How commodity price volatility impedes poverty reduction, and what to do about it.* Available at:
https://www.iisd.org/sites/default/files/publications/boom_or_bust_commodity.pdf
68 Chatham House (2012), *Resources Futures.* Available at:
https://www.chathamhouse.org/sites/default/files/public/Research/Energy%2C%20Environment%20and%20Development/1212r_resourcesfutures.pdf
69 Ian Keay (2010), *The Impact of Commodity Price Volatility on Resource Intensive Economies.* Available at:
https://www.econ.queensu.ca/sites/econ.queensu.ca/files/qed_wp_1274.pdf
70 Richard Dobbs et al (2015), *No ordinary disruption: The four global forces breaking all the trends.* Available at:
https://onlinelibrary.wiley.com/doi/abs/10.1111/1475-4932.12272
71 Makbul et al (2020), *Impact of rice prices on farm revenue: Evidence from Indonesia*. Available at:
https://www.researchgate.net/publication/341321833_Impacts_of_Rice_Prices_on_Farm_Revenue_Evidence_from_Indonesia
72Widarjono (2018), *Analysis of rice imports in Indonesia: AIDS approach*. Available at:
https://www.researchgate.net/publication/329987309_Analysis_of_Rice_Imports_in_Indonesia_AIDS_approach
73 Reuters (2015), "Indonesia's infrastructure promises fail the chilli challenge." Available at:
https://www.reuters.com/article/indonesia-chilli/indonesias-infrastructure-promises-fail-the-chilli-challenge-idUSL3N10N1YO20150819
74 Intani Dewi et al (2017), *Price Volatility Analysis in Indonesian Beef Market.* Available at:
https://knepublishing.com/index.php/KnE-Life/article/view/1060/2798
75 Hardjanto (2014), *Volatilitas Harga Pangan dan Pengaruhnya terhadap Indikator Makroekonomi Indonesia*. Available at:
https://repository.ipb.ac.id/bitstream/handle/123456789/70328/2014aha1.pdf?sequence=1&isAllowed=y
76 Mirza Sativa (2017), *Impact of Red Chilli Reference Price Policy in Indonesia*. Available at:
https://pdfs.semanticscholar.org/a037/738c72fbcd04f81bce864491e0e3cdb7689b.pdf
77 Bloomberg (2018), "Indonesia's Jokowi Flip-Flops on Fuel Price Hike." Available at:
https://www.bloomberg.com/news/articles/2018-10-10/indonesia-flip-flops-on-fuel-price-hike-as-crude-rupiah-bite
78 Bloomberg (2018), "Rupiah regains most volatile crown." Available at:
https://www.bloomberg.com/news/articles/2018-08-21/rupiah-regains-most-volatile-crown-as-traders-zero-in-on-deficit#:~:text=Indonesia's%20rupiah%20has%20regained%20the,global%20selloff%20in%20emerging%20markets.
79 World Integrated Trade Solution, *Indonesia Food Products Imports By Country 2018*. Available at:
https://wits.worldbank.org/CountryProfile/en/Country/IDN/Year/LTST/TradeFlow/Import/Partner/by-country/Product/16-24_FoodProd
80 Word Bank (2010), *Boom, Bust and Up Again? Evolution, Drivers and Impact of Commodity Prices: Implications for Indonesia*. Available at:
http://documents1.worldbank.org/curated/en/215601468052135014/pdf/588310v20Revis1C10commodity1english.pdf

It should be stressed that this does not mean reducing Indonesia's links to the global economy. In fact, a circular economy depends on the exchange of technologies, foreign direct investment, and links to international value chains (e.g., offtake markets for recycled plastics) which all necessitate strong trade and investment integration with the global economy.

3. **Advancement in new technologies.** Industry 4.0 refers to technologies that combine the physical, digital, and biological worlds.[81] These technologies include cyber-physical systems, the Internet of Things (IoT), Artificial Intelligence (AI), cloud computing, and cognitive computing. These technologies enable the circular economy transition across a variety of sectors. For example, mobile internet enables the growth of asset sharing platforms such as ridesharing; IoT technology facilitates the tracking of products, allowing for predictive maintenance; 3D printing reduces the waste associated with manufacturing processes; [82] the fall in renewable energy prices due to technological development incentivises companies to replace their fossil fuel-based energy sources with more renewable energy sources.[83]

   In Indonesia, the Government is playing a key role in increasing the adoption of these technologies through the development of a roadmap for Industry 4.0.[84] As part of National Medium-Term Development Plan (RPJMN) 2020-2024, Indonesia has prioritised five sub-sectors, including food & beverage, textile & clothing, and electronics for Industry 4.0.[85] The country is also considering developing a national artificial intelligence (AI) strategy.[86] Moreover, the private sector is increasingly deploying these technologies. The market value of the Internet of Things (IoT) in Indonesia is expected to reach IDR444 trillion (USD30 billion) by 2022.[87] Start-ups, such as Kata.ai and RuangGuru, have built business models reliant on AI-based technologies like natural language processing and machine learning.[88] Moreover, many Indonesian companies are switching to cloud computing services to reduce their operating costs.[89]

   The adoption of a circular economy facilitated by Industry 4.0 technologies is also a complementary factor to support Indonesia's shift towards greater sophistication and value addition in its industrial processes. For example, big data and predictive analytics, which can help reduce food waste in the supply chain, are also crucial to finetuning production volumes and processes, enhancing supply chain management, and providing greater insights on customer segments.

4. **Increasing consumer acceptance.** Consumers are increasingly concerned about the environmental impact of goods and services they consume and are looking for more environmentally friendly alternatives. For example, a recent survey done by WWF Indonesia and Nielsen showed that 63 percent of Indonesians claim that they are willing to pay a premium for green products.[90] Indonesian consumers are already leaders in some areas of the sharing economy, such as ridesharing. The ridesharing market in Indonesia, led by Go-Jek and Grab, has over 26 million users and that number is growing at more than 21 percent annually.[91] The emergence of businesses such as Rentique, Dresshaus, Rent A Couture, and Style Theory that allow consumers to rent garments also demonstrates a shift in consumer attitudes toward circular products.[92]

5. **Shifts in the labour market.** The emergence of Industry 4.0 could have a profound impact on Indonesia's labour market. For example, forthcoming research by the Asian Development Bank (ADB) shows that the importance of routine physical tasks will decline with the application of Industry 4.0 technologies.[93] In the F&B manufacturing industry, by 2030, workers could spend 13 percent less time on physical tasks (which are often a large component of upstream jobs).[94] Close to 23 million jobs could be displaced by automation by 2030 in Indonesia.[95] A circular economy could help prepare Indonesia's labour market in light of such automation trends. A circular economy can shift jobs from upstream industries, such as mining, into downstream industries, such as remanufacturing, repair, servitisation, and recycling. Since upstream jobs are more likely to be automated than downstream jobs, a circular economy could generate jobs that are least at risk from being displaced.[96] Moreover, these jobs are likely to be associated with higher job quality. Based on a labour force survey carried out in four of Europe's major manufacturing economies, Italy, Poland, Germany

81 Klaus Schwab (2017), *The Fourth Industrial Revolution.*
82Ghaffar, et al (2018). *Additive manufacturing technology and its implementation in construction as an eco-innovative solution.* Available at: https://www.sciencedirect.com/science/article/pii/S0926580517309731
83 Irena (2017), *Renewable power: Sharply falling generation costs.* Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/%20IRENA_Sharply_falling_costs_2017.pdf
84 Ministry of Industry (2018), "Making Indonesia 4.0." Available at: https://www.kemenperin.go.id/download/19347
85 Republic of Indonesia (2020), *Rencana Pembangunanjangka Menengah Nasional 2020-2024.* Available at: https://drive.bappenas.go.id/owncloud/index.php/s/4q7Cb7FBxavq3lK#pdfviewer
86 The Diplomat (2020), "What's Next for Indonesia's Artificial Intelligence Strategy Plans?" Available at: https://thediplomat.com/2020/03/whats-next-for-indonesias-artificial-intelligence-strategy-plans/
87 OpenGov (2018), "The potential of IoT in Indonesia." Available at: https://www.opengovasia.com/the-potential-of-iot-in-indonesia/
88 McKinsey Global Institute (2017), *Artificial Intelligence and Southeast Asia's Future.* Available at: https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Artificial%20Intelligence/AI%20and%20SE%20ASIA%20future/Artificial-intelligence-and-Southeast-Asias-future.ashx
89 The Jakarta Post (2019), "More companies turn to cloud computing to cut operating costs." Available at: https://www.thejakartapost.com/news/2019/08/06/more-companies-turn-to-cloud-computing-to-cut-operating-costs.html
90 Tempo (2018), "63% Consumers Willing to Pay Premium for Green Products". Available at: https://en.tempo.co/read/910387/63-percent-consumers-willing-to-pay-premium-for-green-products
91 Information sourced from Statista. Available at: https://www.statista.com/outlook/368/120/ride-hailing/indonesia
92 The ASEAN Post (2019), "Can dress rentals save the fashion industry?" Available at: https://theaseanpost.com/article/can-dress-rentals-save-fashion-industry
93 Asian Development Bank (forthcoming), *Reaping Benefits from Industry 4.0 in High-Growth Industries Through Skills Training Development in Southeast Asia: Indonesia report.*
94 Asian Development Bank (forthcoming), *Reaping Benefits from Industry 4.0 in High-Growth Industries Through Skills Training Development in Southeast Asia: Indonesia report.*
95 McKinsey & Company (2019), *Automation and the future of work in Indonesia.* Available at: https://www.mckinsey.com/featured-insights/asia-pacific/automation-and-the-future-of-work-in-indonesia
96 International Labor Organization (ILO), *ASEAN in Transformation.* Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_579554.pdf

and the UK, circular economy jobs were found to have more adequate hours, provided more stable employment, and employees reported higher job satisfaction.[97] Based on evidence from Europe, circular activities are generally labour-intensive. For instance, reuse and repair activities are, on average, more labour-intensive than manufacturing and waste collection.[98] Hence, a circular economy could be ideal for Indonesia to make use of its vast labour force and counter the impact of the forthcoming automation technologies, which could severely affect upstream manufacturing jobs.

6. **Supportive regulatory changes.** Government action is increasingly focusing on addressing the enormous environmental costs associated with a linear growth model. Some of these regulatory actions are driven by commitments under agreements such as the United Nations Sustainable Development Goals (for example, halving food loss and waste by 2030), the Paris Agreement within the United Nations Framework Convention on Climate Change, and various national-level pledges. For example, Indonesia has pledged to cut marine plastic waste by 70 percent by 2025.[99] Indonesia has also developed a Low Carbon Development Plan.[100]

7. **Availability of new capital to support investment.** A circular economy is in line with Goal 12 of the Sustainable Development Goals (SDGs), which aims to ensure "sustainable consumption and production patterns." In Asia, circular economy opportunities in food, automotive, appliances, and electronics are among the 15 largest business opportunities linked to the SDGs and could be worth almost USD1 trillion by 2030 (Exhibit 5).[101] There are over USD30 trillion in sustainable investment assets under management globally already, and the size of this asset pool is growing fast (around 34 percent between 2016 and 2018).[102] New investment pools increasingly look at circular economy opportunities. For example, BlackRock launched a new thematic fund, the BGF Circular Economy Fund, in 2019 which aims to drive investment in businesses already benefiting from, or contributing to the transition to a circular economy. The fund was launched with USD20 million seed capital from BlackRock.[103] Decalia Asset Management also launched its first equity investment fund, the Decalia Circular Economy fund, dedicated to the circular economy in 2018.[104]

   In 2019, Circulate Capital, an investment management firm, received commitments worth USD90 million from leading global companies, such as PepsiCo, Procter & Gamble, Danone, Unilever, the Coca-Cola Company, and Dow to finance companies that are combatting ocean plastic in South and Southeast Asia.[105] Indonesia has already realised investments from this fund. The Circulate Capital Ocean Fund, created by Circulate Capital, invested in Indonesia's Tridi Oasis Group that specialises in recycling PET bottles into rPET flakes, which are used to manufacture circular packaging and textiles.[106]

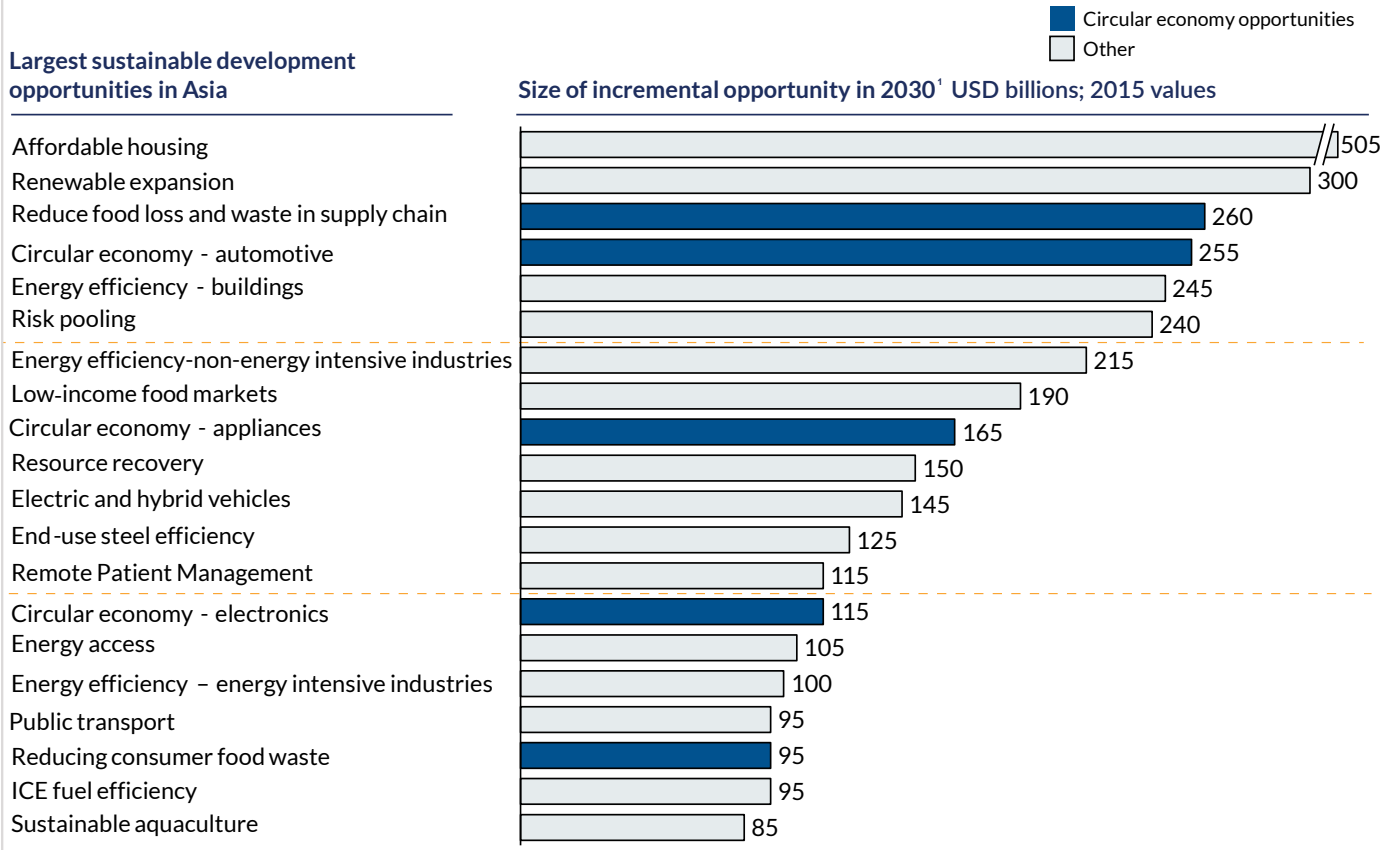
8. **Greater collaboration due to urbanisation.** By 2030, 60 percent of the world's population could live in cities.[107] Over the next two decades, nearly all of the world's net population growth is expected to occur in urban areas, with about 1.4 million people added each week.[108] While greater urbanisation could lead to an increase in waste volumes (e.g., by increasing the length of supply chain and the volume of supply chain food loss and waste), the ensuing density could also encourage an exchange of ideas among urban communities and foster innovation.[109] It could enable asset sharing business models to scale, lowering the cost and complexity of collecting, sorting, and treating end-of-use materials not only among consumers but also local governments. For example, Muniret lets local municipalities in the US rent equipment to one another.[110]

   Indonesia is also experiencing a wave of urbanisation. The country's cities are growing at a rate of 4.1 percent per year.[111] Over 35 million people are expected to move to cities in Indonesia between 2019 and 2025.[112] The growing urbanisation in Indonesia could provide impetus to circular economy-focused business models. Several businesses have emerged in the country that focus on the sharing economy. Examples include CoHive (office space sharing), Nebengers (trip sharing), and RuangGuru (online tutors).

97 Emily Coats and Dustin Benton (2016), *Jobs quality in a circular economy*. Available at: https://www.green-alliance.org.uk/resources/Job%20quality%20in%20a%20circular%20economy.pdf
98 Lorente-Gonzalez and Vence (2020), *How labour-intensive is the circular economy? A policy-orientated structural analysis of the repair, reuse and recycling activities in the European Union*. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0921344920303505?via%3Dihub
99 Luhut B. Pandjaitan (2020), "Here's how Indonesia plans to take on its plastic pollution challenge". Available at: https://www.weforum.org/agenda/2020/01/here-s-how-indonesia-plans-to-tackle-its-plastic-pollution-challenge/
100 Bappenas (2019), Pembangunan Rendah Karbon: Pergeseran Paradigma Menuju Ekonomi Hijau di Indonesia. Available at: https://www.bappenas.go.id/id/berita-dan-siaran-pers/pembangunan-rendah-karbon-pergeseranparadigma-menuju-ekonomi-hijau-di-indonesia/
101 Business & Sustainable Development Commission, Temasek and AlphaBeta (2017), *Better Business Better World Asia*. Available at: http://report.businesscommission.org/reports/better-business-better-world-asia
102 GreenBiz (2019), "Global sustainable investing assets surged to D30 trillion in 2018". Available at: https://www.greenbiz.com/article/global-sustainable-investing-assets-surged-30-trillion-2018
103 Euromoney (2019), "Blackrock breaks new ground with circular economy fund". Available at: https://www.euromoney.com/article/b1hhxvg28z5ghv/esg-blackrock-39breaks-new-ground39-with-circular-economy-fund
104 Decalia (2018), "DECALIA launches the first equity fund dedicated to the circular economy." Available at: https://www.decaliagroup.com/en/decalia-launches-the-first-equity-fund-dedicated-to-the-circular-economy/
105 Circulate Capital (2018), "Circulate Capital Expects $90M in Funding to Combat Ocean Plastic." Available at: https://www.circulatecapital.com/post/waste360
106 UrbanLinks (2020), "USAID partner announces inaugural investments in India and Indonesia." Available at: https://urban-links.org/insight/usaid-partner-circulate-capital-announces-inaugural-investments-in-india-and-indonesia/
107 United Nations (2016), *The world's cities in 2016*. Available at: https://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf
108 UN Department of Economic and Social Affairs, Population Division (2014), *World Urbanization Prospects, the 2014 revision*. Available at: https://www.un.org/en/development/desa/publications/2014-revision-world-urbanization-prospects.html
109 John West (2018), *Making the most of urbanization's potential*. Available at: https://link.springer.com/chapter/10.1007/978-981-10-7182-9_5
110 World Economic Forum (2017), *Collaboration in cities: From sharing to 'sharing' economy*. Available at: http://www3.weforum.org/docs/White_Paper_Collaboration_in_Cities_report_2017.pdf
111 World Bank (2016), "Indonesia's Urban Story". Available at: https://www.worldbank.org/en/news/feature/2016/06/14/indonesia-urban-story
112 United Nations Department of Economic and Social Affairs, *World Urbanization Prospects 2018*. Available at: https://population.un.org/wup/Download/

Exhibit 5

Circular economy opportunities in Asia are among the top 15 business SDG opportunities and could be worth ~USD 1 trillion in 2030



1. Based on estimated savings or projected market sizings in each area. Only the high case opportunity is shown here. Rounded to nearest USD5 billion
SOURCEBusiness & Sustainable Development Commission; AlphaBeta analysis

INTERNATIONAL RESEARCH HAS DEMONSTRATED THE RANGE OF POTENTIAL BENEFITS OF A CIRCULAR ECONOMY

The concept of a circular economy is embraced for its potential to create jobs and future-proof economic growth while decreasing the negative impact on the environment. As an example, the introduction of circular economy principles within the European Union is estimated to increase GDP in the EU by seven percent (by 2030) and improve the disposable income of households by up to 11 percent compared to the linear "business as usual" model.[113]

Individual European countries like Denmark, Finland, France, Belgium and the Netherlands have outlined their circular economy policies and strategies, expecting specific economic benefits (job creation, more competitive business environment and improved market value, investments in new technologies, improvement of the trade balance, reduction of primary material consumption). A Denmark study that focused on five sectors found that further transition towards a circular economy by 2035 could unlock an increase in GDP of 0.8-1.4 percent, create between 7,000-13,000 jobs, and reduce the country's carbon footprint by up to seven percent.[114] Beyond Europe, studies in China and India have shown that a circular economy can generate substantial benefits in developing countries. A study on China found that a circular economy trajectory could save businesses and households approximately CNY32 trillion in 2030, equivalent to around 14 percent of China's projected GDP that year. Other impacts include a reduction in greenhouse gas emissions by about 11 percent and a decline in traffic congestions by 36 percent by 2030.[115] In India, a study estimated that a circular economy could bring annual benefits of INR40 lakh crore (USD624 billion) in 2050.[116]

113 Ellen MacArthur Foundation (2015), *Growth within: A circular economy vision for a competitive Europe*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf
114 Ellen MacArthur Foundation (2017), *Delivering the circular economy: a toolkit for policymakers*. Available at: https://www.ellenmacarthurfoundation.org/resources/apply/toolkit-for-policymakers
115 Ellen MacArthur Foundation and Arup (2018), *The circular economy opportunity for urban and industrial innovation in China*. Available at: https://www.ellenmacarthurfoundation.org/publications/chinareport
116 Ellen MacArthur Foundation (2016), *Circular economy in India: Rethinking growth for long-term prosperity*. Available at:

Exhibit 6 illustrates some of the estimated benefits to the economy, jobs, and CO_2e from these studies. Note that these numbers are not directly comparable as the methodology and scope of analysis differ across studies. For example, the study on China includes the value of externalities like CO_2 emissions in its economic impact. Moreover, some studies look at the impact on the entire economy while others look at the impact in selected sectors. Despite the differences in methodology across the studies, all studies demonstrate the strong potential benefits of transitioning towards a circular economy.

Exhibit 6

Potential economic impact of a circular economy

Estimated potential contribution of a circular economy to economic growth, job creation and reduction of greenhouse gas emissions

	Country	Jobs (# vs BAU) Thousands	GDP impact[1] USD billion	GDP impact as % of total GDP in reference year%	GHG reduction %	Ref. year	Source
Economy wide (materials)	Netherlands	54	3.3	0.3	23	2030	Rabobank TNO
	Czech Republic	100	NA	NA	8	2030	Club of Rome, MAVA Foundation
	Poland	200	NA	NA	7	2030	Club of Rome, MAVA Foundation
	Sweden	100	NA	NA	70	2030	Club of Rome, MAVA Foundation
	UK	517	NA	NA	NA	2030	WRAP UK
	EU28	3,000	NA	NA	NA	2030	WRAP UK
Economy wide (energy)	Finland	31	1.2	0.4	6	2025	Sitra , Cambridge Econometrics
Selected sectors (materials)	Denmark	13	7.1	1.4	7	2035	Ellen MacArthur Foundation
	China	NA	5,100.0	NA	11	2040	Ellen MacArthur Foundation, ARUP
	India	NA	624.0	NA	44	2050	Ellen MacArthur Foundation
	Australia	17	7.5	0.4	NA	2048	KPMG
	EU28	NA	1,800.0	7.8	17	2030	McKinsey, Ellen MacArthur Foundation (Growth Within)
	Indonesia	4,400	42.0	2.3	9	2030	UNDP (this report)

1. The GDP impact for the 'selected sectors' studies refers to the impact on the sector GDP not the economy-wide GDP

SOURCE: Ellen MacArthur Foundation; Arup; KPMG; McKinsey; WRAP UK; Club of Rome

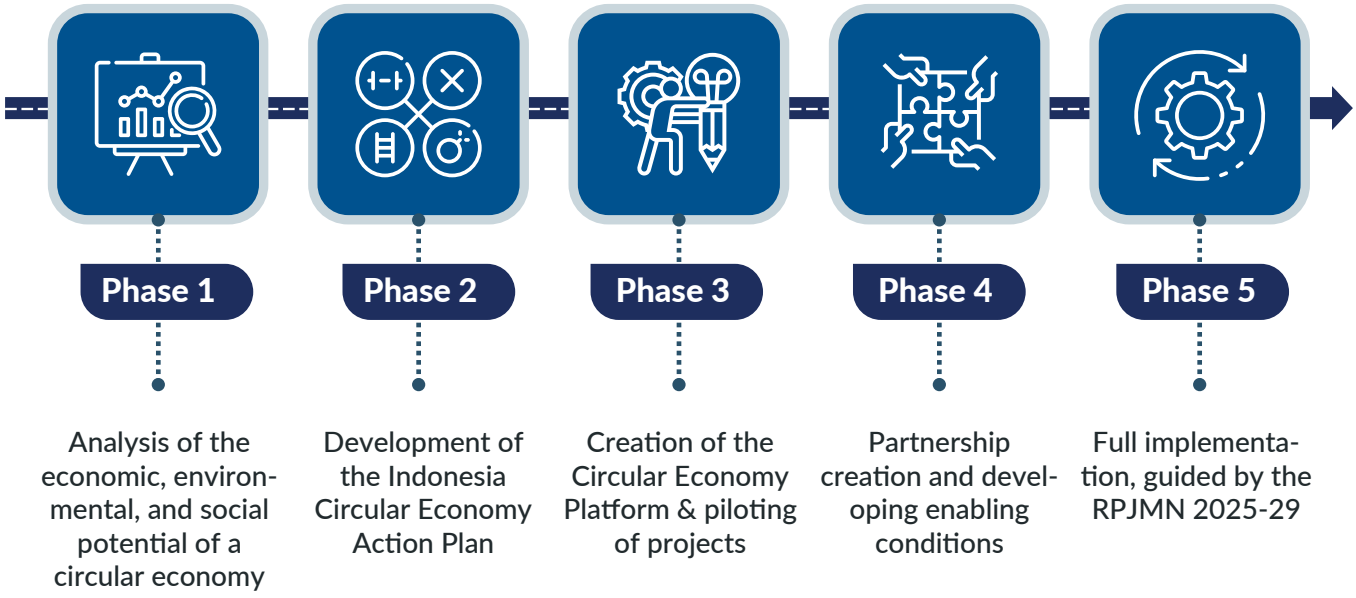
THE NATIONAL CIRCULAR ECONOMY ROADMAP WILL GUIDE INDONESIA'S EFFORTS IN CREATING A CIRCULAR ECONOMY

To expedite the transition toward a circular economy, the Ministry of National Development Planning (Bappenas) in cooperation with United Nations Development Programme (UNDP) and supported by the Kingdom of Denmark have launched a partnership to develop a circular economy roadmap for Indonesia. Exhibit 7 describes the timeline of this roadmap.

https://www.ellenmacarthurfoundation.org/assets/downloads/Summary_Circular-economy-in-India_5-Dec_2016.pdf

Exhibit 7

Timeline for the National Circular Economy Roadmap



SOURCE: Bappenas; UNDP

1. **Phase 1: Analysis of the economic, environmental and social potential of the circular economy in Indonesia**
   The first step of the National Circular Economy Roadmap is to analyse the potential for a circular economy in Indonesia. This report is a crucial output of this phase. The analysis presented in the report identifies the critical circular economy opportunities in key sectors of the Indonesian economy and sizes the potential economic, social, and environmental benefits from the circular economy associated with each sector. The analysis also identifies potential barriers and possible solutions to accelerate the circular economy. Based on this report, the Government of Indonesia and project stakeholders will have an informed "map" of opportunities that identifies the areas of the Indonesian economy that have the biggest potential for a circular economy including possible bottlenecks and policy options.

2. **Phase 2: Development of a National Circular Economy Action Plan**
   The National Circular Economy Action Plan will consist of a multi-year roadmap with sector-specific strategies, toolboxes, and interventions to create the enabling framework and capture the circular economy potential in the prioritised key sectors. The action plan will be developed in close partnership between the Government and the private sector, assisted by the UNDP and a team of expert consultants.

3. **Phase 3: Creation of a Circular Economy Platform and piloting of projects**
   This phase will include the establishment of a National Circular Economy Platform for the overall steering and implementation of the action plan. The platform will be the central integrator between policymakers, the private sector, civil society, investors, and other stakeholders. This phase will also include the piloting of projects to create near-term impact.

4. **Phase 4: Partnership creation and development of enabling conditions**
   This phase will focus on developing international partnerships to attract investments and spread the Indonesian circular economy model to other countries in the region, as well as developing the appropriate enabling conditions to support a circular economy.

5. **Phase 5: Full implementation guided by the RPJMN 2025-2029**
   This phase will focus on the full implementation of the circular economy roadmap, with guidance provided by the National Medium-Term Development Plan (RPJMN) 2025-2029.

2. Overview of the economic, social and environmental impact of the circular economy in Indonesia

This chapter discusses the prioritisation of sectors and the potential economic, social and environmental impact of the circular economy in Indonesia in 2030. Five sectors were prioritised in the Indonesia analysis based on their potential to create economic benefits from a circular approach. Adopting a circular economy approach could drive growth and employment across these five sectors, reduce household costs, and create significant benefits for the environment. By creating new job and growth opportunities, and increasing the resilience of supply chains, a circular economy could also play an important role in Indonesia's economic recovery from the COVID-19 pandemic.

Based on the IO Table and ICOR methodologies, adopting circular economy practices could help Indonesia generate an additional GDP benefit worth IDR593 to 638 trillion (USD42 to 45 billion) in 2030. Between 2021 and 2030, 4.4 million cumulative net jobs could also be created (of which 75 percent could be for women), household savings worth IDR4.9 million (USD344) could be captured, and CO_2e emissions and water use could be reduced in 2030 by 126 million tonnes and 6.3 billion cubic metres, respectively (equivalent to nine percent of the current emissions and three percent of the current water usage). Using a system dynamics approach, the impact on the five focus sectors (excluding the broader impacts on other sectors of the Indonesian economy), were found to vary under different scenarios of circular economy adoption. An approach focused on producers adopting circular economy opportunities (as opposed to consumers) was found to have the most significant benefit for the five focus sectors.

5 FOCUS SECTORS HAVE SIGNIFICANT POTENTIAL TO CREATE BENEFITS FROM CIRCULARITY IN INDONESIA

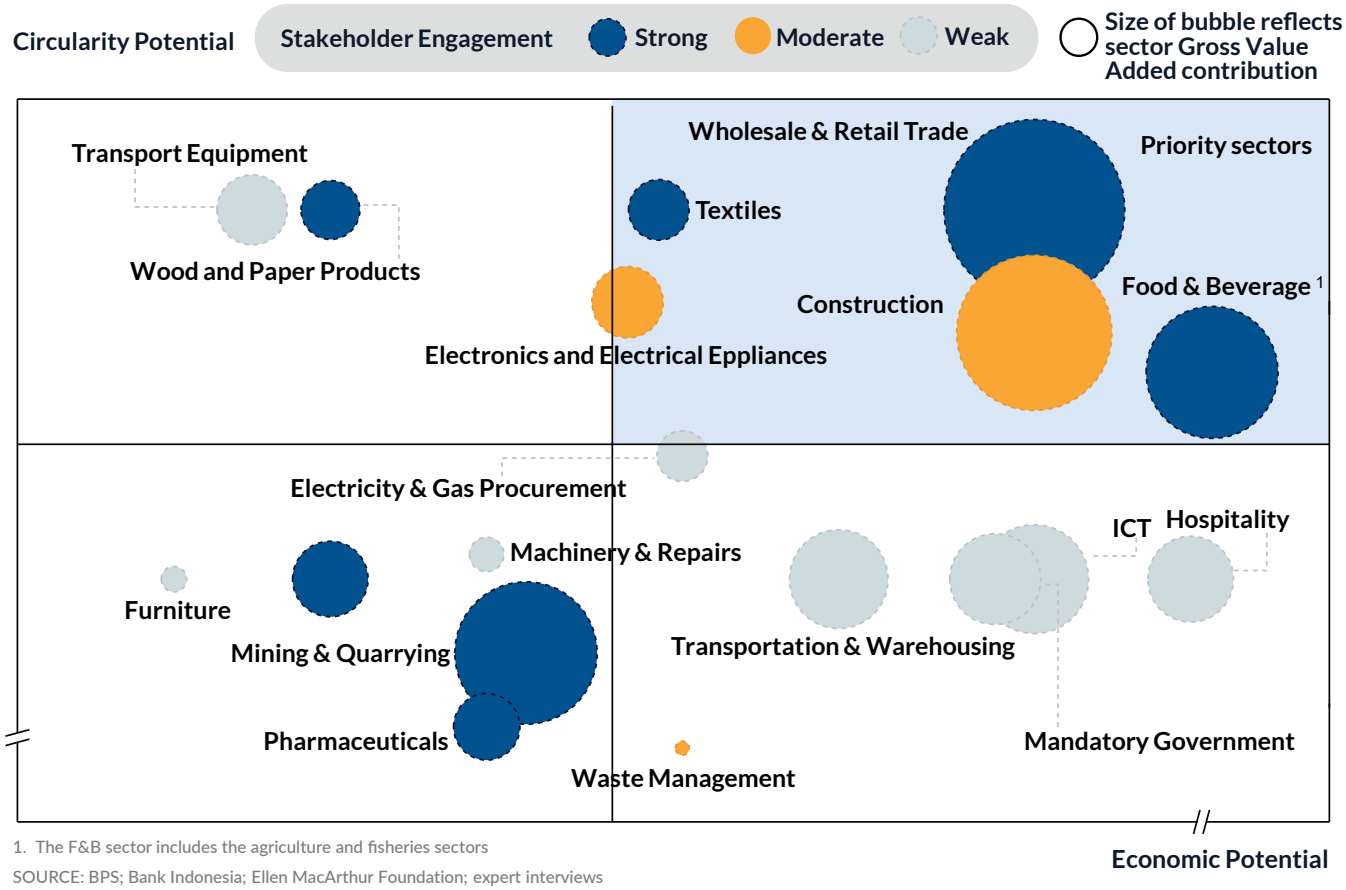
The report prioritised five sectors to better understand the promise of a circular economy in Indonesia: food & beverage, textile, construction, wholesale and retail trade, and electrical and electronic equipment (Exhibit 8).[117] Five sectors were chosen to evaluate in this report to provide focus to circular economy efforts going forward. Existing studies on the circular economy also typically prioritise three to five economic sectors. For example, the case study on Denmark published by the Ellen MacArthur Foundation focused on five sectors: food & beverage, construction & real estate, machinery, plastic packaging, and hospitals.[118] Elsewhere, a report evaluating the potential for a circular economy in India focused on three focus areas: cities and construction, food and agriculture, and mobility and vehicle manufacturing.[119] Similarly, a report estimating the economic pay-off of adopting a circular economy in Australia focused on three sectors: food, transport, and built environment.[120]

To arrive at these five sectors, three criteria were used: i) the economic potential of the sector, ii) the circularity potential, and iii) the level of stakeholder support, both private and public, in advancing circularity within the sector.[121] To assess the economic potential of the sectors, the gross value added and employment statistics of the sectors were examined. To understand the circularity potential of the sectors, the material intensity, waste volumes, share of waste unrecovered, and the circularity potential (defined by the Ellen MacArthur Foundation) were assessed for each sector. This assessment was complemented by international case studies and expert interviews. Finally, to evaluate the level of stakeholder support, in-depth, qualitative desktop research (e.g., the number of private-sector partnerships and initiatives associated with circular economy adoption in each sector, relevant government strategies) and several interviews with Indonesian policymakers, private sector leaders, and circular economy experts were conducted. Greater details on the methodology behind the sector selection can be found in the Annex.

117 The food & beverage sector in the exhibit includes agriculture
118 Ellen MacArthur Foundation (2015), *Potential for Denmark as a circular economy: a case study from delivery the circular economy – a toolkit for policymakers*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/government/20151113_DenmarkCaseStudy.pdf
119 Ellen MacArthur Foundation (2016), *Circular Economy in India: Rethinking growth for long-term prosperity*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Circular-economy-in-India_5-Dec_2016.pdf
120 KPMG (2020), *Potential economy pay-off of a circular economy*. Available at: https://assets.kpmg/content/dam/kpmg/au/pdf/2020/potential-economic-pay-off-circular-economy-australia-2020.pdf
121 The detailed methodology can be found in the Annex.

Exhibit 8

Five sectors were prioritised based on several criteria to understand the potential of a circular economy in Indonesia



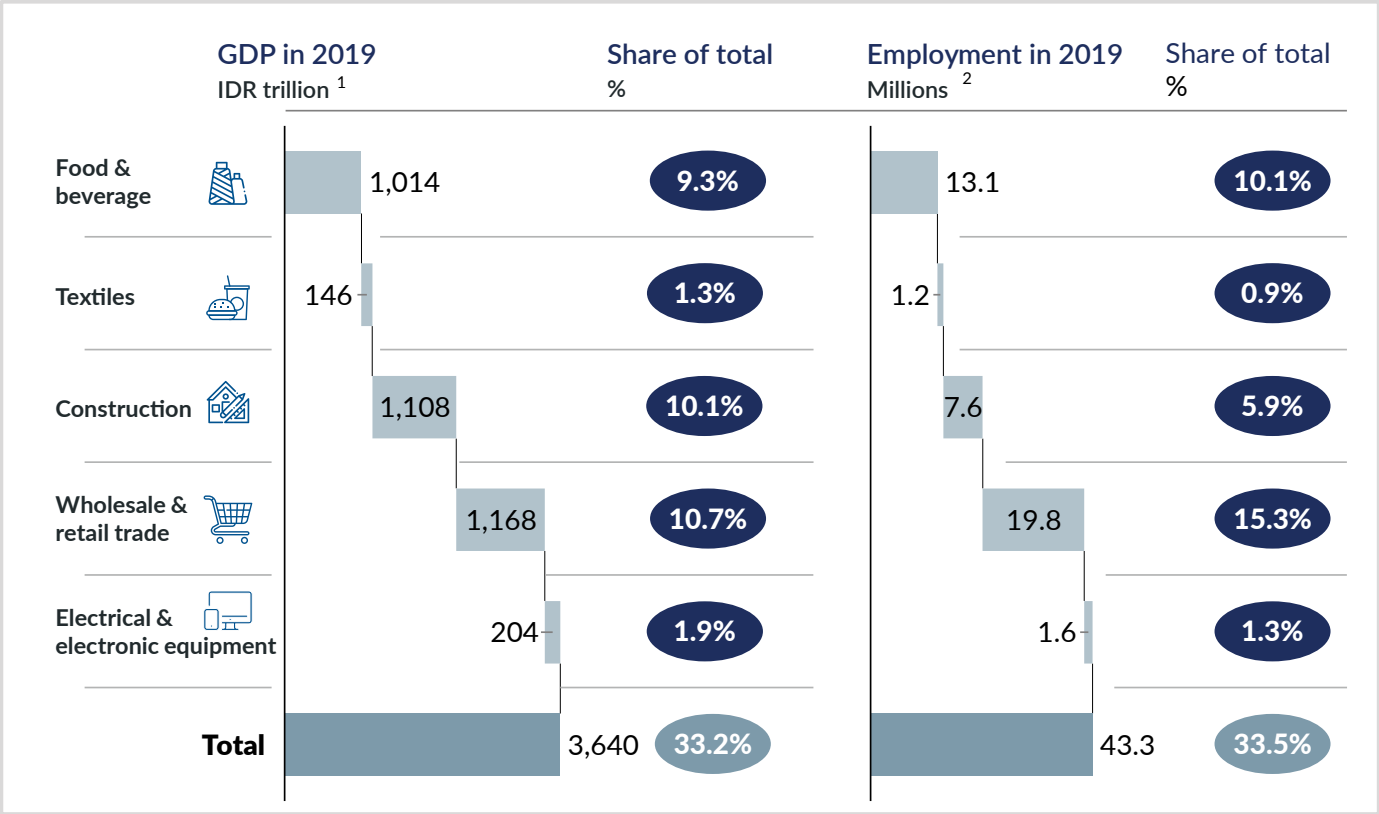
1. The F&B sector includes the agriculture and fisheries sectors

SOURCE: BPS; Bank Indonesia; Ellen MacArthur Foundation; expert interviews

The five focus sectors play a pivotal role in Indonesia's economy, contributing over 30 percent to Indonesia's current GDP and employing more than 43 million people, or one-third of Indonesia's workforce (Exhibit 9). Below are further details on the importance of the circular economy of the five sectors selected in this report.

Exhibit 9

The five focus sectors account for ~33% of GDP and employ over 43 million people



1. GDP figures are in 2010 prices
2. The employment for the focus sectors was estimated using the sector employment data published by BPS. Due to the limited data availability on sub - sector employment, it was assumed that the labour productivity is constant across the sub-sectors

SOURCE: Bank Indonesia; BPS

1. Food & beverage (with a focus on food loss and waste)

The Indonesian food & beverage (F&B) sector is highly relevant to drive a circular economy transformation. It accounted for 9.3 percent of the total GDP in 2019 and was the largest sub-sector of the manufacturing sector, which itself was the largest industry sector in Indonesia.[122]

The need for a circular economy transformation in the food production system is urgent. According to an analysis by the World Resources Institute, around 26 percent of all food available is wasted every year in South and Southeast Asia.[123] In Southeast Asia, most of the food loss and waste occurs (65 percent) during the production or the handling & storage stage of the value chain.[124] Unscheduled harvesting due to lack of weather data and lack of proper storage are examples of drivers of waste generation in these two stages. Drivers behind waste occurring in the supply chain and consumption stages include improper transport logistics and consumer behaviour, respectively. Food loss and waste in Indonesia impacts a variety of food products, including rice, fruits, and vegetables. For example, according to the Association of Indonesian Chilli Agribusiness, 15 percent of chillies reach their destination spoilt or too dry for Indonesian tastes.[125]

A circular economy can not only help avoid food loss and waste (e.g., by shortening supply chains) but could help to deploy food loss and waste for more productive purposes, such as the generation of compost and biogas. More localised value chains and regenerative agriculture can lead to increased agrobiodiversity. Other countries have identified a large opportunity within the F&B system. Within the European Union, the total opportunity of reducing waste in the food system amounts to approximately USD320 billion by 2030.[126]

Furthermore, today's food production creates significant negative externalities both environmentally and socially – among

122 Bank Indonesia, "Economic Data." Available at: https://www.bi.go.id/en/iru/economic-data/real-sector/Contents/Default.aspx
123 WRI (2019), *Reducing food losses and waste – setting a global agenda*. Available at: https://wriorg.s3.amazonaws.com/s3fs-public/reducing-food-loss-waste-global-action-agenda_1.pdf
124 This report uses the FAO definition for food loss and waste. FAO defines food loss as the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retailers, food service providers and consumers. Food waste refers to the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers. The definition is available at: http://www.fao.org/food-loss-and-food-waste/flw-data)
125 Reuters (2015), "Indonesia's infrastructure promises fail the chilli challenge." Available at: https://www.reuters.com/article/indonesia-chilli/indonesias-infrastructure-promises-fail-the-chilli-challenge-idUSL3N10N1YO20150819
126 Ellen MacArthur Foundation (2015), *Growth Within Report: A circular economy vision for a competitive Europe*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf

others via excessive application of fertilisers, pesticides, and antibiotics in food production, excessive use of freshwater resources, high energy consumption, and inefficient and unsafe disposal of organic by-products. Globally these negative externalities have been estimated at USD5.7 trillion.[127] Improving agricultural practices, designing out wastes and chemicals from the food value chain, and making the most out of all nutrients, therefore, could have significant economic, social, and environmental benefits.

2. Textiles (with a focus on textile waste)

The textiles sector is a major driver of Indonesia's employment and exports and is also an important focus of the Government of Indonesia's future export strategy. The sector employs an estimated 4.2 million people, over 26 percent of employment in Indonesia's manufacturing sector.[128] Indonesia is among the top 10 textile-producing nations in the world.[129] Despite the global decline in textile demand, the Indonesian textile sector was expected to grow at 5.7 percent per annum from 2018-2024.[130] The Indonesian Government has also set a target to increase the export value of textiles and garments to USD75 billion by 2030.[131]

The environmental impacts of textile manufacturing occur all along the value chain, with the largest impact coming at the dyeing and finishing processes which are the most energy, water, and chemically intensive steps.[132] All types of fabrics typically go through a wet processing step, which consists of cleaning, bleaching, dyeing, and finishing to produce finished fabrics. This wet processing step consumes large quantities of freshwater and releases significant volumes of potentially toxic substances. Indonesia has sought to address this challenge through the introduction of a voluntary sustainability standard for its textile sector – the "Standar Industri Hijau (SIH)" (Green Industrial Standard). The standard seeks to minimise the use of raw materials and the emission of hazardous chemicals.

The SIH could be used as a starting point to transform the Indonesian textile sector. But circularity in clothing and apparel needs to go beyond the production steps. According to the Ellen MacArthur Foundation, globally, USD500 billion in value is lost from the textile manufacturing system due to under-utilised clothes and a lack of recycling. Of the total fibre input used for clothing, 87 percent is landfilled or incinerated, representing a lost opportunity of more than USD100 billion annually. Less than one percent of the material used to produce clothing is recycled into new clothing.[133] Hence, recycling of textile waste could be a substantial business opportunity. Panipat in India, considered the global hub for textile recycling, recycles textile waste to produce various textile products, such as doormats and blankets. It employs 20,000 people and brings in annual revenues of USD62 million.[134]

A fully circular economy in textiles manufacturing would bring numerous benefits to the Indonesian economy: material cost savings and reduced exposure to input resource price volatility, profit opportunities for businesses through new services (fashion-as-a-service), additional economic growth through a more regenerative and restorative value chain. The environmental benefits would be seen in lower GHG emissions, reduced consumption of virgin, non-renewable materials and of energy, to name just a few.

3. Construction and built environment (with a focus on C&D waste)

Infrastructure is the foundation for urban and rural development, poverty alleviation, and improvement in access to communal service. The construction sector in Indonesia accounts for 10 percent of total GDP and is set for strong future growth driven by forces such as increased urbanisation.[135] Construction and infrastructure have a considerable resource demand for energy and clean water. Globally, construction and operation of infrastructure consume around 40 percent of a country's energy budget.[136] It can also be a large contributor to solid waste and holds significant recycling potential. Nearly all C&D waste is recyclable, but only one to 15 percent of the waste is estimated to be recycled in developing countries like Indonesia.[137,138] The result of the current linear economic model results in an industry where only limited and restricted innovation exists, where the main assets are largely under-used, and where there is a significant waste of both materials and energy.[139]

127 Ellen MacArthur Foundation (2019), *Cities and the Circular economy for Food*. Available at: https://www.ellenmacarthurfoundation.org/publications/cities-and-circular-economy-for-food
128 ILO (2017), *Mixed picture for Indonesia's garment sector*. Available at: https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-jakarta/documents/publication/wcms_625195.pdf
129 Mordor Intelligence (2019), *Indonesia Textiles Industry – Growth, Trends, and Forecast (2019-2024)*. Available at: https://www.mordorintelligence.com/industry-reports/indonesia-textiles-industry
130 Mordor Intelligence (2019), *Indonesia Textiles Industry – Growth, Trends, and Forecast (2019-2024)*. Available at: https://www.mordorintelligence.com/industry-reports/indonesia-textiles-industry
131 Global Business Guide Indonesia, "Indonesia's Upstream Textile Sector; On the Rise After a Slump." Available at: http://www.gbgindonesia.com/en/manufacturing/article/2017/indonesia_s_upstream_textile_sector_on_the_rise_after_a_slump_11803.php
132 Kate Fletcher (2008), *Sustainable Fashion and Textiles: Design journeys*. Available at: https://www.researchgate.net/publication/286774073_Sustainable_fashion_and_textiles_Design_journeys
133 Ellen Macarthur Foundation (2017), *A New Textiles Economy: Redesigning fashion's future*. Available at: https://www.ellenmacarthurfoundation.org/publications/a-new-textiles-economy-redesigning-fashions-future
134 The Economist (2017), "Panipat, the global centre for recycling textiles, is fading." Available at: https://www.economist.com/business/2017/09/07/panipat-the-global-centre-for-recycling-textiles-is-fading
135 Bank Indonesia, "Economic Data." Available at: https://www.bi.go.id/en/iru/economic-data/real-sector/Contents/Default.aspx
136 Schneider Electric (Global energy management company)
137 Esa et al (2017), *Strategies for minimizing construction and demolition wastes in Malaysia*. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0921344916303901
138 Zhang and Tan (2020), *Demolition waste recycling in China: New evidence from a demolition project for highway development*. Available at: https://journals.sagepub.com/doi/abs/10.1177/0734242X20904440
139 Ellen Macarthur Foundation (2015), *Reimagining Construction in Denmark*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/government/20151113_DenmarkCaseStudy.pdf

Led by the Green Building Council Indonesia, Indonesia has already begun implementing requirements relating to energy and water efficiency in Jakarta and other cities. But "greening" existing built infrastructure is both challenging and insufficient. A more systemic approach is needed to remove the inefficiencies in the system. The European experience with circular economy approaches shows that the construction and real estate sectors typically offer one of the highest potentials. In Denmark, the potential value of unlocking the circular economy in the built environment was estimated to be between EUR0.85 and 1.2 billion annually.[140] In India, the green building market is expected to grow to USD35 to 50 billion by 2022.[141]

4. Wholesale and retail trade (with a focus on plastic packaging waste)

Plastic waste has become an enormous challenge for Indonesia. Indonesia generates 6.8 million tonnes of plastic waste annually, which is expected to double to 13.6 million tonnes by 2040.[142] In 2017, only 30 percent of Indonesia's plastic waste was managed (10 percent was recycled and 20 percent was sent for managed disposal). The other 70 percent was either openly burnt, dumped on land, sent to official dumpsites, or leaked into the ocean or waterways.[143]

An estimated 10 percent of global ocean plastic leakage comes from Indonesia.[144] The Indonesian Government has already committed to reducing marine plastic debris by 70 percent by 2025.[145] Consequently, it embarked on initiatives to reduce plastic waste and move from end-of-pipe recycling approaches to a circular economy model. Most notably, the Coordinating Ministry for Maritime Affairs and Investment and the Ministry of Environment and Forestry have engaged with the Global Plastic Action Partnership (GPAP) to create circular economy solutions in coastal areas battling plastic waste. The economic potential is enormous. According to the World Economic Forum, achieving near-zero plastic pollution by 2030 could generate 150,000 direct jobs in Indonesia and create a USD13.3 billion investment opportunity between 2025 and 2040.[146]

5. Electrical and electronic equipment (with a focus on e-waste)

The electrical and electronic equipment sector (or simply, the electronics sector) is a critical opportunity area for circular economy initiatives in Indonesia. The manufacturing of metal products, computers, optical products, and electronics contributed 1.9 percent to Indonesia's GDP in 2019.[147] Estimates suggest that Indonesia has the fourth-largest population of smartphone users and the third-biggest number of mobile internet users in the world at 78 million and 65.2 million, respectively.[148] The electronics sector was selected as one of the key sectors by the Government in April 2018 as part of the country's overall Indonesian industrial development strategy.[149]

The economic opportunity of a circular economy in the electrical and electronic equipment sector is significant. A typical iPhone is estimated to contain 0.034g of gold, 0.34g of silver, 0.015g of palladium and less than one-thousandth of a gram of platinum.[150] The global economic potential of a more intelligent, circular looping of just smartphones and their materials alone could be worth over USD11 billion annually.[151] In Indonesia, the reuse and recycling market for electronic products is dominated by small, informal players.[152] Formalising the e-waste recovery and recycling sector through upskilling of informal workers could substantially increase the economic value associated with end-of-life electronic products and e-waste.

A circular economy can also generate significant environmental benefits. Mining of rare earth metals used in the manufacturing of electronic and electrical products can adversely impact the environment. Processing one ton of rare earth elements produces 2,000 tonnes of toxic waste and requires significant amounts of energy.[153,154] Moreover, the disposal of electronics can lead to leakage of toxic chemicals to the environment.[155] Circular business models that rely on reuse, refurbishment, and recycling of electrical and electronic equipment can reduce the reliance on material resources and avoid the associated detrimental environmental effects.

140 The Danish Government (2018), *Strategy for Circular Economy: More value and better environment through design, consumption, and recycling.* Available at: https://mfvm.dk/publikationer/publikation/pub/hent-fil/publication/strategy-for-circular-economy/
141 The Hindu Business Line (2018), "Indian green building market to double by 2022." Available at: https://www.thehindubusinessline.com/news/real-estate/indian-green-building-market-to-double-by-2022/article23391602.ece
142 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership.* Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
143 Based on analysis conducted by SYSTEMIQ
144 Jambeck et al. (2015), "Plastic waste inputs from land into the ocean". Science 13 Feb 2015: Vol. 347, Issue 6223, pp. 768-771. Available at: https://science.sciencemag.org/content/347/6223/768
145 Presidential Regulation No. 97/2017 on waste management
146 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership.* Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
147 Bank Indonesia, "Economic Data." Available at: https://www.bi.go.id/en/iru/economic-data/real-sector/Contents/Default.aspx
148 Global Business Guide Indonesia.
149 Jarot (2018), "Dorong Daya Saing Global, Kemenperin Luncurkan Peta Jalan Industri 4.0" Katadata, 4 April, 2018.
150 BBC news (2016), "Your old IPhone is full of untapped precious metals". Available at: https://www.bbc.com/future/article/20161017-your-old-phone-is-full-of-precious-metals
151 Ellen MacArthur Foundation (2018), *Circular Consumer Electronics: An Initial Exploration.* Available at: https://www.ellenmacarthurfoundation.org/publications/circular-consumer-electronics-an-initial-exploration
152 Fauziah F. Rochman et al (2016), *E-waste, money and power: Mapping electronic waste flows in Yogyakarta, Indonesia.*
153 The Guardian (2014), "Rare earth mining in China: the bleak social and environmental costs." Available at: https://www.theguardian.com/sustainable-business/rare-earth-mining-china-social-environmental-costs
154 GreenBiz (2019), "Rare earth minerals power the world, but mining leaves local and global footprints in the land." Available at: https://www.greenbiz.com/article/rare-earth-minerals-power-world-mining-leaves-local-and-global-footprints-land
155 Devin N. Perkins, et al, *E-waste: A global hazard.* Available at: https://annalsofglobalhealth.org/articles/abstract/10.1016/j.aogh.2014.10.001/

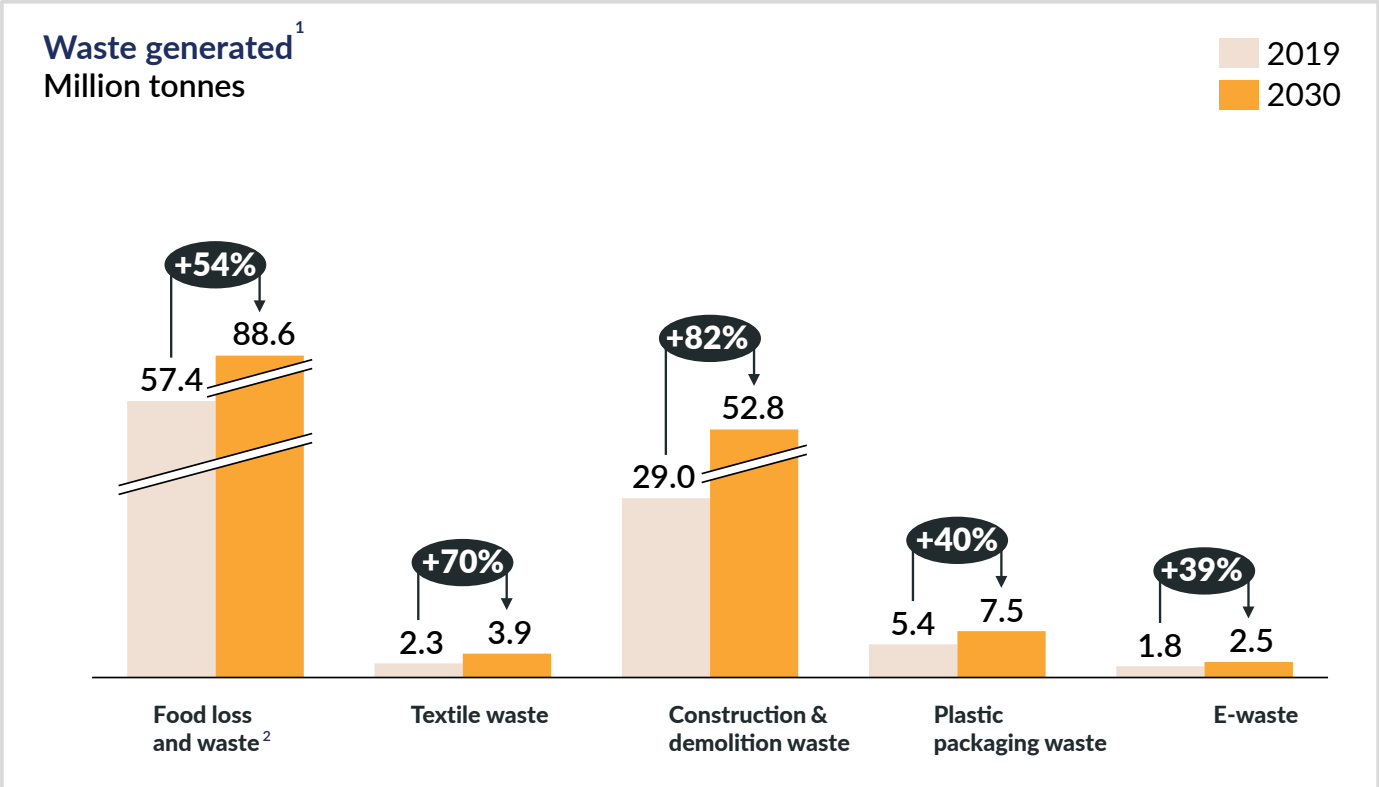
TODAY'S SIZEABLE RESOURCE WASTAGE IN THESE SECTORS IS SET TO GROW SIGNIFICANTLY BY 2030

These sectors are important drivers of waste generation. For example, the FAO estimated that total food waste could be worth nearly USD1 trillion. Food waste worth roughly USD680 billion and USD310 billion is lost in industrialised countries and developing countries, respectively.[156] According to Indonesia's waste composition in 2019, food waste at the supply chain and consumption stage makes up 44 percent of the household and household-related waste, equivalent to almost 30 million tonnes.[157] Apart from material waste such as food, textile, or C&D waste, Indonesia is also generating significant quantities of structural waste, such as unused office space. In 2019, Jakarta had vacant office space of 218 hectares.[158] These waste figures are expected to increase significantly by 2030 under a BAU scenario.

Two underlying factors drive the waste trajectory of these five focus sectors (Exhibit 10). First, more than 90 million Indonesians could join the consuming class by 2030.[159] Such rising levels of income will fuel demand for both consumer staples (e.g., packaged food) and discretionary consumer products (e.g., electronics and clothing). Second, more than 35 million people are expected to move into cities in Indonesia between 2019 and 2030.[160] Urbanisation also raises the demand for homes and public infrastructure. Sector-specific reasons, such as government prioritisation and policies, could also drive sector activity and associated waste generation. Subsequent chapters discuss these in more detail.

Exhibit 10

Under a "business-as-usual" approach, waste generated by the 5 key sectors could increase by up to 82% in 2030



1. Percentages are rounded to the nearest percent
2. Excludes food loss generated at the production stage

SOURCE: BPS; WRI ; Ellen Macarthur Foundation; World Economic Forum ; ITU (see annex for more details)

156 Food and Agriculture Organization of the United Nations [FAO], "Food Wastage Footprint". Available at: http://www.fao.org/nr/sustainability/food-loss-and-waste/en/
157 Republic of Indonesia (2017), *Presidential Regulation No. 97 of 2017*. Available at: http://ditjenpp.kemenkumham.go.id/arsip/ln/2017/ps97-2017.pdf
158 Jakarta Post (2019), "Jakarta's offices empty with 218 hectares unoccupied". Available at: https://www.thejakartapost.com/news/2019/06/27/jakartas-offices-empty-with-218-hectares-unoccupied.html
159 McKinsey Global Institute (2012), *The archipelago economy: Unleashing Indonesia's potential*. Available at: https://www.mckinsey.com/~/media/mckinsey/featured%20insights/asia%20pacific/the%20archipelago%20economy/mgi_unleashing_indonesia_potential_executive_summary.ashx.
160 United Nations Department of Economic and Social Affairs, *World Urbanization Prospects 2018*. Available at: https://population.un.org/wup/Download/

THE CIRCULARITY POTENTIAL OF THE "5R" S VARY ACROSS THE DIFFERENT SECTORS

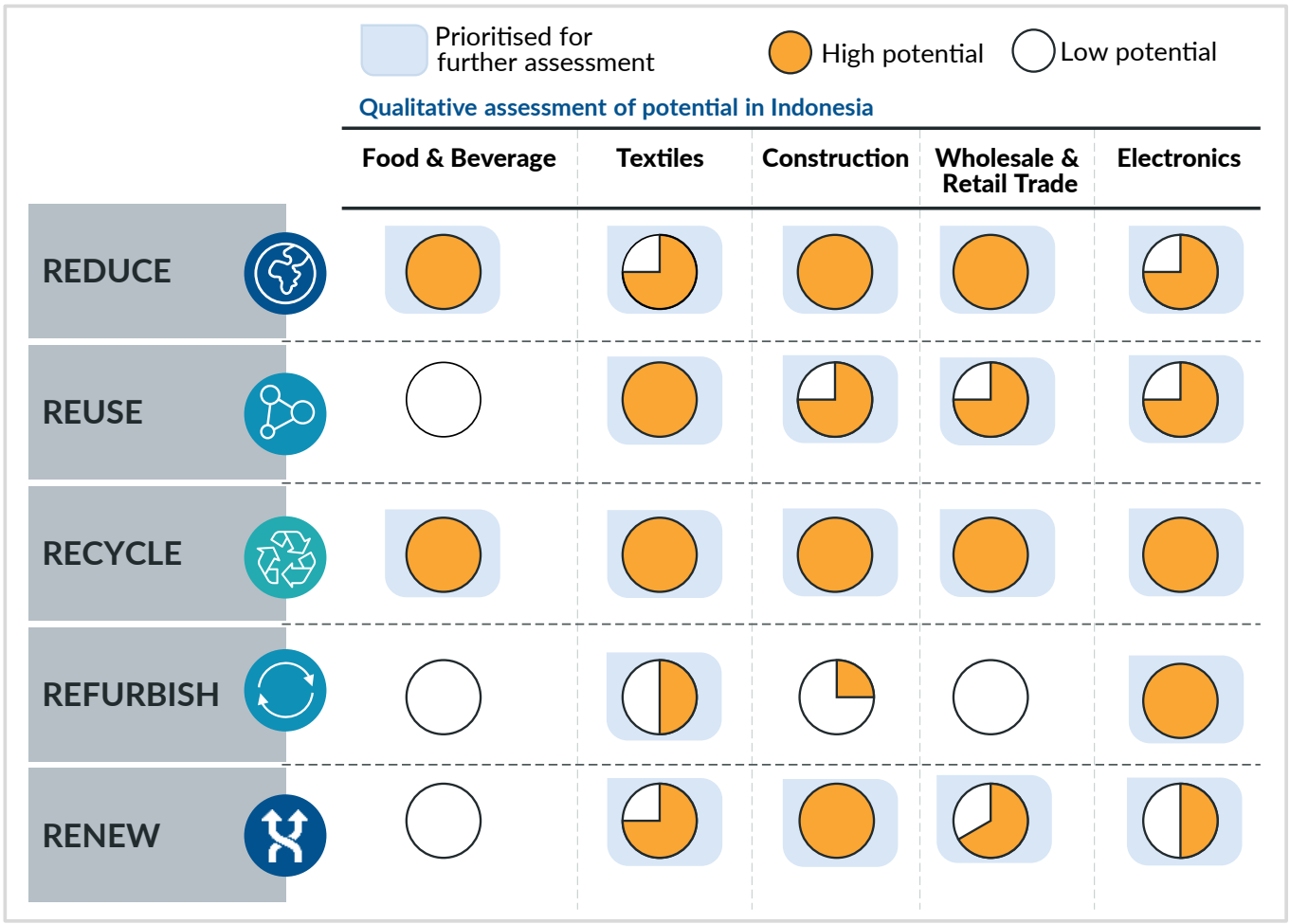
Exhibit 11 shows that the circular economy potential of the "5R"s varies across the prioritised sectors. Two factors drive this variation – the degree of the perishability of products and the feasibility of circular technologies in these sectors.

The degree of the perishability of products influences the "Reduce" and "Reuse" potential of these sectors. Since food products are highly perishable, they have a higher risk of waste or spoilage than non-perishable products such as electronics. This makes the potential for waste reduction in the F&B sector higher as compared to other sectors. Conversely, "Reuse" opportunities are less relevant for F&B due to the perishable nature of food but highly applicable for textiles and electronics, due to the high percentage of products that are disposed of before they have reached the end of their useful life.

The potential adoption rates of different circular economy opportunities also vary across sectors. In construction, Singapore is a leading example of adopting circular approaches, recycling nearly all of its C&D waste.[161] But in textiles, Germany is a best-case scenario even though it recycles close to 35 percent of its textile waste.[162] C&D waste is relatively easier to recycle since there is usually a lower concentration of players that are responsible for construction, which makes regulating easier and decreases the collection cost for C&D waste. Most of the textile waste, on the other hand, is produced by millions of consumers making regulating and collection more expensive and cumbersome. Moreover, recycling textile waste is relatively more complex since it requires significant investment in capital equipment.[163]

Exhibit 11

The circularity potential varies across the 5Rs for each of the focus sectors



SOURCE: Ellen MacArthur Foundation; expert interviews

161 National Environmental Agency Singapore, "Waste Statistics and Overall Recycling." Available at: https://www.nea.gov.sg/our-services/waste-management/waste-statistics-and-overall-recycling
162 Gustav Sandin and Greg Petres (2018), *Environmental impact of textile reuse and recycling – A review*. Available at: https://www.sciencedirect.com/science/article/pii/S0959652618305985
163 Based on an expert interview of Marina Chahboune, Founder of Closed Loop Fashion.

Based on the circularity potential of the 5Rs for each sector, sector-specific circular opportunities were prioritised (Exhibit 12). These opportunities were prioritised based on the available evidence on which opportunities were likely to generate the largest impact in the sector and were revised based on stakeholder consultations.

Exhibit 12

THIS TABLE IS NOT EXHAUSTIVE OF ALL CIRCULAR ECONOMY OPPORTUNITIES

Sector-specific opportunities were selected based on the circularity potential of the 5Rs

High potential
Moderate potential
Low potential

Circular economy opportunities prioritised for each sector based on the 5Rs

5R	F&B	Textile	Construction	Wholesale & Retail Trade	Electrical and electronics equipment
Reduce	Reduce post-harvest food loss	Reduce waste in production	Generate less C&D waste through existing processes	Reduce plastic packaging	Virtualise and dematerialise physical goods
	Reduce supply chain food loss and waste		Generate less C&D waste through new processes		
	Reduce consumer food waste		Optimise building usage		
Reuse		Reuse products	Reuse materials	Reuse plastic packaging	Reuse products
Recycle	Process food loss and waste	Recycle materials	Recycle materials	Redesign plastic packaging for improved recyclability	Recycle materials
				Increase recycling rate of recyclable packaging	
Refurbrish					Increase product lifespan and reduce obsolescence
					Refurbish products
Renew		Use more sustainable materials	Use more sustainable materials	Replace with more sustainable packaging	
			Design and build more resource-efficient buildings		

SOURCE: Expert interviews; focus group discussions

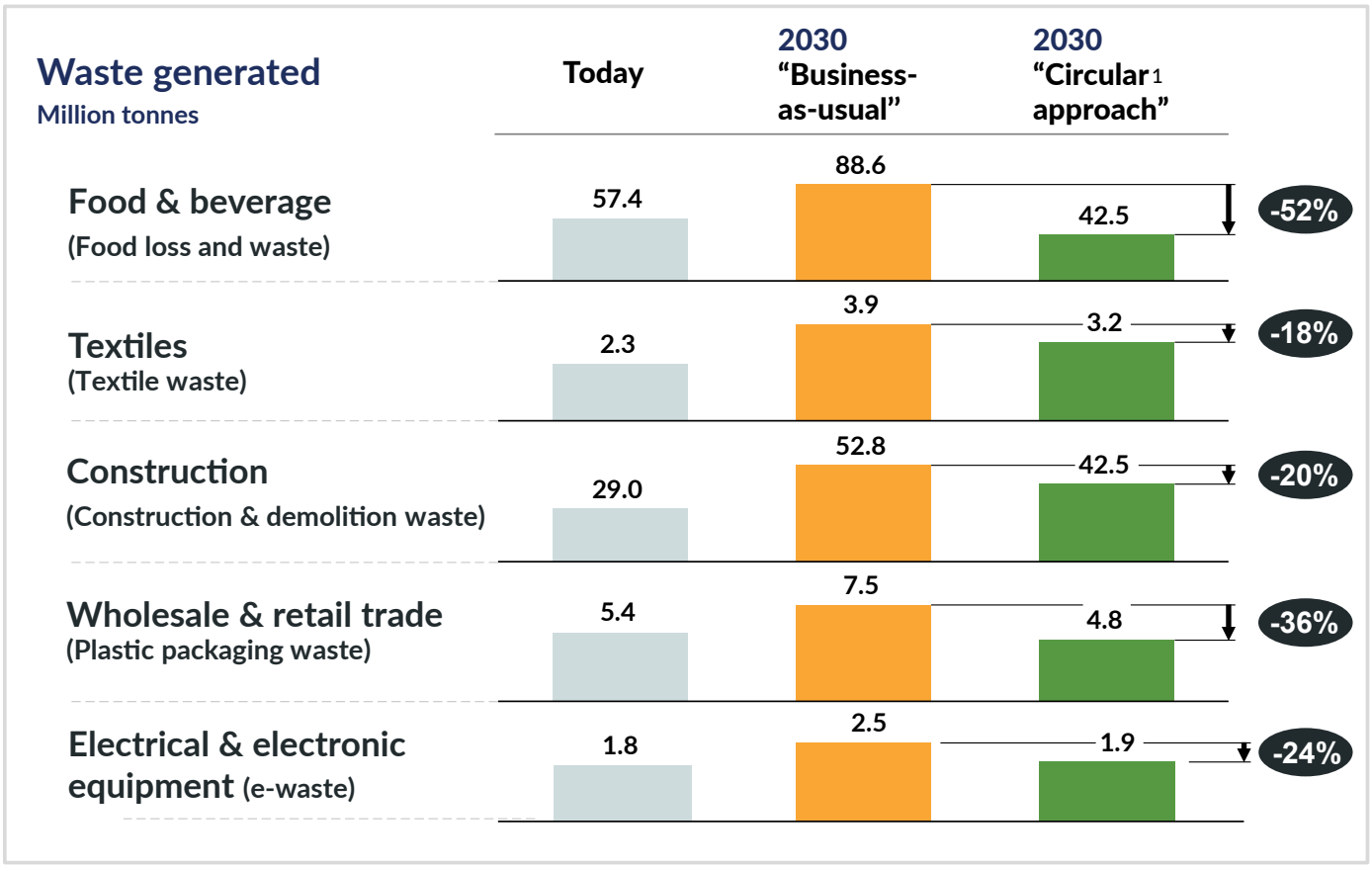
THE ECONOMIC, ENVIRONMENTAL, AND SOCIAL IMPACTS COULD BE SIGNIFICANT

A successful transition towards the circular economy can help Indonesia reduce waste and increase its waste recycling significantly. A circular economy could help the five sectors reduce their waste generated at source by 18-52 percent between 2019 and 2030 (Exhibit 13). To calculate the amount of waste that a circular economy could reduce in 2030, the waste volumes for the five focus sectors were projected for 2030 and the amount of waste that circular opportunities (outlined in Exhibit 12) could reduce relative to a BAU scenario was estimated. The extent to which Indonesia would be able to adopt the circular opportunities was judged based on global case studies. For example, based on data published by Mairizal et al. (forthcoming) on e-waste in Indonesia,[164] it was estimated that Indonesia could generate nearly 2.5 million tonnes of e-waste by 2030. It was assumed that Indonesia could increase its current e-waste recycling rate from five percent to India's e-waste recycling rate of 21 percent by 2030.[165] The increase in e-waste recycling rate could help Indonesia reduce its e-waste by 289,000 tonnes. The details on the impact on waste generation from each circular opportunity are provided in the Annex.

164 Mairizal et al, *Electronic Waste Generation, Distribution Map, and Possible Recycling Routes in Indonesia*. Forthcoming.
165 The Hindu (2017)," E-waste recycling has doubled, says Centre". Available at:
https://www.thehindu.com/news/national/e-waste-recycling-has-doubled-says-centre/article30983383.ece

Exhibit 13

Adoption of the identified circular economy opportunities could decrease waste generation in each sector by 18-52% in 2030



1. The waste figures represent the remaining waste after it is reduced, reused, refurbished, or recycled due to the adoption of circular economy opportunities

SOURCE: BPS; Bank Indonesia; Ministry of Environment and Forestry; WRI; World Economic Forum; ITU; Ellen MacArthur Foundation ; expert interviews (see annex for more details)

Adoption of a circular economy could help Indonesia reduce waste generation at source and increase its waste recycling rates (Exhibit 14). It is important to note that the figures in Exhibit 13 do not precisely match those presented in Exhibit 14. For example, the recycling rate for food loss and waste could increase by four percent (see Exhibit 14) by 2030, however, its impact on the food loss and waste volumes relative to the BAU scenario would be two percent. This is because the increase in recycling rate only applies to the 50 percent of the food loss and waste that remains after reducing the food loss and waste at the post-harvest, supply chain, and consumer stages of the value chain in the F&B sector.

Moreover, there were differences in the rate of waste reduction and recycling between the five sectors. For example, Indonesia could potentially reduce 50 percent of its food loss and waste by 2030, while it could reduce 14 percent of its textile waste by 2030. These differences could be explained by the variation in the potential of the "5R" s across the five sectors (explained earlier in this chapter), as well as two reasons specific to Indonesia and this research design:

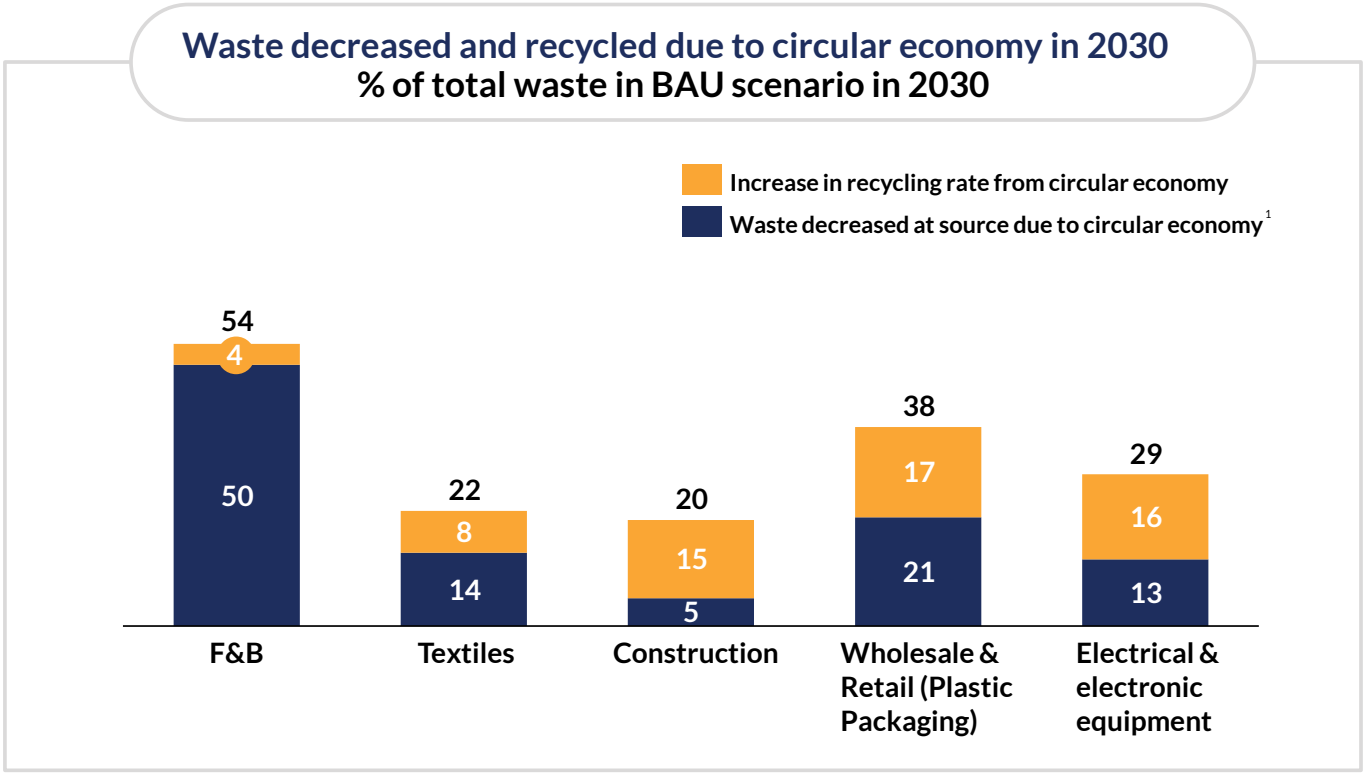
- **Scope of circularity opportunities identified across the value chain.** In some sectors (e.g., food & beverage), circularity opportunities identified cover most of the value chain (from post-harvest through to consumption). In contrast, for other sectors (e.g., textiles), the opportunities were more concentrated in certain areas of the value chain. This research had only identified the main opportunities for tackling waste reduction in the sector, and not all opportunities. In textiles, for example, there could be further opportunities in the supply chain process to tackle waste, such as improving the collection rates of discarded textiles, that were not covered in this research.

- **Potential for improvement.** The potential for improvement from "business-as-usual" varies for each opportunity and sector. This variation is driven by the difference between Indonesia's current levels and the relevant feasible best-practice case study or target. This factor generally accounts for far less of the variation in estimated potential across opportunities and sectors (i.e., the potential for improvement is relatively similar

across different opportunities) as compared to the first factor, "scope of circularity opportunities identified across the value chain".

Exhibit 14

A circular economy in Indonesia could make significant contributions in decreasing waste generation at source and recycling waste



1. The decrease in waste generation at source takes into account the impact of reduction, reuse, and refurbishment circular economy opportunities

SOURCE: BPS; Bank Indonesia; Ministry of Environment and Forestry; WRI; World Economic Forum; ITU; Ellen MacArthur Foundation; expert interviews (see annex for more details)

Transitioning towards a circular economy could create an additional GDP of IDR593-638 trillion (USD42-45 billion) for Indonesia in 2030 (Exhibit 15).[166] This additional economic value is above the BAU scenario where Indonesia does not actively pursue circular economy opportunities. The economic impact from the circular economy could boost overall GDP growth by 2.3-2.5 percent in 2030.

It is important to note that these economic benefits may not necessarily be captured by the five focus sectors. Some of the benefits could be captured by the focus sectors while some could be captured by other sectors (e.g., health or education). The sectors that capture these benefits would depend upon the investment decisions taken by households and businesses. For instance, households could increase their savings by reducing the purchase of new electronics and instead refurbishing them or purchasing second-hand products. The additional household savings could then be invested in the education sector.

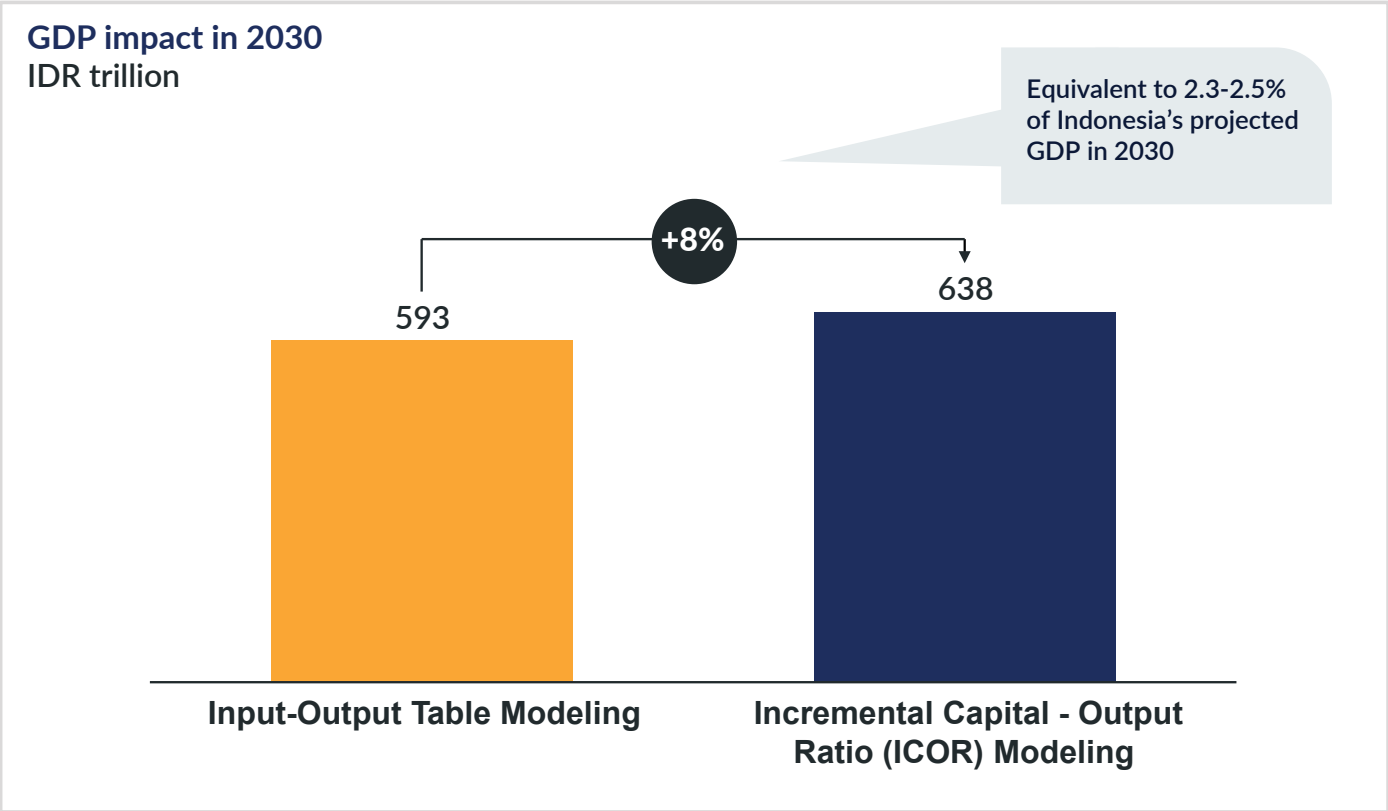
A system dynamics approach was conducted to support the main economic analysis with the findings shown in the Annex. The system dynamics analysis focused only on the direct impact of the five focus sectors (excluding the analysis of the broader economy-wide effects on those sectors, such as the spending of the savings). According to the analysis, the adoption of business efficiency opportunities related to a circular economy (that reduce waste generated relative to production) could create significant benefits to GDP growth and jobs in the focus sectors, but if circular economy opportunity adoption by consumers leads to reduced demand (e.g., by reducing waste at the consumer level and hence their need for additional

166 The range in estimates is due to the use of two methodologies to improve robustness: IO table modelling and ICOR modelling. The estimation of the impact of different circular economy opportunities has been designed to avoid overlaps in opportunities, enabling the individual opportunities to be summed to provide an overall number for each sector and the economy. This approach is described in further detail in the Annex.

purchases of those items), this could lead to slower growth than under business-as-usual (BAU). The analysis shows that a consumer-centric approach could lead to a negative GDP impact of IDR1,563 trillion on the five focus sectors relative to a BAU scenario by 2030 (Exhibit 16).[167] In contrast, a producer-centric approach could generate a positive GDP impact of IDR312 trillion by 2030. A combined consumer and producer-centric approach may only lead to a modest economic impact of IDR21 trillion. These findings must be caveated given they do not take into account the economy-wide multipliers from the spending of savings from a circular economy, but nonetheless, they reinforce the importance of understanding that there will be potential winners and losers from migration to a circular economy, and businesses and policymakers must prepare accordingly to ensure the transition does not adversely impact certain sections of the Indonesian economy and society.

Exhibit 15

A circular economy could generate an additional economy-wide GDP impact of IDR593-638 trillion in 2030

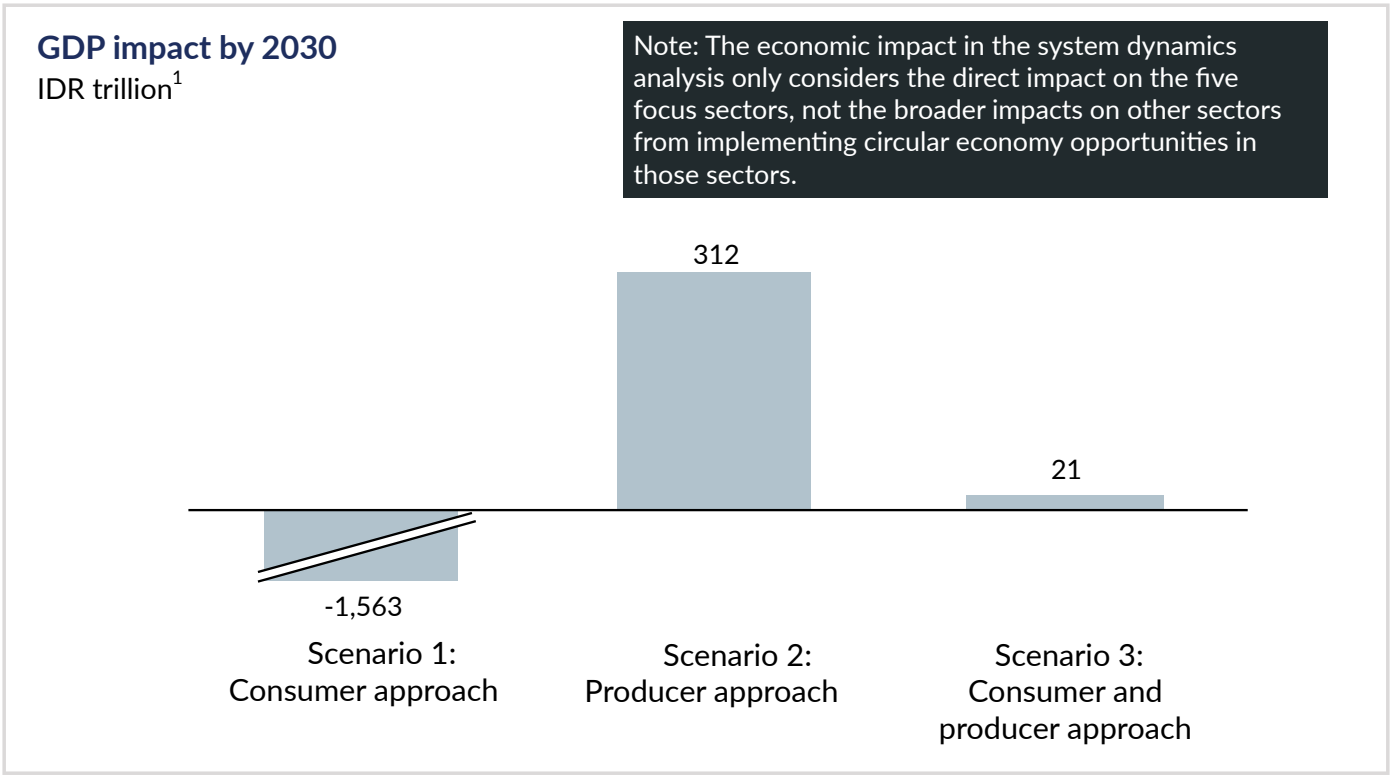


SOURCE: BPS; Bank Indonesia; Ministry of Environment and Forestry; ADB; WRI; ITU; expert interviews (see annex for more details)

167 The estimates in the system dynamics analysis are in constant 2010 prices

Exhibit 16

Based on the system dynamics analysis, the additional GDP impact on the 5 focus sectors could be up to IDR312 trillion by 2030



1. All figures in this exhibit are in constant 2010 prices

SOURCE: Ministry of Environment and Forestry; WRI; World Economic Forum; Ellen MacArthur Foundation; ITU; expert interviews (see annex for more details)

Based on a BAU pathway where Indonesia's labour productivity continues to grow at pre-COVID historical rates and the growth in the workforce increases in line with population growth, Indonesia is likely to see economic growth of around 4.9 percent per year. However, if Indonesia starts implementing circular activities from 2021 onward, and achieves the full economic potential of a circular economy identified in this report by 2030, a circular economy could add 0.6 percentage to its GDP growth (Exhibit 17). Indonesia is likely to realise more of the opportunity closer to 2030 due to time lags in implementation linked to infrastructure investment, behavioural change, regulatory modifications, and skills development.

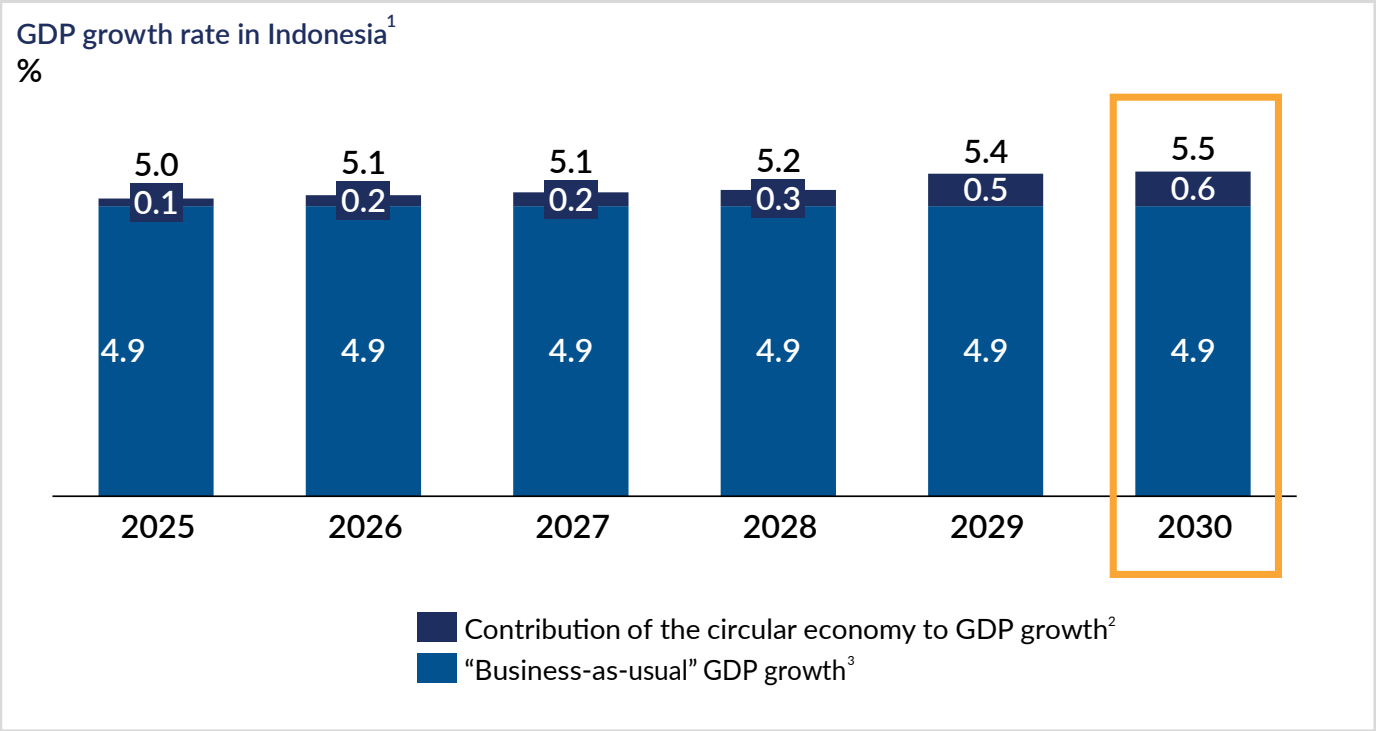
A circular economy can boost Indonesia's GDP in three ways. First, it can improve productivity, particularly of investments, by reducing waste and increasing lifespan of assets. This is important in Indonesia as an analysis by the Asian Development Bank showed that Indonesia has an incremental capital-output ratio (ICOR) of 5.5 versus three to 4 in Singapore, Malaysia, Thailand.[168] This implies that Indonesia needs nearly double the amount of investment to generate the same level of GDP as these countries. By improving capital productivity, this can drive significant growth. Second, a circular economy can create new business models and investment opportunities to drive growth. Work by the Business and Sustainable Development Commission (BSDC) has shown that business opportunities associated with circular business models in automotive, appliances, and electronics sector could be worth USD1.7 trillion by 2030.[169] Third, a circular economy can improve the resilience of the economy to shocks to ecosystem services. WEF / PWC showed that USD44 trillion of global GDP is dependent on ecosystem services (about half of global GDP) and Indonesia's Low Carbon Growth plan showed that there had been a 7.2 percent reduction in gross national income per year due to reductions in natural capital.[170,171]

168 ADB (2016), *Sector assessment (Summary): Industry and trade*. Available at: https://www.adb.org/sites/default/files/linked-documents/48134-006-ssa.pdf
169 BSDC (2017), *Valuing the SDG prize: Unlocking business opportunities to accelerate sustainable and inclusive growth*. Available at: http://s3.amazonaws.com/aws-bsdc/Valuing-the-SDG-Prize.pdf
170 World Economic Forum (2020), *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy*. Available at: http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf
171 Bappenas (2019), *Low carbon development: A paradigm shift towards a green economy in Indonesia. Available at:* https://drive.bappenas.go.id/owncloud/index.php/s/ZgL7fHeVguMi8rG#pdfviewer

Exhibit 17

A circular economy could increase Indonesia's GDP growth rate by 0.6% in 2030

BASED ON IO METHODOLOGY



1. Percentages are rounded off
2. Assumed that Indonesia will start implementing circular economy activities from 2021 and that the benefits from the circular economy will be achieved exponentially from 2021 to 2030
3. The "business-as-usual" growth rate is assumed to be 4.9%. It is calculated by estimating the growth in labour force (1.3%) and the growth in labour productivity (3.6%). Growth in labour force is driven by additional workers joining the work force due to demographics and assuming no change in work-force participation or employment rates. Growth in productivity is estimated using historical trend in Indonesia from 2010-19

SOURCE: BPS; Bank Indonesia; Ministry of Environment and Forestry; World Bank; United Nations Population Division (see annex for more details)

"Based on the analysis, it was estimated that 4.4 million cumulative net jobs could be created between 2021 and 2030 (Exhibit 18). Based on the analysis, 75 percent of the total net jobs created by a circular economy by 2030 could be for women. This is driven by the potential job displacement in male-dominant sectors (e.g., construction, where women make up only two percent of the total jobs) due to a circular economy and the likely job creation in female-dominant sectors (e.g., education, where households could reinvest their savings and where women make up 61 percent of all jobs)[172]. This underlines the importance of a circular economy for improving gender equality in Indonesia and the necessity of a proactive women-centric approach to policy development.

Due to the adoption of circular economy opportunities, there would be some displacement of jobs in upstream, resource-intensive sectors into higher productivity service sector jobs. Such displacement was factored into the calculations for the net jobs estimate shown above. According to the system dynamics analysis, the direct jobs impact in the five focus sectors could vary between -13.9 to 2.5 million jobs based on different scenarios (The details about the scenarios can be found in the Annex).

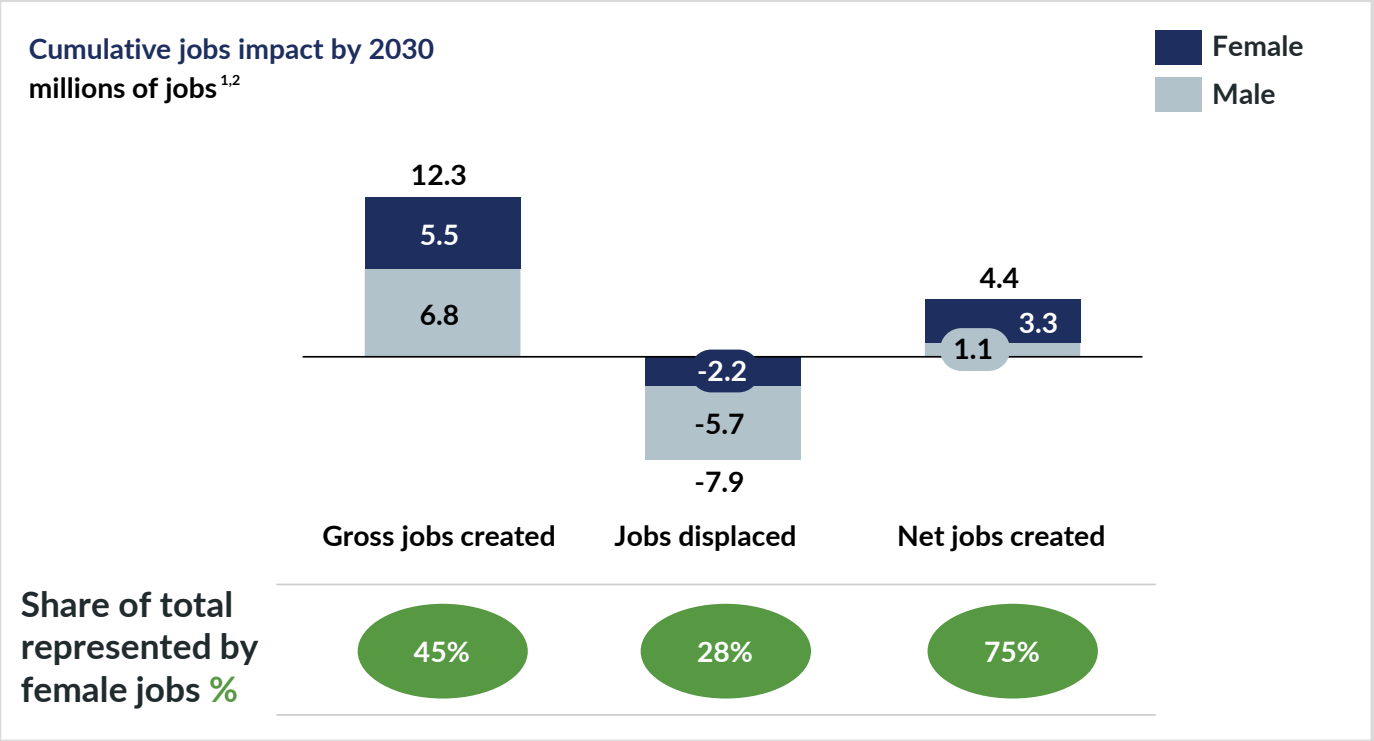
The loss of upstream jobs from the adoption of these circular economy opportunities is potentially likely to happen anyway due to broader technological trends. For example, forthcoming research by the Asian Development Bank (ADB) shows that the importance of routine physical tasks will decline with the application of Industry 4.0 technologies.[173] In the F&B manufacturing sector in Indonesia, by 2030, workers could spend 13 percent less time on physical tasks (which are often a large component of upstream jobs).[174] Supporting these displaced workers to move into alternative employment will require the development of new industry-led TVET (technical vocational education training) programmes. This could be

172 BPS (2018), *Feb 2018 labor force survey.*
173 Asian Development Bank (forthcoming), *Reaping Benefits from Industry 4.0 in High-Growth Industries Through Skills Training Development in Southeast Asia: Indonesia report.*
174 Asian Development Bank (forthcoming), *Reaping Benefits from Industry 4.0 in High-Growth Industries Through Skills Training Development in Southeast Asia: Indonesia report.*

supported by strengthening incentives for firms to invest in worker retraining. For example, the Government of Singapore provides firm subsidies for employee training course fees and absentee payroll salary costs, with higher incentives awarded for government-certified courses.[175]

Exhibit 18

The circular economy could create 4.4 million net jobs by 2030, of which three-quarters could be for women



1. The total jobs in 2030 were calculated by growing the total jobs in Indonesia in 2019 with Indonesia's BAU labour force growth rate of 1.3% till 2030. The total jobs in 2030 are inclusive of the net jobs created by the circular economy in 2030
2. To estimate the jobs created for women in 2030, it was assumed that the gender share of jobs in each sector in 2018 would remain unchanged till 2030. The data from the Labour Force Situation report published by BPS in February 2018 on the gender share of jobs in each of the 17 sectors of Indonesia's economy was used

SOURCE: Bank Indonesia; BPS; World Bank; UN Population Division (see annex for more details)

Understanding the exact number of potential jobs that could be lost is difficult, given limited data availability. However, policies must be in place to support the transition of jobs by retraining displaced workers to fill new roles created by the circular economy. This is especially important in Indonesia, where a significant number of workers are informal workers who lack safety nets and would potentially be at high-risk due to the COVID-19 crisis.[176] Some suggestions to manage this jobs transition are outlined in Box 3. The detailed policy response required will be assessed in detail in the next phase of this project.

175 SkillsFuture Singapore, (2019), "Funding Support for Employers." Available at: https://www.ssg.gov.sg/programmes-and-initiatives/funding/funding-for-employer-based-training.html.
176 Manning (2020), The labour market shock and policy responses to COVID-19." Available at: https://www.dropbox.com/s/ctwixpldp8sxywq/Chris%20Manning%20-%20Covid%20%20and%20Labour%20Markets.pdf?dl=0

Box 3. ***Overview of international approaches to managing jobs transition***

The development of Indonesia's roadmap for the circular economy will look in detail about how to prepare Indonesians for the new jobs that will be created and help transition from the jobs that will be lost. Encouragingly, some useful international examples show how this process can best be managed.

A starting point is a need for clear sector roadmaps. Industry Transformation Maps (ITMs), like in Singapore, provide information on technology impacts, career pathways, the skills required for different occupations, and reskilling options.[177] Co-created by industry, government, and civil society actors, the ITMs also provide a list of training programs for skills upgrading.

There will also be a need to scale up industry-led training programs, which could build on existing successful efforts like the Djarum Foundation's vocational schools which offer practical courses on F&B processing techniques and technologies in laboratory environments.[178]

Flexible skills certification mechanisms will be important, which go beyond traditional qualifications attained through the education system, and recognise the skills upgrading of workers. For example, in Malaysia, individuals who do not possess formal educational qualifications have the opportunity to enter into their desired careers through the Malaysian Skills Certification Program.[179]

There will also be a need for a strong focus on enhancing workplace training. This will include educating businesses about the benefits and availability of new training courses and providing incentives to encourage them to invest in such training programs. For example, the Government of Malaysia's Skills Upgrading Program provides grants covering 70 percent of training fees for small and medium-sized enterprises for technical and soft skills.[180]

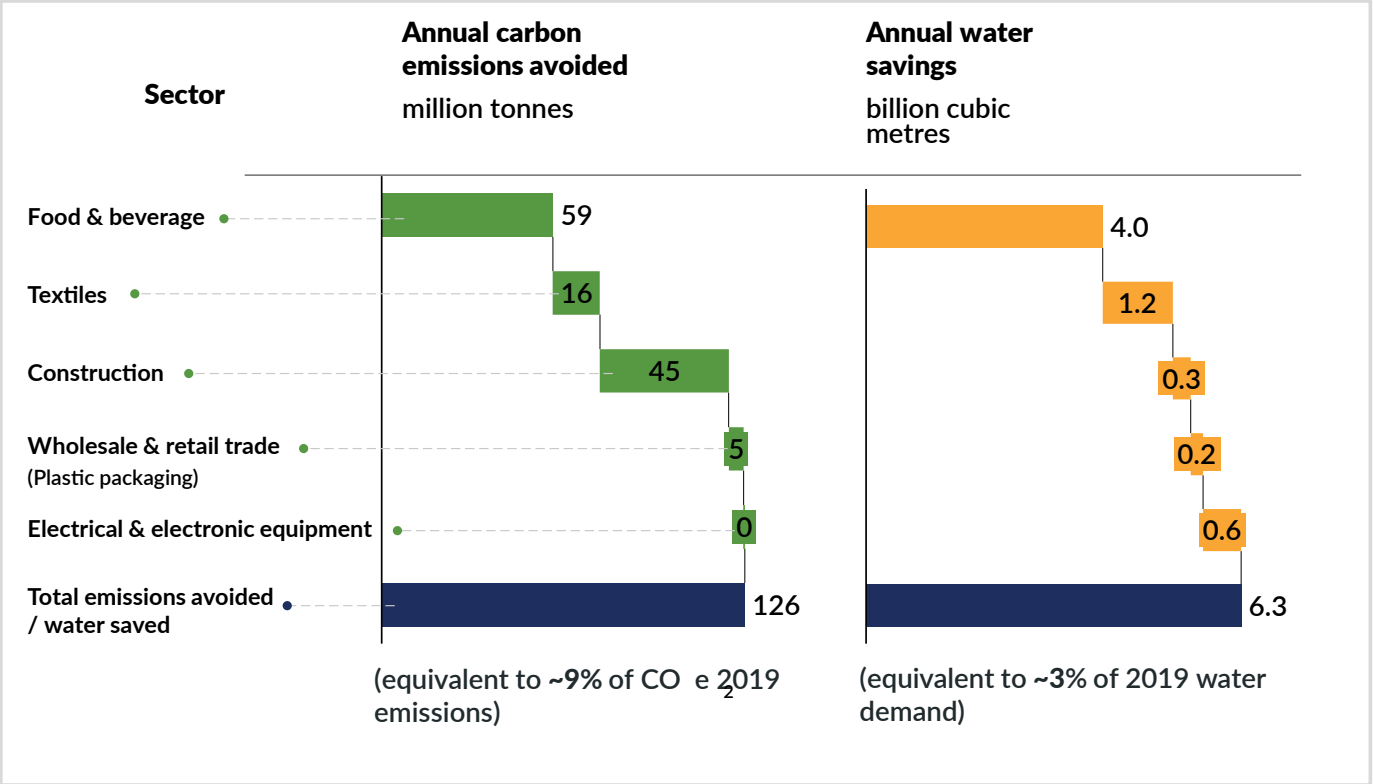
The environmental benefits of a circular economy scenario could also be significant. Exhibit 19 shows that the total carbon emissions avoided under the circular economy scenario (relative to the BAU scenario) are close to 126 million tonnes in 2030 (equivalent to 9 percent of the current total emission levels). Reducing carbon emissions by 126 million tonnes is equivalent to keeping close to 27 million cars off roads for a year. The largest reduction in carbon footprint is in the food & beverage sector. Based on the system dynamics analysis, the annual carbon emissions avoided in 2030 could vary between 79 to 94 million tonnes based on the scenario that Indonesia chooses for its circular economy implementation (i.e., consumer vs producer-centric).

Water savings were also calculated where data was available. In the circular economy scenario, the total water savings across the sectors amount to around 6.3 billion cubic metres in 2030 – enough to meet the demand of nearly 15 million households for a year.

177 SkillsFuture (2019), "Skills Framework". Available at:
https://www.skillsfuture.sg/skills-framework
178 Consultation with KADIN in July 2019; Djarum Foundation (2019), "Vocational School Improvement Program, 2018–2019"
179 Department of Skills Department, "Malaysian Skill Certificate (SKM)". Available at:
https://www.dsd.gov.my/jpky4/index.php/en/malaysian-skills-certificate
180 SME Corp Malaysia (2019), "Skills Upgrading Programme". Available at:
http://www.smecorp.gov.my/index.php/en/slides/86-program-sme/103-skills-upgrading-programme

Exhibit 19

A circular economy could help Indonesia reduce CO_2e emissions by 126 million tonnes and water use by 6.3 billion cubic metres



SOURCE: WRI; World Economic Forum; Ellen MacArthur Foundation; International Energy Agency; expert interviews (see annex for more details)

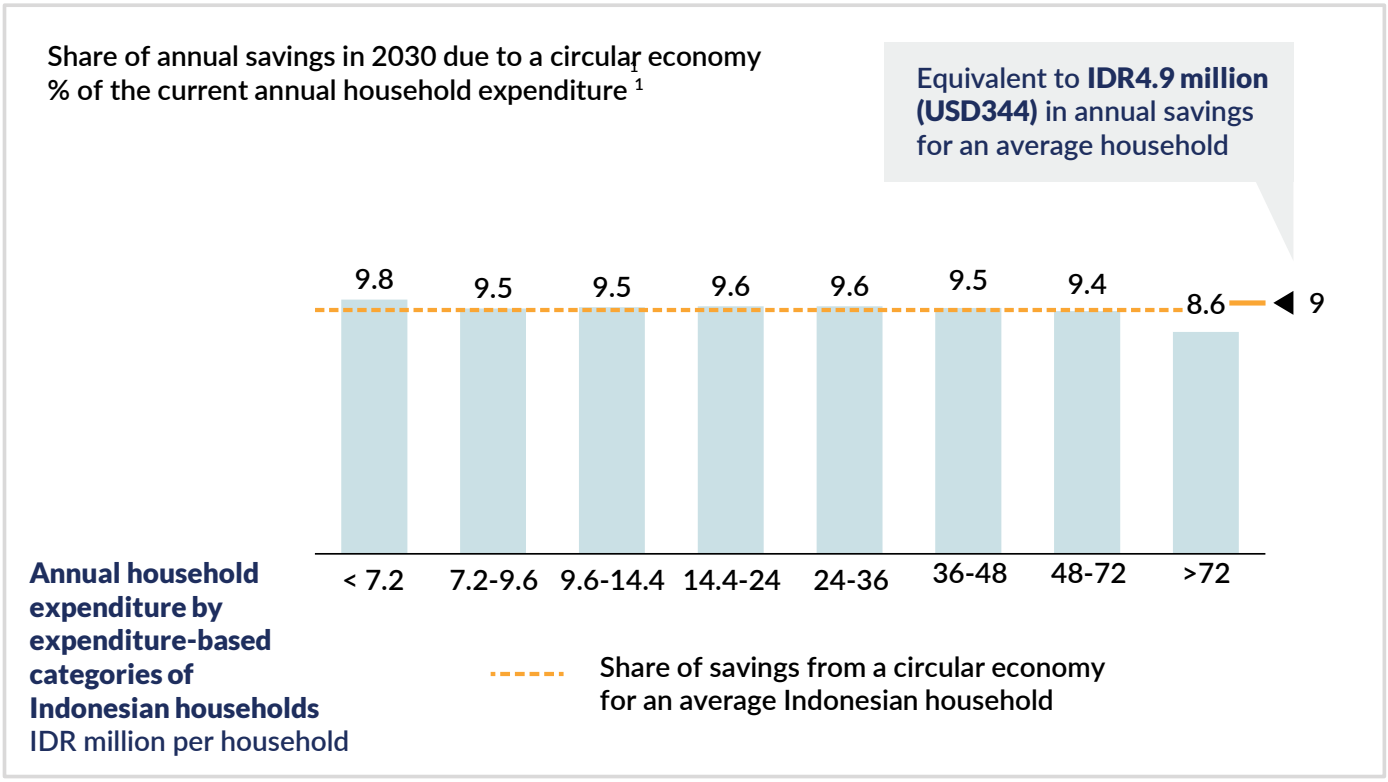
This study also shows that a successful shift towards the circular economy could lead to significant monetary savings for households, either through direct savings from a shift in consumer demand, or a pass-through from producers.[181] Exhibit 20 shows that an average Indonesian household that spends approximately three-quarters of its budget on food and, housing and household facilities (e.g., sanitation and electricity) could save around IDR4.9 million (USD344) or nine percent of its annual household expenditure due to benefits from the circular economy. The savings could have a larger impact on a household from a lower expenditure category. For example, the savings from a circular economy could represent 9.8 percent of the annual household expenditure of a household in the lowest expenditure category (spends less than IDR7.2 million annually).

However, it is important to stress that the annual household savings could be lower than IDR4.9 million (USD344) subject to the implementation approach. For example, it is likely that the introduction of extended producer responsibility (EPR) could increase costs for businesses, some of which could be passed on to consumers. Calculating the impact of such implementation costs on household savings is challenging since the impact would depend on the policies chosen by the Government of Indonesia, their implementation, and the market response.

181 The exact pass-through rate depends on the relative price elasticities of products

Exhibit 20

A circular economy could generate annual savings worth 9% of the total expenditure for an average household in Indonesia in 2030



1. BPS data for an average household from 2018 was used for this purpose. The data for different expenditure-based categories of households was only available for 2016. This data was used to project household spending by item in 2018 for the different household categories. The items listed by BPS in its data were matched to the 5 focus sectors: food and beverage ("total food"); textiles ("clothing, footwear, and headgear"); construction ("housing and household facilities"); plastic packaging ("goods and services"); and electronics ("durable goods")

SOURCE: BPS(see annex for more details)

THE COVID-19 CHALLENGES AND OPPORTUNITY[182]

The emergence of the COVID-19 pandemic will have drastic consequences for Indonesia. Based on the latest government estimates, Indonesia's GDP is expected to shrink by 1.6 to 2.2 percent in 2020.[183] There are a number of key trends linked to COVID-19 that will likely have significant implications for the socio-economic development in Indonesian and circularity.

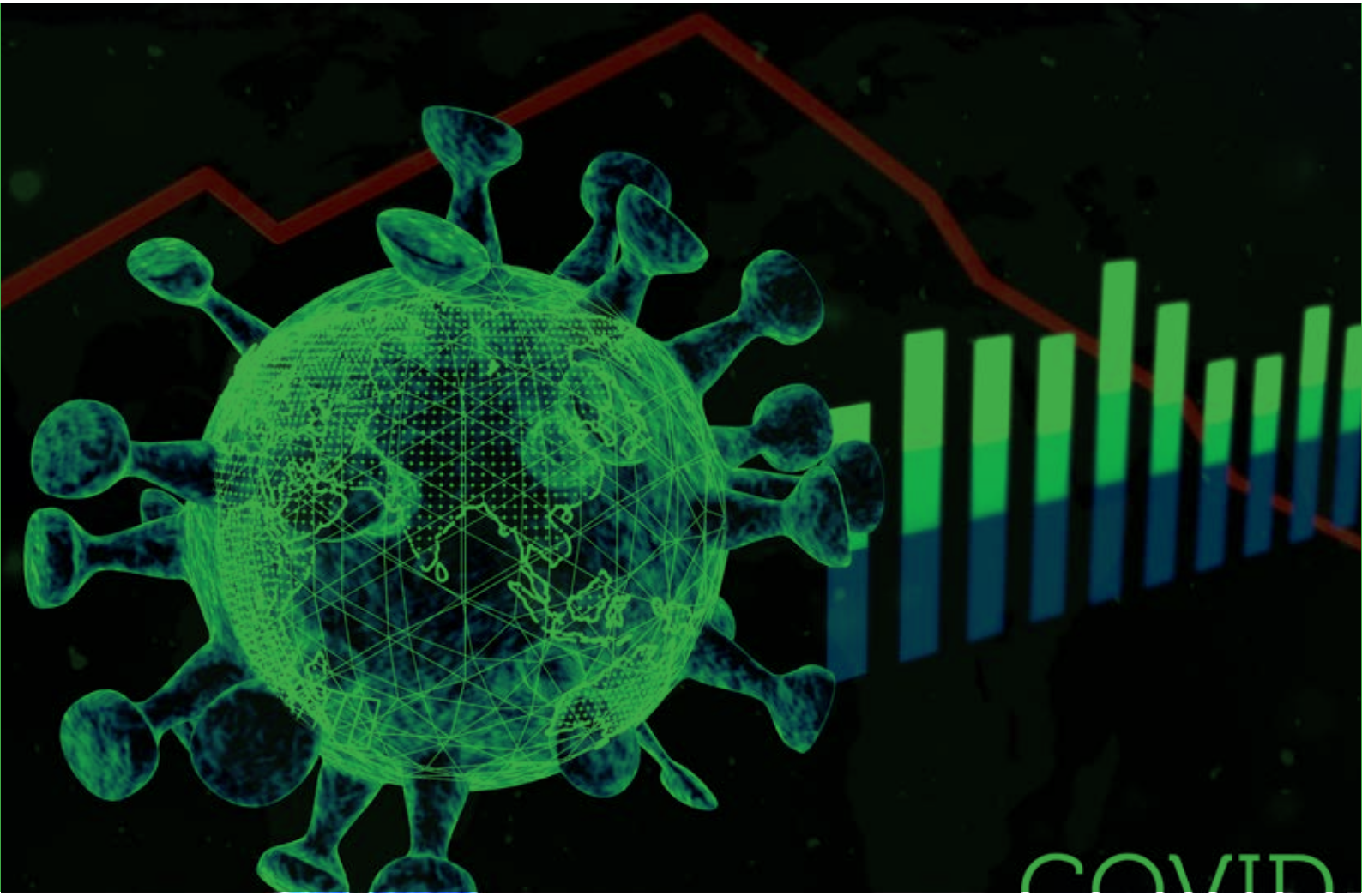
- **Constraints on government finance.** The economic impact of the COVID-19 pandemic will include lower fiscal revenues and rising government debt, potentially constraining future spend. The Government of Indonesia has unveiled a stimulus package worth IDR695 trillion or 4.3 percent of its GDP to tackle the COVID-19 crisis so far.[184] While this could create barriers for required government investment in circular economy opportunities, it could also stimulate demand for circularity opportunities that help improve the efficiency of government spending. For example, Indonesia decided to ration purchases of food staples amid disruptions in imports from China.[185] The Indonesian Government could consider investing in cold storage and other circular opportunities that could reduce food loss and waste and minimise the risk from similar disruptions.
- **Need for MSME support.** Micro Small and Medium-Sized Enterprises (MSMEs) are likely to be particularly impacted by cashflow issues. MSMEs can be significant beneficiaries of a circular economy, but face barriers to participation which must be addressed (which is discussed more in the final chapter).
- **Resilience of supply chains.** COVID-19 has shown the importance of ensuring supply chains remain efficient. Circular economy opportunities can help build resilience by reducing wastage and increasing recycling, reusing, and refurbishing thereby minimising dependency on imports.

182 The estimates in this report were not adjusted for the COVID-19 crisis due to a lack of clarity on the long-term impact of COVID-19 on waste volumes in Indonesia. More details are provided in the Annex.
183 The Jakarta Post (2020), "Govt again revises down 2020 GDP amid year-end surge of COVID-19 cases." Available at: https://www.thejakartapost.com/news/2020/12/22/govt-again-revises-down-2020-gdp-amid-year-end-surge-of-covid-19-cases.html
184 World Bank (2020), *Towards a secure and fast recovery.* Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/34930/Indonesia-Economic-Prospects-Towards-a-Secure-and-Fast-Recovery.pdf?sequence=1&isAllowed=y
185 The Straits Times (2020), "Coronavirus: Indonesia rations purchases of staples, eyes fuel price cuts." Available at: https://www.straitstimes.com/asia/se-asia/coronavirus-indonesia-rations-purchases-of-staples-eyes-fuel-price-cuts

- **Supporting the labour market.** Due to COVID-19, nearly five million people (2.5 percent of the working-age population) became unemployed or exited the labour market and another 24 million individuals (11.8 percent of the working-age population) worked reduced hours.[186] In the third quarter of 2020, the unemployment rate rose by 1.8 percent (compared to the year before) to 7.1 percent. In August 2020, 35 to 50 percent of workers reported earning less than before the crisis. The job impacts of COVID-19 are likely to be felt more acutely by informal workers, overseas migrant workers, and university graduates. Indonesians working overseas face a high risk of losing their jobs as travel restrictions continue and labour migration policies tighten worldwide. Over 3,000 overseas migrant workers originating from Bali were reported to have lost their jobs and were forced to return in April 2020; a further 100,000 from across Indonesia were at risk of losing their jobs as their contracts ended in July 2020.[187,188] With the number of job postings and companies actively hiring declining by 75 percent and 50 percent respectively in April 2020 as compared to March 2020, fresh graduates in Indonesia potentially face difficulties securing employment. This job impact comes against the backdrop of a region that is already facing the potential threat of significant job automation through Industry 4.0 technologies. Identifying efficient channels to re-skill Indonesian workers to shift to new jobs and adjust to changes in their professions will be crucial to soften the negative impact and accelerating the adoption of these circular economy opportunities could play an important role.

It could seem that the COVID-19 pandemic creates a significant challenge to circularity. However, a closer review reveals that a circular economy could have increasing relevance due to the pandemic. This is due to a circular economy being crucial for the economic recovery from COVID-19, as well as strengthening the resilience of supply chains. The Annex discusses the specific implications for COVID-19 for each of the five prioritised sectors.

In the chapters that follow, the economic, social and environmental impact associated with the transition to a circular economy is explored in greater depth in each of the five focus sectors.



186 World Bank (2020), *Towards a secure and fast recovery.* Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/34930/Indonesia-Economic-Prospects-Towards-a-Secure-and-Fast-Recovery.pdf?sequence=1&isAllowed=y
187 Liputan 6 (2020), "Corona COVID-19, Ribuan Pekerja Migran Bali Kehilangan Pekerjaan." Available at: https://www.liputan6.com/regional/read/4219368/corona-covid-19-ribuan-pekerja-migran-bali-kehilangan-pekerjaan
188 BBC (2020), "Virus corona dan pekerja migran: Kemenkes rilis prosedur kepulangan WNI setelah ratusan ribu orang sudah pulang ke Indonesia." Available at: https://www.bbc.com/indonesia/indonesia-52311159

3. Food & Beverage: Tackling food loss and waste

This chapter explores the current status of food loss and waste in Indonesia and how it could evolve under a "business-as-usual" approach to 2030. It then identifies potential circular economy opportunities (based on detailed analysis and extensive stakeholder engagement) and sizes the economic, social, and environmental impact associated with these circularity opportunities.

Adopting circular economy practices could help the food & beverage sector in Indonesia generate an economic impact worth IDR375 trillion (USD26.3 billion) in 2030, create 2.4 million cumulative net jobs between 2021 and 2030 (of which 73 percent could be for women), produce annual household savings worth IDR2.5 million (USD177), and reduce CO_2e emissions and water use by 59 million tonnes and 4 billion cubic metres, respectively in 2030.

THERE IS SIGNIFICANT FOOD LOSS AND WASTE TODAY IN INDONESIA, WHICH COULD INCREASE SIGNIFICANTLY BY 2030

Based on data published by the Ministry of Environment and Forestry and the World Resources Institute, around 57 million tonnes of food was wasted across the value chain in Indonesia in 2019. This does not include the food lost during agriculture production. On a positive note, food loss and waste is receiving increased attention in Indonesia. For example, led by the Food and Land Use Coalition, many stakeholders created the Food Loss and Waste Action Partnership in Indonesia to reduce food loss and waste in Indonesia by 50 percent by 2030.[189] Moreover, a multi-stakeholder coalition has created I-PLAN (Indonesia Post-harvest Loss Alliance for Nutrition) to reduce post-harvest fish losses.[190]

Food loss and waste (excluding loss during agriculture production) can be broken down into several sub-segments (Exhibit 21).

- **Food loss at the post-harvest stage.** In 2019, an estimated 27.8 million tonnes of food was lost at this stage in Indonesia.[191] This includes waste occurring during or immediately after harvesting on the farm, and after produce leaves the farm for handling, storage, and transport. This could be driven by factors such as inadequate storage facilities which leads to edible produce degraded by pests, fungus, or disease poor harvest practices.[192] Apart from physical losses, poor post-harvest practices could also lead to quality losses. For example, in small-scale fisheries in Indonesia, poor on-board handling (e.g., excessive soaking time) contributed to a 28 percent loss in the value of fishes.[193] According to one estimate, the post-harvest loss in Indonesia's fishery sector in the next five years could be valued at IDR63 to 84 trillion every year.[194]

- **Food loss and waste in the supply chain (Distribution and wholesale/retail).** In 2019, an estimated 20.2 million tonnes of food was wasted at this stage in Indonesia. This includes waste during processing, packaging, distribution to food markets, and spoilage at wholesale and retail markets. Due to urbanisation, the food supply chains have been extended. Thus, a lack of infrastructure, such as roads, storage, cooling, and market logistics, can cause edible food to expire or spoil while on the way to distribution channels for sale.[195] According to the Indonesian Cooling Chain Association, in 2014, Indonesia's total fishery production is 14 million tonnes, but the installed capacity of cold storage was only 7.2 million tonnes.[196] Since the fish needs to be transported to markets, the lack of a cold chain can lead to spoilage. A case study on bananas in Indonesia showed distribution times and distance were the main factors responsible for waste generation at the supply chain stage.[197] A study of a leading Indonesian supermarket reveals four leading causes of food waste at the retail stage,[198] including (i) the lack of coordination between supply and demand (e.g., lack of expertise by purchasing manager) that leads to over-ordering; (ii) staff's lack of ability to perform quality checks that would reduce instances of consumer rejection; (iii) poor handling and temperature maintenance of perishable goods; and (iv) failure to adhere to "first-in-first-out" principle where earlier arrived goods are sold first, causing spoilage. Lack of proper storage and handling practices are especially relevant for Indonesia, where most retail is dominated by traditional outlets, like wet markets. While the market share of

189 P4G Partnerships. "Indonesia Food Loss and Waste Action Partnership." Available at: https://p4gpartnerships.org/partnership/indonesia-food-loss-and-waste-action-partnership
190 The Jakarta Post (2020), "Tackling food loss, waste could benefit Indonesia on many fronts: Experts." Available at: https://www.thejakartapost.com/news/2020/09/29/tackling-food-loss-waste-could-benefit-indonesia-on-many-fronts-experts.html
191 Based on team analysis. More information on the estimates can be found in the annex
192 World Resource Institute (2013), *Reducing food loss and waste. Available at:* https://wriorg.s3.amazonaws.com/s3fs-public/reducing_food_loss_and_waste.pdf
193 Wibowo et al (2017), *Case studies on fish assessment of small-scale fisheries in Indonesia.* Available at: http://www.fao.org/3/a-i6282e.pdf
194 JP2GI, *Post—harvest food losses in food and nutrition in the fisheries sector.* Working Paper Series 2: Indonesia Post-Harvest Food Loss Alliance for Nutrition.
195 Julian Parfitt et al (2010), *Food waste within food supply chains: Quantification and potential for change to 2050.* Available at: https://royalsocietypublishing.org/doi/pdf/10.1098/rstb.2010.0126
196 Neraca (2014), "Fasilitas Fiskal Minim - Industri Rantai Pendingin Sulit Berkembang." Available at: https://www.neraca.co.id/article/38959/fasilitas-fiskal-minim-industri-rantai-pendingin-sulit-berkembang
197 Muhammad Noval Irsyadillah et al (2020), *Analysis of Number of Fruit Loss in The Fruit Distribution Process: Case Study of Banana Fruit.* Available at: https://aip.scitation.org/doi/pdf/10.1063/5.0002840
198 The Crawford Fund (2016), *Waste not, want not. The circular economy to food security.* Available at: https://ageconsearch.umn.edu/record/257228/files/Pages%20from%20Conf2016-10.pdf

modern retail is increasing at the expense of traditional outlets,[199] traditional retail remains dominant in Indonesia. As of 2018, traditional grocery outlets had more than 80 percent market share in the retail sales of packaged food, soft drinks, and alcoholic drinks.[200] While some practices associated with modern retail, such as better infrastructure, may decrease food waste generation, other practices, such as strict aesthetic standards imposed by supermarkets, can increase food waste generation.[201] According to the FAO, about 25-30 percent of carrots in the world, don't make it to the grocery store because of physical or aesthetic defects.[202] Moreover, bulk offers and "buy one get one free" marketing of modern retail could lead to over-purchase and eventual spoilage of food products.[203]

- **Food waste at consumption.** In 2019, an estimated 9.3 million tonnes of food was wasted at this stage in Indonesia. This includes wastage that occurs in the home or business of the consumer, including restaurants and caterers.[204] This is driven by a range of factors, including lack of consumer understanding of use-by dates and cultural tendencies towards an oversupply of food (e.g., excessive food at celebrations such as weddings).[205] The practise of "gifting" and storing excessive food in refrigerators among upper-class Indonesians is also considered to be a significant driver in generating food waste at the consumer stage.[206]

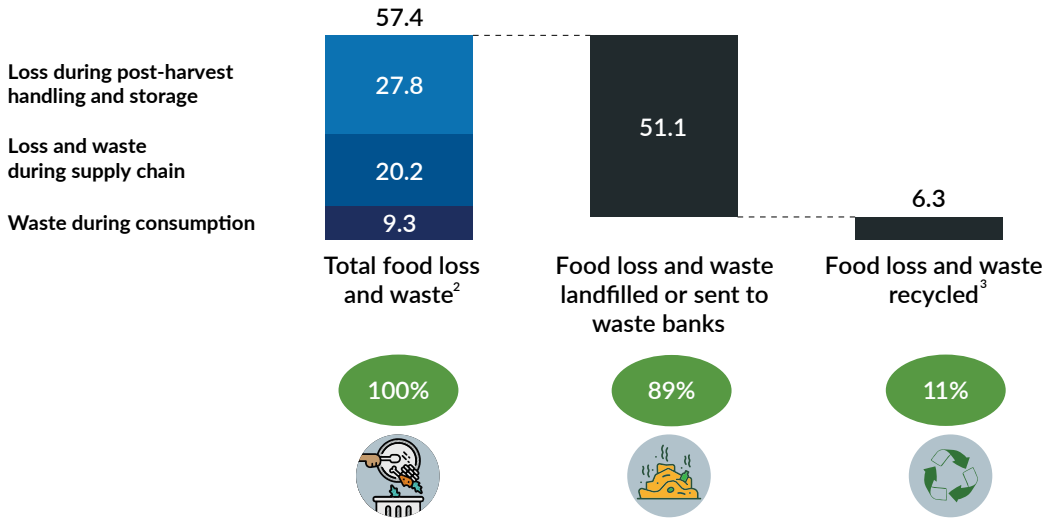
At present, only around 11 percent of food loss waste is estimated to be recycled in Indonesia, for composting, biogas, or fuel purposes. An example of best practice is South Korea, which has raised its food waste recycling rate from just two percent in 1995 to 95 percent.[207] South Korea achieved this through a range of policy measures from the banning sending food to landfills and having designated food waste collection buckets, to enforcing consumers to purchase biodegradable bags for food disposals, where the proceeds are used to fund the country's waste management system.[208]

Exhibit 21

FOOD AND BEVERAGE

Currently, only 11% of food loss and waste is estimated to be recycled in Indonesia

Quantity of food loss and waste at each stage of value chain in 2019[1]
Million tonnes



1. Calculated based on total waste estimates of the Ministry of Environment and Forestry in 2019, FAO's estimates for growth in Indonesia's food demand, and WRI's estimates for the average amount of food lost and wasted in South and Southeast Asia in the food value chain
2. Excludes waste generated at production stage
3. Calculated based on National Waste Management 2018 estimates given in Dr. Novrizal Tahar's presentation on Pengelolaan Sampah Plastik in 2019. Recycling includes food waste used for composting, biogas, and fuel

SOURCE: WRI; Ministry of Environment and Forestry; FAO (see annex for more details)

199 Daniel Suryadarma et al (2010), *Traditional food traders in developing countries and competition from supermarkets: Evidence from Indonesia*. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0306919209001304
200 Global Agriculture Information Network (2019), *Indonesia – Retail Foods Update*. Available at: https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Retail%20Foods_Jakarta_Indonesia_7-1-2019.pdf
201 Soma (2017), *Wasted infrastructures: Urbanization, distancing and food waste in Bogor, Indonesia*. Available at: https://www.ingentaconnect.com/contentone/alex/benv/2017/00000043/00000003/art00010?crawler=true&mimetype=application/pdf
202 FAO (2018), "Beauty (and taste!) are on the inside." Available at: http://www.fao.org/fao-stories/article/en/c/1100391/
203 Tristram Stuart (2009), *Waste: Uncovering the Global Food Scandal*.
204 World Resource Institute (2013), *Reducing food loss and waste. Available at:* https://wriorg.s3.amazonaws.com/s3fs-public/reducing_food_loss_and_waste.pdf
205 The Jakarta Post (2018), "Indonesia takes a bite out of food waste one wedding at a time". Available at: https://www.thejakartapost.com/news/2018/06/20/indonesia-takes-a-bite-out-of-food-waste-one-wedding-at-a-time.html
206 Tammara Soma (2018), *Planning from "Table to Dump": Analyzing the Practice of Household Food Consumption and Food Waste in Urban Indonesia*. Available at: https://tspace.library.utoronto.ca/bitstream/1807/95706/1/Soma_Tammara_R_201806_PhD_thesis.pdf
207 World Economic Forum (2019), "South Korea once recycled 2% of its food waste. Now it recycles 95%." Available at: https://www.weforum.org/agenda/2019/04/south-korea-recycling-food-waste/
208 Huffington Post (2019), "The country winning the battle on food waste". Available at: https://www.huffpost.com/entry/food-waste-south-korea-seoul_n_5ca48bf7e4b0ed0d780edc54

In a "business-as-usual" approach, total food loss and waste could get significantly worse in Indonesia by 2030, increasing by 54 percent to 89 million tonnes (Exhibit 22). Rising incomes and urbanisation directly contribute to higher food loss and waste under BAU conditions. For example, according to the FAO, high-income countries tend to generate more food loss and waste than low to medium-income countries.[209] Higher-income households tend to over-purchase from supermarkets (compared to wet markets and traditional warungs) and stock up food in refrigerators rather than buy what is necessary on a daily basis.[210] Urbanisation in Indonesia may not only lead to a shift in food consumption patterns[211] but could also exacerbate food loss and waste through ever-growing distances between consumption and production centres because these extended supply chains are often not adequately equipped to prevent spoilage and losses. Urbanisation could negatively affect resource effectiveness in the food sector in other ways too. For example, a study of Bogor shows that sustainable food waste management practices traditionally practised in the city, such as burying or composting waste, are becoming increasingly challenging due to pressures related to urban development.[212]

Exhibit 22

FOOD AND BEVERAGE

Food loss and waste could get worse by 2030

Growing consumer class

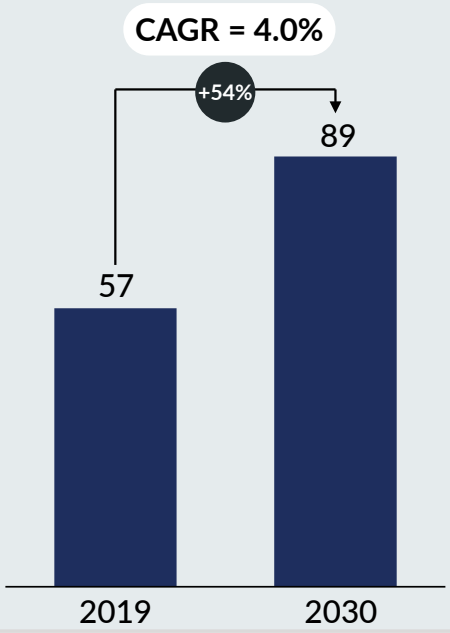
- An estimated 90 million Indonesians could join the ranks of the consuming class by 2030, creating higher demand for food
- Higher per capita incomes tend to lead to greater food wastage at the consumption stage

Higher urbanisation rate

- Over 35 million people are expected to move to cities in Indonesia between now and 2030
- Urbanisation leads to longer supply chains as consumption moves away from production centres, likely leading to greater losses in the supply chain

Estimated increase in food loss and waste[1,2]

Food loss and waste in Indonesia
million tonnes



1. Calculated based on total waste estimates of the Ministry of Environment and Forestry in 2019 and FAO's estimates for growth in Indonesia's food demand
2. Excludes waste generated at production stage

SOURCE: United Nations Population Division, WRI; Ministry of Environment and Forestry; World Bank (see annex for more details)

209 FAO (2011), *Extent of food losses and waste.* Available at: http://www.fao.org/3/mb060e/mb060e02.pdf
210 Soma (2017), *Wasted infrastructures: Urbanization, distancing and food waste in Bogor, Indonesia.* Available at: https://www.ingentaconnect.com/contentone/alex/benv/2017/00000043/00000003/art00010?crawler=true&mimetype=application/pdf
211 Warr (2020), *Urbanisation and the Demand for Food.* Available at: https://www.tandfonline.com/doi/abs/10.1080/00074918.2020.1742285?journalCode=cbie20
212 Soma (2017), *Wasted infrastructures: Urbanization, distancing and food waste in Bogor, Indonesia.* Available at: https://www.ingentaconnect.com/contentone/alex/benv/2017/00000043/00000003/art00010?crawler=true&mimetype=application/pdf

THERE ARE LARGE ECONOMIC, SOCIAL, AND ENVIRONMENTAL COSTS ASSOCIATED WITH FOOD LOSS AND WASTE

The potential increase in food loss and waste could be a matter of concern for Indonesia, given the economic, social, and environmental costs associated with it. For example, annual fish losses in Indonesia were estimated to be worth USD135 to 226 million.[213] Elsewhere, the Indonesian Government spends around USD1.5 billion to deliver subsidised food to the poor (including the RASTRA program which replaced the RASKIN program),[214] and more than USD2.3 billion on fertiliser subsidies annually.[215] If Indonesia were to reduce its food loss and waste, fulfilling the food demand may require lower public funds and these funds could be redirected to other pressing areas such as infrastructure. Lower food loss and waste generation could also help lower food prices for consumers. Indonesian consumers are paying more than twice what their ASEAN peers are paying for rice.[216] Finally, Indonesia's food imports are an increasingly large proportion of its total imports, directly contributing to the country's persistent current account deficits that have made the Rupiah the most volatile Asian currency in 2018.[217]

Food loss and waste also has significant social consequences. Indonesia ranks 62nd out of 113 countries in terms of food security.[218] According to the Global Alliance for Improved Nutrition (GAIN), the annual loss of fresh fish in Indonesia leads to a loss of 16,500 – 27,500 tonnes of protein, which is equivalent to the daily needs of 2.7 – 4.4 million children in Indonesia.[219]

Finally, food loss and waste has significant implications for the environment. Currently, around 70 percent of waste that goes to Indonesian landfills is organic, primarily from food waste.[220] Food waste sent to landfills decomposes and releases greenhouse gases like methane, a powerful greenhouse gas with 28 times the heat-trapping power of carbon dioxide. A study estimated that Jakarta's landfills alone generate nearly seven million tonnes of CO_2e emissions from treating the city's municipal solid waste (MSW), which includes food waste.[221] Indonesia's waste contributes 64.7 million tonnes or three percent of its total CO_2e emissions.[222] Residents living near landfills can suffer from several health problems due to the harmful by-products released during the degradation process of waste.[223] Moreover, food waste makes up 44 percent of Indonesia's landfill waste and hence, it is a major contributor to the capacity constraints Indonesia's landfills are facing.[224] For example, the Supit Urang landfill in Malang is only capable of processing around 70 percent of the city's daily waste, while the Sarimukti landfill can only process around half of the waste produced by the four cities (Bandung City, Cimahi, Bandung and West Bandung) that are sharing the landfill.[225] Furthermore, more than half of Indonesia's landfills, including Suprit Urang, still operate as open-dumping sites where waste is disposed of in a way that is environmentally unfriendly and has a high risk of fires.[226] Due to problems of insufficient budget, inadequate equipment, uncollected waste, and unplanned future landfill locations faced by Indonesia's local governments, developing sanitary landfills remains a challenge in Indonesia.[227]

213 Dalberg (2017), "GAIN's Indonesia "Postharvest Loss Alliance for Nutrition (I-Plan)."
214 OECD (2020), *Agricultural policy monitoring and evaluation 2020: Indonesia*. Available at:
https://www.oecd-ilibrary.org/sites/9e2cf2f4-en/index.html?itemId=/content/component/9e2cf2f4-en
215 FFTC Agricultural Policy Platform (2018), *"An overview of Indonesia's agricultural policies in 2018"*. Available at:
http://ap.fftc.agnet.org/ap_db.php?id=903
216 Indonesia Expat (2017), "Indonesian Rice Prices Double Global Average". Available at:
https://indonesiaexpat.biz/news/indonesia-high-rice-price/
217 Jakarta Post (2018), "Rupiah regains most volatile crown". Available at:
https://www.thejakartapost.com/news/2018/08/23/rupiah-regains-most-volatile-crown.html
218 The Jakarta Post (2020), "Indonesia's food security good, but climate change lurks as threat: Report". Available at:
https://www.thejakartapost.com/news/2020/01/14/indonesias-food-security-good-but-climate-change-lurks-as-threat-report.html
219 GAIN (2020), "Driving Innovation and collective action in Indonesia's fish value chain." Available at:
https://www.gainhealth.org/sites/default/files/publications/documents/driving-innovation-and-collective-action-in-indonesia-fish-value-chain.pdf
220 State of the Green (2018), "Turning waste into value in Indonesia". Available at:
https://stateofgreen.com/en/partners/state-of-green/news/better-waste-management-in-indonesia-and-more-landfills/
221 Aprillia, et al (2015), *GHG Emissions Estimation from Household Solid Waste Management Jakarta and Surabaya*. Available at:
http://www.ilcan.or.id/wp-content/uploads/2015/12/GHG-Emission-Estimation-from-Housesold-SWM-in-Jakarta-and-Surabaya_Aprilia-Aretha_new.pdf
222 USAID (2017), *GHG Emissions Factsheet Indonesia*. Available at:
https://www.climatelinks.org/sites/default/files/asset/document/2017_USAID_GHG%20Emissions%20Factsheet_Indonesia.pdf
223 Prince O. Njoku et al (2019), *Health and Environmental Risks of Residents Living Close to a Landfill: A Case Study of Thohoyandou Landfill, Limpopo Province, South Africa.* Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6617357/
https://www.eco-business.com/news/landfills-have-a-huge-greenhouse-gas-problem-heres-what-we-can-do-about-it/
224 Republic of Indonesia (2017), *Presidential Regulation No. 97 of 2017*. Available at:
http://ditjenpp.kemenkumham.go.id/arsip/ln/2017/ps97-2017.pdf
225 *The Jakarta Post (2019)*, "*Inadequate landfills worsen Indonesia's waste problems*". *Available at:*
https://www.thejakartapost.com/news/2019/03/03/inadequate-landfills-worsen-indonesias-waste-problems.html
226 *The Jakarta Post (2019)*, "Inadequate landfills worsen Indonesia's waste problems". *Available at:*
https://www.thejakartapost.com/news/2019/03/03/inadequate-landfills-worsen-indonesias-waste-problems.html
227 Christia Meidiana and Thomas Gamse (2010), *The new Waste Law: Challenging opportunity for future landfill operation in Indonesia.*

CIRCULARITY OPPORTUNITIES COULD POTENTIALLY TRANSFORM THIS SECTOR

Analysis of global approaches and extensive engagement with local stakeholders revealed four circularity opportunities to complement the existing efforts by the Government of Indonesia (Box 4).

Box 4. *Overview of existing Indonesian government policies to combat food loss and waste*

Various national policies regulate food loss waste. These include Law No. 18/2008 Concerning Solid Waste Management, Law No. 32/2009 Concerning Environmental Protection & Management, and Government Regulation No. 81/2012 Concerning Household Solid Waste & Household-Like Solid Waste Management. Ministry of Agriculture's Regulation No 44/ 200 also details Good Handling Practices (GHP) to reduce post-harvest food losses.

The Government has established national waste management policies and strategies known as JAKSTRANAS – based on Presidential Regulation No. 97 of 2017 concerning National Waste Management Policies and Strategies for household and household-related waste. Through the JAKSTRANAS policy, the Government is targeting to reduce waste by 30 percent and to handle the remaining 70 percent by 2025. These targets apply to all household and household-related waste, including food, textile, and plastic waste.

To manage food waste, Indonesia is also considering anaerobic digesters. In Indonesia, a government initiative implemented low-cost household anaerobic digestion systems.[228] Moreover, several small-scale pilots have taken place at the regional level.[229,230] Anaerobic digesters where organic matter such as animal or food loss and waste is broken down in the absence of oxygen to produce biogas and bio-fertiliser are a sustainable alternative to manage food waste over incineration-reliant waste-to-energy (WtE) plants.[231] Incineration is not the most sustainable method to recover food loss and waste for several reasons.[232,233] First, incineration reduces the economic value of organic waste since it inhibits the recovery of valuable chemical compounds and nutrients from the waste. Second, WtE plants are likely to suffer from a high share of organic waste in Indonesia's waste mix, since high moisture content found in organic waste is problematic for the energy balance of incinerators. Third, WtE plans create a "lock-in-effect". Once installed, the plans must be continually fed with waste and become a barrier to waste avoidance, recycling, and other initiatives, which could capture more of the value of the waste flows.

Based on a literature review, focus group discussions, and expert interviews, the "Reuse", "Refurbish", and "Renew" approaches are not relevant in this sector (Exhibit 23).

228 Usack et al (2014), *Improved Design of Anaerobic Digesters for Household Biogas Production in Indonesia: One Cow, One Digester, and One Hour of Cooking per Day*. Available at: https://www.hindawi.com/journals/tswj/2014/318054/
229 Mohammad Helmy (2015), *Promoting anaerobic digestion of municipal solid waste in Indonesia*. Available at: https://www.unescap.org/sites/default/files/Indonesia%20Solid%20Waste%20Association%2C%20Indonesia.pdf
230 Marco Ghiandelli (2017), *Development and implementation of small-scale biogas balloon biodigester in Bali, Indonesia*. Available at: https://www.diva-portal.org/smash/get/diva2:1198348/FULLTEXT01.pdf
231 Swati Hegde and Thomas A. Trabold (2019), *Anaerobic Digestion of Food Waste with Unconventional Co-Substrates for Stable Biogas Production at High Organic Loading Rates*. Available at: https://www.mdpi.com/2071-1050/11/14/3875/pdf; Anqi Gao et al (2016), *Comparison between the technologies for food waste treatment*. Available at: https://www.sciencedirect.com/science/article/pii/S1876610217308883
232 Kunwar Paritosh et al (2017), *Food Waste to Energy: An Overview of Sustainable Approaches for Food Waste Management and Nutrient Recycling*. Available at: https://www.hindawi.com/journals/bmri/2017/2370927/
233 National Geographic (2019), "Is burning plastic waste a good idea?" Available at: https://www.nationalgeographic.com/environment/2019/03/should-we-burn-plastic-waste/

Exhibit 23

FOOD AND BEVERAGE

The "Reduce" and "Recycle" approaches offer the highest potential for circularity in the food & beverage sector in Indonesia

High potential | Low potential | Prioritised for further assessment

Qualitative assessment of potential in Indonesia

REDUCE	The Food Loss and Waste Action Partnership aims to reduce Indonesia's food loss and waste by 50% by 2030
REUSE	Not relevant since food is a single-use good
RECYCLE	~11% of food waste is estimated to be recycled in Indonesia. In the US, 25% of food waste is used to produce compost and energy
REFURBISH	Not relevant since food is a single-use good
RENEW	More renewable sources of energy could be used in the food value chain but that could have limited impact on food loss and waste

SOURCE: WRI; Environmental Protection Agency (EPA); focus group discussions; expert interviews

The United States' Environmental Protection Agency (EPA) provides clear guidance on the actions that stakeholders should prioritise for sustainable management of food. It suggests that the reduction of food waste at source should be the top priority followed by feeding hungry people, feeding animals using food scraps, using food waste for industrial uses, and using food waste for composting. Landfilling or incineration should be the last resort for stakeholders.[234]

Four circular opportunities for this sector were identified that represent significant potential (Exhibit 24).

234 EPA, "Sustainable Management of Food." Available at: https://www.epa.gov/sustainable-management-food

Exhibit 24

FOOD AND BEVERAGE

Examples of circular economy opportunities and benefits in the food & beverage sector

#	Circular opportunities	5Rs	Brief description	Significance/Examples
1	**Reduce post-harvest food loss**	**Reduce**	Overcoming wastage due to poor storage facilities and insufficient infrastructure, particularly amongst smallholders	37% of food loss and waste occurs during the post-harvest stage in South and Southeast Asia[1]
2	**Reduce supply chain food loss**	**Reduce**	Reducing food loss and waste during processing, packaging, and distribution of food. Example levers to reduce waste include affordable cold storage transportation systems and new packaging films	19% of food loss and waste occurs during the supply chain stage in South and Southeast Asia
3	**Reduce consumer food waste**	**Reduce**	Reducing food waste at the point of consumption. Example levers include better information on "use by" labelling, trayless dining, etc.	13% of food waste occurs during the consumption stage in South and Southeast Asia
3	**Process food loss and waste**	**Recycle**	Finding more productive uses of food waste, such as energy, composting, and nutrient extraction. This includes bio-refineries that capture the full value of by-product and waste streams by extracting several different products	Impact assessment suggests that cascading bio-refineries could create an annual value of EUR300 - 500 million in Denmark by 2035

1. Based on WRI's estimates for the average amount of food loss and wasted in South and Southeast Asia in the food value chain

SOURCE: Ellen MacArthur Foundation; WRI; focus group discussions; expert interviews

- **Reduce post-harvest food loss.** This includes the reduction of wastage that occurs due to poor storage facilities (e.g., warehouses or granaries), the use of improper harvesting methods such as rough handling, untimely harvesting, or the use of improper packaging that reduces shelf-life of food.[235] Building better storage infrastructure and improving post-harvest handling could be two levers that help Indonesia reduce post-harvest food loss. For instance, improved onboard handling of fishes has shown to reduce losses by 30 percent in Indonesia.[236] Reducing food loss could have several benefits, particularly for farmers in the long-term. Research suggests that reducing food loss may depress market prices if the demand for that crop is elastic, but it may provide incentives to farmers to move toward more high-value crops, which could increase their incomes in the long-term.[237]

- **Reduce supply chain food loss and waste.** This refers to the reduction of food loss and waste during processing, packaging, and distribution of food. Example levers to reduce wastage include affordable cold storage transportation systems, improved logistics, and shortening food supply chains. As mentioned earlier, according to the Indonesian Cooling Chain Association, in 2014, Indonesia's total fishery production was 14 million tonnes, but the installed capacity of cold storage was only 7.2 million tonnes.[238] Apart from reducing supply chain food loss and waste, improved logistics and transportation could also help farmers secure better margins for their produce. On occasions, the prices received by Indonesian farmers are unable to cover their cost of transportation. For example, tomato farmers in Garut, West Java, in 2016 expecting prices of IDR3,000 (nearly USD0.2) per kilogramme but

235 Victor Kiaya (2014), *Post-harvest losses and strategies to reduce them*. Available at: https://www.actioncontrelafaim.org/wp-content/uploads/2018/01/technical_paper_phl__.pdf
236 Wibowo et al (2017), *Case studies on fish assessment of small-scale fisheries in Indonesia*. Available at: http://www.fao.org/3/a-i6282e.pdf
237 National Academies Press (2019), "Reducing Impacts of Food Loss and Waste: Proceedings of a Workshop". Available at: https://www.ncbi.nlm.nih.gov/books/NBK542000/
238 Neraca (2014), "Fasilitas Fiskal Minim - Industri Rantai Pendingin Sulit Berkembang." Available at: https://www.neraca.co.id/article/38959/fasilitas-fiskal-minim-industri-rantai-pendingin-sulit-berkembang

were quoted IDR500 (nearly USD0.04) upon harvest. They ended up disposing of their tomatoes. Due to labour costs, transportation costs, and other costs associated with selling crops, the farmers would have incurred a bigger financial loss from selling their crops than disposing of them.[239]

An improved transport infrastructure could help farmers lower their costs and secure higher prices by removing middlemen in the supply chain. Companies are exploring the farm-to-table business model in Indonesia that could shorten supply chains, reduce food waste, and provide improved prices to the farmers. For example, Limakilo, Sayurbox, and Tanihub have established online marketplaces that allow consumers to purchase fresh produce directly from farmers.[240] Eden Farm is another start-up that aims to directly supply produce from farmers to restaurants in Indonesia's cities in a bid to improve prices for the farmers and reduce food waste.[241] Policymakers, however, should be cognizant of the spillover effects of such business models. For example, the adoption of online marketplaces could lead to a rise in plastic packaging waste.[242]

Adoption of technologies could also help Indonesia reduce food loss and waste during the supply chain stage. Research from India suggests that the adoption of Programmable Logic Controllers (PLCs), Machine to Machine (M2M) communication systems, and Enterprise Resource Planning (ERP) software could help reduce food loss and waste by improved tracking and monitoring of food supply chains.[243]

- **Reduce consumer food waste.** This refers to the reduction of food waste at the point of consumption. Existing efforts in Indonesia are aiming to reduce food waste generated at this stage. FoodCycle, an NGO, supplies leftover wedding dishes to some of the poorest members of the society. Till 2018, it had serviced 37 weddings and transformed two tonnes of leftovers into 2,600 portions of food, which were distributed at food banks in South and East Jakarta.[244] While such efforts are focused on redistributing leftovers, Indonesia could also consider initiatives that reduce the generation of consumer food waste at source. These include providing better information to consumers on "use by" labelling, initiating tray-less dining, reducing buffets, and reducing portion sizes at restaurants. Studies have demonstrated that Indonesian cultural or religious teachings could be helpful in reducing food wastage.[245] Such local teachings could counter other cultural tendencies that lead to waste generation, such as over-supply of food at celebratory events like weddings.

- **Process food loss and waste.** This includes finding more productive uses of food loss and waste, such as nutrient extraction, composting, and energy production. For example, Pilot efforts in Bali have demonstrated the use of cooking oil waste as a fuel for school buses.[246] "ijen", the first restaurant in Indonesia to follow a zero-waste philosophy, either recycles its food waste into compost or feeds it to pigs at the local farms.[247] Bio-refineries could capture the full value of by-product and waste streams by extracting several different products. To process food loss and waste, Indonesia could consider building anaerobic digesters, which also produce by-products like biogas and bio-slurry. Indonesia has the potential to install two million small anaerobic digesters, which could help reduce 6.4 million tonnes of CO_2 emissions every year.[248] Anaerobic digesters have been piloted in Jambi city in South Sumatra and in Bali[249,250], and small-scale digesters have been operationalised in Bandung city.[251] However, anaerobic digesters require a clean organic waste stream with source separation or sorting, which could make their adoption more challenging.

Among all options to process food loss and waste, composting could be the least capital-intensive and easiest to adopt at scale. It could also yield several benefits. For example, according to the United Nations Convention to Combat Desertification, land degradation and loss of soil fertility is a major issue.[252] Land application of compost could help avoid land degradation and thereby reduce the need to clear land in pursuit of new fertile agricultural

239 Food Security and Food Justice (2016), "Rotten tomatoes: the story of post-harvest food waste in Indonesia". Available at: https://foodsecurityfoodjustice.com/2016/01/25/rotten-tomatoes-the-story-of-the-post-harvest-food-waste-in-indonesia/
240 The Ken (2020), "Sayurbox, Tanihub offer fix for Indonesia's flawed food supply." Available at: https://the-ken.com/sea/story/sayurbox-tanihub-offer-fix-for-indonesias-flawed-food-supply/; KrAsia (2019), "From farm to kiosk: Indonesian micro-retail startup Warung Pintar acquires Limakilo." Available at: https://kr-asia.com/from-farm-to-kiosk-indonesian-micro-retail-startup-warung-pintar-acquires-limakilo
241 TechCrunch (2019), "YC-backed Eden Farm wants to cut out the middlemen between farmers and restaurants in Indonesia." Available at: https://techcrunch.com/2019/08/14/yc-backed-eden-farm-wants-to-cut-out-the-middlemen-between-farmers-and-restaurants-in-indonesia/
242 K. Chueamuangphan et al (2019), *Packaging Waste from E-Commerce: Consumers' Awareness and Concern.* Available at: https://link.springer.com/chapter/10.1007/978-981-13-7071-7_3
243 Chauhan (2020), *Food Waste Management with Technological Platforms: Evidence from Indian Food Supply Chains.* Available at: https://www.mdpi.com/2071-1050/12/19/8162
244 Southeast Asia Globe (2018), "How wedding leftovers can help curb Indonesia's rampant food wastage." Available at: https://southeastasiaglobe.com/foodcycle-wedding-leftovers/
245 Tammara Soma (2016), *The Tale of the Crying Rice: The Role of Unpaid Foodwork and Learning in Food Waste Prevention and Reduction in Indonesian Households.* Available at: https://link.springer.com/chapter/10.1057/978-1-137-53904-5_2
246 Seasia (2018), "Recycled Cooking Oil Powers Eco-friendly Buses in Bali." Available at: https://seasia.co/2018/03/08/recycled-cooking-oil-powers-eco-friendly-buses-in-bali
247[185] Resa Setia Adiandri (2017), "Reducing food losses as a strategy for strengthening food security." Available at: http://apec-flows.ntu.edu.tw/upload/edit/file/2%20SR_2017_C_S3-03_Indonesia-Revised2.pdf
DesignBoom (2018), "Built from recycled materials, 'ijen' is Indonesia's first zero-waste restaurant." Available at: https://www.designboom.com/design/andra-matin-ijen-first-zero-waste-restaurant-bali-indonesia-12-03-2018/
248 Stockholm Environment Institute (2019), *Risks, barriers and responses to Indonesia's biogas development.* Available at: https://www.sei.org/wp-content/uploads/2019/05/indonesia-biogas-development.pdf
249 Mohammad Helmy (2015), *Promoting anaerobic digestion of municipal solid waste in Indonesia.* Available at: https://www.unescap.org/sites/default/files/Indonesia%20Solid%20Waste%20Association%2C%20Indonesia.pdf
250 Marco Ghiandelli (2017), *Development and implementation of small-scale biogas balloon biodigester in Bali, Indonesia.* Available at: https://www.diva-portal.org/smash/get/diva2:1198348/FULLTEXT01.pdf
251 Encep Amit et al (2016), *Socio-Economic Considerations of Converting Food Waste into Biogas on a Household Level in Indonesia: The Case of the City of Bandung*
252 UNCCD (2015), *Indonesia -Land Degradation Neutrality National Report.* Available at: https://knowledge.unccd.int/sites/default/files/inline-files/indonesia_ldn_country_report.pdf

land to counter the loss of soil fertility elsewhere.[253] Tidy Planet, a UK-based company, has partnered with UNTHA UK to build an Integrated Waste Management Facility (IWMF) at a liquid gas plant in Tanguhh, where the facility will help process food waste into compost.[254] Hence, the Government may consider prioritising composting and investing in anaerobic digestion only when energy prices make it feasible.

Apart from traditional composing, businesses and households could also consider other innovating approaches to recycle food loss and waste. For instance, Magarlava, a Jakarta-based company, uses Black Soldier Fly and its larvae to accelerate the decomposition process to convert food and other organic waste into protein used for animal feed, pet food, and organic fertiliser.

Indonesia could reduce its food loss and waste by 50 percent and increase its food loss and waste recycling rate from 11 to 15 percent by 2030. Together, these opportunities could result in 46 million tonnes of food loss and waste being kept out of Indonesia's landfills in 2030 (Exhibit 25).

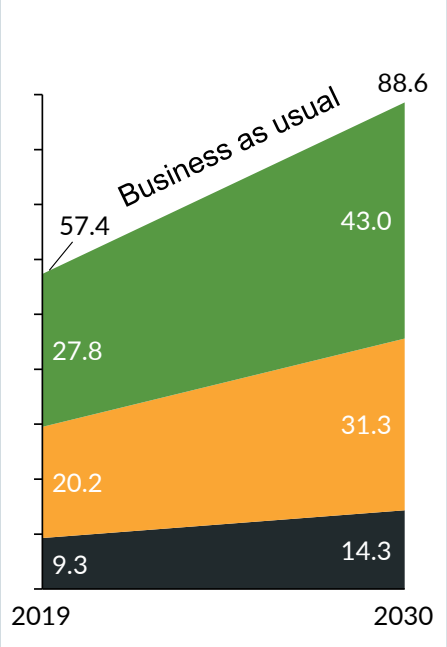
Exhibit 25

FOOD AND BEVERAGE

Indonesia could reduce and recycle 52% of its food loss and waste in 2030 through circular economy opportunities

Food loss and waste in 2030 under a "business-as-usual" scenario[1] and circularity opportunities

Million tonnes



Circularity opportunities	Circularity target	Million tonnes saving	% of 2030 BAU food loss and waste[2]
Reduce post-harvest food loss	Indonesia matches food loss reduction seen in global pilot studies[3]	21	24
Reduce supply chain food loss and waste	Indonesia matches food loss and waste reduction seen in global pilot studies	16	18
Reduce consumer food waste	Indonesia matches food waste reduction seen in global pilot studies	7	8
Process food loss and waste	Indonesia recovers and recycle 15% of its food waste	2	2
	Total	**46**	**52**

1. Excludes loss during agricultural production. Assumes that Indonesia's food loss and waste would grow at the same rate as food demand i.e. 4.03% every year
2. Percentages are rounded off
3. Based on global case studies. For example, pilot studies in Benin, Cape Verde, India, and Rwanda have shown that food waste could be reduced by 60%

SOURCE: BPS; WRI; Ministry of Environment and Forestrty (see annex for more details)

253 FAO (2015), "Composting: let's give the soil something back." Available at: http://www.fao.org/soils-2015/news/news-detail/en/c/280674/
254 Tidy Planet (2020), "Organic waste specialists collaborate in £1.25M global food waste projects." Available at: https://www.tidyplanet.co.uk/organic-waste-specialists-collaborate-1-25m-global-food-waste-project/

Box 5. ***Case studies of circularity in food loss and waste***

Great Giant Food (GGF) is a leading F&B manufacturer in Indonesia, with several subsidiaries focused on producing fresh fruit; processed fruit; packaged food and beverages, such as juice, protein, and dairy milk; and tapioca starch. Its flagship product, canned pineapple produced by PT Great Giant Pineapple (GGP), is manufactured in the largest integrated canned pine facility in the world.

GGF has adopted several circular economy principles in its business model. For instance, the organic solid waste created by its canned pineapple factory is repurposed as organic livestock feed under GGF's PT Great Giant Livestock business. Furthermore, the manure from the livestock is used as organic fertiliser for its pineapple plantation. In addition, solid waste generated from pineapple stem is used to generate bromelain enzyme production under its PT Bromelain Enzyme business. GGF also treats its wastewater and uses it as an input for GGF's Biogas Plant, which fulfils the energy needs for its tapioca factory and its co-gen plant.

GGF's circular approach highlights how different business models could be synergised to support a circular economy and could help generate a competitive advantage by reducing waste management cost.

THE ECONOMIC, SOCIAL, AND ENVIRONMENTAL BENEFITS OF CIRCULARITY OPPORTUNITIES

This reduction in food loss and waste can lead to significant economic benefits. First, food loss and waste reduction through better production techniques can improve productivity and contribute to sustained higher economic growth. Second, policies to reduce food loss and waste can indirectly lead to the growth of other industries, thus expanding a country's industrial base and diversify its labour market. For example, Massachusetts' organic waste industry experienced significant growth after the state modified its existing waste ban to add food to the list of materials banned from disposal.[255] Finally, the reduction of post-harvest and supply chain waste and the associated economic losses could improve farmer incomes by incentivising them to shift toward high-value crops.

This analysis shows that both producers (farmers and retailers) and consumers economically benefit from reduced food loss and waste, although the flow-through of benefits to the consumer are likely to be lower due to the inelastic nature of food. The redirection of savings to sectors, such as education and healthcare on the consumers' part, creates additional economic output. Based on the analysis, reducing and recycling food loss and waste could generate an annual economic impact of IDR375 trillion (USD26.3 billion) in 2030, equivalent to around 14 percent of the sector's estimated GDP in 2030 (Exhibit 26).[256] It is important to note that all economic benefits may not be captured by the F&B sector. Some of these benefits could be captured by other sectors in the economy (e.g., waste management if businesses focus on improving their food loss and waste collection or education if households decide to invest their savings from reducing food waste in education).

Such economic growth could, in turn, create over 2.4 million cumulative net jobs for Indonesia between 2021 and 2030 (Exhibit 27). Based on this analysis, of these jobs, 73 percent could be for women. This is driven by the potential job displacement in male-dominant sectors (e.g., waste management, where women make up only 26 percent of the total jobs) due to a circular economy and the likely job creation in female-dominant sectors (e.g., education, where households could reinvest their savings and where women account for 61 percent of all jobs).

From a social standpoint, circularity in the F&B sector could also lead to annual household savings worth IDR2.5 million (USD177) in 2030 or 4.7 percent of the current average annual household expenditure (Exhibit 28). This is based on reducing consumer food loss and waste, as well as consumers capturing some portion of upstream waste reductions. The reduction in food loss and waste can also enhance food security and improve the nutrition profile of the most food-insecure part of the population, contributing to the overall well-being of those communities.

Generating less and recycling more food loss and waste yields significant environmental benefits, too (Exhibit 29). Food production requires considerable water usage and produces greenhouse gas emissions through land-use change, the use of fertilisers and fuels, and during the processing and transporting stages. Exhibit 29 shows that by reducing and recycling 46 million tonnes of food loss and waste, Indonesia could avoid almost 59 million tonnes of CO_2e emissions and save 4 billion cubic metres of water in 2030.

The detailed methodology for quantifying and adding up these impacts is covered in the Annex.

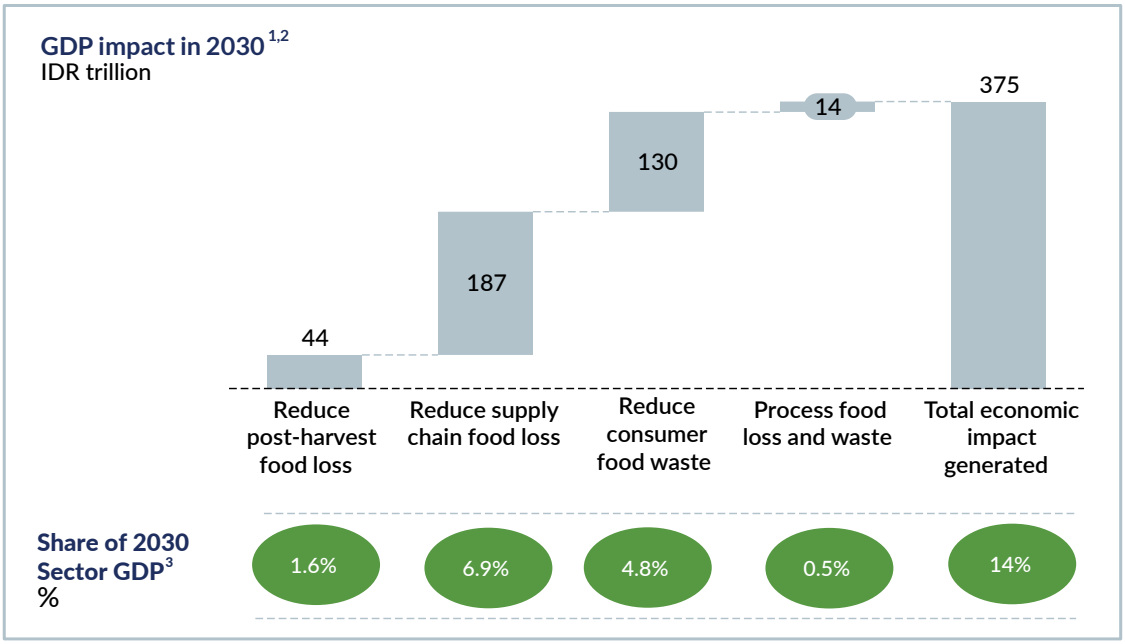
255 FAO (2019), *The State of Food and Agriculture 2019: Moving Forward on Food Loss and Waste Reduction.*
256 Based on IO table methodology (See the Annex for further details). Based on the ICOR methodology, the economic impact from the F&B sector is nearly IDR195 trillion. The ICOR economic impact is lower than the economic impact estimated using the IO table since the adoption of circular opportunities in the F&B sector (e.g., reduce consumer food waste) require low capital investments

Exhibit 26

FOOD AND BEVERAGE

BASED ON IO METHODOLOGY

A circular F&B sector could generate a net economic impact of IDR375 trillion (USD26.3 billion) or 14% of the sector GDP in 2030



1. Excludes waste during agriculture production
2. The economic benefits are not all captured by the specific sector where the circularity opportunities exist. In some cases, the savings from a circular economy opportunity are passed through to consumers who may spend them in other sectors such as health, education, and recreational services
3. Share of estimated sector GDP in 2030 is calculated based on a "business-as- usual" scenario growth rate of 4.92%. Percentages are rounded off

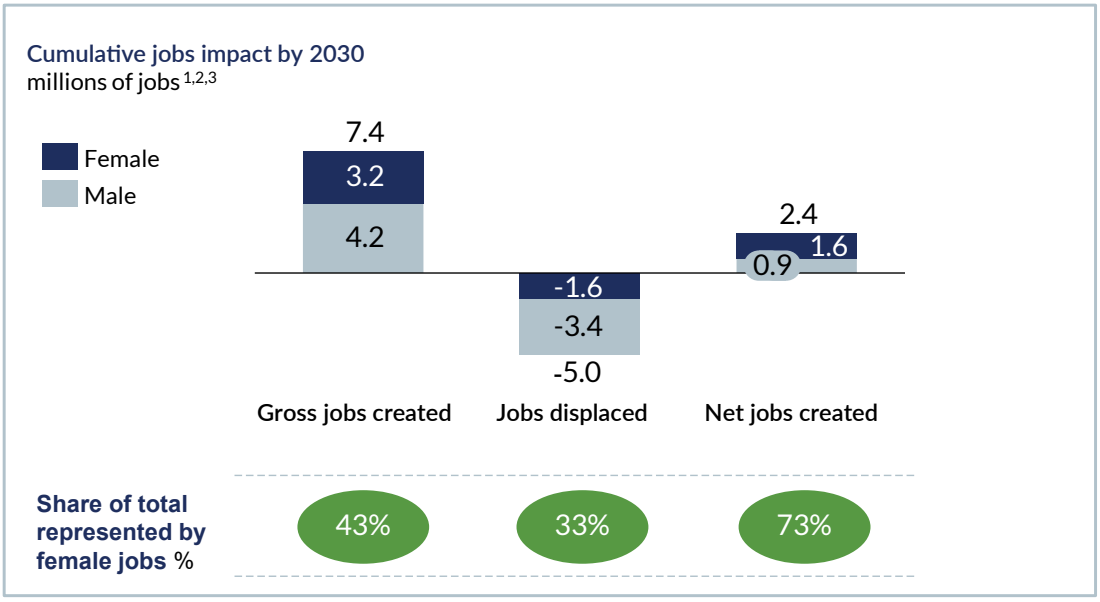
SOURCE: BPS; WRI; Ministry of Environment and Forestry (see annex for more details)

Exhibit 27

FOOD AND BEVERAGE

BASED ON IO METHODOLOGY

A circular F&B sector could add 2.4 million net jobs by 2030, of which 73% could be for women



1. The jobs created are not necessarily created in the F&B sector. They are created economy-wide from the savings that are reinvested by consumers and businesses
2. Calculated using data from the UN Population Division and applying Indonesia's labour force participation rate of 2019 and employment rate of 2016. The total estimated jobs in 2030 are inclusive of the net jobs created due to circular economy
3. To estimate the jobs created for women in 2030, it is assumed that the gender share of jobs in each sector in 2018 would remain unchanged till 2030. The data from the Labour Force Situation report published by BPS in February 2018 on the gender share of jobs in each of the 17 sectors of Indonesia's e conomy was used

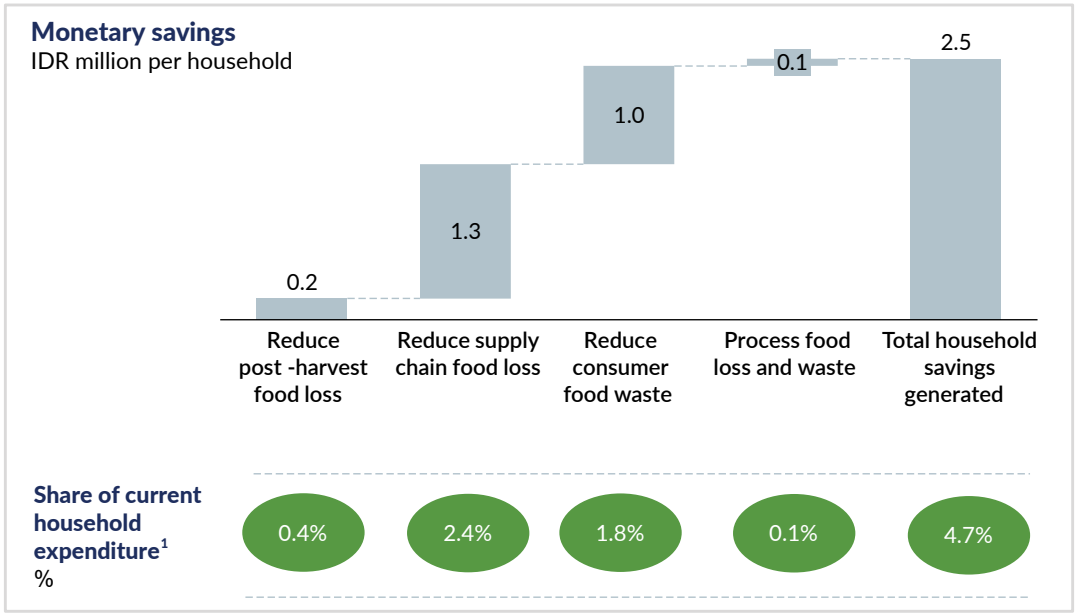
SOURCE: BPS; UN Population Division; IMF; World Bank (see annex for more details)

Exhibit 28

FOOD AND BEVERAGE

BASED ON IO METHODOLOGY

A circular F&B sector could generate annual household savings of ~IDR2.5 million (USD177) or 4.7% of the current annual household expenditure in 2030



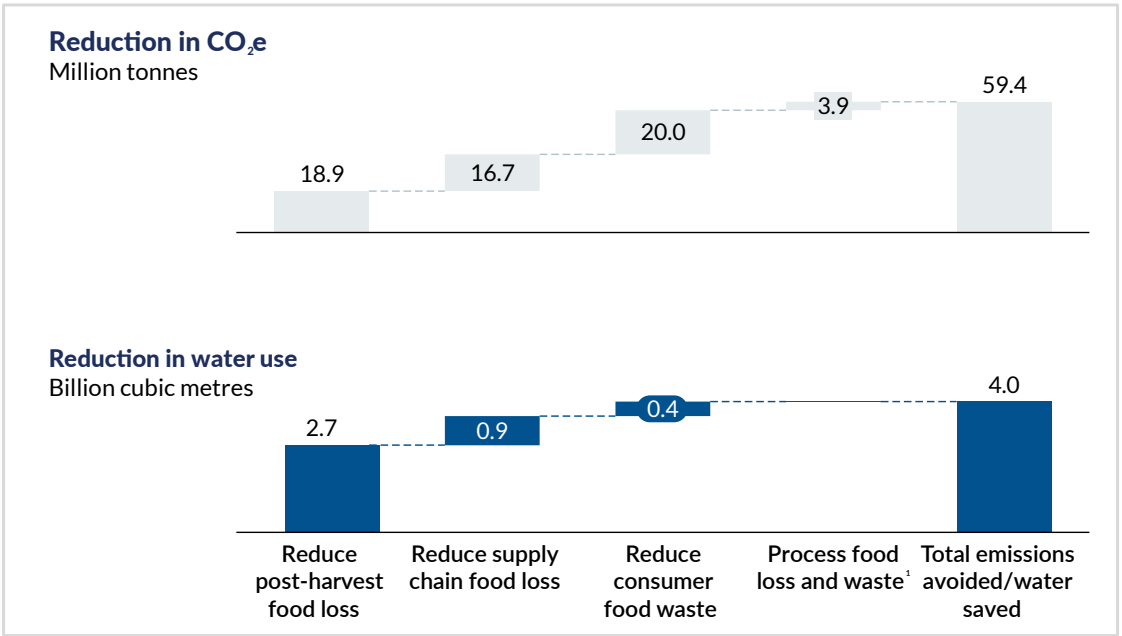
1. Percentages are rounded off

SOURCE: BPS; WRI; Ministry of Environment and Forestry (see annex for more details)

Exhibit 29

FOOD AND BEVERAGE

Indonesia could avoid 59 million tonnes of CO_2e emissions and save 4 billion cubic metres of water relative to BAU in 2030



1. The water savings from processing food loss and waste were not estimated due to limited data availability on the amount of water required in the production of compost, biogas, and other food loss and waste recycling purposes

SOURCE: BPS; WRI; Ministry of Environment and Forestry (see annex for more details)

BARRIERS IMPACTING CIRCULAR ECONOMY ADOPTION IN THIS SECTOR

Firms in the F&B sector are likely to face several barriers in adopting circular economy opportunities (Exhibit 30). While these barriers will be explored in detail in the next phase of this project, an initial synthesis of the barriers along with possible policy responses to address them is outlined below based on consultations with experts and discussions with private sector firms in the sector (Box 6).

Exhibit 30

FOOD AND BEVERAGE

There are a range of potential barriers that could prevent firms from capturing the circularity opportunities in the F&B sector

Highly significant[1]

#	Barrier	Opportunities			
		Reduce post-harvest food loss	Reduce supply chain food loss and waste	Reduce consumer food waste	Process food loss and waste
1	Difficulty in changing customs and habits of businesses and consumers	■		■	
2	Unintended consequences of existing regulations				
3	Lack of infrastructure	■	■		■
4	Implementation and enforcement failures				■
5	Poorly defined targets and objectives				
6	Inadequately defined legal frameworks				
7	Not profitable				■
8	Insufficient end markets				■
9	Lack of capital		■		
10	Imperfect information	■		■	

1. Highly significant refers to barriers that were identified in the sector focus group discussions and expert interviews as being of key concern to stakeholders in Indonesia

SOURCE: Lliterature review; focus group discussions; expert interviews

- **Difficulty in changing customs and habits of businesses and consumers.** The ingrained patterns of consumers and businesses may hinder the transition towards a circular economy. For example, Indonesian households have a cultural tendency towards an oversupply of food at celebratory events such as weddings and religious events, which could be difficult to alter. The practise of "gifting" and storing excessive food in refrigerators among upper-class Indonesians is considered a significant driver in generating food waste at the consumer stage.[257] Behavioural change may also make it challenging to reduce post-harvest food waste. Even once the necessary investment is in place, case studies have shown that farmers must change their behaviour to capture the full benefits of reducing post-harvest waste. For example, one major issue in the adoption of using metal silos in some African countries has been the fact that most farmers wanted to keep the grain stored in the safety of their own homes, in case of theft.[258]

- **Lack of infrastructure.** A cold storage system is required to reduce food loss and waste, especially at the supply chain stage. However, according to the Indonesian Cooling Chain Association, there is a shortage of cold storage in

257 Tammara Soma (2018), *Planning from "Table to Dump": Analyzing the Practice of Household Food Consumption and Food Waste in Urban Indonesia*. Available at: https://tspace.library.utoronto.ca/bitstream/1807/95706/1/Soma_Tammara_R_201806_PhD_thesis.pdf
258 Food and Agriculture Organization (2019), *Agricultural transformation centres in Africa*. Available at: http://www.fao.org/3/CA3008EN/ca3008en.pdf?eloutlink=imf2fao

Indonesia. In 2014, the production of poultry was 3.7 million tonnes, but only 1.9 million tonnes of cold storage was available; and beef production was 580 thousand tonnes, with a cold storage capacity of 400 thousand tonnes.[259] Even when cold storage facilities have been built, they have not been fully utilised. For example, in eastern Indonesia, cold storage is available in the provincial capital instead of fishing ports. Hence, many fishermen do not bother sending their products to cold storage.[260]

- **Not profitable.** An analysis conducted on the economic feasibility of anaerobic digesters in the city of Bandung showed that the net present value of these digesters is in fact, negative.[261] The economic value of anaerobic digesters is driven by the production of two resources – biogas, used for electricity, and bio-slurry, a by-product commonly used as a fertiliser. The researchers found that the low penetration of bio-slurry into local fertiliser supply-chains and low sales of biogas reduced the economic value associated with anaerobic digesters. Consumers preferred compost over bio-slurry for the same price and preferred LPG over biogas due to subsidies associated with LPG.[262]

- **Lack of capital.** The improved storage and transportation necessary to reduce waste are capital-intensive. A modern cold storage system with a capacity of 30,000 tonnes would have an annualised cost of more than USD100 million.[263] The Indonesia Cold Chain Association argued that Indonesia's food cold chain sector needed an investment of around USD400 million to keep up with domestic consumption in Indonesia.[264]

- **Implementation failures.** A study carried out to monitor the performance of anaerobic digesters found degradation in the intermediate treatment facilities (ITF), where six anaerobic digesters were located in Indonesia.[265] The researchers argued that this might have occurred due to inaction on behalf of the local authorities who were responsible for managing and operating the digesters. In most facilities, they found that "leakage in hydrolysis room, broken piping system and waterproofing problem in sludge drying wall" were recurring issues.

259 Neraca (2014), "Fasilitas Fiskal Minim - Industri Rantai Pendingin Sulit Berkembang." Available at: https://www.neraca.co.id/article/38959/fasilitas-fiskal-minim-industri-rantai-pendingin-sulit-berkembang
260 CCI France Indonesia (2016), *EIBN Sector Reports – Cold Storage*. Available at: https://indonesien.ahk.de/fileadmin/AHK_Indonesien/Publication/PDF_Publication/EIBN/EIBNSecRep2016_ColdStorage_FULL-19984.pdf
261 Encep Amit et al (2016), *Socio-Economic Considerations of Converting Food Waste into Biogas on a Household Level in Indonesia: The Case of the City of Bandung*
262 Encep Amit et al (2016), *Socio-Economic Considerations of Converting Food Waste into Biogas on a Household Level in Indonesia: The Case of the City of Bandung*
263 McKinsey Global Institute (2011), *Resource Revolution: Meeting the world's energy, materials, food, and water needs*. Available at: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability/Our%20Insights/Resource%20revolution/MGI_Resource_revolution_full_report.ashx
264 Neraca (2014), "Fasilitas Fiskal Minim - Industri Rantai Pendingin Sulit Berkembang." Available at: https://www.neraca.co.id/article/38959/fasilitas-fiskal-minim-industri-rantai-pendingin-sulit-berkembang
265 Cindy R. Priadi et al (2015), *Sustainability of anaerobic digestion for municipal biowaste in Indonesia*. Available at: https://www.researchgate.net/publication/287209897_Sustainability_of_anaerobic_digestion_for_municipal_biowaste_in_Indonesia

Box 6. Examples of *potential interventions that could overcome these barriers*

The detailed policy solutions for addressing the barriers to a circular economy in the food & beverage sector will be explored in the next phase of the circular economy work. However, this box provides some examples of the type of interventions by policymakers, the private sector, and civil society that could help address the identified barriers.

- **Collaborative efforts.** To change consumer and businesses behaviour toward food loss and waste, the Government could collaborate with the private sector and civil society organisations to create information campaigns that highlight the economic, social, and environmental impact of food loss and waste. This could build on existing efforts in Indonesia. For example, led by the Food and Land Use Coalition, the Food Loss and Waste Action Partnership aims to bring together government ministries, private sector, and civil society partners to build a cross-sector program to reduce food loss and waste in Indonesia by 50 percent by 2030.[266]
- **Training of smallholders**. To tackle post-harvest and supply chain waste, Indonesia should prioritise working with smallholder farmers and provide them with technical expertise, which could improve their handling practices.
- **Improving infrastructure.** In addition, the Government would need to find mechanisms to fund the purchase of capital-intensive equipment and storage. The Government of Indonesia is considering developing a large-scale cold storage warehouse, which may cost IDR3 trillion (USD207.4 million), and could play a key role in stabilising domestic prices and decrease the incentives of farmers to throw away their produce.[267] For cold storage focused on fisheries, the Government could attempt to build facilities closer to the ports to maximise their potential. This could also create more economic opportunities for farmers by creating alternative markets closer to the farms.
- **Promote food processing.** The Government of Indonesia could also consider promoting the food processing industry to address post-harvest waste. A food processing industry that focuses on value-added products, such as, tomato sauce, could help absorb the excess supply of agricultural products and reduce post-harvest loss.[268]
- **Encourage composting and use of anaerobic digesters.** Researchers have argued that to make anaerobic digesters economically more sustainable in Indonesia, the Government could set biogas production targets for local authorities responsible for operating the intermediate treatment facilities (ITF) in Indonesia.[269] Creating targets for the authorities could make them more accountable. Due to the lack of profitability of anaerobic digesters, the Government of Indonesia could consider prioritising composting and investing in anaerobic digestion when energy prices make them feasible. Moreover, reducing energy subsidies for fossil fuels could also make renewable energy, such as biogas, more competitive.[270]

266 P4G. "Indonesia food loss and waste action partnership." Available at: https://p4gpartnerships.org/partnership/indonesia-food-loss-and-waste-action-partnership
267 Jakarta Globe (2015). "Govt Plans Rp3t Cold Storage Facility to Tackle Price Fluctuations." Available at: https://jakartaglobe.id/business/govt-plans-rp3t-cold-storage-facility-tackle-price-fluctuations/
268 Food Security and Food Justice (2016). "Rotten tomatoes: the story of post-harvest food waste in Indonesia". Available at: https://foodsecurityfoodjustice.com/2016/01/25/rotten-tomatoes-the-story-of-the-post-harvest-food-waste-in-indonesia/
269 Cindy R. Priadi et al (2015), *Sustainability of anaerobic digestion for municipal biowaste in Indonesia*. Available at: https://www.researchgate.net/publication/287209897_Sustainability_of_anaerobic_digestion_for_municipal_biowaste_in_Indonesia
270 International Institute for Sustainable Development. "Unpacking fossil fuel subsidies in Indonesia." Available at: https://www.iisd.org/gsi/faqs/indonesia

4. Apparel and textiles sector: Tackling pre- and post-consumer waste

This chapter explores the current status of textile waste in Indonesia and how it could evolve under a "business-as-usual" approach to 2030.[271] *Furthermore, it identifies potential circular economy opportunities (based on detailed analysis and extensive stakeholder engagement) and sizes the economic, social, and environmental impact associated with these circularity opportunities.*

Adopting circular economy practices could help the textile sector in Indonesia generate an economic impact worth IDR19.3 trillion (USD1.4 billion) in 2030, create 164,000 cumulative net jobs between 2021 and 2030 (of which 89 percent could be for women), produce household savings worth nearly IDR172,000 (USD12.1), and reduce CO_2e emissions and water use by approximately 16.4 million tonnes and 1.2 billion cubic metres, respectively in 2030.

THERE IS SIGNIFICANT WASTE TODAY IN TEXTILES, WHICH COULD INCREASE SUBSTANTIALLY BY 2030

The textile sector plays an important role in Indonesia's economy. The sector employs an estimated 4.2 million people.[272] There are 197 garment companies registered with the Ministry of Sector and 78 percent of their workers are women. The value of garment exports of Indonesia in 2017 was USD12.4 billion.[273] Indonesia is among the top 10 textile-producing nations in the world and is the 12th largest textile and apparel exporter.[274]

However, the sector is also a major contributor to waste and pollution, particularly due to the increasing global demand for fast fashion goods and related mass production of low-cost garments. Based on the analysis, in 2019, Indonesia produced close to 2.3 million tonnes of textile waste in 2019 (Exhibit 31). Based on data published by the Ministry of Environment and Forestry, 12 percent of all household and household-related waste is recycled in Indonesia. Assuming that this rate also applies to textile waste, only 0.3 million tonnes of textile waste is recycled in Indonesia. In contrast, nearly two million tonnes of waste is landfilled or incinerated. Drivers for the incineration of pre-consumer textile waste are the contracts developed by garment brands, which treat textile designs as their intellectual property right and incentivises textile factories to burn unwanted textile products.[275]

Textile waste is categorised into pre-consumer production waste and post-consumer waste. Pre-consumer waste is generated throughout all manufacturing stages, from fibre production to Cut-Make-Trim (CMT). On average, between 15 and 25 percent of textile materials used during the manufacturing process gets discarded.[276,277] A considerable amount of waste is generated during the garment cutting process. Manual cutting processes, outdated computer-aided design (CAD) systems, and inefficient garment designs are three drivers for textile waste generation during the CMT stage. Manual cutting processes instead of using computerized automatic cutting systems, for example, reduce precision and increase the incidence of human errors, leading to greater wastage.[278]

The rapidly increasing low-priced "fast fashion" segment is a major driver of post-consumer textile waste. The average consumer in the world currently purchases 60 percent more clothing items than 15 years ago, thus significantly increasing the quantity of pre-consumer and post-consumer textile waste.[279] A consequence of the production of low-value garments is a shorter use phase with consumers discarding their clothes after fewer uses. Globally, consumers use their clothes for half as long as they did 15 years ago.[280] From 1998 to 2005, the mean useful life of apparel has reduced by 35 percent globally.[281] A similar trend has been witnessed in Indonesia. A recent survey revealed that three in 10 Indonesians had discarded their unwanted clothes after wearing them only once.[282] This could worsen since the low utility of fashion items

271 Note: The sizing for this sector is based on the entire textiles sector, including apparel, garments, and household items such as carpets, rugs and towels.
272 ILO (2017), *Mixed picture for Indonesia's garment sector.* Available at:
https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-jakarta/documents/publication/wcms_625195.pdf
273 Trade Union Rights Center TURC (2020), *Indonesia's Garment Industry: The impact of workers in the time of Pandemic.*
274 Mordor Intelligence (2019), *Indonesia Textiles Industry – Growth, Trends, and Forecast (2019-2024).* Available at:
https://www.mordorintelligence.com/industry-reports/indonesia-textiles-industry
275 Based on a focus group discussion of industry representatives on 10th December 2020
276South East Asia Globe (2019), "Out of Fashion". Available at:
https://southeastasiaglobe.com/out-of-fashion/
277Reverse Resources (2016), "How much does garment industry actually waste?" Available *at:*
https://reverseresources.net/news/how-much-does-garment-industry-actually-waste
278 Chan et al (2005), *Optimization of manual fabric-cutting process in apparel manufacture using genetic algorithms.* Available at:
https://www.researchgate.net/publication/225619614_Optimization_of_manual_fabric-cutting_process_in_apparel_manufacture_using_genetic_algorithms
279 McKinsey & Company (2016), "Style that's sustainable: A new fast-fashion formula". Available at:
https://www.mckinsey.com/business-functions/sustainability/our-insights/style-thats-sustainable-a-new-fast-fashion-formula
280 McKinsey & Company (2016), "Style that's sustainable: A new fast-fashion formula". Available at:
https://www.mckinsey.com/business-functions/sustainability/our-insights/style-thats-sustainable-a-new-fast-fashion-formula
281 Krolokow (2015), *Konsum, Bedarf und Wiederverwendung von Bekleidung und Textilien in Deutschland.* Available at:
https://www.bvse.de/images/pdf/Leitfaeden-Broschueren/150914_Textilstudie_2015.pdf
282 YouGov (2017), "Fast fashion: 3 in 10 Indonesians have thrown away clothing after wearing it just once." Available at:
https://id.yougov.com/en-id/news/2017/12/06/fast-fashion/

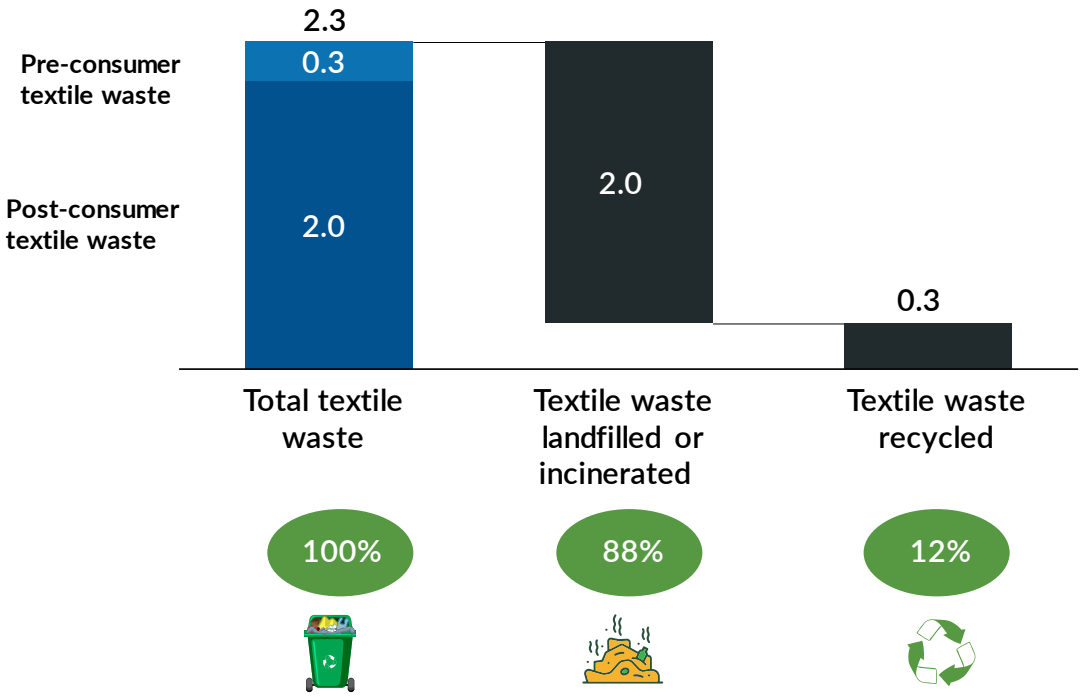
is likely to increase with higher household incomes.

Exhibit 31

Currently, 88% of textile waste is lost to landfills or incineration in Indonesia

Quantity of textile waste at each stage in 2019[1]

Million tonnes



1. Calculated based on total waste estimates of Ministry of Environment and Forestry and their estimates of the share of textile waste in total waste

In a "business-as-usual" approach, the total amount of textile waste could get significantly worse in Indonesia by 2030, increasing by almost 70 percent to over 3.5 million tonnes (Exhibit 32). Growth in the volume of pre-consumer textile waste is driven by the growth in Indonesia's textile sector. The annual growth of Indonesia's textile sector between 2019 and 2024 was estimated to be 5.1 percent.[283] However, the growth in pre-consumer textile waste generation could be reduced to some extent if an increasing number of local manufacturers adopt sustainability practices.

Similar to other key sectors, the rise of Indonesia's consuming class and rapid urbanisation are key drivers for increasing demand for fashion, home textile items, and non-woven materials. Greater demand for textile products could lead to greater generation of pre-consumer waste due to increased production and could lead to greater post-consumer waste as consumers build a larger stock of textiles. Prior to COVID-19, Indonesia's long-term market outlook for the hospitality industry was very robust, with more than 120 new hotels opening in the pipeline in the coming years,[284] raising the demand for products such as carpets, bedding, towels, kitchen accessories, amongst many others. Likewise, the development of urban infrastructure such as hospitals will increase demand for medical textiles such as surgical gowns, covers, personal protective equipment (PPE), and hosiery. Government targets and a more favourable industrial policy could also drive textile demand. The Indonesian Government has set a target to increase the export value of textiles and garments to USD75 billion by 2030, which could increase Indonesia's share of global exports in textiles and apparel products to five percent by 2030.[285]

283 Ishaque (2019), "Indonesian textile industry." Available at: http://textilefocus.com/indonesian-textile-industry/
284 Top Hotel News (2019), "Country overview: Indonesia's hotel market to see 124 openings". Available at: https://tophotel.news/country-overview-indonesias-hotel-market-to-see-124-openings/
285 Market Watch (2019), "Indonesia Textiles Market Size, Share, Application Analysis, Regional Outlook, Growth Trends, Key Players, Competitive Strategies and Forecasts, 2019 to 2024". Available at: https://www.marketwatch.com/press-release/indonesia-textiles-market-size-share-application-analysis-regional-outlook-growth-trends-key-players-competitive-strategies-and-forecasts-2019-to-2024-2019-11-25

Exhibit 32

TEXTILES

Textile waste could get worse by 2030

Pre-consumer textile waste

Growing consumer class
- A bigger consumer class will demand more textile goods, increasing pre-consumer textile waste volumes

Adoption of sustainability practices
- Greater adoption of sustainability practices among manufacturers could reduce the rate of pre-consumer textile waste generation

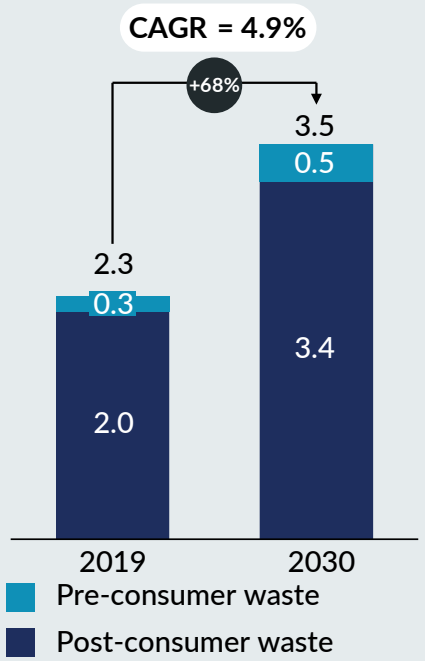
Post-consumer textile waste

Growing consumer class
- ~90 million Indonesians could join the ranks of the consuming class by 2030

Higher urbanisation rate
- Urban population could account for 71% of the total population by 2030

Estimated increase in textile waste in Indonesia[1]

Million tonnes



1. Calculated based on total waste estimates of Ministry of Environment and Forestry and their estimates of the share of textile waste in total waste

SOURCE: Ellen MacArthur Foundation, McKinsey Global Institute (see annex for more details)

THERE ARE LARGE ECONOMIC, SOCIAL, AND ENVIRONMENTAL COSTS ASSOCIATED WITH TEXTILE WASTE

Pre- and post-consumer textile waste impose high economic and environmental costs on countries. Around 95 percent of textile waste can be recycled or reused.[286] However, according to the Ellen MacArthur Foundation, 73 percent of the textile waste globally is landfilled or incinerated.[287] These rates could be lower in developing countries like Indonesia. Evidence from Bangladesh, which like Indonesia is a garment-exporting country, suggests that repurposing pre-consumer textile waste is a common practice in such countries.[288] However, with growing incomes, urban consumers could generate significant quantities of post-consumer textile waste. A survey reported that one in twenty millennials have previously burned unwanted clothes in Indonesia.[289] These textiles wasted by consumers represent a significant economic loss. The generation of textile waste also increases Indonesia's dependence on other countries for raw materials. Indonesia imported close to 3.5 million bales of cotton in 2018-19[290], making it the fifth-largest importer of cotton in the world by value.[291] This resource dependence can severely impact supply chains in case of supply shocks such as trade wars or pandemics.

The production of virgin synthetic fibres imposes high social and environmental costs in Indonesia. Air pollution from textile factories reportedly led to negative health effects for villagers residing near factories producing synthetic fibres in Java.[292] Textile waste can also generate an adverse environmental impact due to the resource-intensive nature of the sector. According to the EMF, the textile sector uses around 93 billion cubic meters of water annually, representing 4 percent of global freshwater withdrawal, and emits 1.2 billion tonnes of CO_2e emissions every year globally.[293] Water is required across various stages in the textile value chain. It is needed to produce raw materials such as cotton where close to 4,600 litres of water is required to produce one kilogram of cotton. Production processes like dyeing and finishing also have significant water requirements. In terms of carbon footprint, emissions are released during the production of raw materials and their processing. EMF estimated that 4.7 tonnes CO_2e emissions are released to produce one kg of cotton fibre and 9.6 tonnes of CO_2e emissions are released for every tonne of fibre during yarn production, dyeing, weaving, and knitting.

In addition to the impact of the textile sector on carbon emissions and water use, several incidents in Indonesia have highlighted the negative impact of wastewater from textile factories. In 2018, close to 280 tonnes of toxic waste were dumped into the Citarum river daily, including wastewater or effluent from textile-producing factories, contributing to decreasing land fertility.[294,295] A local waterway in West Jakarta was heavily polluted due to textile waste from a local factory.[296]

Moreover, increasing demand for viscose (a type of rayon fibre) has also contributed to deforestation in Indonesia.[297] Adverse environmental effects have also been found in the indigenous batik industry. For instance, the industry produces a large amount of wastewater with high toxicity, which has mutagenic and carcinogenic properties and could be potentially dangerous to humans and animals.[298]

CIRCULARITY OPPORTUNITIES COULD TRANSFORM THIS SECTOR

Circular opportunities in the textile sector could help reduce the economic, social, and environmental costs imposed on Indonesia. Given that Indonesia's estimated textile recycling rate of 12 percent is less than the 20 percent recycling rate that could be achieved globally,[299] it appears to have high potential across the 5Rs (Exhibit 33). The high amount of underutilised clothes also provides opportunities for reuse through second-hand or rental markets.

286 South East Asia Globe (2019), "Out of Fashion". Available at:
https://southeastasiaglobe.com/out-of-fashion/
287 Ellen MacArthur Foundation (2017), *A new textiles economy: Redesigning fashion's future.* Available at:
https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf
288 F. Tabassum et al (2017), *Garments waste recycling in Dhaka: A case study of Mirpur area.*
289 YouGov (2017), "Fast fashion: 3 in 10 Indonesians have thrown away clothing after wearing it just once." Available at:
https://id.yougov.com/en-id/news/2017/12/06/fast-fashion/
290USDA Foreign Agricultural Services (2019), *Indonesia Cotton and Products Annual Report 2019*. Available at:
https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Cotton%20and%20Products%20Annual_Jakarta_Indonesia_4-2-2019.pdf
291World's Top Exports (2019), "Cotton imports by country". Available at:
http://www.worldstopexports.com/cotton-imports-by-country/
292La Croix International (2018), "Indonesian villagers battle air, water pollution". Available at:
https://international.la-croix.com/news/indonesian-villagers-battle-air-water-pollution/7869
293 Ellen MacArthur Foundation (2017), *A new textiles economy: Redesigning fashion's future.* Available at:
https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf
294Channel News Asia (2018), "The toxic waste that enters Indonesia's Citarum River, one of the world's most polluted". Available at:
https://www.channelnewsasia.com/news/asia/indonesia-citarum-river-worlds-most-polluted-toxic-waste-10124436
295Undark (2017), "Worse for Wear: Indonesia's Textile Boom". Available at:
https://undark.org/2017/02/23/indonesia-textiles-citarum-river-pollution-2/
296The Jakarta Post (2017), "Textile waste pollutes West Jakarta waterways: Residents". Available at:
https://www.thejakartapost.com/news/2017/09/11/textile-waste-pollutes-west-jakarta-waterways-residents.html
297BBC, "5 fashion materials you didn't realise were bad for wildlife". Available at:
https://www.bbcearth.com/blog/?article=fashion-materials-you-didnt-realise-were-bad-for-wildlife
298 Kusumawati et al (forthcoming), *Chapter 3 - Batik became two sides of blade for the sustainable development in Indonesia.* Available at:
https://www.sciencedirect.com/science/article/pii/B9780128177426000037?via%3Dihub
299 South East Asia Globe (2019), "Out of Fashion". Available at:
https://southeastasiaglobe.com/out-of-fashion/

Exhibit 33

TEXTILES

The "Reuse" and "Recycle" approaches offer the highest potential for circularity in the textile sector in Indonesia

SOURCE: Ellen MacArthur Foundation; Guardian; YouGov; literature review; focus group discussions; expert interviews

Based on an analysis of global approaches and extensive engagement with local stakeholders in Indonesia, four circularity opportunities were identified that could complement the existing efforts by the Government of Indonesia (see Box 7).

Box 7. *Overview of Indonesian government policies to combat textile waste*

The "Standar Industri Hijau (SIH)" (Green Industrial Standard) contains provisions on raw materials, auxiliary materials, energy, production processes, products, business management, and waste management for 17 industries, including textiles. Apart from contributing to Indonesia's energy efficiency and greenhouse gas emissions reduction, the SIH aims to raise the export competitiveness of local companies through producing more environmentally friendly products at potentially lower costs. The initial phase of the SIH is voluntarily, but compliance could be made mandatory once all infrastructure and industry players are ready. Once this policy becomes compulsory, non-compliant firms could be subject to sanctions. Companies within the 17 industries will be awarded the green industry logo, which authenticates the firm's commitment to green industry principles.[300]

Moreover, the Government of Indonesia, led by the Ministry of Industry, is also encouraging the domestic textile industry to use locally grown natural fibres like banana and pineapple to reduce the country's dependence on polyester and rayon imports.[301]

Four major circular opportunities were identified for this sector (Exhibit 34).

Exhibit 34

TEXTILES

Examples of circular economy opportunities and benefits in the textile sector

#	Circular opportunities	5Rs	Brief Description	Significance/Examples
1	**Reduce waste in production**	**Reduce**	Reducing waste during the manufacturing phase through more efficient use of resoures. An example is to track and control steam pipe temperatures, and regulate the air-fuel ratio in boilers etc	Up to 15% reduction in energy costs possible in textiles
2	**Reuse products**	**Reuse, Refurbish**	Aims to alter the consumer value proposition (e.g. "servitisation" models that encourage leasing / repairs)	Higher clothing utilisation rates –global customers miss out on USD460 billion of annual value by throwing away clothes that they could continue to wear
3	**Use more sustainable materials**	**Renew**	Involves altering supply chain processes to use more sustainable materials (e.g. sustainable sourcing or innovation to develop sustainable alternatives)	In 2019, 57% of all materials sourced by H&M group were either recycled or sourced in a more sustainable way
4	**Recycle materials**	**Recycle**	Increased recycling of waste materials from textile production. This will require the redesign products to improve recyclability, and overall improvement in collection systems to enhance recycling	Dutch Awareness creates clothes using 100% recyclable polyester that uses 95% less water, 64% less energy and produces 73% fewer carbon emissions compared to cotton

SOURCE: Ellen MacArthur Foundation; focus group discussions; expert interviews

300 Kementerian Perindustrian (2016), "Standar Industri hijau (SIH) untuk 17 Jenis Industri. Available at: http://bppi.kemenperin.go.id/blog/standar-industri-hijau-sih-untuk-17-jenis-industri/
301 Fibre2Fashion, "Indonesia encourages use of natural fibres in textiles." Available at: https://www.fibre2fashion.com/news/textile-news/newsdetails.aspx?news_id=159823

- **Reduce waste in production.** This opportunity refers to improvements in production methods that will increase resource efficiencies and reduce waste. For instance, the Indonesian fashion brand Hlaii reduces cutting waste significantly through the development of zero waste patterns for its designs and avoids overstock waste by introducing a made-to-order concept for customers.[302] In Myanmar, SMART Myanmar, a project organised by the EU-funded SWITCH-Asia, a team of local and international textile experts advised local factories on resource efficiencies, leading to reductions in fabric wastage by around 20 percent.[303]

- **Reuse products.** This includes shifting to service-based business models that aim to alter the consumer value proposition by extending the lifespan of a garment through services such as clothing repair, rental, and resale. Following successful international platforms such as RealReal in the US, for clothing rental and resale, similar business models have emerged in Indonesia, which underline the feasibility of these business models in the country.[304] While the reuse of clothing is typically common in low to middle-income countries like Indonesia,[305] such business models could extend the lifespan of fashion products among the growing consumer class in Indonesia. Online start-ups like Rentique and Style Theory provide garment rental services to consumers in Indonesia. Tinkerlust is an e-commerce business where consumers can resell their branded and luxury fashion products. While such companies encourage the reuse of the same textile products, others reuse the textile products and upcycle them into different products. For example, Tri-upcycle, a social enterprise, upcycles textile waste sourced from hotels and villas in Bali into textile products such as bandanas, handkerchiefs, tote bags, and travel pouches.[306] Such start-ups focus on reusing textile that otherwise might have been wasted by consumers, but there is also significant potential to reuse pre-consumer textile waste. Pre-consumer textile waste is considered to be easier to reuse than post-consumer textile waste since it does not have the same hygiene and collection challenges, associated with post-consumer waste.[307] Threadapeutic is an Indonesian brand that uses fabric off-cuts or fabric remnants and upcycles them to manufacture interior products and fashion accessories like clutches and bags.[308] Pilot efforts in Indonesia have also shown the potential to upcycle batik remnants to manufacture women's wear products.[309] Upcycled textile waste could be marketed to Indonesian millennials who have shown to be more environmentally conscious and could be willing to pay a higher price for such products.[310] Elsewhere, research by Indonesia's Maranatha University demonstrated how pre-consumer textile waste could be upcycled into lingerie and bodywear products.[311]

  Existing cultural norms on passing on unwanted garments in Indonesia can be leveraged to maximise this opportunity. According to a survey of close to 7,000 respondents in Indonesia, more than half Indonesians pass on their unwanted clothes to their friends/family or donate to charity.[312]

- **Use more sustainable materials.** This opportunity involves substituting resource-intensive materials with more sustainable alternatives. Polyester is the most used fibre within the fashion industry, with a global market share of close to 40 percent.[313] With a growing demand for more sustainable materials, textile factories are increasingly using polyester staple fibre (re-PSF), a synthetic fibre made from polyester waste and post-consumer PET bottles. The demand for recycled polyester staple fibre (re-PSF) in Indonesia was estimated to reach 931,000 tonnes in 2019 and is expected to increase annually by seven percent.[314] Many businesses in Indonesia have adopted more sustainable alternatives. H&M (in collaboration with fabric producer Nusantara Fabrics and yarn producer Kahatex) uses recycled PET (rPET) from plastic bottles for its garments,[315] and Inocycle uses re-PSF for a broad range of non-woven textile products, used in car manufacturing and a variety of other industries.[316] Global brands like H&M, IKEA, and Target, have also committed to accelerating their adoption of rPET.[317] Elsewhere, partnerships have developed that help garment factories maximise the potential of their pre-consumer waste. Closed Loop Fashion is working on a pilot project in Indonesia to create an integrated, transparent, and environmentally friendly value chain that encourages the adoption

302 What's New Jakarta (2019), "6 sustainable brands in Indonesia". Available at: https://whatsnewindonesia.com/jakarta/sustainable-fashionable-brands-in-indonesia/
303 Smart Myanmar (2015), *Smart Myanmar: Garment factories improvement program*. Available at: https://www.acmfn.com/wp-content/uploads/2015/09/SMART-Myanmar-Garment-Factories-Improvement-Program.pdf
304 Extra Crunch (2019), *Luxury consignment e-tailer The RealReal to enter the unicorn club with new funding*. Available at: https://techcrunch.com/2019/04/23/luxury-consignment-e-tailer-the-realreal-to-enter-the-unicorn-club-with-new-funding/
[173] Lau, Yuk-Ian (2015), *Reusing pre-consumer textile waste*. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4796196/
305 N. Bairagi (2018), *Recycling of Post-Consumer Apparel Waste in India: Channels for Textile Reuse*. Available at: https://www.researchgate.net/publication/323575723_Recycling_of_Post-Consumer_Apparel_Waste_in_India_Channels_for_Textile_Reuse
306 Tri-Upcycle. Available at: https://triupcycle.com/products/
307 Lau, Yuk-Ian, *Reusing pre-consumer textile waste*. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4796196/
308 See profile of Threadapeutic. Available at: https://www.threadapeutic.com/profile
309 Novita (2012), *Utilization of textile waste (batik remnants) for womens'wear in Yogyakarta, Indonesia*. Available at: https://pdfs.semanticscholar.org/cd75/6a680a7c51762fef18babe333d3ffd947811.pdf?_ga=2.184216290.594119853.1593663908-1003791673.1585896863
310 C A Parung (2019), *How do the Indonesian ecologically conscious millennials value upcycled clothing?* Available at: https://iopscience.iop.org/article/10.1088/1757-899X/703/1/012031/pdf
311 Closed Loop Fashion, "Creating lingerie from textile waste?" Available at: https://closedloopfashion.com/innovative-design/creating-lingerie-from-textile-waste-2/
312 YouGov (2017), "Fast fashion: 3 in 10 Indonesians have thrown away clothing after wearing it just once." Available at: https://id.yougov.com/en-id/news/2017/12/06/fast-fashion/
313 Textile Exchange (2017), *Preferred fiber & materials market report 2017*. Available at: https://store.textileexchange.org/wp-content/uploads/woocommerce_uploads/2019/04/Textile-Exchange_Preferred-Fiber-Materials-Market-Report_2017-1.pdf
314 The Jakarta Post (2019), Inocycle turns trash into treasure as public awareness of plastic waste grows." Available at: https://www.thejakartapost.com/news/2019/10/25/inocycle-turns-trash-into-treasure-as-public-awareness-of-plastic-waste-grows.html
315 Indonesia Expat (2013), "Nusantara Fabrics Leading the Way on Recycled Polyester." Available at: https://indonesiaexpat.biz/lifestyle/nusantara-fabrics-leading-the-way-on-recycled-polyester/
316 The Jakarta Post (2019), "Inocycle turns trash into treasure as public awareness of plastic waste grows." Available at: https://www.thejakartapost.com/news/2019/10/25/inocycle-turns-trash-into-treasure-as-public-awareness-of-plastic-waste-grows.html
317 Textile Exchange. "Recycled polyester commitment." Available at: https://textileexchange.org/recycled-polyester-commitment/

of recycled polyester fabrics produced from pre-consumer textile waste.[318]

Many Indonesian companies have turned to innovation to offer sustainable alternatives. These alternatives are lab-grown, biodegradable, recyclable, and sourced from raw material inputs from agriculture or other industries waste streams. For example, Mycotech is an Indonesian start-up based near Bandung. It invented a vegan leather called Mylea made from Mycelium mushrooms. The mushrooms are grown on fresh coffee ground waste, involving the local community at the farming stage and the leather can be used to manufacture shoes, bags, swatches, among other products. Cinta Bumi, a fashion brand based in Bali, uses barkcloth, a sustainable material created from paper mulberry and Ficus tree barks from Central Sulawesi, in many of its products.[319]

- **Recycle materials.** This requires redesigning products to improve the recyclability of textiles after their end-of-use phase and an overall establishment of reverse logistics systems for discarded garments and other textile wastes. For example, garments made from one fibre type could be easily disassembled, sorted, and recycled at the end of their useful life.[320]

  Textile factories typically generate waste from the remains of yarns and fabrics that are discarded during the cutting process.[321] Cotton waste could be sorted, carded, and respun into new fibre for the sector. Larger pieces of cloth could be repurposed directly into new products. Unlike reusing textile waste, recycling textile waste involves a mechanical or chemical process that changes the structure of the material. Mechanical recycling is a simpler way to recycle materials than chemical recycling. The process involves mechanically deconstructing the fabrics into re-useable fibres and material, which can then be used to make new yarn and fabric. However, mechanical recycling shortens the fibres, which decreases their quality and limits circularity.[322] Chemical recycling could overcome this shortcoming by recycling fibres into a fibre of equal or superior quality; however, its application remains limited. In Indonesia, there are no applications of fibre-to-fibre chemical recycling beside the non-woven segment.[323]

  Apart from the share of textile waste that is recycled, emphasis should also be placed on the output from the recycling process, i.e., whether the recycling process creates a downcycled or upcycled product. Most textile waste around the world is currently downcycled.[324] Many factors make recycling textile waste challenging. First, the quality of the textile waste used as an input in recycling processes is usually very low. Second, since there are no defined standardisations for the composition of waste materials, waste is often heterogeneous that makes fibre-to-fibre recycling difficult. Given the current quality and composition of textile waste used in recycling, waste can be recycled for nonwoven materials or fillings in the automotive, acoustic, or toy industries. However, it cannot be recycled into high-quality yarns suitable for the fashion industry.[325] Redesigning textiles to make it more recyclable could help increase the adoption of this opportunity. For example, many leading global jeans brands (e.g., Guess, H&M, Wrangler) have committed to redesigning their jeans to make them more durable and recyclable.[326]

How big could the opportunity be to tackle textile waste in Indonesia? Four opportunities listed below could help reduce textile waste by 14 percent. Indonesia could also increase its textile waste recycling rate from 12 percent to 20 percent (Exhibit 35).

318 Closed Loop Foundation, "Fiber-to-Fiber Polyester Recycling and Textile Waste Management." Available at: https://closedloopfashion.com/project/polyester-recycling-and-textile-waste-management/
319 What's New in Indonesia (2019), "6 Sustainable Fashion Brands in Indonesia." Available at: https://whatsnewindonesia.com/sustainable-fashion-brand-in-indonesia/
320 Cattermole Consulting. "Ways to increase textile recycling." Available at: https://www.cattermoleconsulting.com/ways-to-increase-textile-recycling/
321 Gabriel Farias Iribarren (2018), "Organic cotton vs Recycled cotton." Available at: https://gabrielfariasiribarren.com/en/organic-cotton-vs-recycled-cotton/
322 Ellen MacArthur Foundation (2017), *A new textiles economy: Redesigning fashion's future.* Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf
323 Based on inputs from Marina Chahboune, Founder of Closed Loop Fashion
324 Gustav Sandin and Greg Peters (2018), *Environmental impact of textile reuse and recycling – A review.* Available at: https://www.sciencedirect.com/science/article/pii/S0959652618305985
325 Based on inputs from Marina Chahboune, Founder of Closed Loop Fashion
326 Ellen MacArthur Foundation, "The Jeans Redesign." Available at: https://www.ellenmacarthurfoundation.org/our-work/activities/make-fashion-circular/the-jeans-redesign

Exhibit 35

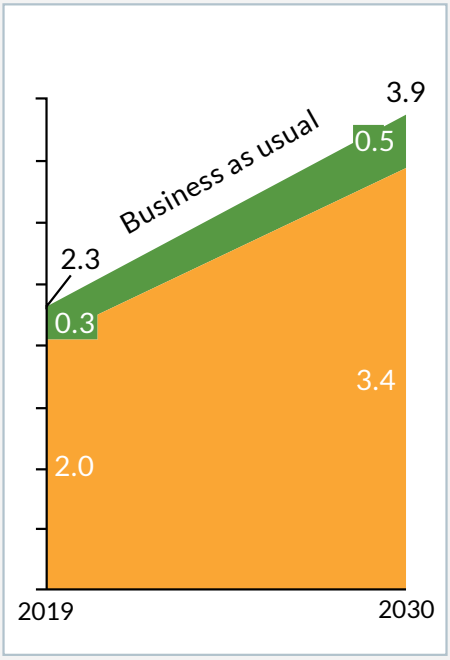
TEXTILES

Indonesia could reduce and recycle 18% of its textile waste in 2030 through circular economy opportunities

Textile waste in 2030 under a "business-as usual" scenario 1 and circularity opportunities

'000 tonnes

Pre-consumer textile waste
Post-consumer textile waste
Applies to all stages of the value chain



Circularity opportunities	Circularity target	'000 tonnes saving	% of 2030 BAU textile waste[1]
Reduce waste in production	Indonesian factories match the results shown by SMART Myanmar in reducing waste	95	2
Reuse products	Indonesia increases the reuse rate from 50% to 70%	295	8
Use more sustainable materials	Indonesia doubles the use of recycled cotton and polyester	156	4
Recycle materials	Indonesia increases recycling rate from 12% to 20%	173	4
	Total	**719**	**18**

1. Percentages are rounded off

SOURCE: Ellen MacArthur Foundation; SMART Myanmar; Ministry of Environment and Forestry; Textile Exchange (see annex for more details)

Box 8. ***Case study of circularity in the textiles sector***

Setali Indonesia aims to introduce circular fashion in Indonesia by reusing, repairing, and recycling garments. It follows a four-step process. First, it collects clothes donated by consumers via donation boxes or at its warehouse. Second, it sorts the clothes by quality. The high-quality clothes are sold at its charity points, on the social media platform, Instagram, or the second-hand goods website, Carousell. The low-quality clothes are upcycled for second-hand use or to produce textile art through its "Sight From The Earth" brand. For instance, it has previously used denim scraps to manufacture rugs, bags, and shoes.

Style Theory is another example of a company that is promoting circular fashion in Indonesia. Style Theory launched its services in Indonesia in 2018. As of September 2018, it had over 20,000 active users in Indonesia.[327] It provides a subscription service at IDR590,000 (USD40) per month that allows users to rent clothes and designer bags. Its subscription plan includes unlimited rental of three pieces at a time, delivery and returns, and dry-cleaning services. Across Singapore, Indonesia, and Hong Kong it reportedly has 50,000 pieces of clothing and 2,000 designer bags in its inventory.[328] Its subscribers rent up to 20 pieces of clothing a month In Indonesia.

By giving consumers an ample choice through its large inventory and fletxibility through the unlimited number of rentals within a month, clothes rental models, such as that of Style Theory, disincentivise consumers from purchasing and owning many pieces of apparel. Moreover, such business models reduce the risk of a sparsely used apparel ending up in the landfill prematurely since it could be rented out by its owner for financial gain. The reuse of textiles through such models depends on the trust that users have on the cleaning process adopted by rental companies. To counter hygiene fears, on its website, Style Theory has listed its laundry partners and uploaded a video that depicts its typical cleaning process. Apart from reuse, clothes rental models could also increase recycling rates by creating a centralised collection point.

THE ECONOMIC, SOCIAL, AND ENVIRONMENTAL BENEFITS OF CIRCULARITY OPPORTUNITIES

Since both producers and consumers drive the textile waste generation, different actors along the textile supply chain would benefit from circular opportunities. The producers and consumers could reinvest the savings generated from reducing waste generation and increased recycling of waste into other activities. Factories could reinvest their savings into better machinery. Brands that would develop business models focused on reusing textiles may reinvest their savings in procuring professional and technical services for market research. In comparison, consumers could reinvest their savings into the education, health, or recreation sectors. Our model shows that the implied monetary savings from reducing and recycling textile waste could generate an annual economic impact of over IDR19.3 trillion (USD1.4 billion) in 2030, equivalent to around 5.5 percent of the sector's estimated GDP (Exhibit 36).[329]

It is important to note that all economic benefits may not be captured by the textile sector. Some of these benefits could be captured by other sectors in the economy (e.g., waste management if businesses focus on improving pre-consumer textile collection or education if households decide to invest their savings from reducing post-consumer textile waste on education).

The economic value generated from a circular economy in the textiles could help generate approximately 164,000 cumulative net jobs for Indonesia between 2021 and 2030 (Exhibit 37). Based on the analysis of these jobs, 89 percent could be for women. This is driven by the potential job displacement in male-dominant sectors (e.g., waste management, where women make up 26 percent of the total jobs) due to a circular economy and the likely job creation in female-dominant sectors (e.g., education, where households could reinvest their savings and where women account for 61 percent of all jobs). From a social standpoint, circularity in the textile sector could also lead to annual household savings worth IDR172,000 (USD12.1) in 2030 or 0.3 percent of the average annual household expenditure (Exhibit 38).

327 The Jakarta Post (2018), "Singaporean fashion rental platform Style Theory gains ground in Indonesia". Available at: https://www.thejakartapost.com/life/2018/09/17/singaporean-fashion-rental-platform-style-theory-gains-ground-in-indonesia.html

328 TechCrunch (2019), "Style Theory, a fashion rental start-up in Southeast Asia, raises USD15 million led by SoftBank Ventures Asia". Available at: https://techcrunch.com/2019/12/06/style-theory-a-fashion-rental-startup-in-southeast-asia-raises-15-million-led-by-softbank-ventures-asia/

329 Based on IO table methodology (See the Annex for further details). Based on the ICOR methodology, the economic impact from the textile sector is nearly IDR38 trillion. The ICOR economic impact is higher than the economic impact estimated using the IO table since the adoption of circular opportunities in the textile sector (e.g., recycle materials) require significant capital investments

Reducing textile waste and increasing the volume of textile waste that is recycled could yield significant environmental benefits as textile production requires considerable water usage and emits significant CO_2e emissions. Exhibit 39 shows that reducing and greater recycling of approximately 0.7 million tonnes of textile waste could lead to almost 16.4 million tonnes of CO_2e emissions avoided and 1.2 billion cubic metres of water saved in 2030.

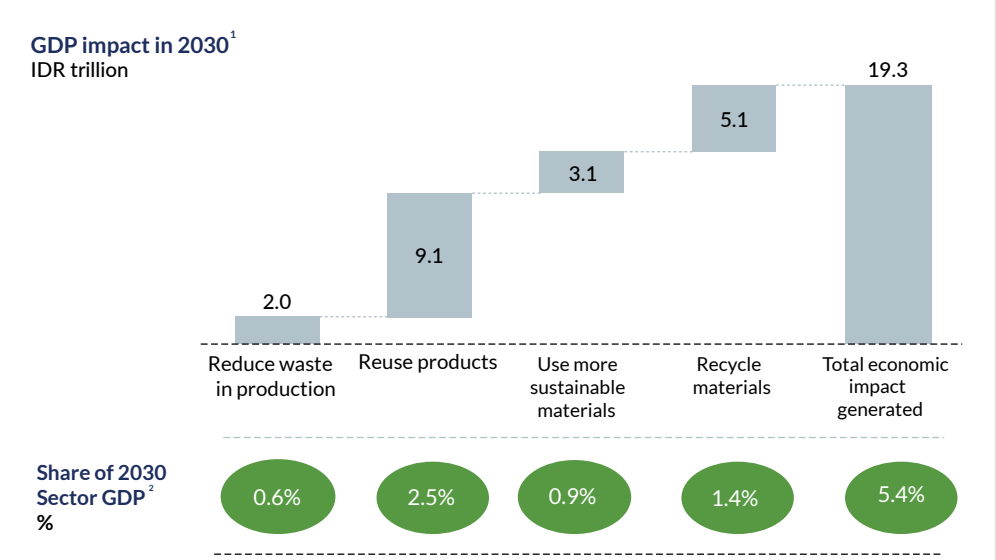
The detailed methodology for quantifying economic, social and environmental impact is outlined in the Annex.

Exhibit 36

TEXTILES

BASED ON IO METHODOLOGY

Circular economy in textiles could generate a net economic impact of IDR19.3 trillion (USD1.4 billion) or 5.5% of the sector GDP in 2030



1. The economic benefits are not all captured by the specific sector where the circularity opportunities exist. In some cases, t he savings from a circular economy opportunity are passed through to consumers who may spend them in other sectors such as health, education, and recreational services
2. Share of estimated sector GDP in 2030 is calculated based on a "business as usual" scenario growth rate of 4.92%. Percentages are rounded off

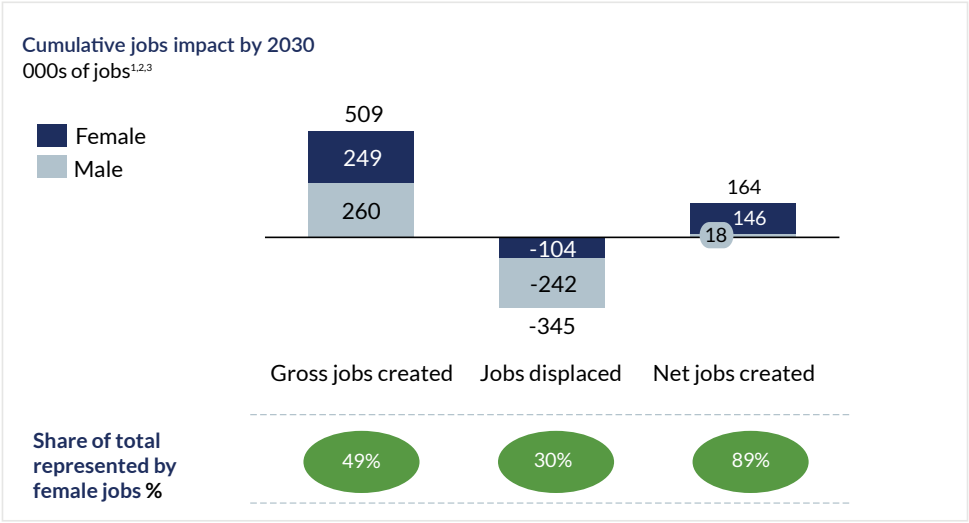
SOURCE: Bank Indonesia; BPS; Ministry of Environment and Forestry; Ellen MacArthur Foundation (see annex for more details)

Exhibit 37

TEXTILES

BASED ON IO METHODOLOGY

A circular textile sector could add 164,000 net jobs by 2030, of which 89% could be for women



1. The jobs created are not necessarily created in the textile sector. They are created economy wide from the savings that are rein vested by consumers and businesses
2. Calculated using data from the UN Population Division and applying Indonesia's labour force participation rate of 2019 and employment rate of 2016. The total estimated jobs in 2030 are inclusive of the net jobs created due to circular economy
3. To estimate the jobs created for women in 2030, it is assumed that the gender share of jobs in each sector in 2018 would rema in unchanged till 2030. The data from the Labour Force Situation report published by BPS in February 2018 on the gender share of jobs in each of the 17 sectors of Indonesia's e conomy was used

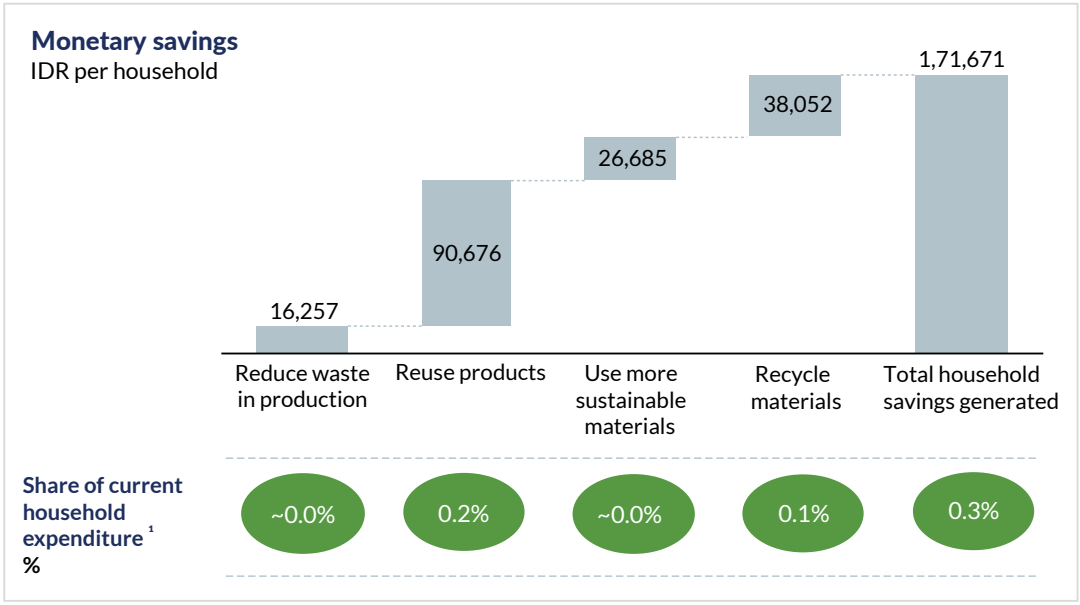
SOURCE: BPS; UN Population Division; IMF; World Bank (see annex for more details)

Exhibit 38

TEXTILES

BASED ON IO METHODOLOGY

Circularity in the textile sector could generate household savings worth ~IDR172,000 (USD12.1) or 0.3% of the current annual household expenditure in 2030



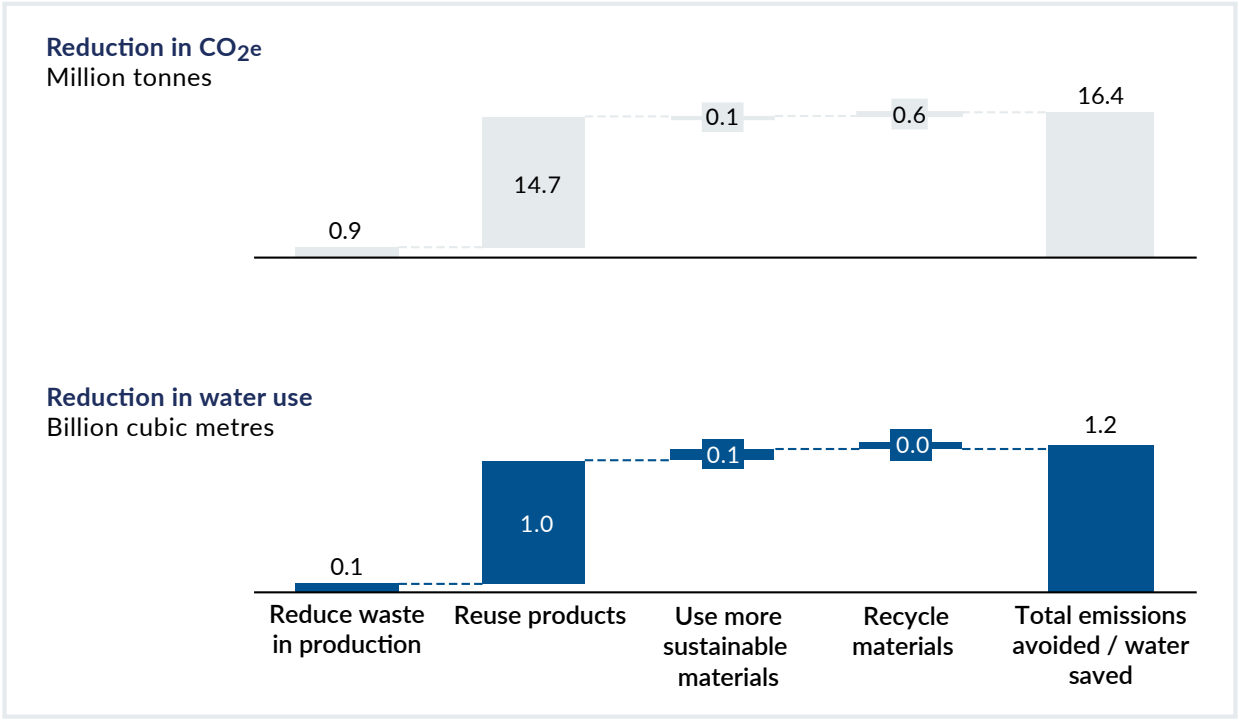
1. Percentages are rounded off

SOURCE: BPS; Ellen MacArthur Foundation (see annex for more details)

Exhibit 39

TEXTILES

Indonesia could avoid 16.4 million tonnes of CO2e emissions and save 1.2 billion cubic metres of water relative to BAU in 2030



SOURCE: BPS; Ellen MacArthur Foundation (see annex for more details)

BARRIERS IMPACTING CIRCULAR ECONOMY ADOPTION IN THIS SECTOR

Firms in the textile sector are likely to face several barriers in adopting circular economy opportunities (Exhibit 40). While these barriers will be explored in detail in the next phase of this project, an initial synthesis of the barriers along with possible interventions to address them is outlined below based on consultations with experts and discussions with private sector firms in the sector (Box 9).

Exhibit 40

TEXTILES

There are a range of potential barriers that could prevent firms from capturing the circularity opportunities in the textile sector

Highly significant[1]

#	Barrier	Opportunities			
		Reduce waste in production	Reuse products	Use more sustainable materials	Recycle materials
1	Difficulty in changing customs and habits of businesses and consumers		■		■
2	Unintended consequences of existing regulations				
3	Lack of infrastructure	■	■		■
4	Implementation and enforcement failures				
5	Poorly defined targets and objectives				
6	Inadequately defined legal frameworks				
7	Not profitable				
8	Insufficient end markets		■		■
9	Lack of capital	■	■	■	■
10	Imperfect information			■	

1. Highly significant refers to barriers that were identified in the sector focus group discussions and expert interviews as being of key concern to stakeholders in Indonesia

SOURCE: Lliterature review; focus group discussions; expert interviews

- **Difficulty in changing customs and habits of businesses and consumers.** To increase the reuse and recycling of textiles, businesses and consumers would need to play an active role to facilitate the collection of textiles and textile waste for reuse and recycling, respectively. While the emergence of businesses, such as "Rent A Theory"; setting up of thrift shops in Jakarta;[330] and the use of rPET in textile manufacturing have shown that businesses and consumers are willing to facilitate collection of used garments and textile waste, consumer and businesses attitude would need to change significantly to scale up quantities and to encourage a shift in demand for sustainable and circular products.

- **Lack of infrastructure.** Lack of infrastructure for reverse logistics and lack of technological infrastructure could make adoption of circular opportunities challenging for the textile sector in Indonesia. The adoption of a business model focused on "Reuse" and "Recycle" would also require sufficient investment in reverse logistics and third-party logistics (3PL). Evidence from other developing countries has shown that the adoption of reverse logistics

330 The Jakarta Post (2019), "Thrift shops set up for thrifty disadvantaged in Indonesia." Available at: https://www.thejakartapost.com/life/2019/10/28/thrift-shops-set-up-for-thrifty-disadvantaged-in-indonesia.html

could be challenging.[331] A case study on the reverse logistics implementation in the car battery industry in Indonesia found eleven key barriers, including financial constraints of businesses.[332]

Moreover, using more sustainable materials, such as organic cotton, hemp, linen, recycled material, and Tencel require textile manufacturers to retool their production processes. This may be especially difficult for MSMEs, who may not have sufficient access to capital to modify their production systems. The lack of infrastructure also pertains to insufficient capacity in the world to produce sustainable materials, such as rPET. Adoption of rPET in textile manufacturing is constrained globally due to its limited supply.[333]

- **Inadequately defined legal frameworks.** Currently, there is no standardisation on the sorting, collecting, and handling processes related to textile waste. Moreover, there are different requirements for factories based in Special Economic Zones (SEZs) and different for those that are based outside the SEZs. Current legislation also makes it difficult for textile companies to trade and use materials that are declared as "waste". Unclear and inconsistent regulations could discourage businesses from adopting circular models.

- **Not profitable.** Unless inputs are collected at scale, turning recycling textile waste into a profitable business opportunity would be challenging, especially for MSMEs. While a factory that is vertically integrated could save money from recycling, as it can reuse its own in-house waste, for other factories, recycling fibres could be more expensive than using virgin materials. Moreover, recycled polyester fibres are more expensive than virgin polyester fibres due to low oil prices and because collecting, cleaning, and processing of PET bottles is time-consuming and labour-intensive, which may discourage factories from using sustainable alternatives. A study focusing on textile waste management in Makassar city in Indonesia found that craftsmen upcycling textile waste into heat-holders and doormats could not produce substantial profits.[334] The textile recycling industry in Panipat, India has also found it difficult to compete with cheap textiles manufactured in China. For example, a new polar fleece blanket manufactured in China costs USD2.5 in retail, compared to USD2 for a recycled blanket manufactured in Panipat.[335]

- **Lack of capital.** During the Inception Workshop, in February 2020, one Indonesian textile company highlighted that many of the machines deployed in Indonesian textile factories are dated and resource inefficient. Increasing the resource efficiency of Indonesian textile factories would require significant capital investments to purchase updated machinery. Lack of funding and financial incentives could make it challenging for firms to adopt circular opportunities.

- **Lack of information.** According to industry representatives, lack of data on textile waste is a significant barrier against circular economy adoption. During the Focus Group Discussion in December 2020, the industry representatives reported that a lack of field studies that estimate the pre-consumer textile waste in Indonesia prevents raising awareness in the industry on the economic and environmental costs imposed by pre-consumer textile waste.

331 Muhammad Waqas et al (2018), Critical Barriers to Implementation of Reverse Logistics in the Manufacturing Industry: A Case Study of a Developing Country. Available at: https://www.mdpi.com/2071-1050/10/11/4202
332 Diana Puspita Sari et al (2018), *Barriers of Reverse Logistics Implementation: A Case Study in a Car Battery Industry in Indonesia*. Available at: https://ojs.excelingtech.co.uk/index.php/IJSCM/article/view/1978
333 Textile World (2019), "Challenges Facing Recycled Polyester." Available at: https://www.textileworld.com/textile-world/features/2019/07/challenges-facing-recycled-polyester/
334 Suryani et al (2017), *The waste management of clothing home industries in Makassar City, Indonesia*. Available at: https://www.researchgate.net/publication/319805408_The_waste_management_of_clothing_home_industries_in_Makassar_City_Indonesia
335 Economic Times (2018), "With new clothes as cheap as used ones, Panipat's recycling industry goes out of fashion." Available at: https://economictimes.indiatimes.com/small-biz/sme-sector/with-new-clothes-as-cheap-as-used-ones-panipats-recycling-industry-goes-out-of-fashion/articleshow/62517509.cms?from=mdr

Box 9. *Examples of potential interventions that could overcome these barriers*

The detailed policy solutions for addressing the barriers to a circular economy in the textiles sector will be explored in the next phase of the circular economy work. However, this box provides some examples of the type of interventions by policymakers, the private sector, and civil society that could help address the identified barriers.

- **Consider providing financial support.** The Government of Indonesia could consider providing financial support to incentivise Indonesian textile factories, especially MSMEs, to upgrade their machinery. The Government could also work with the private sector to collect data and forecast the domestic and foreign supply of sustainable materials, such as rPET to facilitate the adoption of sustainable material alternatives in Indonesian textile factories.
- **Use public procurement to encourage adoption.** A strong vehicle to create demand for circular textile products could be public procurement. The Indonesian Government procures significant quantities of school uniforms, military uniforms, and government staff. Crafting regulations concerning public procurement that promote circular products would incentivise the local industry to adopt circular opportunities. The Netherlands has demonstrated the use of public procurement in promoting circularity in the textile industry.[336]
- **Launch "matchmaking" efforts.** Research on craftsmen in Makassar city highlighted that craftsmen were unable to sell their products directly to the end-consumers and instead had to sell to wholesalers, which could have undermined their profitability.[337] The Government could consider launching "matchmaking" efforts that allow the end-consumers to discover these products through online or offline distribution networks.
- **Define clear environmental standards.** The Government could also draft regulations on the environmental standards that textile waste must meet before companies use it as part of their production processes. Clear regulations could also decrease the asymmetry of information on how textile waste must be dealt with by producers and users of textile waste. The Government could also enable cross-country trading on textile waste to facilitate the adoption of circular opportunities. Enabling cross-country trading on textile waste could encourage the industry to see textile waste as a valuable economic resource.
- **Encourage garment brands to take a leading role.** A circular textile industry would require shared responsibility between several stakeholders, including brands and manufacturers. To encourage garment brands to play their part, the Government could create regulations against the burning of pre-consumer textile waste, which is driven by contractual obligations imposed by the brands on garment manufacturers, which treat garments as the intellectual property right of the brands and as a consequence, force the manufacturers to get rid of unwanted textiles.

336 Ministry of Infrastructure and Environment, Netherlands. "Public Procurement of textiles in the Netherlands." Available at: https://ec.europa.eu/environment/gpp/pdf/Textiles_webinar_28_june_pratical_experiences.pdf
337 Hamidah Suryani et al (2017), *The waste management of clothing home industries in Makassar City, Indonesia*. Available at: http://eprints.unm.ac.id/7744/1/JURNAL%20POLLUTION%20RESEARCH.pdf

5. Construction and built environment: Tackling construction and demolition waste, energy use, and vacant floor space

This chapter explores the current status of C&D waste in Indonesia and how it could evolve under a "business-as-usual" approach to 2030. It then identifies potential circular economy opportunities (based on detailed analysis and extensive stakeholder engagement) and sizes the economic, social, and environmental impact associated with these circularity opportunities.

Adopting circular economy practices could help the construction sector in Indonesia generate an economic impact worth IDR172.5 trillion (USD12.1 billion) in 2030, create 1.6 million cumulative net jobs between 2021 and 2030 (of which 90 percent could be for women), produce annual household savings worth approximately IDR2 million (USD137), and reduce CO_2e emissions and water use by 44.8 million tonnes and 0.3 billion cubic metres, respectively, in 2030.

THE CONSTRUCTION SECTOR HAS SIGNIFICANT WASTE TODAY, WHICH COULD INCREASE SUBSTANTIALLY BY 2030

C&D waste contributes between 13 and 30 percent of all solid waste found in landfills worldwide, which indicates the significance of this sector in a circular economy.[338] The total C&D waste globally is expected to increase from 1.3 billion tonnes in 2012 to 2.2 billion tonnes in 2025.[339] Based on the estimates, Indonesia currently generates 29 million tonnes of C&D waste every year (Exhibit 41). Apart from material waste, the built environment also generates significant volumes of structural waste, such as vacant, abandoned, or derelict office space and houses. For instance, in 2017, half the housing development provided by the Government as part of Indonesia's affordable housing provision in Yogyakarta was unoccupied.[340]

338 PoombeteThongkamsuk, et al (2017), *Waste generated in high-rise buildings construction: A current situation in Thailand.* Available at: https://www.sciencedirect.com/science/article/pii/S1876102173512992via%3Dihub
339 Transparency Market Research, *Construction Waste Market - Global Industry Analysis, Size, Share, Growth, Trends, and Forecast 2017 – 2025.* Available at: https://www.transparencymarketresearch.com/construction-waste-market.html
340 The World Bank (2017). "Five lessons on affordable housing provision from Indonesia." Available at: https://blogs.worldbank.org/sustainablecities/five-lessons-affordable-housing-provision-indonesia

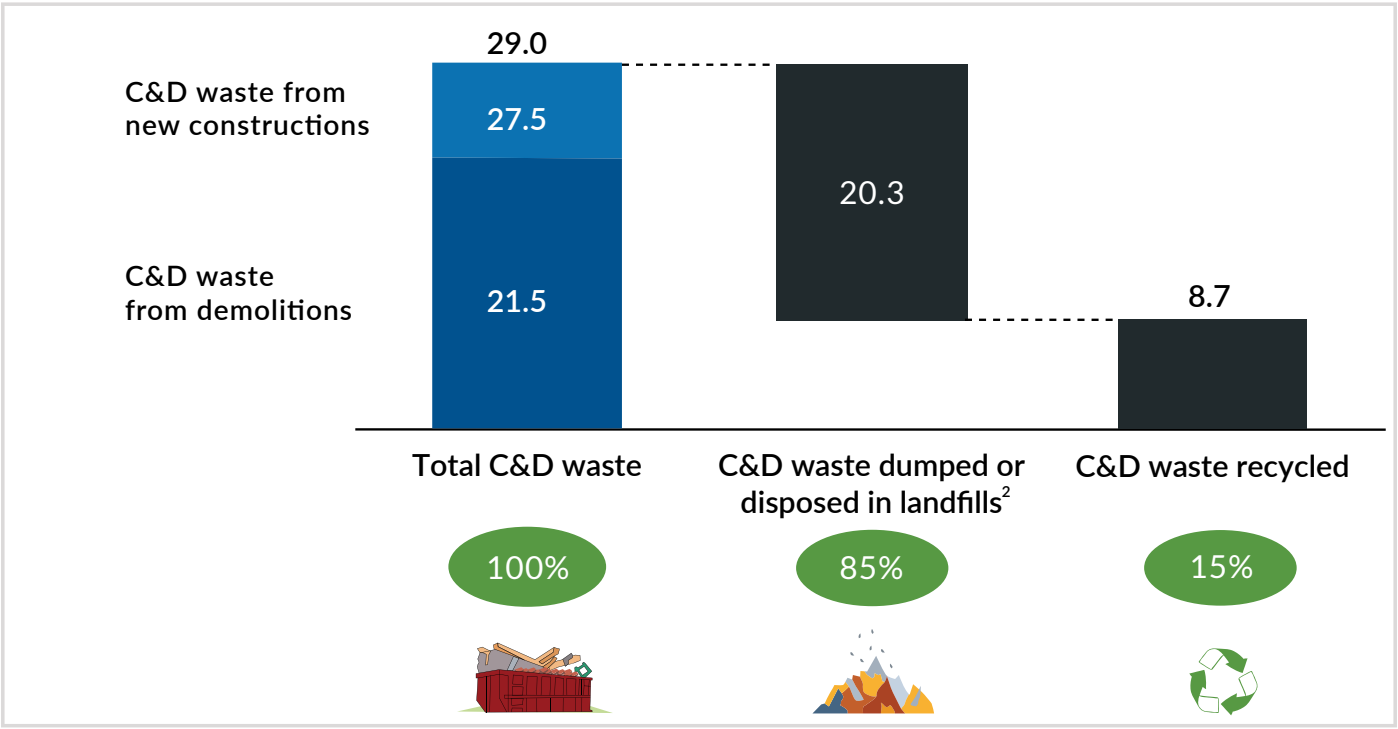
Exhibit 41

CONSTRUCTION

Currently, only 15% of construction and demolition waste is recycled in Indonesia

Quantity of construction and demolition (C&D) waste at each stage in Indonesia in 2019 [1]

Million tonnes



1. Data for the split of construction waste between new constructions and demolitions is based on figures published for C&D waste in Thailand
2. Based on estimates from a study by Esa et al (2017) on construction and demolition waste in Malaysia (see annex for more details)

SOURCE: Esa et al; BPS; Thongkamsuk et al (see annex for more details)

In a "business-as-usual" scenario, total C&D waste could get significantly worse in Indonesia, estimated to increase by 82 percent from 29 million tonnes in 2019 to 52.8 million tonnes in 2030 (Exhibit 42). Growing urbanisation and the significant importance placed by the Government on infrastructure are two key reasons behind this likely growth. Indonesia's urbanisation rate is expected to increase from 55 percent in 2019 to 62 percent in 2030.[341] This growth in urbanisation will lead to a greater demand not only for housing but also for offices, retail spaces, and other services catering to the new consumers. Jakarta, for example, is expected to see the highest growth in hotel rooms in Asia-Pacific.[342] The greater demand for construction services will not only come from the middle and upper class but also the urban poor. President Jokowi launched the "One Million Houses" programme to decrease the backlog of urban housing for the poor from 7.6 million houses in 2015 to 5.4 million housing units in 2019.[343] So far, under this programme, three million housing units have been built. The Government has also planned to spend over IDR5,957 trillion (USD412 billion) between 2020 and 2024 to build airports, power plants, and other infrastructure to decentralise Indonesia's growth beyond Java.[344]

341 United Nations Department of Economic and Social Affairs, *World Urbanization Prospects 2018*. Available at: https://population.un.org/wup/Download/
342 The Jakarta Post (2018), "Jakarta has third-largest growth rate for hotel rooms in Asia-Pacific". Available at: https://www.thejakartapost.com/travel/2018/06/02/jakarta-has-third-largest-growth-rate-for-hotel-rooms-in-asia-pacific.html
343 The Jakarta Post (2019), "Government doubles down on building more, better-quality homes". Available at: https://www.thejakartapost.com/news/2019/01/24/government-doubles-down-to-build-more-better-quality-homes.html
344 Bloomberg (2019), "Indonesia Has a Grand $412 Billion Plan to Rebuild the Country". Available at: https://www.bloomberg.com/news/articles/2019-05-16/indonesia-has-a-412-billion-plan-to-rebuild-the-country

Exhibit 42

CONSTRUCTION

Construction and demolition waste could get worse by 2030

Higher urbanisation rate

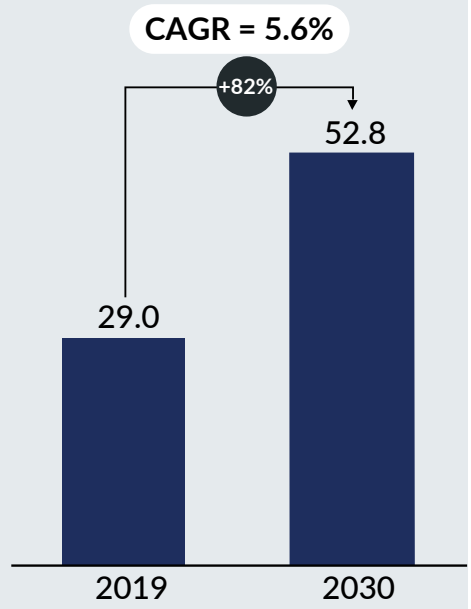
- Over 35 million people are expected to move to cities in Indonesia between now and 2030
- Urban population could account for 71% of the total population by 2030
- This will increase the demand for construction of residential, commercial, and industrial buildings

Increased expenditure on public infrastructure

- The Indonesian government has outlined its ambition to spend over USD400 billion across hundreds of projects, including 25 new airports, power plants, waste-to-energy facilities. and mass transit projects.

Estimated increase in C&D waste[1]

C&D waste in Indonesia
million tonnes



1. The rate of growth in construction waste is assumed to be the same as that of the growth in the real value of Indonesia's construction sector output
SOURCE: McKinsey Global Institute, UN Population Division; The Straits Times (see annex for more details)

THERE ARE LARGE ECONOMIC, ENVIRONMENTAL, AND SOCIAL COSTS ASSOCIATED WITH CONSTRUCTION AND DEMOLITION WASTE

Construction materials constitute around 50 percent of the total cost for a typical construction project.[345] Since most construction materials that are wasted end up in landfills, C&D waste can represent a significant economic loss. Vacant floor space – residential or commercial – also represents a lost economic opportunity. In 2019, Jakarta had empty office space of 218 hectares.[346] Based on estimates provided by Colliers International, the vacancy rates for offices, residential apartments, and retail space in Jakarta in 2019 varied between 20 percent to 34 percent.[347] Moreover, international studies show that a large share of office space is underutilised, even when under a lease.[348] COVID-19 may have increased the vacancy rates in office space as a significant share of workers were forced to work from home and some may continue doing so, beyond the pandemic.

The environmental effects due to C&D waste and inefficient energy use in buildings are also significant. The C&D waste can have an adverse effect on the health and surrounding environment when it is dumped unprotected in landfills. Research on demolition waste in Surabaya found that the leachate associated with the waste had a higher concentration of lead than the Indonesian standards.[349] The production of concrete, key construction material in many buildings and

345 Home Guide, "How much does it cost to build a house?" Available at:
https://homeguide.com/costs/cost-to-build-a-house#material
346 Jakarta Post (2019), "Jakarta's offices empty with 218 hectares unoccupied". Available at:
https://www.thejakartapost.com/news/2019/06/27/jakartas-offices-empty-with-218-hectares-unoccupied.html
347 Colliers International (2018), *Jakarta Property Market Report*. Available at:
https://www.colliers.com/-/media/files/marketresearch/apac/indonesia/Q2-2018-ColliersQuarterly-Jakarta.pdf?la=en-GB
348 Ellen MacArthur Foundation and McKinsey (2015), *Growth within: A circular economy vision for a competitive Europe*. Available at:
https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability/Our%20Insights/Growth%20within%20A%20circular%20economy%20vision%20for%20a%20competitive%20Europe/Growth_Within.ashx
349 Yatnanta Padma Devia et al (2017), *Leachate of Demolition Waste*. Available at:
https://www.matec-conferences.org/articles/matecconf/pdf/2017/52/matecconf_eacef2017_08002.pdf

public infrastructure, is responsible for four to eight percent of the world's CO_2e emissions.[350] Concrete accounts for 40 percent of building materials used in construction in Indonesia.[351] Apart from emissions, concrete production can lead to other adverse environmental effects. 20 percent of Java's karsts have been destroyed due to the production of cement, an ingredient of concrete.[352] Karst is a geological formation comprising water-soluble rocks, such as limestone and gypsum, two of the necessary ingredients to manufacture building materials. This destruction could impact the carbon circulation function of the karsts. According to Petrasa Wacana, a cave researcher from the Acintyacunyata Speleological Club in Yogyakarta, the karst regions in Indonesia play an important role by absorbing 0.4 billion tonnes of carbon dioxide from the atmosphere and discharging 0.3 billion tonnes annually.

Building usage can also cause negative environmental impacts in the form of water consumption, wastewater production, and energy use. According to the International Energy Agency (IEA), the building sector globally accounts for 28 percent of total energy-related emissions. When the embedded energy from construction and renovation materials are included, the share of energy-related CO_2e emissions from buildings jumps to close to 40 percent.[353]

Social costs imposed on Indonesian households are substantial too. An average Indonesian household spends 25 percent of its annual budget on "housing and household facilities", the highest expenditure category after food. Since C&D waste potentially increases construction and renovations costs for households, and inefficient energy use in buildings increases their expenditure on energy, wastage in the construction sector keeps Indonesian households from spending on other important categories such as health and education.

CIRCULARITY OPPORTUNITIES COULD POTENTIALLY TRANSFORM THIS SECTOR

Based on an analysis of global approaches and extensive engagement with local stakeholders in Indonesia, six circularity opportunities were identified along the 5Rs to complement existing efforts by the Government of Indonesia (see Box 10).

350The Guardian (2019), "Concrete: the most destructive material on Earth". Available at: https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth
351 Concrete Show Asia (2018), "Indonesia's government encourages to use concrete products in infrastructure projects." Available at: https://www.concreteshowseasia.com/2018/07/07/indonesias-government-encourage-to-use-concrete-products-in-infrastructure-projects/
352 Henrich Boll Stiftung (2016), "Dirty Cement: The Case of Indonesia". Available at: https://th.boell.org/en/2016/12/09/dirty-cement-case-Indonesia
353IEA (2019), *The Critical Role of Buildings*. Available at: https://www.iea.org/reports/the-critical-role-of-buildings

Box 10. ***Overview of existing Indonesian government policies to reduce C&D waste, vacant floor space, and energy use***

The Government Regulation No. 27 of 2020 on the Management of Specific Garbage recognises six types of waste, including building demolition debris. The regulation assigns responsibility to both producers and non-producers to manage the garbage. For example, the regulation asks the producer to prepare plans and/or programs to limit the produced garbage.[354]

There are three key national regulations that govern sustainability in the construction sector in Indonesia: The Ministry of Environmental Decree No. 8 of 2010 on Criteria and Certification of Eco-friendly Building, the Regulation of the Minister of Public Works and Public Housing No 2 of 2015 on Green Building, and Regulation of the Minister of Public Works and Public Housing No. 5 of 2015 about General Guidelines for Sustainable Construction Implementation. The Provincial Government in Jakarta also instituted a regulation for green buildings: Gubernatorial Regulation No. 38/2012 on Green Buildings.[355]

The Ministry of Environmental Decree No. 8 of 2010 regulates the criteria for and the certification process of green buildings. Green Building Council Indonesia (GBCI), currently the only certification body in Indonesia, has established three different rating tools: GREENSHIP New Building, GREENSHIP Existing Building, and GREENSHIP Interior Space. As of 2015, GBCI certified 14 buildings with this certification and 140 buildings were expected to receive green building certifications.[356] The Regulation of the Minister of Public Works and Public Housing No 2 of 2015 lists the requirements that need to be fulfilled in each step of the construction process – initial planning, technical planning, construction process, utilisation, and demolition – for buildings to receive a green building certification.[357] The Ministry of Public Works and Housing Circular Letter No. 17 of 2020 also helps regulate the use of OPC cement to minimise the greenhouse gas emissions in Indonesia.[358]

The Governor Regulation No. 38 of 2012 on Green Buildings in Jakarta ties construction permits to energy and water-efficiency requirements thereby mandating energy efficiency measures. The regulation mandates 45 watts of electricity per square meter, optimised natural lighting, a minimum temperature of 25 degrees Celsius in residential buildings, and treatment and use of wastewater.[359,360] However, this regulation only applies to office and residential buildings over 50,000 sqm, hotels over 20,000 sqm, and schools over 10,000 sqm.[361] Therefore, many buildings remain outside the purview of this law. To support this regulation, the Jakarta Government, in collaboration with the IFC and GBCI, implemented an international standard called "Excellence in Design for Greater Efficiencies" (EDGE) in 2015. By 2018, 339 buildings were certified with EDGE.[362] IFC and the GBCI aim to certify at least 20 percent of new construction projects by 2021.[363] The Jakarta Government also signed the 30:30 commitment to reduce energy consumption, carbon emissions, and water consumption from buildings by 30 percent by 2030.[364] To promote energy conservation, the Presidential Regulation No. 22 of 2017, implemented by the Ministry of Energy and Mineral Resources, issued a national plan called Rencana Umum Energi Nasional (RUEN). The RUEN, which covers the buildings sector, aims to achieve energy efficiency of 17.4 percent by 2025 and 38.9 percent by 2050 relative to the BAU in 2005 in Barrel Oil Equivalent.[365]

The Jakarta Government also mandated reductions in the electricity consumption in its government buildings under Jakarta Governor Regulation No. 156 of 2012 on Electricity and Water Savings. After implementing this regulation in 2013, the city achieved a reduction in its energy bills of four percent.[366]

To discourage vacancy in apartments, the Indonesian Government had also planned in 2017 to impose taxes on vacant apartments. However, this proposal was rebuffed by Indonesia's real estate industry since it believed that it would discourage investment in the sector.[367]

The government regulation, Peraturan Pemerintah No. 27 of 2012 concerning Environmental Permits, provides a legal basis for an environmental impact assessment for buildings, known as AMDAL. Buildings that have a land area of at least five hectares and a building area of at least 10,000 square meters are required to apply.[368]

Recognising the importance of the Building Information Management (BIM), the Ministry of Public Works and Housing (PUPR) developed a BIM roadmap for Indonesia 2017-2024 and formed a BIM Team to accelerate the BIM adoption in the Indonesian Government, especially the Ministry of Public Works and Housing.[369] As a consequence, in 2018, the Ministry issued the regulation number 22 of 2018 that mandates the use of BIM in the construction of government buildings.[370] BIM could help develop and maintain material inventories for buildings, which could help in urban mining and material recovery, increasing the likelihood of construction materials being reused and recycled.

354 Cabinet Secretariat of the Republic of Indonesia (2020), Gov't Issues Regulation on Specific Waste Management. Available at:
https://setkab.go.id/en/govt-issues-regulation-on-specific-waste-management/
355 Wuri Virgayant (2017), *Legal framework on green building in Indonesia and the alternative policy*. Available at:
https://rechtsvinding.bphn.go.id/ejournal/index.php/jrv/article/view/159
356 Asia Green buildings (2015), "Indonesia : 140 buildings to receive green building certification." Available at:
http://www.asiagreenbuildings.com/12489/indonesia-140-buildings-to-receive-green-building-certification/
357 Zhonghua Gou (2020), *Green Building in Developing Countries*. Available at:
https://www.springer.com/gp/book/9783030246495
358 Based on information shared by the Ministry of Public Works and Housing.
359 The Jakarta Post (2019), "Lack of awareness for green buildings in Jakarta." Available at:
https://www.thejakartapost.com/news/2019/03/14/lack-of-awareness-for-green-buildings-in-jakarta.html
360 The Jakarta Post (2012), "New green building code to focus on water, electricity efficiency." Available at:
https://www.thejakartapost.com/news/2012/09/13/new-green-building-code-focus-water-electricity-efficiency.html
361 Building Shows (2015), "Green building in Indonesia – the carrot or the stick?" Available at:
http://www.buildingshows.com/market-insights/indonesia-insights/green-building-in-indonesia-the-carrot-or-the-stick/801775956
362 USAID (2019), "Mandatory green buildings aim to save on energy costs." Available at:
http://www.iced.or.id/en/mandatory-green-buildings-aim-to-save-on-energy-costs/
363 IFC. "Green Housing Opens the Door to a Cleaner Indonesia." Available at:
https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/green-housing-opens-door-to-cleaner-indonesia
364 Asia Green Buildings (2016), "Indonesia : Jakarta signs the green building "30:30 commitment" regulation." Available at:
http://www.asiagreenbuildings.com/14726/indonesia-signed-green-building-commitment/
365 Government of Indonesia (2017), *Presidential Regulation No. 22 of 2017*. Available at:
https://www.esdm.go.id/assets/media/content/content-rencana-umum-energi-nasional-ruen.pdf
366 Berita Satu (2013), "Lakukan Hemat Energi, Tagihan Listrik DKI Turun 4 Persen." Available at:
https://www.beritasatu.com/megapolitan/99475/lakukan-hemat-energi-tagihan-listrik-dki-turun-4-persen
367 The Jakarta Post (2017), "Real Estate Indonesia rejects plan to tax vacant apartments." Available at:
https://www.thejakartapost.com/news/2017/04/10/real-estate-indonesia-rejects-plan-to-tax-vacant-apartments.html
368 Waste4Change. "The Role of AMDAL in Achieving Functional Environments." Available at:
https://waste4change.com/the-role-of-amdal-in-achieving-functional-environments/
369 Sopaheluwakan and Adi (2020), *Adoption and implementation of building information modeling (BIM) by the government in the Indonesian construction industry*. Available at:
https://iopscience.iop.org/article/10.1088/1757-899X/930/1/012020/pdf
370 Republik Indonesia (2018), *NOMOR 22/PRT/M/2018: Tentang, Pembangunan Bangunan Gedung Negara*. Available at:
https://bulelengkab.go.id/assets/instansikab/110/bankdata/permen-pupr-no-22prtm2018-35.pdf

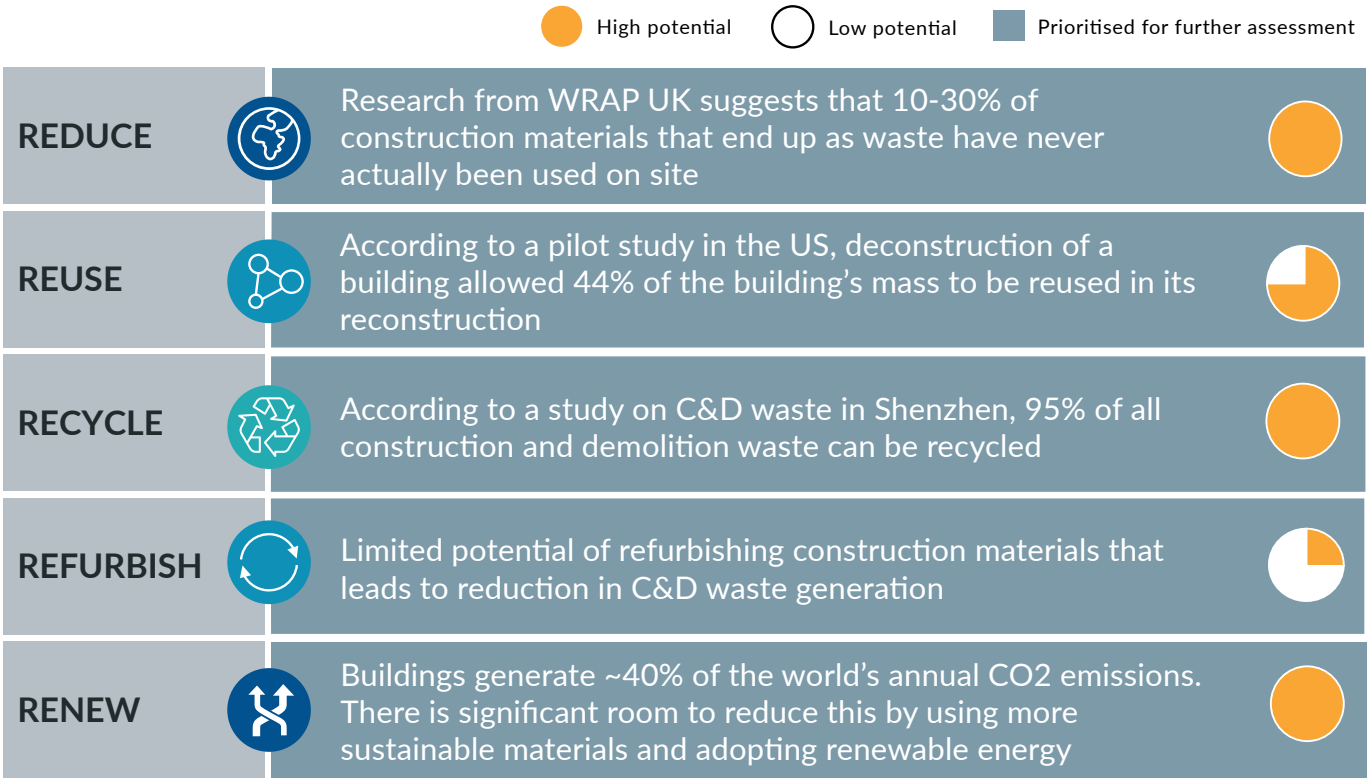
Based on literature review, focus group discussions, and expert interviews, the "Reduce", "Recycle," and "Renew" approaches seem to offer the biggest potential for circularity in the construction sector (Exhibit 43). Research from WRAP UK suggests that 10 to 30 percent of construction materials that end up as waste are never actually been used on-site, implying that there is enormous potential in reducing waste in construction sites.[371] Moreover, 95 percent of C&D waste is estimated to be recyclable.[372]

Since buildings are responsible for close to 40 percent of energy-related carbon emissions, the "Renew" approach is particularly attractive for circularity in the construction sector. In a growing number of applications, carbon-intense materials such as concrete could be replaced with less carbon-intense ones like timber (which has the added benefit of being renewable), stabilised mud blocks, or compacted fly ash blocks.[373] The sector could reduce the energy consumption of buildings in the use phase through more energy-efficient practices and technologies, such as lighting systems.

Exhibit 43

CONSTRUCTION

"Reduce", "Reuse", and "Renew" approaches offer the highest potential for circularity in the construction sector in Indonesia



SOURCE: WRAP UK; UN Environment

Six circular opportunities for this sector were identified that represent significant potential (Exhibit 44).

371 Steel Construction Info, *Construction and demolition waste.* Available at: https://www.steelconstruction.info/Construction_and_demolition_waste#Waste_and_Resources_Action_Programme_.28WRAP.29
372 Chinda and Doan, *Modelling construction and demolition waste recycling program in Bangkok: Benefit and cost analysis.* Available at: https://www.researchgate.net/publication/303889493_Modeling_Construction_and_Demolition_Waste_Recycling_Program_in_Bangkok_Benefit_and_Cost_Analysis
373 B.V. Venkatarama Reddy (2009), *Sustainable materials for low carbon buildings.* Available at: https://academic.oup.com/ijlct/article/4/3/175/710965

Exhibit 44

CONSTRUCTION

Examples of circular economy opportunities and benefits in the construction sector

#	Circular opportunities	5Rs	Brief Description	Significance/Examples
1	**Generate less C&D waste through existing processes**	**Reduce**	Optimise existing construction practices and processes to reduce wastage in construction yards	Over-ordering of materials due to inaccurate estimates of building material requirements
2	**Generate less C&D waste through new processes**	**Reduce**	Introducing new industrial manufacturing methods, modularisation, and 3D printing to reduce time and cost of construction and renovation	Chinese construction company WinSun claimed 80% labour savings and 30-60% material savings from 3D printing
3	**Use more sustainable materials**	**Renew**	Switching to more sustainable and longer life materials to reduce environmental footprint of construction	Timber buildings could be a USD40 billion opportunity globally due to their lower CO2 emissions when compared to concrete and steel
4	**Reuse and recycle materials**	**Recycle, Reuse**	Tighter 'looping' of building components through either reuse or high-quality recycling	Modular design enables about 80% of the components in the envelope of a building to be re-used and refurbished. Singapore recycles nearly 100% of its used slag and construction debris
5	**Optimise building usage**	**Reuse, Refurbish**	Increase utility of existing buildings through sharing, multi-purposing, and repurposing	Approximately 40 billion square metres of floor space globally remains under-utilised during office hours
6	**Design and build more resource-efficient buildings**	**Renew**	Improve the energy efficiency of buildings in Indonesia	Green buildings certified in India have energy savings of 40 - 50% compared to conventional buildings

SOURCE: Ellen MacArthur Foundation; focus group discussions; expert interviews

- **Generate less C&D waste through existing processes.** This opportunity refers to improving the penetration of existing technologies and best practices for waste avoidance. For example, over-ordering of construction materials due to inaccurate estimates of requirements and poor on-site protocols are two leading causes for C&D waste generation. Better material requirement planning (MRP) and project management; incorporating a project-specific waste allowance for contractors; and having better on-site protocols such as making sure that materials that are not rain-proof are kept indoors are some of the tried and tested but often underleveraged methods to access this opportunity. A qualitative study on Indonesia's C&D waste found that "waiting for materials" was one of the main contributing factors in the generation of C&D waste in Indonesia.[374] The Project Managers interviewed for the research argued that designing a site layout that could facilitate materials flows without any interruptions and effectively communicating with suppliers could reduce wastage.

- **Generate less C&D waste through new processes.** This opportunity refers to using new technologies to improve efficiency in construction and thereby, decrease C&D waste generation. Some examples of such technologies are 3D printing, modular construction, and Building Information Management (BIM). 3D printing (or additive manufacturing) can reduce C&D waste by increasing construction precision. Modular construction (or prefabricated construction) can reduce C&D waste by allowing manufacturers to manage better the flow of materials in a controlled environment instead of on-site. Modular construction has also shown to meaningfully reduce the time it takes to construct homes. A study on modular construction in Jakarta estimated that prefabricated houses could

374 Sugiharto Alwi (2002), *Waste in the Indonesian Construction Project*. Available at: https://core.ac.uk/download/pdf/143869729.pdf

be built in a week, where conventional houses built on-site could take up to two months.[375] BIM helps to reduce C&D waste in many ways such as by providing 3D visualisations of buildings that give a better project overview to engineers and architects, thereby minimising time-consuming changes later and allowing for more accurate estimates of the required construction materials. [376] Global case studies have shown that 3D printing, modular construction, and BIM can reduce C&D waste by 30 percent,[377] 50 percent,[378] and 45 percent,[379] respectively.

There have been some applications of these technologies in Indonesia. For example, PT. Bondor Indonesia has developed modular buildings in Merauke and Timika (Papua) and Muara Tuhup (Kalimantan).[380] Rawhaus, an Indonesian company, has used modular construction to develop an environmentally sustainable microhouse.[381] A survey of 20 respondents operating in the construction sector showed that 60 percent of them had already begun using BIM in their projects.[382] Jaygoe, a tech company based in Jakarta, considered using 3D printing to reconstruct house for earthquake-affected residents in Palu.[383] President Jokowi has also reportedly spoken about the potential of using 3D-printed houses as part of the Government's Million Homes Programme (locally known as PSR).[384]

However, the application of these technologies in Indonesia has been on a limited scale. A qualitative study on the level of BIM implementation in Indonesia found that the maturity level of the industry about BIM is low.[385] Therefore, the current adoption rates in Indonesia for 3D printing, modular construction, and BIM are assumed to be close to zero in this analysis, indicating a significant potential to adopt such technologies.[386]

- **Use more sustainable materials.** This refers to switching to more sustainable materials to reduce the environmental footprint of construction. For example, straw bale, rockwool, and paper insulation can replace concrete and bricks in some construction applications. These materials can bring significant economic and environmental benefits, for example, by being more energy-efficient.[387] Such materials can decrease energy requirements during the lifecycle of a building by providing insulation in different weather conditions. Using sustainable materials like bamboo and wood not only help reduce C&D waste that ends up in landfills since they are easily recyclable, but they are also renewable and have the additional benefit of being more earthquake-resilient than concrete and bricks.[388] Villagers in Lombok reconstructed their houses from bamboo and wood following the August 2018 earthquake.[389] Indonesian developers rediscovering the heritage uses of wood in construction might expedite the replacement of concrete with wood. For example, Aaksen Responsible Architecture renovated an old house in West Java into a modern timber house.[390] Bali is also witnessing a rise in constructions of "joglo", a traditional wooden house from Java.[391] Research in Indonesia has also demonstrated how circular economy-focused traditional wooden houses could be built.[392]

  Indonesia could also consider using more sustainable alternatives to conventional construction materials when using natural materials such as wood may not be possible. For example, building tall skyscrapers with wood could be a challenge given the high wind speeds in higher floors.[393] In those cases, Indonesia could replace conventional steel with higher-strength steel, which can reduce the weight of steel used by 30 percent.[394]

  Besides natural materials like wood and bamboo, locally manufactured innovative and sustainable alternatives are also emerging in Indonesia. Greensense Concrete has developed a concrete, which has been used in various

375 Raka Gumilang Raksamala Basmara Putra and Dalhar Susanto (2017), *Prefabricated house in real estate business development in Jabodetabek*. Available at: https://www.researchgate.net/publication/322283548_Prefabricated_house_in_real_estate_business_development_in_Jabodetabek
376Connect and Construct, "Top 10 Benefits of BIM in Construction". Available at: https://connect.bim360.autodesk.com/benefits-of-bim-in-construction
377Ghaffar, et al (2018), *Additive manufacturing technology and its implementation in construction as an eco-innovative solution*. Available at: https://www.sciencedirect.com/science/article/pii/S0926580517309731
378WRAP, *Waste Reduction Potential of Offsite Volumetric*. Available at: https://www.wrap.org.uk/sites/files/wrap/VOLUMETRIC%20-%20Full%20case%20study.pdf
379McKinsey & Company (2019), *Modular construction: From projects to products*. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/modular-construction-from-projects-to-products
380 Bondor, "Modular & Transportable Building." Available at: https://bondor.co.id/applications/modular-transportable-building.html
381 A HAUS. Rawhaus. Available at: https://www.rawhaus-id.com/a-haus
382 Jati Hatmoko et al, *Investigating Building Information Modelling (BIM) Adoption in Indonesia Construction Industry*. Available at: https://www.researchgate.net/publication/330624729_Investigating_Building_Information_Modelling_BIM_Adoption_in_Indonesia_Construction_Industry
383 Arsia News (2018), "3D-Printed Houses Could Be The Right Solution for Palu Reconstruction." Available at: https://arsianews.com/2018/12/3d-printing-houses-could-be-the-right-solution-for-palu-reconstruction/
384 Retalk Asia (2018), "Is the Indonesian Gov't's target of a million homes a year just a click away?" Available at: https://www.retalkasia.com/news/2018/04/12/indonesian-govts-target-million-homes-year-just-click-away/1523498445
385 Dewi Larasati et al (2018), *Factors that Affects Maturity Level of BIM Implementation in Indonesia; Case Studies of 5 Construction Key Actors*. Available at: http://anzasca.net/wp-content/uploads/2019/01/79-Factors-that-Affects-Maturity-Level-of-BIM-Implementation-in-Indonesia_-Case-Studies-of-5-Construction-Key-Actors.pdf
386 Based on expert interview of Mr.Tiyok Prasetyoadi; there is limited data availability on adoption rates of such technologies in Indonesia
387 Larisa Brojan, et al (2013), *A comparative study of brick and straw bale wall systems from environmental economic, and energy perspectives*. Available at: https://www.researchgate.net/publication/266618563_Comparative_study_of_brick_and_straw_bale_wall_systems_from_environmental_economical_and_energy_perspectives
388 MarketPlace (2018), "Why bamboo and earth are better than steel and concrete after a Himalayan earthquake." Available at: https://www.marketplace.org/2018/04/25/why-bamboo-and-earth-are-better-steel-and-concrete-after-himalayan-earthquake/
389VOA News (2018), "Indonesians Discover Bamboo and Wood Beat Concrete and Steel". Available at: https://www.voanews.com/east-asia-pacific/indonesians-discover-bamboo-and-wood-beat-concrete-and-steel
390 Inhabitat (2019), "A modern timber house in Indonesia celebrates "mummified" wood". Available at: https://inhabitat.com/a-modern-timber-house-in-indonesia-celebrates-mummified-wood/
391 Indonesia Expat (2020), "Building Joglo: The New Craze in Bali Property." Available at: https://indonesiaexpat.biz/business-property/building-joglo-the-new-craze-in-bali-property/
392 Tsai and Wonodihardjo (2018), *Achieving Sustainability of Traditional Wooden Houses in Indonesia by Utilization of Cost-Efficient Waste-Wood Composite*. Available at: https://www.mdpi.com/2071-1050/10/6/1718/htm
393 BBC (2017), "'Plyscrapers': The rise of the wooden skyscraper." Available at: https://www.bbc.com/future/article/20171026-the-rise-of-skyscrapers-made-of-wood
394 BSDC and AlphaBeta (2017), *Valuing the SDG Prize*. Available at: http://s3.amazonaws.com/aws-bsdc/Valuing-the-SDG-Prize.pdf

projects in Indonesia, which could have a lower carbon footprint.[395] "b-panel", a reinforced concrete sandwich panel system, claims to offer a more sustainable alternative to bricks since it could reduce material waste and improve the energy efficiency of buildings.[396] Mycotech has produced a composite board called BIOBO, made from mycelium, that aims to replace conventional composite boards made up of wood, plastic, and binding agents.

- **Reuse and recycle materials.** This opportunity refers to increasing the reuse and recycling rate of C&D waste. C&D waste has different components. It can comprise two types of waste – valuable and non-valuable. Valuable waste includes waste that could be reused or resold, such as wood, roof, tiles, steel, and other metals. Non-valuable waste includes inert waste (e.g., concrete, brick masonry, sand, gravel) which could be recycled as an aggregate and used to manufacture new concrete or deployed in road construction.[397] Reusing and recycling C&D waste have direct and indirect benefits. Direct benefits include a lower purchase cost of construction materials. For example, used teak frames in Indonesia could be around 20 percent cheaper than new teak frames and used steel reinforcement in Indonesia could be 30 percent cheaper than new steel reinforcements.[398] Indirect benefits include reductions in transportation costs and leasing costs to allocate space for C&D waste. Nearly all C&D waste can be recycled according to international studies.[399] A research study conducted in Jakarta estimated that 40 to 60 percent of C&D waste could be recovered and recycled.[400] By using Malaysia's construction waste recycling rate as a proxy, it was assumed that Indonesia's current construction waste recycling rate is 15 percent.[401] In developing countries like Indonesia, construction waste recycling undertaken by the informal sector is unlikely to be recorded in formal statistics. It is not uncommon for scavengers to collect C&D waste from construction sites.[402] However, increasing the formal recycling of C&D waste could potentially increasing the economic value that could be recovered from Indonesia's C&D waste.

  Designing of buildings from a circular economy perspective could also unlock benefits by increasing the reuse of construction materials. For example, Circl, a new pavilion in Amsterdam's Zuidas district, was built not only be reusing construction materials but was also designed to ensure that it could be disassembled easily. This ensures that building materials – from the wood used in its construction to the aluminium on its outer walls – could be put to new uses in the future.[403]

- **Optimise building usage.** This opportunity refers to reducing real estate waste or vacant floor space by optimising building and space usage, hence avoiding new construction. Savills Indonesia estimated 2.18 million square meters of office floor space was vacant in Jakarta in 2019.[404] There is significant vacant floor space in the residential apartment market and the retail market too, implying that there is substantial capacity in Indonesia to reduce this vacant space.[405] Developing co-working / co-living / co-retail business models in Indonesia can optimise the use of building space and thus reduce the need for more construction. Such business models have already emerged in Indonesia, with nearly 250 co-working spaces in Indonesia, including the likes of Co-Hive, GoWork, Kolega, and UnionSPACE.[406] Co-Hive has also ventured into the co-living industry. In 2019, it introduced a co-living space in West Jakarta in collaboration with Keppel Land. Due to the importance of reducing waste at source, optimising building usage should be prioritised by the Indonesian Government over processes that help reducing construction waste generation in new constructions.

- **Design and build resource-efficient buildings.** This opportunity refers to reducing energy in building operations through design changes and resource-efficient appliances. Globally, energy efficiency measures for buildings have the potential to save an estimated EUR280 to 410 billion on energy spending.[407] In Southeast Asia, the International Energy Agency (IEA) estimated that the adoption of sustainable energy practices for buildings could lead to a reduction in energy use by 28 percent.[408] The Green Building Council Indonesia (GBCI) estimated that

395 EcoSmart, "Greensense Concrete: Saving resources and increasing efficiency." Available at: http://www.ecosmarthub.com/ecoSmart_concrete.pdf
396 b-panel (2012), "White paper - b-panel® Building System." Available at: http://www.b-panel.com/wp-content/uploads/pdf/White-paper-b-panel-Sep-2012-rev.3.6-ENG-low.pdf
397 Yatnanta Padma Devia et al (2017), *Leachate of Demolition Waste*. Available at: https://www.matec-conferences.org/articles/matecconf/pdf/2017/52/matecconf_eacef2017_08002.pdf
398 Fransisca Theresia Sembiring (2018), *Study of recycling demolition waste material product in Jakarta, Indonesia*. Available at: https://www.researchgate.net/publication/329592644_Study_of_recycling_demolition_waste_material_product_in_Jakarta_Indonesia
399 The Institution Recycling Network (2005), *Recycling construction and demolition wastes*. Available at: https://archive.epa.gov/region1/healthcare/web/pdf/cdrecyclingguide.pdf
400 Fransisca Theresia Sembiring (2018), *Study of recycling demolition waste material product in Jakarta, Indonesia*. Available at: https://www.researchgate.net/publication/329592644_Study_of_recycling_demolition_waste_material_product_in_Jakarta_Indonesia
401 Esa et al (2017), *Strategies for minimizing construction and demolition wastes in Malaysia*. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0921344916303901
402 Based on an interview with the Indonesia Circular Economy Forum
403 Circl, the *making of Circl*. Available at: https://circl.nl/themakingof/en/
404 Jakarta Post (2019), "Jakarta's offices empty with 218 hectares unoccupied." Available at: https://www.thejakartapost.com/news/2019/06/27/jakartas-offices-empty-with-218-hectares-unoccupied.html
405 Colliers International (2018), *Jakarta Property Market Report*. Available at: https://www.colliers.com/-/media/files/marketresearch/apac/indonesia/Q2-2018-ColliersQuarterly-Jakarta.pdf?la=en-GB
406 Jakarta Post (2019), "Thriving start-ups drive strong growth for coworking spaces." Available at: https://www.thejakartapost.com/news/2019/06/27/thriving-start-ups-drive-strong-growth-for-coworking-spaces.html
407 European Commission (2015), *Savings and benefits of global regulations for energy efficient products*. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/Cost%20of%20Non-World%20-%20Final%20Report.pdf
408 IEA (2019), *Southeast Asia Energy Outlook 2019*. Available at: https://www.iea.org/reports/southeast-asia-energy-outlook-2019

its GREENSHIP certification has helped buildings save 23.4 to 45.3 percent of energy.[409,410] Green buildings are also an attractive business opportunity. In Jakarta alone, the market for new constructions and retrofitting older buildings could be worth USD16 billion.[411] Many developers are tapping into this opportunity. More than 2,000 homes in the Citra Maja Raya complex in Jakarta have been built using IFC's EDGE standards, which, according to the IFC, help save 1.6 kilowatt-hours of electricity.[412]

This opportunity not only involves constructing buildings keeping energy-efficiency in mind but also while operating them. The biggest share of electricity consumption in Indonesia's buildings goes to air-conditioners (AC). ACs represents 47 percent and 65 percent of annual energy bills in office and hotel buildings, respectively.[413] While the current standard for thermal comfort in Indonesia is based on the American "ASHRAE" standards of 24.0°C[414], many public spaces including shopping malls, offices, and hotels in Jakarta have temperatures as low as 20.0°C.[415] Moreover, a 2001 study found that Indonesians could be comfortable in a higher temperature range of 24.9 to 28.0°C.[416] Increasing the AC temperatures in buildings could have a significant impact. IFC estimated that increasing the average set point temperature by 2.0°C can save up to 11 percent of the total energy use in typical Jakarta buildings.[417] IFC also suggests that the tolerance to higher temperatures could be further increased in buildings with the use of ceiling fans.

How big could the opportunity be to tackle C&D waste in Indonesia? Four opportunities listed below could help reduce C&D waste by nine percent. A circular economy could also help Indonesia increase its C&D waste recycling rate from 15 percent to 30 percent (Exhibit 45).

Indonesia could also reduce vacant floor space by 21 million square metres (sqm) by optimising the use of floor space and save approximately 79,000 million kWh of energy by adopting green buildings (Exhibit 46). Adoption of energy-efficient practices in buildings could help Indonesia save nearly 47 million barrels of oil equivalent (mboe) by 2030.[418] Though focussing on a different timeframe, this could help the Indonesian Government achieve 21 percent of its target to improve its energy efficiency by 227 million barrels of oil equivalent by 2025.[419]

409 Njo Anastasia (2013), *The Way to Encourage Green Building in Indonesia.* Available at:
https://www.researchgate.net/publication/301557863_The_Way_to_Encourage_Green_Building_in_Indonesia
410 Green Building Council Indonesia, "Conference on sustainable buildings Southeast Asia: New opportunities and challenges." Available at:
http://www.mgbc.org.my/Resources/Day%202/GBC%20Indonesia%20Presentations/Country%20Paper%20-%20GBC%20Indonesia%20Presentation.pdf
411 IFC. "Green Housing Opens the Door to a Cleaner Indonesia." Available at:
https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/green-housing-opens-door-to-cleaner-indonesia
412 IFC. "Green Housing Opens the Door to a Cleaner Indonesia." Available at:
https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/green-housing-opens-door-to-cleaner-indonesia
413 Stephen Blocks et al (2014), *Market Study on Clean Technology in Indonesia.* Available at:
http://www.s-ge.com/de/filefield-private/files/59101/field_blog_public_files/65082
414 Tri Harso Karyono (2001), *Penelitian Kenyamanan Termis Di Jakarta Sebagai Acuan Suhu Nyaman Manusia Indonesia.* Available at:
http://dimensi.petra.ac.id/index.php/ars/article/viewFile/15742/15734
415 The Government of the Province of Jakarta Capital Special Territory. *Jakarta Green Building User Guide: Volume 2 Air Conditioning & Ventilation System.* Available at:
https://greenbuilding.jakarta.go.id/files/userguides/Vol-2-Airconditioning-Ventilation-UserGuide.pdf
416 Tri Harso Karyono (2001), *Penelitian Kenyamanan Termis Di Jakarta Sebagai Acuan Suhu Nyaman Manusia Indonesia.* Available at:
http://dimensi.petra.ac.id/index.php/ars/article/viewFile/15742/15734
417 The Government of the Province of Jakarta Capital Special Territory. *Jakarta Green Building User Guide: Volume 2 Air Conditioning & Ventilation System.* Available at:
https://greenbuilding.jakarta.go.id/files/userguides/Vol-2-Airconditioning-Ventilation-UserGuide.pdf
418 Assuming that one barrel of oil could generated 1700 KWh of electricity. Based on estimates given in
https://www.mcall.com/opinion/mc-xpm-2011-05-24-mc-barrel-oil-explainit-20110524-story.html
419 The Insider Stories (2020), "Indonesia Targets Energy Savings 227MBoE by 2025". Available at:
https://theinsiderstories.com/indonesia-targets-energy-savings-goal-to-227mboe-for-2025/

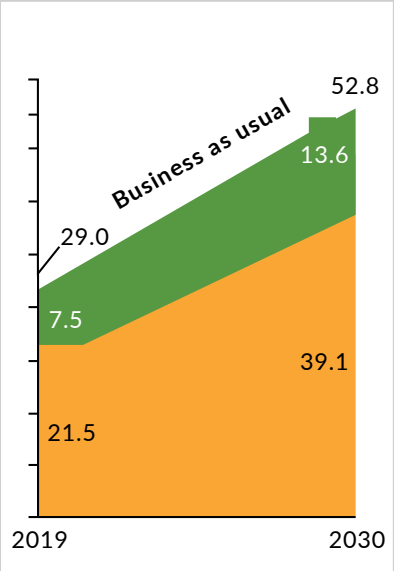
Exhibit 45

CONSTRUCTION

Indonesia could reduce and recycle 20% of its C&D waste in 2030 through circular economy opportunities

C&D waste in 2030 under a "business-as-usual" scenario and circularity opportunities

Million tonnes



Circularity opportunities	Circularity target	Million tonnes saving	% of 2030 BAU C&D waste[1]
Generate less C&D waste through existing processes	Indonesia eliminates 23% of the waste it generates due to over ordering or misplacing of construction materials[2]	1	2
Generate less C&D waste through new processes	Indonesia increases the adoption rates of 3D printing, BIM, and modular construction[3]	2	3
Use more sustainable materials	Indonesian increases wood construction quota and high-strength steel use[4]	~0	1
Reuse and recycle materials	Indonesia doubles its C&D waste recycling rate from 15% to 30%	7	14
	Total	10	20

1. Percentages are rounded off
2. Includes construction materials that are lost due to spillage, soiling, or destruction (example, when materials are left out in the rain)
3. The adoption rates of leading countries were used as benchmarks and contextualised for Indonesia
4. It was assumed that Indonesia matches the wood construction quota of Germany and increases high-strength steel use to the global average

SOURCE: BPS; Environmental Protection Agency; WRAP UK; McKinsey & Company; BSDC; focus group discussions; expert interviews

Exhibit 46

CONSTRUCTION

Indonesia could reduce 50% of floor space use and the energy used in buildings by 28% in 2030

Operation-phase opportunities

	Floor space saved (2030, versus "business-as-usual") Million square metres		Assumption	Impact: % of total floor space saved in 2030[1]
Optimise building usage		21.2	Indonesia reduces its vacant office space, residential apartment space, and retail space by 50% in 2030	50%

	Building energy saved (2030, versus "business-as-usual") Billion kWh		Assumption	Impact: % of total energy use saved in 2030[2]
Design and build more resource-efficient buildings		79.386	Indonesia reduces the energy use for buildings by 28% in 2030	28%

1. Percentages are rounded off
2. Percentages are rounded off

SOURCE: International Energy Agency; Colliers International; focus group discussions; expert interviews

Box 11. ***Case study of circularity in construction and built environment***

Siam Cement Group (SCG) is an example of a company that has built a business model focused on the circular economy in the construction sector. For instance, to manufacture the SCG Lightweight Concrete Indonesia (SLCI), it uses palm kernel shells which are the residue of cooking oil as a raw material for the combustion process. In addition, products under its SCG Smartblock, which cannot be sold in the market, are recycled back as raw materials to manufacture light-weight concrete block.

Moreover, to manufacture its ready-mixed concrete production, SCG utilises industrial waste residues, such as copper slag and fly ash from power plants, to substitute cement. SCG has also demonstrated its circular economy principles in its project implementation. For instance, it used Recycled Concrete Aggregate (RCA) as substrate and concrete to construct roads and sidewalks at the Bintaro RMC Factory and the Bintaro Jaya Exchange 2 project. The constructions used 30 percent RCA, which was applied to the concrete layer. In addition, 100 percent RCA, created from the recycling of concrete specimens and precast concrete waste, was used for the base layer and sub-base. This innovative application of RCA helped SCG reduce the usage of natural resources (split and sand) by 25 tonnes and reduce landfill waste as well as soil, water, and air pollution.

THE ECONOMIC, SOCIAL, AND ENVIRONMENTAL BENEFITS OF CIRCULARITY OPPORTUNITIES

Savings from circularity could occur either during the construction, renovation, or demolition phase of a building or during its operational phase. Most of the savings generated due to circularity during the construction phase of a building would accrue to the businesses in the construction sector while most savings generated during the operation phase of the building would likely accrue to consumers. These savings could then be reinvested into other sectors by businesses and consumers. Businesses might reinvest in better machinery, improving their waste management processes, building better storage facilities to store construction materials, or on hiring technical services to help them adopt new technologies like 3D printing, BIM, or modular construction. While as assumed previously, consumers may spend their savings in education, health, or recreation services.

The economic impact from a circular economy for the construction sector could be worth IDR172.3 trillion (USD12.1 billion), which is equivalent to 6.3 percent of the sector's GDP in 2030 (Exhibit 47).[420] Most of this economic impact is generated by the opportunities related to the operational phase of buildings – optimising building usage and improving the energy efficiency of buildings. These activities contribute close to 98 percent of the economic impact of all the opportunities. This finding is understandable given that operating, maintenance, and rehabilitation costs make up more than 80 percent of total lifecycle costs of new and existing buildings.[421] It is important to note that all economic benefits may not be captured by the construction sector. Some of these benefits could be captured by other sectors in the economy (e.g., waste management if businesses focus on improving C&D waste collection or education if households decide to invest their savings from reducing energy use on education).

The additional IDR172.3 trillion (USD12.1 billion) in economic output under the circular economy scenario could help generate 1.6 million new cumulative net jobs for Indonesia between 2021 and 2030 (Exhibit 48). Based on the analysis of these jobs, 90 percent could be for women. This is driven by the potential job displacement in male-dominant sectors (e.g., construction, where women make up only two percent of the total jobs) due to a circular economy and the likely job creation in female-dominant sectors (e.g., education, where households could reinvest their savings and where women account for 61 percent of all jobs). From a social standpoint, circularity in the construction sector could also lead to annual household savings worth IDR2 million (USD137) or 3.6 percent of the average current annual household expenditure (Exhibit 49).

The environmental benefits are substantial. Circular economy in the construction sector could help Indonesia avoid 44.8 million tonnes of CO_2e emissions and save 0.3 billion cubic metres of water (Exhibit 50). The two opportunities focussing on the operational phase of buildings ("optimising building use" and "design and build more resource-efficient buildings") are largely responsible for these environmental benefits. Making buildings more energy-efficient minimises their energy use and reduces energy-related emissions. Optimising floor space, on the other hand, reduces the demand for new construction and hence for construction materials.

The detailed methodology for quantifying economic, social and environmental impact is outlined in the Annex.

420 Based on IO table methodology (See the Annex for further details). Based on the ICOR methodology, the economic impact from the construction sector is nearly IDR359 trillion. The ICOR economic impact is higher than the economic impact estimated using the IO table since the adoption of circular opportunities in the construction sector (e.g., design and build more resource-efficient buildings) require significant capital investments

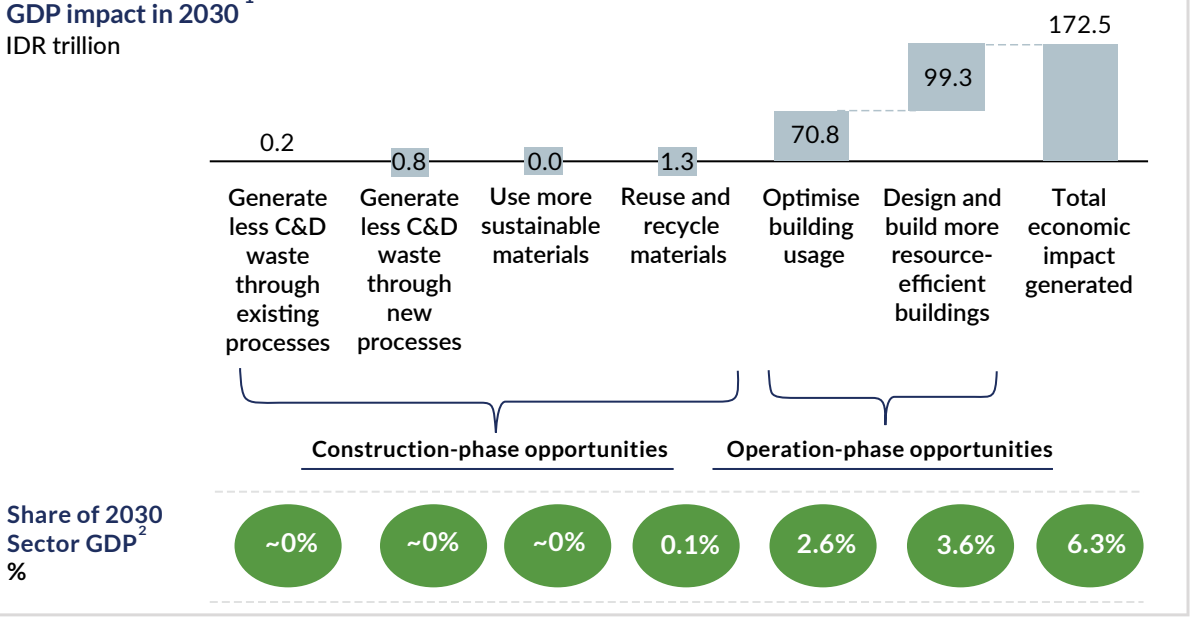
421 Renata Schneiderova-Heralova (2018), *Importance of lifecycle costing for construction projects.* Available at: http://www.tf.llu.lv/conference/proceedings2018/Papers/N405.pdf

Exhibit 47

CONSTRUCTION

BASED ON IO METHODOLOGY

A circular construction sector could generate a net economic impact of IDR172.5 trillion (USD12.1 billion) or 6.3% of the sector GDP in 2030



1. The economic benefits are not all captured by the specific sector where the circularity opportunities exist. In some cases, the savings from a circular economy opportunity are passed through to consumers who may spend them in other sectors such as health, education, and recreational services
2. Share of estimated sector GDP in 2030 is calculated based on a "business-as-usual" scenario growth rate of 4.92%. Percentages are rounded off

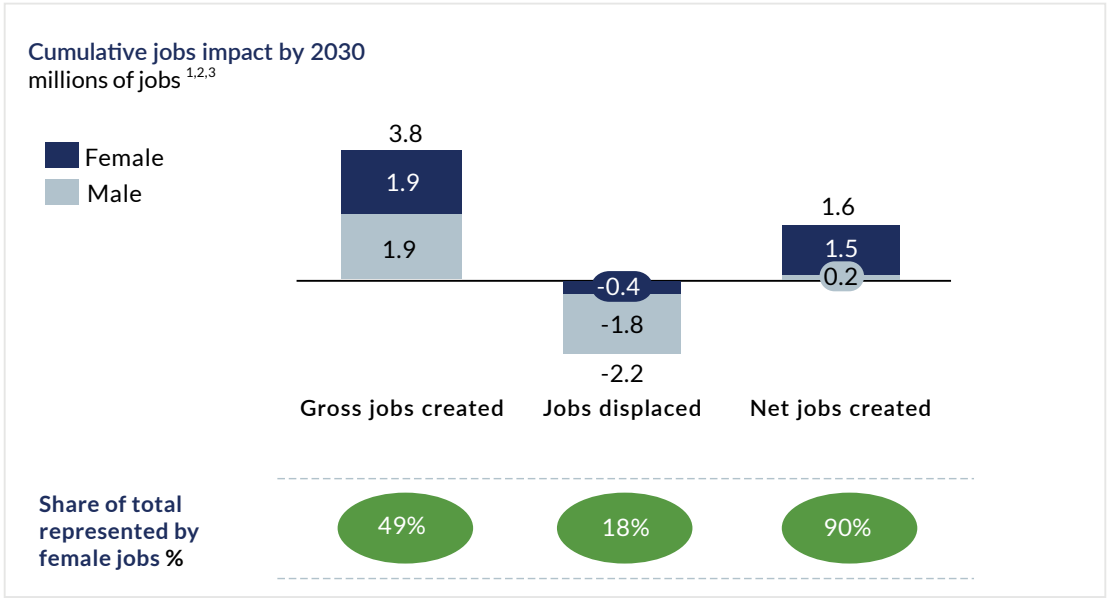
SOURCE: BPS; Bank Indonesia; (see annex for more details)

Exhibit 48

CONSTRUCTION

BASED ON IO METHODOLOGY

A circular construction sector could add 1.6 million net jobs by 2030, of which 90% could be for women



1. The jobs created are not necessarily created in the construction sector. They are created economy-wide from the savings that are reinvested by consumers and businesses
2. Calculated using data from the UN Population Division and applying Indonesia's labour force participation rate of 2019 and employment rate of 2016. The total estimated jobs in 2030 are inclusive of the net jobs created due to circular economy
3. To estimate the jobs created for women in 2030, it is assumed that the gender share of jobs in each sector in 2018 would remain unchanged till 2030. The data from the Labour Force Situation report published by BPS in February 2018 on the gender share of jobs in each of the 17 sectors of Indonesia's economy was used

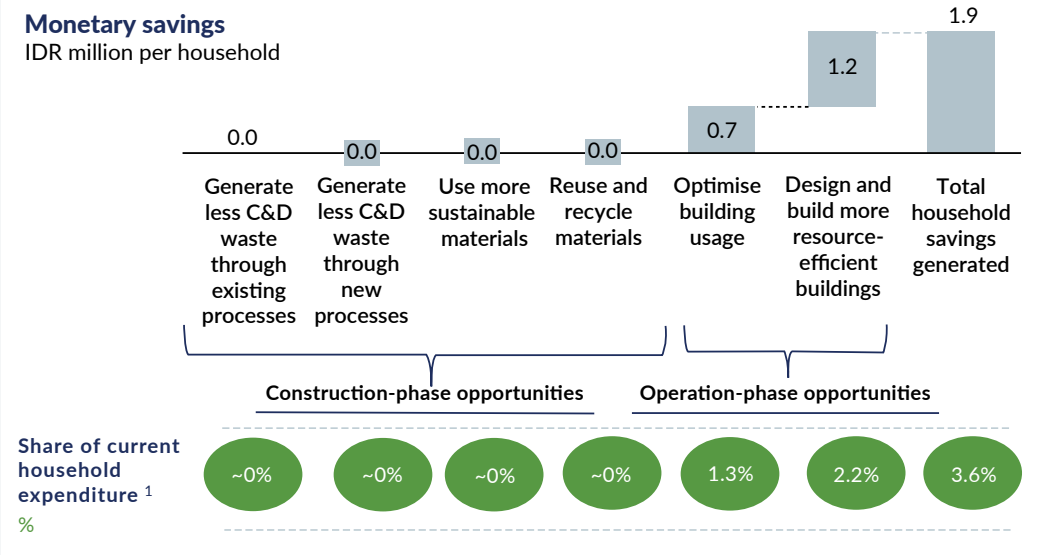
SOURCE: BPS; UN Population Division; IMF; World Bank (see annex for more details)

Exhibit 49

CONSTRUCTION

BASED ON IO METHODOLOGY

A circular construction sector could generate household savings worth IDR1.9 million (USD136.9) or 3.6% of the current annual household expenditure in 2030



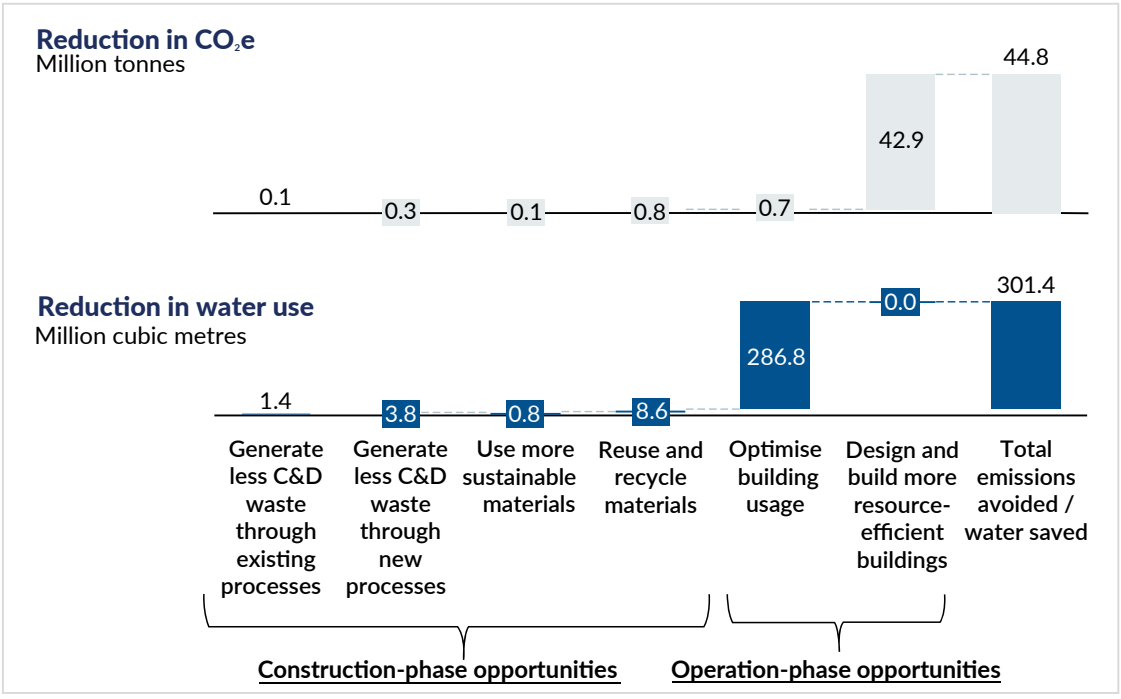
1. Percentages are rounded off

SOURCE: BPS; International Energy Agency (see annex for more details)

Exhibit 50

CONSTRUCTION

Indonesia could avoid 44.8 million tonnes of CO_2e emissions and save 0.3 billion cubic metres of water relative to BAU in 2030



SOURCE: Scientific American; International Energy Agency (see annex for more details)

BARRIERS IMPACTING CIRCULAR ECONOMY ADOPTION IN THIS SECTOR

Firms in the construction sector are likely to face several barriers in adopting circular economy opportunities (Exhibit 51). While these barriers will be explored in detail in the next phase of this project, an initial synthesis of the barriers along with possible policy responses to address them is outlined below based on consultations with experts and discussions with private sector firms in the sector (Box 12).

Exhibit 51

CONSTRUCTION

There are a range of potential barriers that could prevent firms from capturing the circularity opportunities in the construction sector

Highly significant[1]

#	Barrier	Opportunities					
		Generate less C&D waste through existing process	Generate less C&D waste through new process	Use more sustainable materials	Reuse and recycle materials	Optimise building usage	Design and build more resource-efficient buildings
1	Difficulty in changing customs and habits of businesses and consumers			■		■	
2	Unintended consequences of existing regulations						
3	Lack of infrastructure				■		
4	Implementation and enforcement failures						
5	Poorly defined targets and objectives						
6	Inadequately defined legal frameworks		■				
7	Not profitable			■			
8	Insufficient end markets				■		■
9	Lack of capital		■				■
10	Imperfect information	■		■		■	■

1. Highly significant refers to barriers that were identified in the sector focus group discussions and expert interviews as being of key concern to stakeholders in Indonesia

SOURCE: Lliterature review; focus group discussions; expert interviews

- **Not profitable**. According to the Green Building Council Indonesia (GBCI), many developers find the adoption of green building practices costly because they only look at the higher initial cost in their adoption while ignoring the savings they could generate during the lifecycle of buildings (which are captured by the tenant rather than the developer).[422] This misalignment of incentives (also known as split incentives) can lead to underinvestment in green building practices since the developer may not be inclined to make the necessary upgrades to building services when the benefits associated with the resulting energy savings accrue to the tenant.[423] Interestingly, the upfront costs to build green houses are only around 2 to 2.5 percent higher than the regular houses.[424] Some of these opportunities also require scale to achieve cost competitiveness. For example, a study in Jabodetabek estimated that the average cost of a prefabricated house is IDR200,000 per square metre higher than that of a conventional house.[425]

422 Building Shows (2015), "Green building in Indonesia – the carrot or the stick?" Available at: http://www.buildingshows.com/market-insights/indonesia-insights/green-building-in-indonesia-the-carrot-or-the-stick/801775956
423 Department of Agriculture, Water, and Environment, Australia. *Overcoming Split Incentives*. Available at: https://www.environment.gov.au/system/files/energy/files/hvac-factsheet-split-incentives.pdf
424 Asia Green Buildings (2013), "Indonesia: GREENSHIP Home, a Green Residential Rating Tool for Sustainable Future." Available at: http://www.asiagreenbuildings.com/7187/indonesia-greenship-home-a-green-residential-rating-tool-for-sustainable-future/
425 Raka Gumilang Raksamala Basmara Putra and Dalhar Susanto (2017), *Prefabricated house in real estate business development in Jabodetabek*. Available at: https://www.researchgate.net/publication/322283548_Prefabricated_house_in_real_estate_business_development_in_Jabodetabek

- **Lack of capital.** The Asia-Pacific Economic Cooperation (APEC) highlighted many barriers for energy efficiency finance in Indonesia in 2017.[426] It stated that the existing financial credit regulations are not suitable for clean energy finance, lack of information about energy efficiency projects due to the limited stock of reference projects prevents financiers from lending money, and transaction costs for financial institutions are too high given the low demand for energy efficiency projects. Similarly, a lack of capital has also found to be a barrier preventing construction firms in Indonesia from adopting emerging technologies such as BIM.[427]

- **Imperfect information.** Research on C&D waste generated in Indonesia's projects highlighted that slow decision-making, the use of inappropriate decision-making, and unskilled labour are some contributing factors to waste generation. [428] A lack of knowledge about these factors among project managers could prevent the reduction of waste generation on sites. Moreover, there are a limited number of case studies in Indonesia that detail the impact of adopting emerging technologies, such as BIM, and few experts familiar with these technologies, which may prevent firms from adopting such technologies.[429,430] Constructing wood-based buildings in Indonesia also requires specialised knowledge. Cultivation and processing of wood for building materials require special training to minimise the impact on Indonesia's tropical forests.[431]

426 Asia-Pacific Energy Cooperation (2017), *Energy Efficiency Finance in Indonesia*. Available at: https://apec.org/Publications/2017/10/Energy-Efficiency-Finance-in-Indonesia-Current-State-Barriers-and-Potential-Next-Steps
427 Dewi Larasati et al (2018), *Factors that Affects Maturity Level of BIM Implementation in Indonesia; Case Studies of 5 Construction Key Actors*. Available at: http://anzasca.net/wp-content/uploads/2019/01/79-Factors-that-Affects-Maturity-Level-of-BIM-Implementation-in-Indonesia_-Case-Studies-of-5-Construction-Key-Actors.pdf
428 Sugiharto Alwi (2002), *Waste in the Indonesian Construction Project*. Available at: https://core.ac.uk/download/pdf/143869729.pdf
429 Abdi Telaga (2018), *A review of BIM (Building Information Modeling) implementation in Indonesia construction industry*. Available at: https://www.researchgate.net/publication/325088334_A_review_of_BIM_Building_Information_Modeling_implementation_in_Indonesia_construction_industry
430 Zhabrinna et al (2018), *BIM adoption towards the sustainability of construction industry in Indonesia*. Available at: https://www.matec-conferences.org/articles/matecconf/abs/2018/54/matecconf_icrmce2018_06003/matecconf_icrmce2018_06003.html
431 Based on inputs from Mr Tiyok Prasetyo Adi, Deputy to Chairperson of Green Building Council Indonesia

Box 12. ***Examples of potential interventions that could overcome these barriers***

The detailed policy solutions for addressing the barriers to a circular economy in the construction sector will be explored in the next phase of the circular economy work. However, this box provides some examples of the type of interventions by policymakers, the private sector, and civil society that could help address the identified barriers.

- **Upskill unskilled workers.** Since unskilled workers on construction sites are a factor in contributing to C&D waste, in conjunction with construction firms, the Government could consider launching training programmes for labourers and educate them on the concept of C&D waste. To formalise the recycling of C&D waste, the Government could also consider launching training programmes for the informal waste management sector. Efforts from the plastic packaging waste industry have demonstrated how the informal sector could improve Indonesia's waste management.[432]
- **Consider setting public buildings as an example.** As the owner of large real estate and buildings, the Indonesian Government could play a key role in promoting circular practices. For example, it could create regulations that mandate energy efficiency in public buildings. Gabrovo, a town in Bulgaria, has adopted an energy-saving target of at least 30 percent for its public buildings.[433] In South Korea, government agencies submit implementation plans on green purchases every year, along with the previous year's performance records, to the Ministry of Environment.[434] The Government of Indonesia could take the lead in adopting emerging technologies, such as 3D printing, BIM, and modular construction by deploying them in the construction of public works. The Ministry of Public Works and Housing has considered developing a roadmap for Indonesia on BIM.[435] Similar efforts for other technologies could encourage businesses to adopt them.
- **Consider financial and non-financial incentives to promote energy efficiency.** To promote the construction of energy-efficient buildings, the Government could consider communicating the financial advantages of constructing energy-efficient buildings by highlighting the lifecycle savings of these buildings. Financial Services Authority (OJK) Regulation No. 51/POJK.03/2017 aims to enhance financing for projects that promote renewable energy, energy efficiency, green building, green tourism, and sustainable fishery and agriculture.[436] Operationalising this regulation could ease the constraint on the lack of capital. The Government could also consider fiscal measures to boost green building measures. Other countries have used a variety of such measures including grants and subsidies; preferential loans; tax exemptions, rebates, and credits.[437] In Argentina, residential buildings receive a 10 percent VAT exclusion if they include insulation Class B, solar hot water collectors, and LED lighting up to 140,000 UVA.[438] However, industry representatives during a Focus Group Discussion in December 2020 highlighted that the Government could also consider non-financial incentives. For instance, the Government could consider fast-track permits for green buildings.[439] The Gainesville Green Building Program in Florida, for example, combines a fast-track permit process and a 25 percent reduction in permitting fees to private contractors who adhere to the LEED certification standards.[440]
- **Create a framework for waste management.** Using Malaysia as a case study, researchers drafted a strategy which comprises three layers: micro, meso, and macro. The researchers suggested that at the micro-level, the Government could reduce wastes at the source; at the meso-level, ensure that there is a continuous effort in managing wastes; and at the macro-level, provide monitoring, and coordinating mechanisms for effective C&D waste management.[441] A similar framework could help Indonesia develop a clear policy on C&D waste.

432 Jakarta Globe (2019), "Danone-Aqua's First 100 Percent Recycled Plastic Bottle Launched in Bali." Available at: https://jakartaglobe.id/movement/danoneaquas-first-100-percent-recycled-plastic-bottle-launched-in-bali; IndonesiaExpat (2016), "Danone AQUA: Committed to Healthy Hydration." Available at: https://indonesiaexpat.biz/business-property/business-profile/danone-aqua-charlie-capetti/
433 Building Efficiency Accelerator, "BEA Cities." Available at: https://buildingefficiencyaccelerator.org/bea-cities/#gabrovo
434 One Planet Network, "Green Public Procurement of Republic of Korea." Available at: https://www.oneplanetnetwork.org/initiative/green-public-procurement-republic-korea
435 Ministry of Public Works and Public Housing, Republic of Indonesia. "Implementasi BIM." Available at: http://bim.pu.go.id/assets/files/ROADMAP_KONSTRUKSI_DIGITAL_INDONESIA_140917.pdf
436 The Jakarta Post (2019), "Lack of awareness for green buildings in Jakarta." Available at: https://www.thejakartapost.com/news/2019/03/14/lack-of-awareness-for-green-buildings-in-jakarta.html
437 ODI (2016), *Promoting sustainable and inclusive growth in emerging economies: Green Buildings*. Available at: https://economic-policy-forum.org/wp-content/uploads/2016/02/Sustainable-and-Inclusive-Growth-Green-Buildings.pdf
438 IFC (2019), *Green Buildings: A finance and policy blueprint for emerging markets*. Available at: https://www.ifc.org/wps/wcm/connect/a6e06449-0819-4814-8e75-903d4f564731/59988-IFC-GreenBuildings-report_FINAL_1-30-20.pdf?MOD=AJPERES&CVID=mTZbMU
439 IISD (2020), "COVID-19 Stimulus Spending for Green Construction Means Building Back Better." Available at: https://sdg.iisd.org/commentary/guest-articles/covid-19-stimulus-spending-for-green-construction-means-building-back-better/
440 Florida Department of Agriculture and Consumer Services, "City Ordinances: Gainesville Green Building." Available at: https://www.myfloridahomeenergy.com/help/library/highlights/gainesville-green-building/#_ftn2
441 Navarro Ferronato and Vincenzo Torretta (2019), *Waste Mismanagement in Developing Countries: A Review of Global Issues*; Mohd Reza Esa et al (2016), *Developing strategies for managing construction and demolition wastes in Malaysia based on the concept of circular economy*. Available at: https://link.springer.com/article/10.1007/s10163-016-0516-x

6. Wholesale and retail trade: Tackling plastic packaging waste

This chapter explores the current status of plastic waste related to packaging in Indonesia and how it could evolve under a "business-as-usual" approach to 2030. It then identifies potential circular economy opportunities (based on detailed analysis and extensive stakeholder engagement) and sizes the economic, social, and environmental impact associated with these circularity opportunities.

Adopting circular economy practices related to plastic packaging could help the wholesale & retail sector in Indonesia generate an economic impact worth IDR14.4 trillion (USD1 billion) in 2030, create 107,000 cumulative net jobs between 2021 and 2030 (of which 85 percent could be for women), produce household savings worth approximately IDR130,000 (USD9.1), and reduce CO_2e emissions and water use by 5.2 million tonnes and 0.2 billion cubic metres, respectively in 2030.

SIGNIFICANT WASTE TODAY, WHICH COULD INCREASE SUBSTANTIALLY BY 2030

The potential of circular models in Indonesia's wholesale and retail trade through the angle of plastic packaging was estimated. Three-quarters of Indonesia's plastic consumption is driven by packaging applications, which come mostly through the trade.

- **Plastic packaging from rigid mono-materials (19 percent).** Packaging from rigid mono-materials refers to packaging whose shape cannot be modified with ease. This packaging is generally heavier and more expensive than packaging made up of flexible mono-materials. Examples of such packaging include water bottle packaging, bottle tops, straws, plastic cutlery, eggs packaging, and B2B packaging like drums and barrels.
- **Plastic packaging from flexible mono-materials (37 percent).** Packaging from flexible mono-materials refers to packaging whose shape can be modified with ease. This packaging is manufactured usually at low cost but offers limited protection from compression or perforation.[442] Examples of such packaging include plastic grocery bags, takeaway boxes made from expanded polystyrene (EPS), cling films, and plastic pouches.
- **Plastic packaging from multi-materials (18 percent).** Multi-materials or multi-layer plastic packaging is made up of different materials or/and is composed of multiple layers of materials. Examples include sachets, stand-up pouches, chip and biscuit packets, and toothpaste tubes. For example, a typical snack chip bag could be made up of seven layers of aluminium foil and plastic. Toothpaste tubes are composed of sheets of plastic laminate – usually a combination of different plastics – that are often sandwiched around a thin layer of aluminium.[443] Such packaging is light, takes up less space, and is graphics-friendly, which makes it particularly attractive to consumer goods companies[444]. However, recyclers have so far very limited ability to separate the different layers or recycle them together.
- **Plastic used for other purposes (26 percent).** Apart from packaging, plastic has many other applications. These include its uses in durable and single-use household goods such as pots, trays, cosmetics, toys, and hygiene products (cotton buds, wet-wipes, pads, tampons, and diapers).

This analysis focused on packaging applications, given that it represents a significant portion of plastic use in Indonesia (Exhibit 52). Moreover, the analysis in this report was restricted to the plastic found in municipal solid waste due to data availability constraints. Hence, the analysis did not take into account plastic used in numerous other applications, for example, car dashboards and plastics used in medicine.[445]

442 Bizongo (2019), "Flexible Packaging vs Rigid Packaging: Which one should you use?" Available at: https://bizongo.com/blog/flexible-packaging-vs-rigid-packaging/
443 Plastics Today (2019), "Colgate introduces recyclable toothpaste tube; shares technology with competitors". Available at: https://www.plasticstoday.com/packaging/colgate-introduces-recyclable-toothpaste-tube-shares-technology-competitors/17801600762015
444 The Guardian (2014), "Good product, bad package: top sustainable packaging mistakes". Available at: https://www.theguardian.com/sustainable-business/2014/jul/18/good-product-bad-package-plastic-recycle-mistakes
445 Craftech, "The many uses of plastic materials in medicine.: Available at: https://www.craftechind.com/the-many-uses-of-plastic-materials-in-medicine/

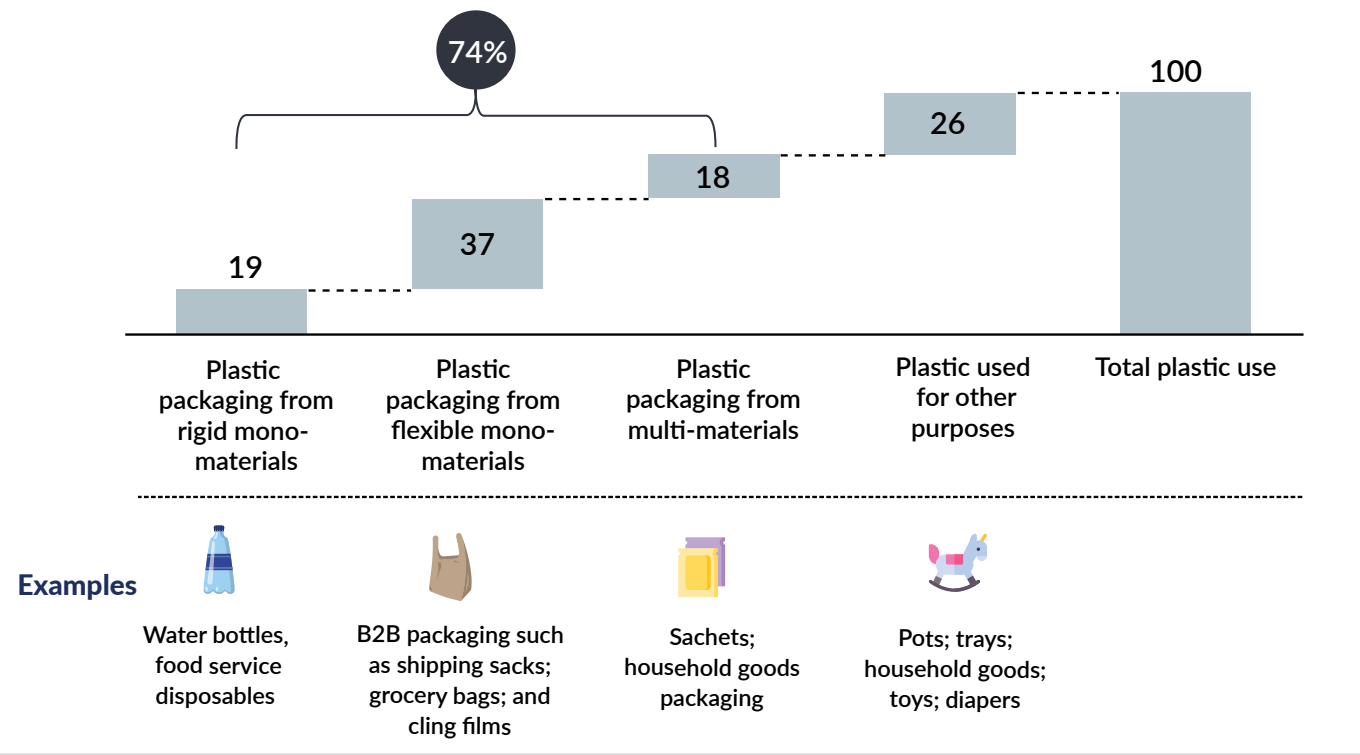
Exhibit 52

WHOLESALE & RETAIL TRADE

The analysis focuses on plastic packaging waste, which accounts for 74% of plastic use in Indonesia

Share of plastic use by type of application [1]

% of total plastic use



1. Only plastics present in Indonesia's municipal solid waste (MSW) are considered. Plastics used in car dashboards and other applications are ignored

SOURCE: SYSTEMIQ; Pew Trusts (see annex for more details)

At present, Indonesia recycles only 12 percent of its plastic packaging waste (Exhibit 53). Plastic waste can be recycled in a mechanical process that is open-loop (i.e., the recycled material cannot be recycled again) or closed-loop (i.e., the recycled material can be recycled again but with quality loss), or in a chemical recycling process (i.e., the recycled material can be recycled again without quality loss). Currently, Indonesia recycles around 83 percent of its plastic waste open-loop and 17 percent in closed-loop processes.[446] Nearly zero plastic waste is recycled through chemical processes since such facilities are hardly commercially available anywhere in the world.

What is not recycled or disposed of in proper landfills, ends up unmanaged. 0.5 million tonnes or nine percent of Indonesia's plastic packaging waste were estimated to have been dumped or leaked into seas, lakes, and rivers in 2019. Global Plastic Action Partnership estimated that close to 95 percent of Indonesia's population lives within one kilometre of a water body,[447] a major driver for such significant leakage.

62 percent of all plastic packaging waste is mismanaged. Of this, 78 percent is openly burnt, 14 percent is sent to unsanitary landfills (i.e., disposal sites that often are poorly sited, without proper infrastructure, and/or largely unmanaged), and eight percent is dumped on land. The main driver of the mismanaged waste is that this waste is uncollected. The collected waste is defined as the waste that is collected either through formal channels like local environmental agencies or through informal channels like kerbside/door-to-door waste pickers and landfill waste-pickers.

19 percent of plastic packaging waste is sent for controlled disposal in engineered landfills with waste compaction and covered daily, or semi-engineered landfills with waste compaction and a minimum of one cover per week.

446 Based on analysis conducted by SYSTEMIQ
447 Based on analysis conducted by SYSTEMIQ

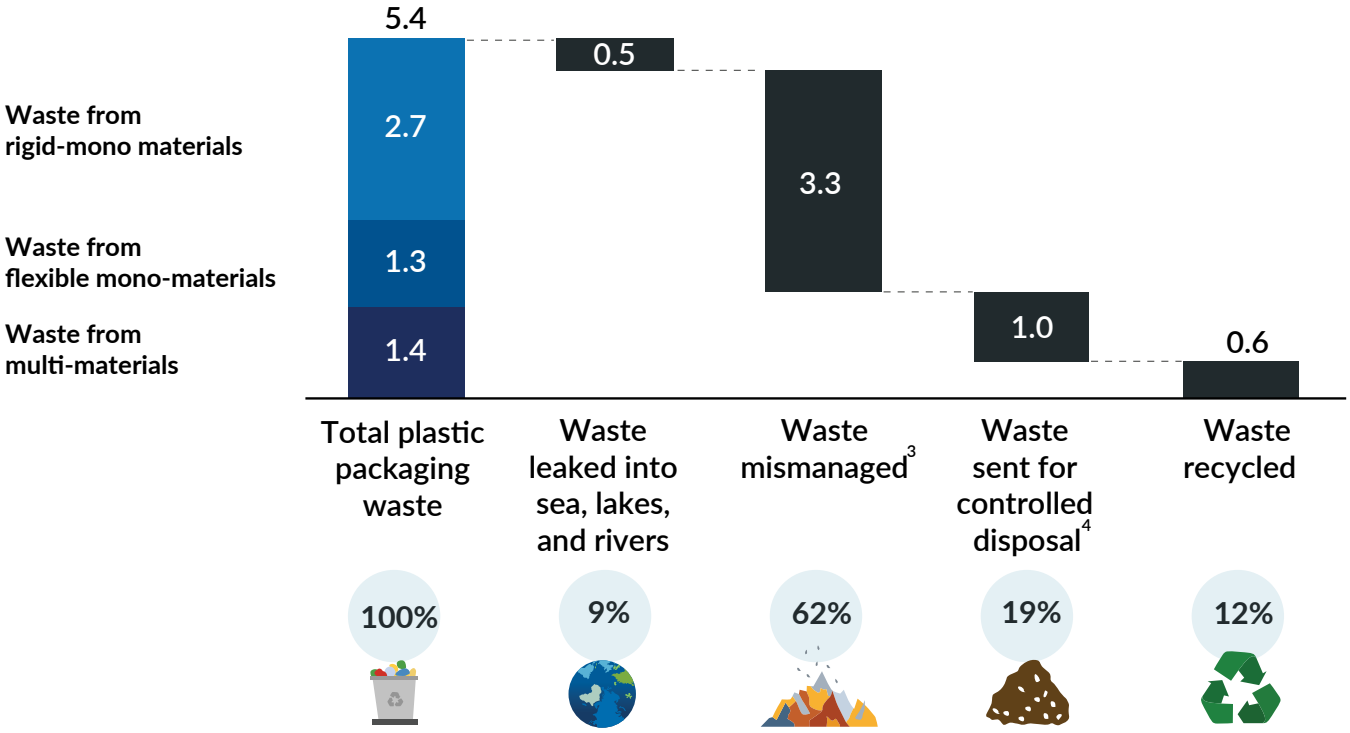
Exhibit 53

WHOLESALE & RETAIL TRADE

Currently, only 12% of plastic packaging waste is recycled in Indonesia

Quantity of plastic packaging waste at each stage in 2019 [1,2]

Million tonnes



1. Based on National Plastic Action Partnership's business-as-usual scenario analysis in 2019 on plastic waste in Indonesia in 2017, 2025, and 2040
2. Percentages and values are rounded off
3. Includes plastic packaging waste that is dumped on land, openly burnt, or sent to official dumpsites
4. Includes plastic packaging waste sent to semi-engineered and engineered landfills

SOURCE: World Economic Forum

In a "business-as-usual" approach, plastic packaging waste could get significantly worse in Indonesia by 2030 (Exhibit 54). Two-interrelated factors primarily drive this. First, an estimated 90 million Indonesians could join the consuming class by 2030.[448] This will fuel demand for a range of consumer products and increase associated packaging waste. Second, more than 35 million people are expected to move to cities in Indonesia between 2019 and 2030.[449] Increased urbanisation can contribute to higher demand for consumer products and associated waste. One of the drivers of this phenomenon could be a shift in retail from wet markets to modern outlets, such as supermarkets, that use plastic packaging in greater volumes.

448 McKinsey Global Institute (2012), *The archipelago economy: Unleashing Indonesia's potential*. Available at: https://www.mckinsey.com/~/media/mckinsey/featured%20insights/asia%20pacific/the%20archipelago%20economy/mgi_unleashing_indonesia_potential_executive_summary.ashx.
Note: the consuming class is defined as individuals with an annual net income of above D3,600 at 2005 purchasing power parity (PPP),
449 United Nations Department of Economic and Social Affairs, *World Urbanization Prospects 2018*. Available at: https://population.un.org/wup/Download/

Exhibit 54

WHOLESALE & RETAIL TRADE

Plastic packaging waste could increase by 2030

Growing consumer class

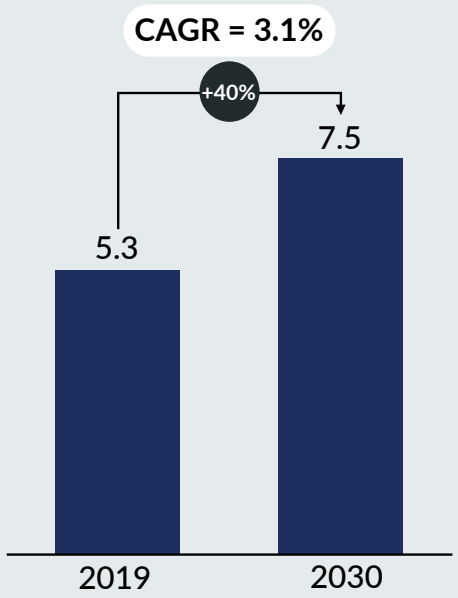
- An estimated 90 million Indonesians could join the ranks of the consuming class by 2030, creating higher demand for products utilising plastic packaging

Higher urbanisation rate

- Over 35 million people are expected to move to cities in Indonesia between now and 2030
- Urban population could account for 71% of the total population by 2030
- Increased urbanisation contributes to total overall trade and corresponding waste

Estimated increase in plastic packaging waste[1]

Plastic packaging waste in Indonesia
million tonnes



1. Based on National Plastic Action Partnership's business-as-usual scenario analysis in 2019 on plastic waste in Indonesia in 2017, 2025, and 2040

SOURCE: McKinsey Global Institute, United Nations Population Division; World Economic Forum (see annex for more details)

THERE ARE LARGE ECONOMIC, SOCIAL, AND ENVIRONMENTAL COSTS ASSOCIATED WITH PLASTIC PACKAGING WASTE

From an economic perspective, plastic waste can impact fisheries, which accounts for nine percent of GDP and five percent of jobs in Indonesia. It can also impact tourism, which also accounts for nine percent of Indonesia's GDP. The World Bank has found that poor sanitation reduces tourism revenues by USD166 million annually.[450] Bali, a popular tourist destination, had to declare a "garbage emergency" after plastic waste inundated its beaches.[451]

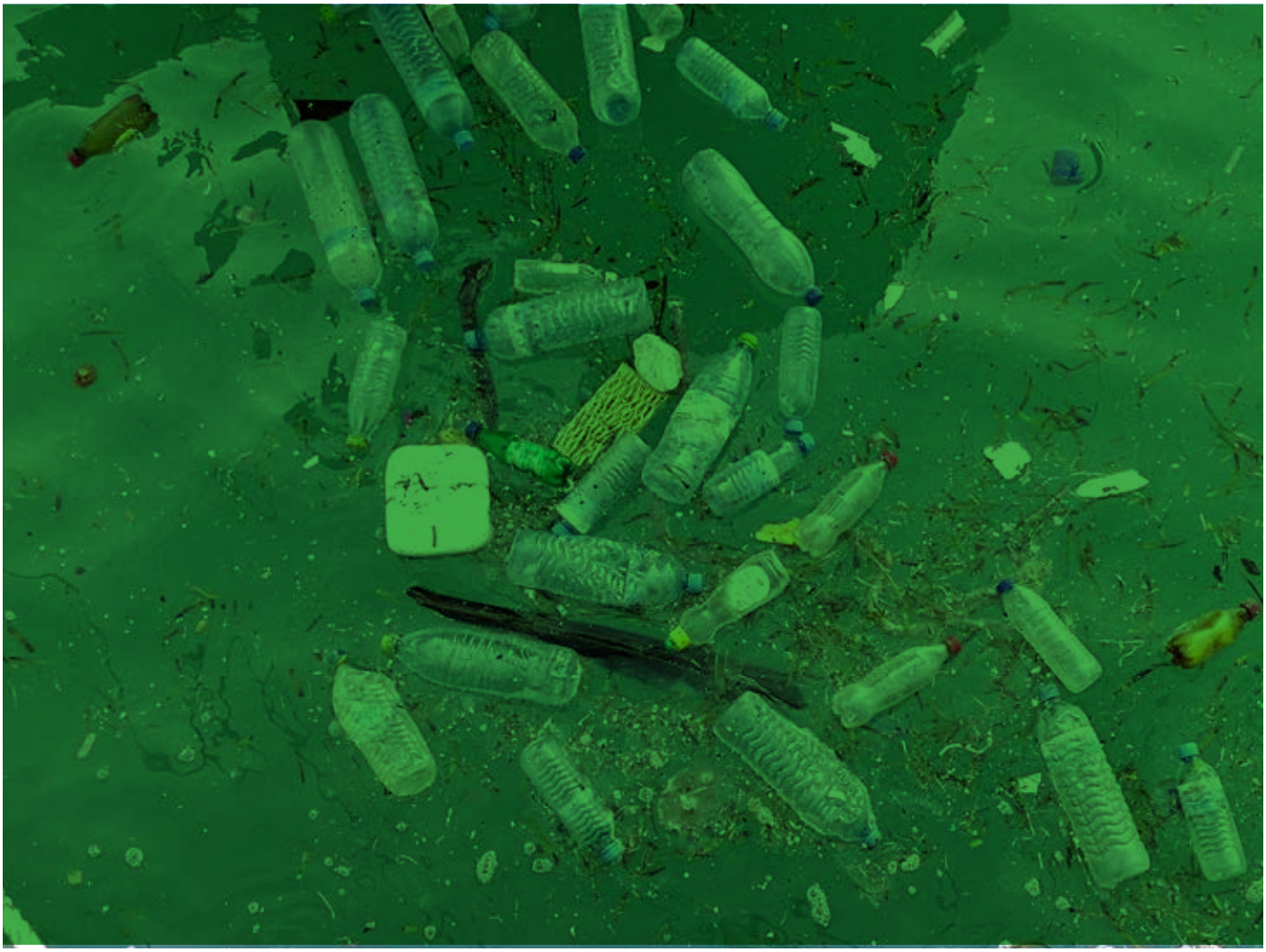
From a social perspective, plastic waste is linked to a variety of diseases, mainly due to the burning of municipal solid waste (MSW). Plastic makes up 15 percent of Indonesia's MSW and its burning can release toxic compounds like dioxins and furans, which can adversely impact human health.[452,453] Dioxins are known to cause cancer and neurological damage and can disrupt reproductive thyroid and respiratory systems. Plastic waste can also be a concern for food safety – 28 percent of fish sold in a fish market in Makassar in Sulawesi were found to contain plastic.[454] A study found that eggs near a tofu factory in Tropodo in East Java that burnt plastic waste for fuel had the second-highest level of dioxins in eggs from Asia ever measured.[455] In addition, poor management of waste, including plastic waste, can cause communicable diseases. Dengue and malaria are known to be exacerbated by poor waste management, and these diseases infect 300,000 Indonesians annually.[456,457]

450 Napitupulu (2008), *Economic impacts of sanitation in Indonesia.* Available at: http://documents.worldbank.org/curated/en/363811468042881744/pdf/721960WSP0Box30UBLIC00esi0indonesia.pdf
451 The Telegraph (2017), "Bali declares rubbish emergency as rising tide of plastic buries beaches". Available at: https://www.telegraph.co.uk/news/2017/12/28/bali-declares-rubbish-emergency-rising-tide-plastic-buries-beaches/
452 Rinku Verma, et al (2016), *Toxic pollutants from plastic waste – a review.* Available at: https://www.sciencedirect.com/science/article/pii/S187802961630158X
453 Republic of Indonesia (2017), *Presidential Regulation No. 97 of 2017.* Available at: http://ditjenpp.kemenkumham.go.id/arsip/ln/2017/ps97-2017.pdf
454 Rochman, C., Tahir, A., Williams, S. et al, *Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption. Sci Rep* **5**, 14340 (2015), Available at: https://doi.org/10.1038/srep14340
455 Ipen, et al (2019), *Plastic waste poisons Indonesia's food chain. Available at:* https://ipen.org/sites/default/files/documents/indonesia-egg-report-v1_9-web.pdf
456 Hapsari et al (2018), *Malaria elimination in Indonesia: halfway there.* Available at: https://www.thelancet.com/journals/lancet/article/PIIS2214-109X(18)30198-0/fulltext
457 The Jakarta Post (2020), *Dengue fever kills 104, infects more than 17,000 nationwide since January.* Available at: https://www.thejakartapost.com/news/2020/03/12/dengue-fever-kills-104-infects-more-than-17000-nationwide-since-january.html

Finally, from an environmental perspective, plastic waste can cause damage to marine ecosystems and fisheries. Every 20 minutes, the equivalent of a 10-tonne truckload of plastic is dumped into the waters around Indonesia.[458] Indonesia is the world's second-largest contributor of plastic pollutants to the oceans after China,[459] and four of Indonesia's rivers feature in the top 20 of the world's most plastic polluting rivers.[460] Waste issues in Indonesia are also linked to clogging up of its rivers and canals.[461] Microplastics also present a significant challenge to Indonesia's environment. Microplastics are tiny plastic particles, less than five millimetres (0.2 inches) in diameter found in tyre dust, pellets, textile microfibers, and personal care products.[462] A study in Surabaya City found an abundance of microplastics in the sediment of Jagir Estuary.[463] This can have a significant impact on marine life. A research study focused on coastal feeding grounds in Indonesia frequented by manta rays and whale sharks showed that microplastics could adversely affect such marine species.[464] Microplastics have also shown to have an adverse impact on human health.[465]

CIRCULARITY OPPORTUNITIES COULD POTENTIALLY TRANSFORM THIS SECTOR

Based on an analysis of global approaches and extensive engagement with local stakeholders in Indonesia, four circularity opportunities were identified that could complement the existing efforts by the Government of Indonesia (see Box 13).



458 World Economic Forum (2019), "Plastic waste from Western countries is poisoning Indonesia". Available at: https://www.weforum.org/agenda/2019/12/plastic-waste-indonesia-pollution-health/
459 Jambeck et al. (2015), "Plastic waste inputs from land into the ocean". Science 13 Feb 2015: Vol. 347, Issue 6223, pp. 768-771. Available at: https://science.sciencemag.org/content/347/6223/768
460 Lebreton et al (2017), *River plastic emissions to the world's oceans.* Available at: https://www.nature.com/articles/ncomms15611
461 BBC (2018), "Giant plastic 'berg blocks Indonesian river". Available at: https://www.bbc.com/news/science-environment-43823883
462 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership.* Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
463 Muhammad Firdaus et al (2020), *Microplastic pollution in the sediment of Jagir Estuary, Surabaya City, Indonesia.* Available at: https://www.sciencedirect.com/science/article/pii/S0025326X19309464
464 Elitza S. Germanov et al (2018), *Microplastics: No Small Problem for Filter-Feeding Megafauna.* Available at: https://www.sciencedirect.com/science/article/abs/pii/S0169534718300090
465 Barboza et al (2018), *Marine microplastic debris: An emerging issue for food security, food safety and human health.* Available at: https://www.sciencedirect.com/science/article/pii/S0025326X1830376X

Box 13. ***Overview of existing Indonesian government policies to combat plastic waste***

Besides the government targets to reduce waste by 30 percent and manage the remaining 70 percent of the waste by 2025, as outlined in Presidential Regulation No. 97 of 2017 (also known as JAKSTRANAS), the Government of Indonesia has developed a National Plan of Action on marine plastic debris for the period between 2017 and 2025.[466] This plan was outlined in the Presidential Decree No.83/2018, which aims to reduce plastic waste by 70 percent by 2025. Sixteen ministries have signed off on an 83-point action plan, and this plan is being monitored on a quarterly basis. A study by the National Plastic Action Partnership was launched in April 2020, which outlined the amount of waste that Indonesia needs to reduce and recycle for it to achieve its plastic waste-related targets. To meet the outlined objectives, the government pledged to spend USD1 billion in 2017 over five years.[467]

The Ministry of National Development Planning/BAPPENAS has mainstreamed the issue of plastic waste management as a priority in the national development plan. Plastic issues have been incorporated in the Indonesian Medium-Term Development Plan (RPJMN) 2020-2024 in National Priority 6 (PN 6) regarding Building the Environment, Enhancing Disaster Resilience and Climate Change and specifically included in Program 1: Improvement of Environmental Quality (Prevention of pollution and environmental damage) and Program 3: Low Carbon Development (Waste management).

The Indonesian Government has also enabled the private sector to participate in the waste management industry by enacting relevant PPP laws, such as the Presidential Decree No. 38/2015, and establishing organisations (such as the Indonesia Infrastructure Guarantee Fund) to provide funding for PPP projects.[468] Moreover, several places in Indonesia, such as Banjarmasin City, Balikpapan City, Bogor City, and Bali Province, have enforced bans on plastic bags.[469] Jakarta also joined these cities in July 2020 in enforcing a ban on single-use plastics.[470] Other existing bans include plastic bag ban in Bogor City and Styrofoam ban in Bandung City.[471] The Government of Indonesia also announced steps in 2019 to reduce the imports of plastic waste into Indonesia.[472]

Legislations such as the "Solid Waste Management Act (No. 18/2008)", "PP 81/2012 The Household Solid Waste & Household-like Solid Waste Management", "National Action Plan on Marine Debris (2017-2025)", and "Implementation Guideline of Reduce, Reuse & Recycle through Waste Bank (No.13/2012)" help govern plastic packaging waste in Indonesia.[473] These policy frameworks range from setting specific solid waste management targets to introducing EPR concepts. The Ministry of Environment and Forestry issued the Ministerial Regulation No. 75/2019 (MR 75/2019) regarding the "Roadmap to Waste Reduction by Producers." The regulation sets strict targets for businesses to achieve by 2029 – it obliges businesses to reduce plastic, aluminium, glass, and paper waste by 30 percent between 2020 and 2029.[474]

Indonesia also has regulations to tackle packaging waste specifically. Law UU No.18 of 2008 outlines that packaging waste is the responsibility of the producer.[475] The producer either needs to pick up the packaging waste or provide incentives to whoever can manage that waste. According to a research study, however, there is a lack of compliance or monitoring of the producers' responsibility despite the law.[476] Oher regulations on packaging include National Agency of Drug and Food Control's (BPOM) regulation No. 20 of 2019, which regulates food packaging comprising both virgin and recycled materials, to ensure food safety.[477]

To develop standards keeping a circular economy in mind, the Government of Indonesia has also taken a proactive approach by becoming an O-member of ISO/TC 323.[478] The membership provides Indonesia access to a platform for information sharing between countries on standardisation-related activities and could help Indonesia formulate sustainable trade practices.[479]

To achieve its target of handling 70 percent of the available waste by 2025, the Government has also placed a growing emphasis on incineration-reliant waste-to-energy (WtE) plants. The WtE plants are based on Presidential Regulation No. 35/2018.[480] This regulation superseded the Presidential Regulation No. 18/2016 and provided a wider city coverage, including twelve major cities in Java, Bali, Sumatra, and Sulawesi.[481] The Government aims to have twelve WtE plants operational by 2022 and expects them to generate up to 234 megawatts of electricity using 16,000 tonnes of waste a day.[482] However, there are significant pollution concerns related to WtE plans due to related dioxin and furan emissions.[483] Hence, the Government should prioritise reducing plastic waste generation at source, and reusing and recycling plastic packaging over WtE plans to manage waste.

466 US Embassy in Indonesia, *U.S. and Indonesia Combat Marine Plastic Waste.* Available at: https://id.usembassy.gov/u-s-and-indonesia-combat-marine-plastic-waste/
467 The Guardian (2017), "Indonesia pledges $1bn a year to curb ocean waste", Available at: https://www.theguardian.com/environment/the-coral-triangle/2017/mar/02/indonesia-pledges-us1-billion-a-year-to-curb-ocean-waste
468 Mondaq (2016), "New PPP Regulations: PR No. 38/2015". Available at: http://www.mondaq.com/x/456354/Government+Contracts+Procurement+PPP/New+PPP+Regulations+PR+No+382015 and IIGF (2018), "About IIGF". Available at: http://www.iigf.co.id/en/about-pt-pii/vision-mission
469 Alliance of Zero Waste Indonesia (2019), "Single-Use Plastics Ban in Indonesia: Evidence of the Implementation of Waste Management Act." Available at: https://www.breakfreefromplastic.org/2019/05/07/single-use-plastics-ban-in-indonesia-evidence-of-the-implementation-of-waste-management-act/
470 The Jakarta Post (2020), "Jakarta begins new chapter in plastic waste reduction." Available at: https://www.thejakartapost.com/news/2020/07/01/jakarta-begins-new-chapter-in-plastic-waste-reduction.html
471 Reuters (2018), "Indonesian city outlaws plastic bags as campaigners push for wider bans". Available at: https://www.reuters.com/article/us-indonesia-plastic-waste/indonesian-city-outlaws-plastic-bags-as-campaigners-push-for-wider-bans-idUSKBN1O30JW and The Jakarta Post (2016), "Bandung implements ban on Styrofoam use". Available at: http://www.thejakartapost.com/news/2016/11/03/bandung-implements-ban-styrofoam-use.html
472 Greeners (2019), "Ministry of environment and forestry urges revision on Ministry of Trade's regulation on plastic waste import." Available at: https://www.greeners.co/english/ministry-of-environment-and-forestry-urges-revision-on-ministry-of-trades-regulation-on-plastic-waste-import/
473 ILO (2008), "Waste Management Law of 2008 (No. 18/2008)". Available at: http://www.ilo.org/dyn/natlex/natlex4.detail?p_lang=en&p_isn=84427&p_country=IDN&p_count=611
UNCRD (2017), *The Republic of Indonesia*. Available at: http://www.uncrd.or.jp/content/documents/5689[Nov%202017]%20Indonesia.pdf, Indonesian Waste Platform (2018), *Indonesia's National Plan of Action on Marine Plastic Debris 2017 – 2025 Executive Summary*. Available at: http://www.indonesianwaste.org/en/indonesias-national-plan-of-action-on-marine-plastic-debris-2017-2015-executive-summary-2/, and
Ministry of Environment (2012), *Implementation Guideline of Reduce, Reuse & Recycle through Waste Bank*. Available at: http://jdih.menlh.go.id/pdf/ind/IND-PUU-7-2012-Permen%20LH%2013%20th%202012%20bank%20sampah.pdf
474 AmCham Indonesia (2020), "Policy alert: Waste reduction roadmap regulation issued." Available at: https://amcham.or.id/en/news/detail/policy-alert4220
475 Republic of Indonesia (2008), *Undang-Undang Republik Indonesia Nomor 18 Tahun 2008*. Available at: https://pelayanan.jakarta.go.id/download/regulasi/undang-undang-nomor-18-tahun-2008-tentang-pengelolaan-sampah.pdf
476 Tammara Soma (2018), *Planning from "Table to Dump": Analyzing the Practice of Household Food Consumption and Food Waste in Urban Indonesia*. Available at: https://tspace.library.utoronto.ca/bitstream/1807/95706/1/Soma_Tammara_R_201806_PhD_thesis.pdf
477 National Agency of Drug and Food Control (2019), *Regulation No. 20 of 2019*. Available at: https://standarpangan.pom.go.id/dokumen/peraturan/2019/PBPOM_Nomor_20_Tahun_2019_tentang_Kemasan_Pangan.pdf
478 Badan Standardisasi Nasional (2019), "Rekomendasi bagi Indonesia untuk Menjadi Anggota ISO/TC 323 Circular Economy." Available at: https://bsn.go.id/main/berita/detail/10538/rekomendasi-bagi-indonesia-untuk-menjadi-anggota-isotc-323-circular-economy
479 Asia-Pacific Economic Cooperation (2020), *13th SCSC Conference: Standardisation in Circular Economy for a More Sustainable Trade*. Available at: http://mddb.apec.org/Documents/2020/SCSC/SCSC1/20_scsc1_038.pdf
480 GBG Indonesia (2018), "Expanded Coverage and New Feed-in Tariff for Indonesia's Waste to Energy Projects". Available at: http://www.gbgindonesia.com/en/main/legal_updates/expanded_coverage_and_new_feed_in_tariff_for_indonesia_s_waste_to_energy_projects.php
481 Global Business Guide, "Expanded Coverage and New Feed-in Tariff for Indonesia's Waste to Energy Projects". Available at: http://www.gbgindonesia.com/en/main/legal_updates/expanded_coverage_and_new_feed_in_tariff_for_indonesia_s_waste_to_energy_projects.php
482 Reuters (2019), "Indonesian president tells cities to build waste-to-energy plants". Available at: https://www.reuters.com/article/us-indonesia-environment-energy/indonesian-president-tells-cities-to-build-waste-to-energy-plants-idUSKCN1UB1CG
483 UN Environment Programme (2019), *Waste to energy: Considerations for information decision-making*. Available at: https://ww.unenvironment.org/ietc/resources/publication/waste-energy-considerations-informed-decision-making

Across the 5R spectrum, the biggest potential seems to be in reducing and recycling (Exhibit 55). Eliminating non-essential plastic packaging and lifting the plastic recycling rate from its current low base (12 percent), are likely to have fewer obstacles than reuse where consumer expectations, as well as food and medical packaging standards, are potential barriers.

Exhibit 55

WHOLESALE & RETAIL TRADE

The "Reduce", "Reuse", and "Recycle" approaches offer the highest potential for circularity in plastic packaging in Indonesia

1. Non-essential plastics refers to plastics that can be eliminated without compromising the functionality of the original product. For example, plastic microbeads that are present in many personal cosmetic and personal care products

SOURCE: Ellen MacArthur Foundation; World Economic Forum; Plastic Oceans; literature review; focus group discussions; expert interviews

Four circular opportunities for this sector were identified (Exhibit 56). How big could the opportunity be to tackle plastic waste in Indonesia? Four opportunities listed below could Indonesia reduce and recycle 36 percent of its plastic packaging waste (Exhibit 57).

Exhibit 56

Examples of circular economy opportunities and benefits in the wholesale and retail trade (plastic packaging) sector

#	Circular opportunities[1]	5Rs	Brief description
1	**Reduce and reuse plastic packaging**	**Reduce, reuse**	Reducing plastic packaging waste by eliminating non-essential plastic packaging, maximising reuse of plastic packaging, and by creating new delivery models that avoid single-use plastics
2	**Replace with more sustainable packaging**	**Renew**	Substituting plastic packaging with more sustainable alternatives, such as paper, coated paper, or compostable materials
3	**Redesign plastic packaging for improved recyclability**	**Renew**	Redesigning products to increase their recyclability. For example, removing dyes and additives to minimise the loss rates of plastics from mechanical recycling
4	**Increase recycling rate of recyclable packaging**	**Recycle**	Increasing the recycling rates for plastic packaging waste that is recyclable

1. Opportunities listed above are based on key levers highlighted by National Plastic Action Partnership in its solution scenario modelling in 2019 on plastic waste in Indonesia

SOURCE: World Economic Forum; focus group discussions; expert interviews

- **Reduce and reuse plastic packaging**. This refers to eliminating non-essential plastic packaging from product designs, maximising reuse of plastic packaging, and creating new delivery models that avoid single-use plastics. Based on data provided by the National Plastic Action Partnership (NPAP), the model estimated that close to one million tonnes of plastic packaging waste, or 14 percent of the total estimated plastic packaging waste in 2030, could be reduced in Indonesia by 2030 by reducing overpackaging and reusing plastic.[484] Many companies in Indonesia and around the world have taken initiatives to maximise this opportunity. For example, Nestle managed to reduce the weight of their water bottles by 22 percent over the last decade as part of its overall waste reduction goals.[485] Elsewhere, Carlsberg, announced that it would replace its plastic six-pack rings with a type of glue which could cut down plastic waste by seven percent.[486] Numerous plastic packaging-free grocery stores have opened up in Jakarta, Surabaya, and Bali.[487] In these stores, customers usually bring their own containers that are weighted, filled with content, and then customers are charged based on the amount of content. CupKita, a start-up based in Jakarta, provides a reusable container service in an attempt to eliminate the use of single-use plastic cups.[488]

- **Replace with more sustainable packaging.** This refers to reducing the use of plastic for packaging by replacing it with more sustainable alternatives. These alternatives include paper or cardboard materials (generally as a replacement for plastic films), coated paper with a coating that meets the criteria for technical recyclability, or internationally certified compostable materials that have suitable after-use systems, such as certified home-compostable materials.[489] By replacing plastic with more recyclable and compostable materials, Indonesia could reduce 0.5 million tonnes of plastic packaging waste based on the model. Business models have emerged in Indonesia that have already adopted this opportunity. For example, the Indonesian start-up Evoware makes cups

484 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership*. Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
485 Nestle, "What is Nestle doing to tackle plastic packaging waste?". Available at: https://www.nestle.com/ask-nestle/environment/answers/tackling-packaging-waste-plastic-bottles
486 Greenmatters (2019), "Carlsberg's Beer 'Snap Packs' use 76% less plastic than six pack rings. Available at: https://www.greenmatters.com/p/carlsberg-beer-snap-packs-glue
487 The Jakarta Post (2020), "Five zero-waste bulk stores to visit in Indonesia." Available at: https://www.thejakartapost.com/life/2020/03/15/five-zero-waste-bulk-stores-to-visit-in-indonesia.html
488 Eco-business (2020), "Indonesia's first reuseable cup rental service launches in Jakarta." Available at: https://www.eco-business.com/news/indonesias-first-reuseable-cup-rental-service-launches-in-jakarta/
489 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership*. Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf

from farmed seaweed and also designs food wrappings and sachets made out of edible seaweed-based material. Compostable alternatives like seaweed packaging are likely to be more environment-friendly than paper or coated paper, given that paper could cause excessive deforestation. MSMEs in Indonesia are also exploring delivery models that use sustainable packaging. For example, Sukkha Citta, an MSME that sells garments handcrafted by artisans in villages, upcycles its scraps and waste threads to produce plastic-free packaging for its garments.[490]

- **Redesign plastic packaging for improved recyclability.** This refers to altering the properties of packaging, which may increase the ease or economics of recycling, such as removing dyes and additives to minimise the loss rates of plastics from mechanical recycling. Another example is the replacement of multi-material packaging with rigid-mono or flexible-mono packaging since the recyclability of multi-material packaging is very limited due to the difficulty in separating its components. Rigid plastics, such as PET bottles, have a higher value for recyclers and cause less pollution, particularly in more urban areas.[491] This opportunity helps increase the potential feedstock for recycling. It was estimated that this opportunity could help Indonesia recycle an additional 40,000 tonnes of plastic packaging waste in 2030. Some companies in Indonesia have already demonstrated their commitment to adopt this opportunity. For example, Danone has made a 100 percent recyclable bottle for its packaged drinking water brand, Aqua.[492]

- **Increase the recycling rate of recyclable packaging.** This refers to increasing Indonesia's recycling rate from current levels of 12 percent.[493] It was estimated that Indonesia could improve its recycling rate of plastic packaging waste from 12 percent in 2019 to 27 percent in 2030. This includes open-loop, closed-loop, and plastic-to-fuel (P2F) recycling through chemical processes. To achieve a recycling rate of 27 percent in 2030, the Indonesian Government would have to increase its collection rates for plastic packaging waste and increase its recycling capacity. Based on NPAP data, the model estimated that Indonesia would need to increase its average collection rate from 47 percent in 2019 to 86 percent in 2030. Moreover, Indonesia would need to increase its recycling capacity for plastic packaging waste by 1.13 million tonnes in a circular economy scenario.

  Several companies in Indonesia are demonstrating how recycled plastic could be put to productive use. For example, Re>Pal produces zero waste pallets made from plastic waste that makes supply chains more sustainable.[494]

490 Sukka Citta. "Why we exist." Available at:
https://www.sukkhacitta.com/pages/impact
491 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership*. Available at:
https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
492 Aqua. Available at:
https://aqua.co.id/en/brand/aqua-100-recycled-1
493 Our estimate of the recycling rate differs from the one produced by National Plastic Action Partnership (NPAP) due to a difference in timeline. Our estimate is for 2019, whereas that of NPAP is for 2017
494 Information gathered from Re>Pal's website. Available at:
https://re-pal.com/

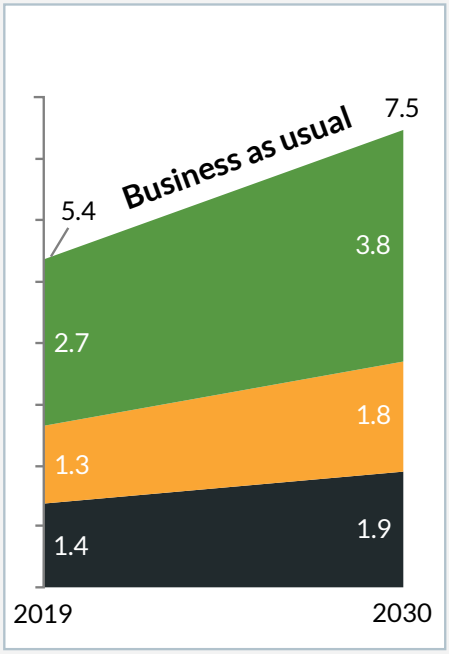
Exhibit 57

WHOLESALE & RETAIL TRADE

Indonesia could reduce and recycle 36% of its plastic packaging waste in 2030

Plastic packaging waste in 2030 under a "business-as-usual" scenario and circularity opportunities

Million tonnes



Circularity opportunities	Circularity target	Million tonnes saving	% of 2030 BAU plastic packaging waste[1,2]
Reduce and reuse plastic packaging	9% and 31% of packaging waste is eliminated from this opportunity in 2025 and 2040	1	14
Replace with more sustainable packaging	4% and 12% of packaging waste is eliminated by substituting packaging in 2025 and 2040	0.5	7
Redesign plastic packaging for improved recyclability	The percentage of recyclable materials in packaging increases from 77% to 84% in Indonesia in 2030	~0	~0
Increase recycling rate	22% and 42% of plastic packaging waste is recycled in 2025 and 2040	1.1	15
	Total	2.7	36

1. Based on National Plastic Action Partnership's solution scenario modelling in 2019 on plastic waste in Indonesia in 2017, 2025, and 2040
2. Percentages are rounded off

SOURCE: World Economic Forum

Box 14. ***Case study of circularity in plastic packaging***

Single-use plastics, such as sachets, are a significant problem in Indonesia. As these plastics are light, low in value, and are made up of multi-material packaging, they have low recycling value and hence, are often not collected, eventually being dumped on land or in waterways. Manufacturers often find it difficult to substitute these plastics due to a lack of viable options.

Evoware in Indonesia is attempting to address this problem. It has created an edible alternative made up of seaweed as a substitute for the multi-layered plastic sachet.[495] Supply of seaweed is both abundant and affordable. Indonesia produces 10 million tonnes of seaweed each year, and it targeted to produce 19 million tonnes by 2020.[496] Since seaweed does not require fertilisers and can be grown offshore, thereby decreasing the demands placed on land, it also has advantages over other packaging alternatives.[497] Using seaweed could also benefit local farmers economically – five out of the six poorest provinces in Indonesia produce seaweed.[498] Evoware's seaweed-based packaging has received safety certification and can dissolve in warm water, making the product a zero-waste product.

In addition to providing edible single-use sachets, Evoware provides many other sustainable packaging products. It is producing edible food wrapping and edible seaweed cups (sold under its Ello Jello brand). It also created a sustainable alternative that combines its seaweed material with Damar resin from Damar trees found in South Asian countries. This combination acts as a compact packaging to hold liquids.[499] It can be used to hold personal care products like shampoos and toothpaste and to secure medical supplies. Moreover, it has created an alternative to plastic bags using starch-based film, vegetable oil derivatives, and other non-toxic materials, and an alternative to plastic food containers using sugarcane bagasse.

THE ECONOMIC, SOCIAL, AND ENVIRONMENTAL BENEFITS OF CIRCULARITY OPPORTUNITIES

The economic impact from a circular economy for plastic packaging could be worth IDR14.4 trillion (USD1 billion), which is equivalent to 0.5 percent of the sector's GDP in 2030 (Exhibit 58).[500] This additional economic output under the circular economy scenario could generate 107,000 cumulative net jobs for Indonesia between 2021 and 2030 (Exhibit 59). Based on the analysis of these jobs, 85 percent could be for women. This is driven by the potential job displacement in male-dominant sectors (e.g., waste management, where women make up only 26 percent of the total jobs) due to a circular economy and the likely job creation in female-dominant sectors (e.g., education, where households could reinvest their savings and where women account for 61 percent of all jobs).

It is important to note that all economic benefits may not be captured by the wholesale and retail sector. Some of these benefits could be captured by other sectors in the economy (e.g., waste management if businesses focus on improving plastic packaging waste collection or education if households decide to invest their savings from a reduction in plastic packaging waste on education).

From a social standpoint, circularity in the wholesale & retail sector could also lead to annual household savings worth IDR130,000 (USD9.1) or 0.2 percent of the average current annual household expenditure (Exhibit 60). These household savings are less than those generated in other sectors, due to two reasons. First, the monetary savings generated in this sector are lower as compared to other sectors. Second, most savings are likely to be captured by businesses in this sector, rather than consumers, based on the price elasticities of the four opportunities related to this sector.

The environmental benefits are substantial. Circular economy in plastic packaging can help Indonesia avoid 5.2 million tonnes of CO_2e emissions and save 0.2 billion cubic metres of water in 2030 (Exhibit 61).

The detailed methodology for quantifying economic, social and environmental impact is outlined in the Annex.

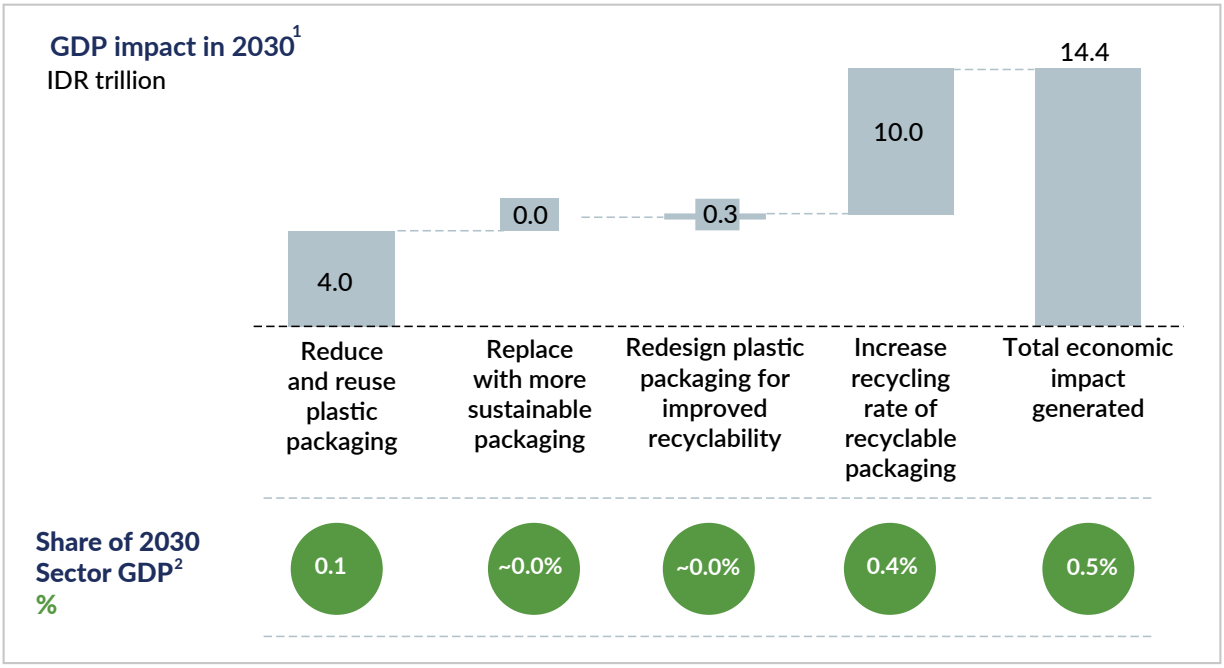
495 Ellen MacArthur Foundation, *Evoware Indonesia: Seaweed-based packaging that replaces billions of small bits of plastics with a nutrient boost.* Available at: https://www.newplasticseconomy.org/innovation-prize/winners/evoware
496 Reuters (2017), "Indonesian startup wages war on plastic with edible seaweed cups". Available at: https://www.reuters.com/article/us-indonesia-evoware/indonesian-startup-wages-war-on-plastic-with-edible-seaweed-cups-idUSKBN1DN0XA
497 The ASEAN Post (2020), "Switching to plant-based plastics". Available at: https://theaseanpost.com/article/switching-plant-based-plastics
498 Food Industry Asia and AlphaBeta (2018), *Sustainable packaging: Tackling plastic waste in Indonesia and the Philippines.*
499 Stylus (2017), "Evoware: Packaging you can eat". Available at: https://www.stylus.com/hmgxwh
500 Based on IO table methodology (See the Annex for further details). Based on the ICOR methodology, the economic impact from the wholesale and retail trade sector is nearly IDR40 trillion. The ICOR economic impact is higher than the economic impact estimated using the IO table since the adoption of circular opportunities in the wholesale and retail trade sector (e.g., increasing recycling rate of recyclable packaging) require significant capital investments

Exhibit 58

WHOLESALE & RETAIL TRADE

BASED ON IO METHODOLOGY

Circularity in the wholesale & retail sector could generate a net economic impact of IDR14.4 trillion (USD1 billion) or 0.5% of the sector GDP in 2030



1. The economic benefits are not all captured by the specific sector where the circularity opportunities exist. In some cases, the savings from a circular economy opportunity are passed through to consumers who may spend them in other sectors such as health, education, and recreational services
2. Share of estimated sector GDP in 2030 is calculated based on a "business-as-usual" scenario growth rate of 4.92%. Percentages are rounded off

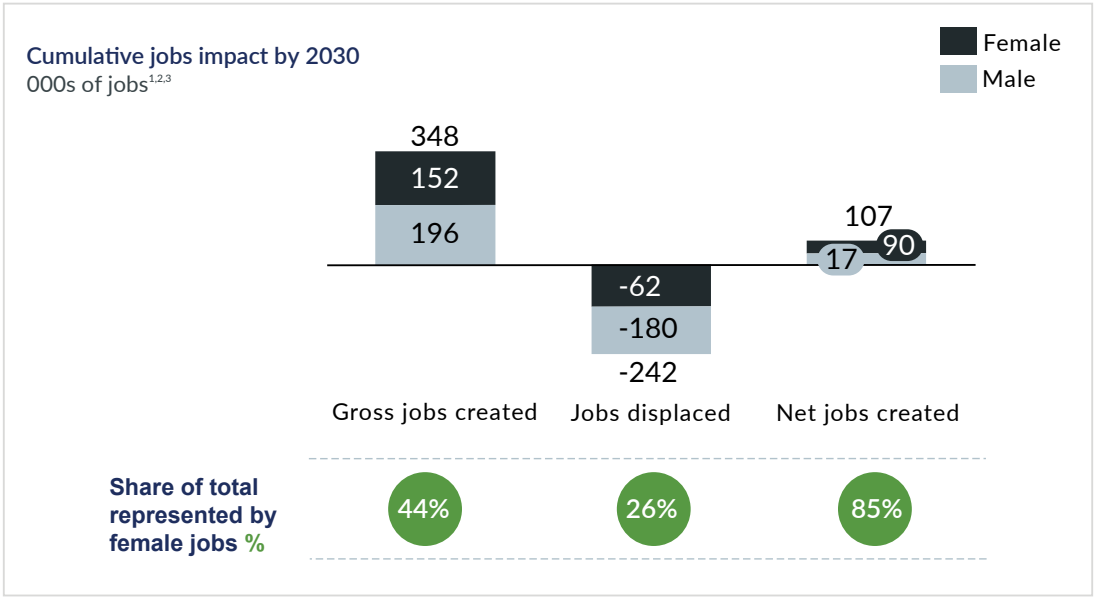
SOURCE: Bank Indonesia; BPS; World Economic Forum (see annex for more details)

Exhibit 59

WHOLESALE & RETAIL TRADE

BASED ON IO METHODOLOGY

A circular wholesale & retail sector could add 107,000 net jobs by 2030, of which 85% could be for women



1. The jobs created are not necessarily created in the plastic packaging sector. They are created economy-wide from the savings that are reinvested by consumers and businesses
2. Calculated using data from the UN Population Division and applying Indonesia's labour force participation rate of 2019 and employment rate of 2016. The total estimated jobs in 2030 are inclusive of the net jobs created due to circular economy
3. To estimate the jobs created for women in 2030, it is assumed that the gender share of jobs in each sector in 2018 would remain unchanged till 2030. The data from the Labour Force Situation report published by BPS in February 2018 on the gender share of jobs in each of the 17 sectors of Indonesia's economy was used

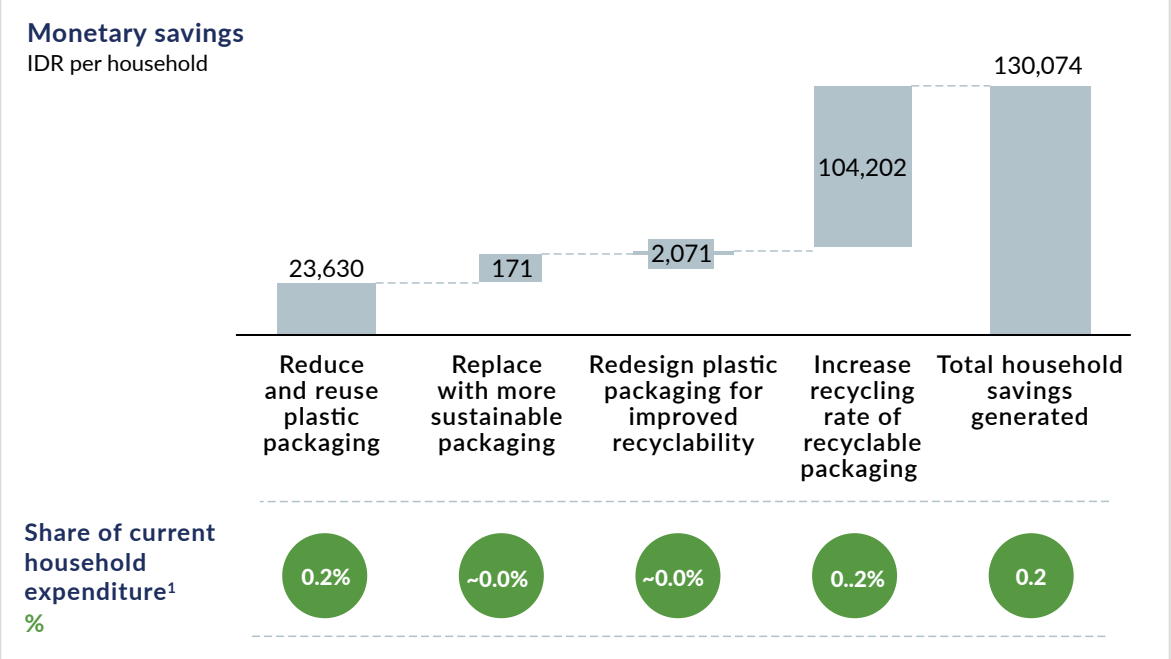
SOURCE: BPS; UN Population Division; IMF; World Bank (see annex for more details)

Exhibit 60

WHOLESALE & RETAIL TRADE

BASED ON IO METHODOLOGY

A circular wholesale & retail sector could generate household savings worth ~IDR130,000 (USD9.1) or 0.2% of the current annual household expenditure in 2030



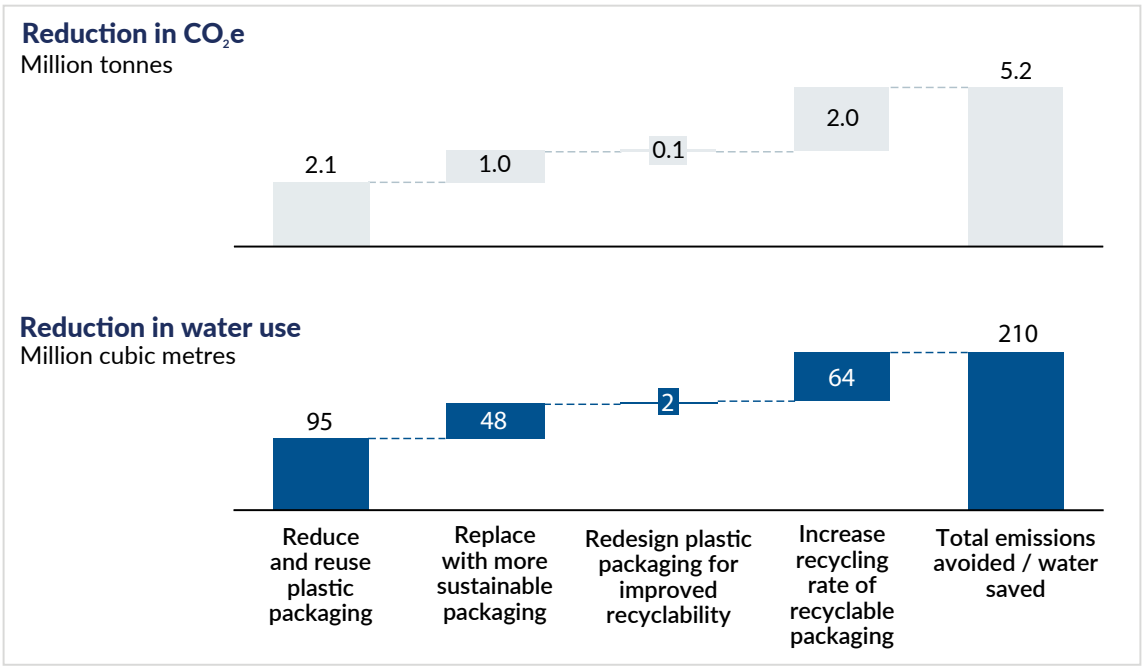
1. Percentages are rounded off

SOURCE: BPS; World Economic Forum (see annex for more details)

Exhibit 61

WHOLESALE & RETAIL TRADE

Indonesia could avoid 5.2 million tonnes of CO_2e emissions and save 0.2 billion cubic metres of water relative to BAU in 2030



SOURCE: World Economic Forum; Ellen MacArthur Foundation (see annex for more details)

BARRIERS IMPACTING CIRCULAR ECONOMY ADOPTION IN THIS SECTOR

Firms in the wholesale & retail (plastic packaging) sector are likely to face several barriers in adopting circular economy opportunities (Exhibit 62). While these barriers will be explored in detail in the next phase of this project, an initial synthesis of the barriers along with possible policy responses to address them is outlined below based on consultations with experts and discussions with private sector firms in the sector (Box 15).

Exhibit 62

WHOLESALE & RETAIL TRADE

There are a range of potential barriers that could prevent firms from capturing the circularity opportunities in the plastic packaging sector

Highly significant[1]

#	BARRIER	OPPORTUNITIES			
		Reduce and reuse plastic packaging	Replace with more sustainable packaging	Redesign plastic packaging for improved recyclability	Increase recycling rate of recyclable packaging
1	Difficulty in changing customs and habits of businesses and consumers	■			■
2	Unintended consequences of existing regulations				
3	Lack of infrastructure		■		■
4	Implementation and enforcement failures				
5	Poorly defined targets and objectives				
6	Inadequately defined legal frameworks				
7	Not profitable	■	■		
8	Insufficient end markets			■	■
9	Lack of capital				■
10	Imperfect information	■	■	■	

1. Highly significant refers to barriers that were identified in the sector focus group discussions and expert interviews as being of key concern to stakeholders in Indonesia
SOURCE: Literature review; focus group discussions; expert interviews

- **Difficulty in changing customs and habits of businesses and consumers.** According to a survey in 2012, 81 percent of a sample of Jakarta residents do not sort their organic waste from their inorganic waste.[501] 36 percent of respondents in a 2020 survey revealed that they do not segregate household waste.[502] This could be a function of both lack of separate collection or disposal facilitations and a lack of knowledge. The lack of knowledge about waste sorting and its benefits, in particular, might present a significant challenge in boosting the circular economy in the plastic packaging sector in Indonesia.[503] The waste sorting challenge is further compounded by the need to sort plastic waste by colour. There is also a large gap between consumers' reported concern with plastic waste issues and their purchasing decisions. A survey of over 400 Indonesian consumers in 2020 revealed that while 92 percent of respondents stated they were extremely concerned by plastic waste issues, only 40 percent stated they are less likely to purchase a product that is made from non-recycled material.[504]

501 Aretha Aprilia et al (2012), *Household Solid Waste Management in Jakarta, Indonesia: A Socio-Economic Evaluation*. Available at: https://www.intechopen.com/books/waste-management-an-integrated-vision/household-solid-waste-management-in-jakarta-indonesia-a-socio-economic-evaluation
502 SEA Circular, Food Industry Asia and AlphaBeta (2020), *Perceptions on plastic waste: Insights, interventions and incentives to action from businesses and consumers in South-East Asia*. Available at: https://www.sea-circular.org/wp-content/uploads/2020/06/PERCEPTIONS-ON-PLASTIC-WASTE_FINAL.pdf
503 Zakianis et al (2017), *The Importance of Waste Management Knowledge to Encourage Household Waste-Sorting Behaviour in Indonesia*.
504 SEA Circular, Food Industry Asia and AlphaBeta (2020), *Perceptions on plastic waste: Insights, interventions and incentives to action from businesses and consumers in South-East Asia*. Available at: https://www.sea-circular.org/wp-content/uploads/2020/06/PERCEPTIONS-ON-PLASTIC-WASTE_FINAL.pdf

- **Lack of infrastructure.** The informal sector plays a predominant role in waste management in Indonesia.[505] Increasing Indonesia's plastic waste collection and recycling rates would require providing capacity building among the informal sector workers to improve Indonesia's solid waste management. Indonesia should also prioritise decentralised waste management systems over-centralised, capital-intensive systems. Experience from other developing countries has shown how decentralised systems could be more effective in serving local needs.[506]

- **Not profitable.** To increase the adoption of sustainable alternatives, such as seaweed, the industry would need to guarantee their supply and scale the supply up to ensure cost-competitiveness relative to plastic. Scaling up the supply would require production to be significantly automated.[507] Moreover, climate change or a bacterial outbreak could hinder efforts to create a reliable, long-term supply of seaweed. [508] Ketut Sudiarta, a scientist in the fisheries department at Bali's Warmadewa University, argued that climate change could significantly impact Indonesia's seaweed farming.

- **Insufficient end markets.** The World Economic Forum argues that Indonesia would need to increase its plastic waste recycling rate from 10 percent in 2017 to 22 percent in 2025 and recycle 1.7 million tonnes of plastic waste by 2025.[509] The economic feasibility of the recycling facilities hinges on the sufficient demand for recycled plastics. While the global market for recycled plastics is expected to witness an average growth of 8.6 percent between 2019 and 2026,[510] it is unclear if the domestic demand would be able to absorb the additional supply of recycled plastics.

- **Lack of capital.** To achieve the targets set out by the Government of Indonesia to reduce marine plastic leakage by 70 percent by 2025, Indonesia would require significant capital. Investments would be required to boost Indonesia's plastic waste collection from 39 percent to 80 percent, double its recycling capacity to process 1.7 million tonnes of plastic waste, and expand its controlled waste-disposal facilities. The World Economic Forum estimated that building such infrastructure could require capital investments worth USD5.1 billion between 2017 and 2025 and an operational annual funding budget of USD1.1 billion in 2025.[511]

- **Imperfect information.** To reduce and redesign the plastic packaging of their wholesale and retail products, businesses would require significant technical knowledge. In the absence of sufficient R&D, businesses could be wary to significantly alter their packaging due to fears of food safety and product damage. A survey of Indonesian F&B businesses in 2020 revealed that less than half are part of any industry group aiming to tackle plastic waste.[512] Without such access to industry technical knowledge, it could be challenging for firms, particularly MSMEs, to change their approaches.

505 Enri Damanhuri (2012), *Post-Consumer Waste Recycling and Optimal Production.*
506 UN Environment (2018), *Africa waste management outlook.* Available at:
https://wedocs.unep.org/bitstream/handle/20.500.11822/25514/Africa_WMO.pdf
507 The Guardian (2018), "Could seaweed solve Indonesia's plastic crisis?" Available at:
https://www.theguardian.com/environment/blog/2018/jun/27/could-seaweed-solve-indonesias-plastic-crisis
508 Eco-business (2020), "Seaweed over plastic: Indonesia's race towards sustainable packaging." Available at:
https://www.eco-business.com/news/seaweed-over-plastic-indonesias-race-towards-sustainable-packaging/
509 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership.* Available at:
https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
510 Globe Newswire (2020), "Recycled Plastic Market Size to Hit USD 72.6 Billion by 2026." Available at:
https://www.globenewswire.com/news-release/2020/06/01/2041626/0/en/Recycled-Plastic-Market-Size-to-Hit-USD-72-6-Billion-by-2026-Increasing-Demand-from-the-Packaging-Industry-Worldwide-to-Spur-Demand-Says-Fortune-Business-Insights.html
511 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership.* Available at:
https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
512 SEA Circular, Food Industry Asia and AlphaBeta (2020), *Perceptions on plastic waste: Insights, interventions and incentives to action from businesses and consumers in South-East Asia.* Available at:
https://www.sea-circular.org/wp-content/uploads/2020/06/PERCEPTIONS-ON-PLASTIC-WASTE_FINAL.pdf

Box 15. ***Potential policy solutions that could overcome these barriers***

The detailed policy solutions for addressing the barriers to a circular economy related to plastic packaging will be explored in the next phase of the circular economy work. However, this box provides some examples of the type of interventions by policymakers, the private sector, and civil society that could help address the identified barriers.

- **Consider EPR and mandatory reporting frameworks.** A key starting point is to create incentives for reduction, reuse, and recycling through the creation of an extended producer responsibility (EPR) framework, which has widespread industry participation. This could be supported by mandatory reporting frameworks on plastic waste by businesses. Under a mandatory reporting framework, obligated businesses are required to report annually on the different types and amounts of waste they place on the local market. International analysis reveals 45 countries with mandatory packaging reporting frameworks and 13 percent of them are in Asia-Pacific.[513] Within ASEAN, Singapore has recently introduced a mandatory packaging reporting framework, which is effective from 2020, and other AMS are considering it.[514] Under Singapore's scheme, firms with revenues over a certain threshold are required to report annually (through a government website) on different types and amounts of waste they place on the local market. In the first phase, brand owners, manufacturers, importers as well as supermarkets with an annual turnover of over SGD10 million will be required to report. Globally, these mandatory packaging reporting schemes have been shown to be effective in bringing transparency into the market and enabling the functioning of EPR efforts. As part of this mandatory reporting effort, companies could be obligated to outline and track progress against packaging targets. 83 percent of Indonesian F&B businesses claim to have packaging targets, but over three-quarters are not shared publicly, and most lack quantitative targets or clear timeframes.[515]
- **Improve household awareness of waste management.** The Government could also consider organising community events that raise awareness about waste management. Research on close to 2,000 respondents in Jakarta found that people who were more involved in social community activities were more likely to partake in community waste disposal activities.[516] Such events, in partnership with industry, civil society, and religious could encourage positive consumer choices, change waste behaviours, and increase participation in reduction, reuse, and innovative waste management and recycling programmes. Mandatory waste segregation and consumer behavioural change plans could also be implemented. Indonesian consumers and businesses both highlighted mandatory waste segregation and consumer information campaigns as among the most important policy levers to tackle plastic waste in a recent survey.[517]
- **Provide incentives to encourage sustainable alternatives.** The Government could stimulate plastic reduction, plastic-free alternatives, and reuse models through innovation and fiscal incentives, such as reuse models that can replace single-use shopping bags, straws, tableware and food-service containers, multi-layer sachets, food and beverage packaging and business-to-business packaging. It could also "walk the talk" by reducing avoidable uses of plastics on premises of government agencies and state-owned enterprises, schools, and universities and incorporating circular principles in procurement guidelines for national government bodies and state-owned enterprises.[518]
- **Upskill informal waste management sector.** Danone, through its bottled water brand, Aqua, has demonstrated how the informal waste management sector could be incorporated into the formal sector. Under its Plastics Waste Recycling Programme, Aqua has built six recycle business units (RBU) in Bali, South Tangerang, Lombok, and Bandung where it trains and upskills local scavengers as part of its Scavengers Empowerment Programme (PEP).[519] Local governments could partner with leading private sector companies that could facilitate the formalisation of Indonesia's waste management sector. The Government could design waste systems that incorporate safe informal / private-sector collection and sorting activities away from landfills or dumpsites and provide opportunities in government-funded waste management and recycling systems for informal sector workers and companies.
- **Mobilise investments.** To bridge the capital gap, Indonesia could mobilise capital investment for equipment and infrastructure and budgets for waste-system operations. The Government could ramp up operational spending on solid-waste management through national budgets (APBN), local budgets (APBD) and cofounding from industry, waste-generating companies (such as through disposal fees) and households (such as through retribution fees from households receiving waste-management services, paid through local taxes or electricity payments).
- **Monitor successful local studies to implement solutions.** Finally, Packaging and Recycling Association for Indonesia Sustainable Environment (PRAISE) was expected to launch a Packaging Recovery Organization (PRO) in August 2020. The Government could use this as a role model and encourage other companies to similarly take responsibility for their packaging waste.[520]

513 AlphaBeta (2020), *Presentation on mandatory reporting frameworks*, Workshop II of the ASEAN Regional Action Plan on Marine Debris, Singapore.
514 Ministry of the Environment and Water Resources [MEWR] and National Environment Agency [NEA] (2019), "Factsheet on Mandatory Packaging Reporting". Available at: https://www.nea.gov.sg/docs/default-source/media-files/news-releases-docs/cos-2019/cos-2019-media-factsheet---mandatory-packaging-reporting.pdf
515 SEA Circular, Food Industry Asia and AlphaBeta (2020), *Perceptions on plastic waste: Insights, interventions and incentives to action from businesses and consumers in South-East Asia*. Available at: https://www.sea-circular.org/wp-content/uploads/2020/06/PERCEPTIONS-ON-PLASTIC-WASTE_FINAL.pdf
516 A. Brotosusilo et al (2020), *The level of individual participation of community in implementing effective solid waste management policies.* Available at: https://www.giesm.net/article_38213_3ef2e86bdc6a3595dfb40c60385a21b2.pdf
517 SEA Circular, Food Industry Asia and AlphaBeta (2020), *Perceptions on plastic waste: Insights, interventions and incentives to action from businesses and consumers in South-East Asia*. Available at: https://www.sea-circular.org/wp-content/uploads/2020/06/PERCEPTIONS-ON-PLASTIC-WASTE_FINAL.pdf
518 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership*. Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
519 Jakarta Globe (2019), "Danone-Aqua's First 100 Percent Recycled Plastic Bottle Launched in Bali." Available at: https://jakartaglobe.id/movement/danoneaquas-first-100-percent-recycled-plastic-bottle-launched-in-bali; IndonesiaExpat (2016), "Danone AQUA: Committed to Healthy Hydration." Available at: https://indonesiaexpat.biz/business-property/business-profile/danone-aqua-charlie-capetti/
520 IDN Financials (2019), "PRAISE supports implementation of circular economy in post consumption packaging." Available at: https://www.idnfinancials.com/archive/news/30016/PRAISE-supports-implementation-of-circular-economy-in-post-consumption-packaging; Use latest source once confirmed by PRAISE

7. Electrical and electronic equipment: Tackling e-waste

This chapter explores the current status of electrical and electronic waste (e-waste) and its management in Indonesia and how these could evolve under a "business-as-usual" approach to 2030. It then identifies potential circular economy opportunities (based on detailed analysis and extensive stakeholder engagement) and sizes the associated economic, social, and environmental impact.

Adopting circular economy practices could help the electrical and electronic equipment sector in Indonesia generate an economic impact worth IDR12.2 trillion (USD0.9 billion) in 2030, create approximately 75,000 cumulative net jobs between 2021 and 2030 (of which 91 percent could be for women), produce annual household savings worth nearly IDR88,000 (USD6), and reduce CO_2e emissions and water use by 0.4 million tonnes and 0.6 billion cubic metres, respectively in 2030.

THERE IS SIGNIFICANT E-WASTE TODAY, WHICH COULD INCREASE SUBSTANTIALLY BY 2030

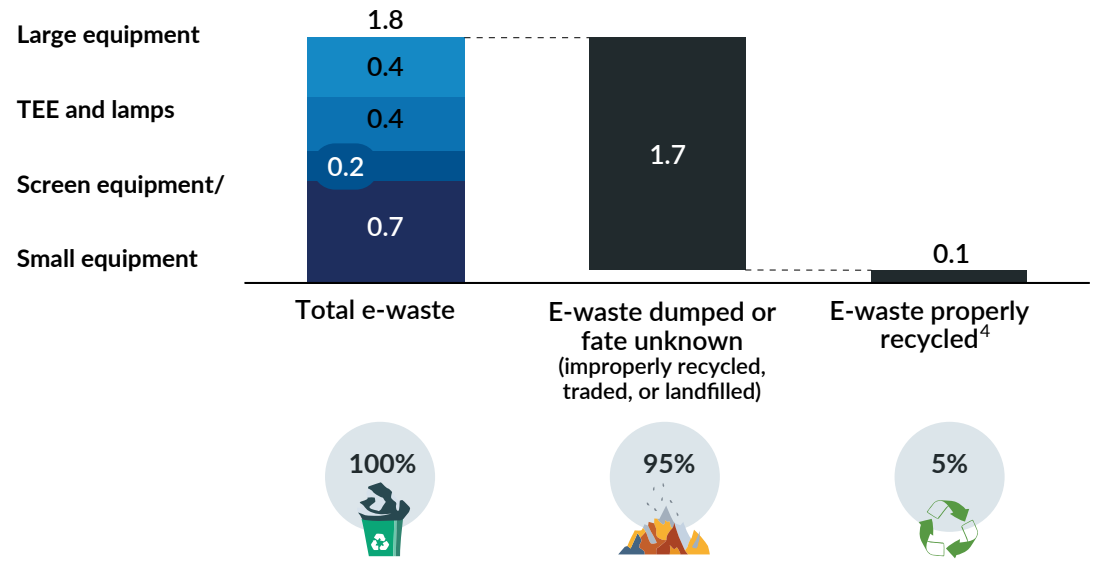
In 2016, an estimated 44.7 million tonnes of e-waste was generated globally.[521] This is expected to grow to 52.2 million tonnes by 2021. Moreover, only 17 percent of this e-waste is collected for recycling. In Asia, the recycling rate is even lower, around 12 percent.[522] In Indonesia, the e-waste recycling rate is five percent.[523] The remainder is improperly disposed of (e.g., dumped), improperly recycled, or illegally traded. Based on the estimates, Indonesia currently generates 1.8 million tonnes of e-waste every year and properly recycles 0.1 million tonnes (Exhibit 63).

Exhibit 63

ELECTRICAL & ELECTRONIC EQUIPMENT

Currently, only 5% of e-waste is properly recycled in Indonesia

Quantity of e-waste at each stage in Indonesia in 2019 [1,2,3]
Million tonnes



1. Large equipment includes washing machines, routers, printing machines; TEE (Temperature Exchange Equipment) includes refrigerators and ACs; lamps include fluorescent or LED lamps; screen equipment includes TVs, monitors, laptops; small equipment includes shavers, calculators, and IT equipment like mobile phones
2. Numbers are rounded off
3. E-waste refers to the waste produced by electrical and electronic equipment
4. Based on a forthcoming paper of Mairizal et al

SOURCE: ITU; Mairizal et al (see annex for more details)

521 ITU et al (2017), *The Global E-waste Monitor 2017*. Available at: https://www.itu.int/en/ITU-D/Climate-Change/Documents/GEM%202017/Global-E-waste%20Monitor%202017%20.pdft
522 UNU and ITU (2020), *The Global E-waste Monitor 2020*. Available at: https://www.itu.int/myitu/-/media/Publications/2020-Publications/Global-E-waste-Monitor-2020.pdf
523 Mairizal et al, *Electronic Waste Generation, Distribution Map, and Possible Recycling Routes in Indonesia*. Forthcoming.

In a "business-as-usual" scenario, Indonesia's e-waste volumes could grow dramatically, increasing from 1.8 million tonnes in 2019 to 2.5 million tonnes by 2030 (Exhibit 64). Greater consumption of electrical and electronic equipment is likely to drive this growth in e-waste volumes. Indonesia is projected to overtake Brazil and Mexico and become the fourth-largest smartphone market in 2020.[524]

Greater consumption of electrical and electronic equipment would not only be driven by economic factors, such as a rise in household incomes and urbanisation, but also structural factors, such as greater penetration of stable electricity, internet, and 4G. As of 2017, more than 30 million Indonesians lack electricity and millions continue to experience blackouts, unpredictable power outages, and unstable connections.[525] Provisions of stable electricity to these Indonesians would boost the demand for electrical and electronic equipment. Moreover, by 2022, close to 140 million people – more than half of Indonesia's population – are expected to have internet access.[526] The share of internet connections reliant on 4G technology in Indonesia is likely to grow from 54 percent in 2019 to 80 percent in 2025.[527]

Exhibit 64

ELECTRICAL & ELECTRONIC EQUIPMENT

E-waste could get worse by 2030

Growing consumer class

- An estimated 90 million Indonesians could join the ranks of the consuming class by 2030, creating higher demand for consumer electronics and appliances

Higher urbanisation rate

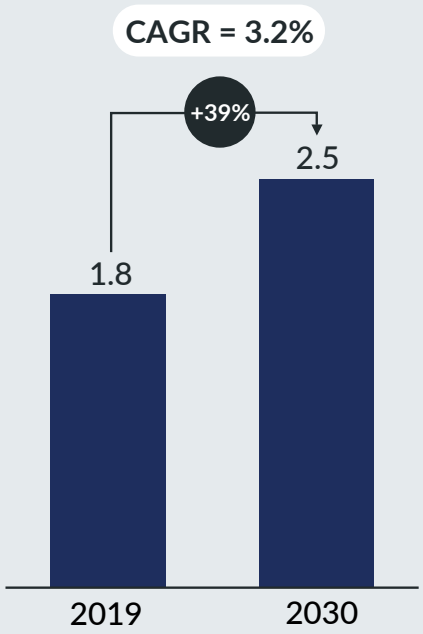
- Over 35 million people are expected to move to cities in Indonesia between now and 2030
- Urban population could account for 71% of the total population by 2030, increasing the demand for consumer electronics

Expanding coverage and adoption of 4G

- The number of 4G users is forecasted to rise significantly. By 2023, 4G will account for 44.2% of the total mobile subscriptions in Indonesia, raising demand for up-to-date electronics

Estimated increase in e-waste

E-waste in Indonesia
million tonnes



SOURCE: GlobalData, McKinsey Global Institute, United Nations Population Division; Mairizal et al (forthcoming); see annex for more details

524 The Star (2017), "Indonesia to become fourth largest smartphone market in 2020". Available at: https://www.thestar.com.my/tech/tech-news/2016/09/07/indonesia-to-become-fourth-largest-smartphone-market-in-2020-report/
525 WRI (2017), "Beyond A Connection: Improving Energy Access in Indonesia with Open Data." Available at: https://www.wri.org/blog/2017/03/beyond-connection-improving-energy-access-indonesia-open-data
526 Statista, *Smartphone market in Indonesia - Statistics and facts*. Available at: https://www.statista.com/topics/5020/smartphones-in-indonesia/
527 GSMA (2020), *Spotlight on Indonesia: Seizing the digital transition opportunity now*. Available at: https://www.gsma.com/spectrum/wp-content/uploads/2020/02/Indonesia-Digital-Dividend.pdf

THERE ARE LARGE ECONOMIC, ENVIRONMENTAL, AND SOCIAL COSTS ASSOCIATED WITH E-WASTE

E-waste represents an astonishing amount of economic value. This analysis indicates that the annual value of e-waste in Indonesia in 2019 was nearly IDR26 trillion (USD1.8 billion) or 11 percent of the GDP contribution made by the manufacturing of electrical and electronic equipment. E-waste also exacerbates Indonesia's import dependence on other countries, with machinery and computers, and electronic apparatus accounting for around 25 percent of Indonesia's imports.[528] Such dependence could be reduced if Indonesia were to reuse, remanufacture, and recycle more electronics. The importance of a circular approach in the electrical and electronic equipment sector has been further underlined after COVID-19 led to significant disruptions in supply chains.[529] As the need for localisation of supply chains increases, a circular economy could become a key tool for Indonesia to build resilience in its supply chains.

E-waste has significant environmental and social impacts. 90 percent of the e-waste in Indonesia is handled by people employed in the informal sector, who face the greatest health risks from e-waste,[530] as e-waste could comprise elements such as lead, cadmium, mercury, and beryllium that are potentially hazardous if the waste is burnt or otherwise recycled improperly.[531] For example, lead in printed circuit boards (PCB) can severely impact the central nervous system of the human body; mercury found in relays, switches, and PCBs can cause chronic damage to the brain and lead to respiratory and skin disorders; cadmium found in chip resistors and semiconductors and beryllium found in motherboards are carcinogenic.[532,533]

Apart from being hazardous to the people employed in the informal recycling industry, dumping or improper e-waste recycling can lead to leakage of these toxic elements causing environmental contamination of the surrounding water, air, and food supplies, which can increase health risk for residents in the surrounding areas.[534]

Apart from avoiding these environmental impacts, the introduction of circular business models in the electrical and electronic equipment sector would also help the sector avoid its extensive use of water and chemicals. Producing one integrated circuit on a 30-centimetre wafer could require close to 8,000 litres of water.[535]

CIRCULARITY OPPORTUNITIES COULD POTENTIALLY TRANSFORM THIS SECTOR

Based on the 5Rs, the biggest potential seems to be in "Recycle" and "Refurbish" approaches (Exhibit 65). Reuse of electronics is also a significant opportunity. The emergence of online marketplaces may encourage a higher uptake of reuse of electronics. For example, CUMI is an Indonesian website that allows consumers to rent electronics and gadgets, gaming consoles, and photograph and videography equipment. Asani is an electronic leasing B2B platform in Indonesia, which leases laptops, computers, and other equipment to businesses. The emergence of such companies reflects the global trend in the growth of the electronics rental and reuse industry. The value of the global appliances rental market could increase from USD3.9 billion in 2017 to USD8.2 billion by the end of 2025.[536]

Similarly, e-waste recycling has a high potential for circularity. While developing countries like Indonesia might be engaged in e-waste recycling, most of the recycling is carried out by the informal sector.[537] Formalising the recycling sector would lead to greater economic, social, and environmental benefits for the country.

528 OEC, "Indonesia exports and imports". Available at: https://oec.world/en/profile/country/idn/
529 Guan et al (2020), *Global supply-chain effects of COVID-19 control measures.* Available at: https://www.nature.com/articles/s41562-020-0896-8
530 Santaso, et al (2019), *Estimating the Amount of Electronic Waste Generated in Indonesia: Population Balance Model.* Available at: https://iopscience.iop.org/article/10.1088/1755-1315/219/1/012006/pdf
531 Pinto (2008), *E-waste hazard: The impending challenge.* Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2796756/
532 Pinto (2008), *E-waste hazard: The impending challenge.* Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2796756/
533 Priyono (2017), *Law enforcement of electrical and electronic waste smuggling in Batam, Indonesia.* Available at: https://www.researchgate.net/publication/327340030_LAW_ENFORCEMENT_OF_ELECTRICAL_AND_ELECTRONIC_WASTE_SMUGGLING_IN_BATAM_INDONESIA
534 Brune, et al (2013), *Health effects of exposure to e-waste.* Available at: https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(13)70020-2/fulltext
535 Triple Pundit (2015), Electronics Industry Slow to Move the Needle on Water." Available at: https://www.triplepundit.com/story/2015/electronics-industry-slow-move-needle-water/57756
536 Globe NewsWire (2019), "Global Appliances Rental Market Set to Exceed $8.2 Billion by the End of 2025". Available at: https://www.globenewswire.com/news-release/2019/08/29/1908630/0/en/Global-Appliances-Rental-Market-Set-to-Exceed-8-2-Billion-by-the-End-of-2025-Rent-A-Center-Aaron-s-and-CORT-a-Berkshire-Hathway-Company-Dominate-the-Landscape.html
537 Fauziah F. Rochmana et al (2017), *E-waste, money and power: Mapping electronic waste flows in Yogyakarta, Indonesia.* Available at: https://www.sciencedirect.com/science/article/abs/pii/S2211464516301129

Exhibit 65

ELECTRICAL & ELECTRONIC EQUIPMENT

The "Recycle" and "Refurbish" approaches offer the highest potential for circularity in the electronics sector in Indonesia

High potential | Low potential | Prioritised for further assessment

Qualitative assessment of potential in Indonesia

REDUCE	The average lifespan of a mobile phone in Indonesia is 3.4 years. According to a study[1], increasing the lifespan of a product by one year can decrease the flow of e-waste by up to 10%
REUSE	The global appliances rental market, which promotes the reuse of electronics, is worth ~USD4 billion and is expected to grow at 10% every year till 2025
RECYCLE	12% of e-waste is properly recycled in Asia. In Indonesia, e-waste recycling rate is 5%. This rate for Europe stands at 35%
REFURBISH	The global market for refurbished smartphones grew by 13% in 2017, while the new smartphone market grew by only 3%
RENEW	Presence of elements such as beryllium, mercury, and lead makes e-waste hazardous thereby decreasing its recyclability. Substituting such elements can improve electronics' circularity

1. Study by Oers and Voet (2002) from Leiden University, Dematerialisation for urban waste reduction: Effectiveness and side-effects

SOURCE: ITU; ResearchandMarkets; literature review; focus group discussions; expert interviews

Based on an analysis of global approaches and extensive engagement with local stakeholders in Indonesia, four circularity opportunities were identified that could complement the existing regulations by the Government of Indonesia. These regulations are detailed in Box 16 below.

Box 16. ***Overview of existing Indonesian government policies to combat e-waste***

The legal basis for e-waste includes various regulations: The Presidential Decree 61/1993 on the Ratification of the Basel Convention; the Government Regulation Number 18 of 1999 on hazardous waste management; the Presidential Regulation 47/2005 on Ratification of Ban Amendment; Law No. 32 of 2009 on Environmental Management; the Presidential Decree number 18/1999; Presidential Decree number 85/1999 on B3 Waste Management; and Law No. 18 of 2008 on Waste Management.[538,539]

Law No. 18 of 2008 on Waste Management categorises e-waste as specific waste. Specific waste refers to waste that needs specific management because of its nature, concentrate, and/or volume. Under Law No. 32 of 2009 on Environmental Protection and Management, e-waste includes hazardous waste. Therefore, the import of e-waste is prohibited by the Government of Indonesia. Despite the existing laws, illegal trade in e-waste persists.[540] Batam is a notable entry point for smuggled e-waste into Indonesia.[541] This e-waste is either dismantled by the informal recycling industry or resold for reuse in many markets, such as Pasar Jodoh, Pasar Aviari, Pasar Tanjung Sengkuang, and My Mart. This highlights the need to ensure stricter enforcement of the exists regulations.

Import of second-hand electronics goods is, however, permitted. Under the Ministerial Decree of Ministry of Industry and Trade No. 756/MPP/Kep/11/2002 machinery and equipment that can be reused or refurbished can be imported.[542] Under the Ministry of Trade Decree No. 48 of 2011, second-hand computers and monitors can be imported if they meet certain conditions such as they are functional (with a proven certificate) and their lifetime is not more than five years.[543] Currently, Indonesia lacks an e-waste management policy that includes Extended Producer Responsibility (EPR). The Ministry for Environment is currently drafting a National E-waste Management policy that will fill these gaps. However, the recent Government Regulation No. 27/2020 on the Management of Specific Garbage recognizes electronic goods that are no longer used as specific garbage and holds producers responsible for preparing plans and/or programs to limit the produced garbage.[544]

Four key circular opportunities in the electrical and electronic equipment sector were identified (Exhibit 66).

538 Aryadi et al (2018), *E-waste: An underrated hazardous waste in Indonesia*. Available at: https://www.researchgate.net/publication/334280098_E-WASTE_AN_UNDERRATED_HAZARDOUS_WASTE_IN_INDONESIA
539 Haruki Augustina (2010), "The challenges of e-waste/WEEE management in Indonesia." Available at: http://gec.jp/gec/jp/Activities/ietc/fy2010/e-waste/ew_1-3.pdf
540 Damanhuri (2006), *Preliminary Identification of E-waste Flow in Indonesia and its Hazard Characteristic.*
541 Priyono (2017), *Law enforcement of electrical and electronic waste smuggling in Batam, Indonesia*. Available at: https://www.researchgate.net/publication/327340030_LAW_ENFORCEMENT_OF_ELECTRICAL_AND_ELECTRONIC_WASTE_SMUGGLING_IN_BATAM_INDONESIA
542 Haruki Agustina (2007), "Identification of e-waste and secondhand e-products in Indonesia." Available at: http://www.smarteeconsulting.com/wp-content/uploads/2008/12/s403_indonesia_paper-e-waste-bcrc-beijing-2.pdf
543 Ministry of Environment, Republic of Indonesia (2018), *E-waste Management in Indonesia. Available at*: https://www.epa.gov/sites/production/files/2014-05/documents/indonesia.pdf
544 Cabinet Secretariat of the Republic of Indonesia (2020), Gov't Issues Regulation on Specific Waste Management. Available at: https://setkab.go.id/en/govt-issues-regulation-on-specific-waste-management/

Exhibit 66

ELECTRICAL & ELECTRONIC EQUIPMENT

Examples of circular economy opportunities and benefits in the electronics sector

#	Circular opportunities	5Rs	Brief description
1	Increase product lifespan and reduce obsolescence	Reduce	Increase product functionality (e.g. batteries) to improve lifespan
2	Refurbish and reuse products	Reuse, Refurbish	Encourage reuse through remanufacturing (disassembly and recovery of components) and refurbishment (returns a product to good working condition by replacing or repairing faulty components)
3	Virtualise and dematerialise physical goods	Reduce	Replace physical goods with electronic formats (e.g. Netflix instead of DVDs)
4	Recycle materials	Recycle	Recycling of e-waste through better design and advanced technology to extract metals and minerals from e-waste

SOURCE: Ellen MacArthur Foundation; focus group discussions; expert interviews

- **Increase product lifespan and reduce obsolescence.** This opportunity requires a three-pronged approach: reducing technical, functional, and style obsolescence in electronic products; increasing the product quality and reducing physical deterioration of products by redesigning products; and bringing about a change in consumer habits that encourages them to extend the use of electronic products.[545] In Indonesia, the average lifespan of mobile phones is one third (3.4 years) that of phones in Europe (9.6 years).[546] This could be a function of not only differences in the technical lifespan of mobile phones in the two regions but also differential consumer habits. A lower median age in Indonesia than Europe may mean that Indonesians are likely to change their phones more frequently. According to a survey of a university in Indonesia, most students only use their mobile phones for only one year.[547]

  There are two benefits of this opportunity. First, the impact on waste reduction is directly proportional to the lifespan extension. So, a product with an average lifespan of 10 years sees its e-waste reduced by 10 percent for each year of lifetime extension.[548] Secondly, the business benefits are increasingly clear. Not only do longer lifespans improve the potential of a different circular opportunity, namely that of refurbishing and reuse, but could also have a direct impact on sales at least in the short-term. A 2016 study commissioned by the European Economic and Social Committee showed that on average, sales of products with a label showing a longer lifespan increased by 13.8 percent relative to competing products.[549] Growing awareness of this opportunity has led to the

545 BBC Future (2016), "Here's the truth about the 'planned obsolescence' of tech." Available at: https://www.bbc.com/future/article/20160612-heres-the-truth-about-the-planned-obsolescence-of-tech
546 Sylfannie Santoso et al (2019), *Estimating the Amount of Electronic Waste Generated in Indonesia: Population Balance Model*. Available at: https://iopscience.iop.org/article/10.1088/1755-1315/219/1/012006/pdf
547 Anisha Ghassani and Bambang Cahyadi, *Analisis Loyalitas Konsumen Terhadap Merek Smartphone Di Kalangan Mahasiswa Teknik Industri Universitas Pancasila*. Available at: https://idocslide.org/embed/analisis-loyalitas-konsumen-terhadap-merek-smartphone-di-kalangan-mahasiswa-teknik-industri-universitas-pancasila
548 Kleijn, et al (2002), *Dematerialisation for urban waste reduction: Effectiveness and side-effects*. Available at: https://www.leidenuniv.nl/cml/ssp/publications/wp2001-014.pdf
549 European Economic and Social Committee (2016), *The Influence of Lifespan Labelling on Consumers*. Available at: https://www.eesc.europa.eu/resources/docs/16_123_duree-dutilisation-des-produits_complet_en.pdf

emergence of businesses focusing their value proposition on extended products lifespans. For example, Fairphone is a crowd-funded social enterprise whose branding revolves around sustainability and e-waste. It manufactures a phone with a lifetime 2.5 times that of other phones and has a principle of "aiming for longer-lasting over latest."[550]

- **Refurbish and reuse products.** This opportunity spans the spectrum of reusing products as-is (potentially after a thorough cleaning); refurbishing products to return them to good working condition by replacing or repairing faulty components; and harvesting good quality components (remanufacturing) for spare parts programs or even to build into new products.[551] Selling refurbished or second-hand electronics is not a novel concept for Indonesia. In Indonesia, electrical appliances usually get passed between many consumers, including friends/family or to other consumers through second-hand markets, before they are disposed of as e-waste.[552] A research study on the e-waste flows in Yogyakarta showed how waste scavengers, aggregators, collectors, and classifiers, comprising the informal sector, facilitate the flow of reusable electronics from consumers into second-hand markets.[553] Informal markets selling "junk" electronics can be found in many Indonesian cities, such as Bandung.[554] A survey of refurbishing shops in Jabodetabek, Bogor, and Depok, among other cities in Indonesia, showed that this sector is dominated by small and unauthorised enterprises that offer their services in traditional retail outlets.[555] Due to lack of training in refurbishing electronics and access to technology, such enterprises may not be able to maximise the economic potential from refurbishing electronics.

  However, a growing number of companies offer increasingly comprehensive services through modern retail outlets and online, which could encourage more consumers and businesses to use repair and refurbishing services. Take PT Sigin Interactive Indonesia. Sigin provides repair and refurbishing services for used electronics and home appliances, dead-on-arrival (DOA) products, and printed circuit boards.[556] The emergence of online marketplaces for second-hand goods, including electronics, such as BelanjaBekas.com, facilitate greater reuse in Indonesia.[557] Brands in Indonesia could also replicate the business model being used by Apple. Apple sells a catalogue of refurbished products that are backed by a one-year warranty and are sold under its "Apple Certified Refurbished" promise. These products can be up to 15 percent cheaper than new products and hence reach entirely new customer segments. Caterpillar, a leading manufacturer of capital equipment, through its "Cat Reman" program remanufactures products at the end of their lives to same-as-new condition.[558] In manufacturing, many industrial customers prefer refurbished and remanufactured products and equipment because these have received detailed quality checks and extensive repairs and updates.

  These opportunities could be more easily monetized through "electronics as a service" business models. Conventional, ownership-based business models, where the user acquires a product through a sales contract, provide little incentive for consumers or manufacturers to reuse or repair products since the net monetary benefits for either party might be limited. If products remain in the ownership of the manufacturer (or a third party), however, and are made available for use through alternative contract models (e.g., service subscription), three things happen. First, manufacturers are motivated to build longer-lived products since this allows them to create more revenue from a single asset. Second, manufacturers can factor the cost of return at end-of-use into the service price. Finally, manufacturers are motivated to initiate and expand refurbish and reman programs, on the one hand, because contracts are now focused on the delivery of quality service, not on the ownership of a shiny new product, and on the other hand because such programs, too, allow them to generate more revenue from the same asset. Such business models are already commonplace for capital equipment in many manufacturing industries. For example, Atlas Copco in Indonesia leases air compressors to the electronics manufacturing industry. With companies like Asani Indonesia, these models are now also emerging in electronics segments.

- **Virtualise and dematerialise physical goods.** This refers to the replacement of physical goods with electronic formats. For example, video and music-streaming services have led to a sharp reduction in the demand for music CDs and DVDs. In the UK, sales of CDs dropped from 132 million units in 2008 to 32 million units in 2018.[559] More recently, virtualisation is being witnessed due to cloud computing. By moving the capability of devices from individual and decentralised hardware to large-scale, centralised data centres, similar and better performance

550 Fairphone, "Extending the life span of our products." Available at: https://www.fairphone.com/en/project/extending-life-span/
551 Note that the terms refurbishing and remanufacturing are often used interchangeably
552 Enri Damanhuri (2018), "Development of e-waste management and technology in Indonesia." Available at: http://202.47.80.50/files/filelibrary/1.4_ED-Perindust-EEE-PDBE-08012018.pdf
553 Fauziah F. Rochman et al (2016), *E-waste, money and power: Mapping electronic waste flows in Yogyakarta, Indonesia.*
554 Michikazu Kojima (2010), *3R policies for Southeast and East Asia.* Available at: https://www.eria.org/RPR-2009-10.pdf#page=79
555 Anonymous, *Untitled.* Available at: https://www.env.go.jp/en/recycle/asian_net/Project_N_Research/E-wasteProject/05.pdf.
556 Sigin Interaction Indonesia, "Services". Available at: http://siginiinteractive.co.id/index.php/sigin-greetings/capability-competence/repair-electronic-and-telecommunication-devices/
557 JakartaGlobe (2017), "BelanjaBekas.com: Alternative Marketplace for Secondhand Goods." Available at: https://jakartaglobe.id/business/belanjabekas-com-alternative-marketplace-secondhand-goods/
558 Caterpillar. "Cat reman process." Available at: https://www.caterpillar.com/en/company/sustainability/remanufacturing/process.html
559Forbes (2019), "Sales Of Physical Music Media Slump As Consumers Move To Streaming Services." Available at: https://www.forbes.com/sites/marksparrow/2019/01/03/sales-of-physical-music-media-slump-as-consumers-move-to-streaming-services/#1a32f4862255

comes with more and more intense product use cycles, reduced redundancies, and decreases waste in the system. Cloud-based services are a growing market in Indonesia, and the industry could contribute around USD40 billion to Indonesia's GDP between 2019 and 2023.[560] Several companies in Indonesia, including Bank Rakyat Indonesia (BRI), are trying to leverage the potential of cloud computing, which are reducing the need for physical servers in offices.[561]

Since virtualisation could increase the demand for electronic equipment to access digital services (e.g., music streaming), dematerialisation of electronics could minimise the spillover impact of virtualisation on e-waste. The weight of a 32" LED TV, a 15" laptop, and a mobile phone decreased on average by 55 percent, 15 percent, and eight percent respectively from 2010 to 2015.[562] Miniaturisation (smaller components), and concentration (more functions on fewer devices) also have a dematerialising effect. Dematerialisation, however, may have an unintended adverse consequence. Together with efforts to use less gold on motherboards, dematerialisation tends to decrease the material value of electronics, and hence reduces the motivation of formal and informal recyclers to collect and process them.

- **Recycle materials.** The recycling opportunity focuses on extracting more value, from a larger share of the waste volume. The opportunity includes recycling e-waste through better design and advanced technology to extract metals and minerals from e-waste. Most of the e-waste recycling in Indonesia is carried out informally. A survey of close to 100 scavengers revealed that most valuable resources are recovered from e-waste before it arrives at the final disposal facility.[563] For example, researchers have shown how the Indonesian informal sector recovers gold from e-waste.[564] However, due to the lack of training and access to technology, the informal sector is not as productive in value extraction from e-waste as it could be. As ongoing efforts in Europe are showing, the potential to extract more value from each tonne of waste entering a recycling facility remains largely untapped.[565] Currently, only around five percent of e-waste is properly recycled in Indonesia.[566] This is low compared to countries like South Korea and Sweden, which recycle around half of their e-waste.[567]

  There are many companies operating in the e-waste management industry in Indonesia. Most of these, however, are engaged in recovering and selling scrap metals — for example, several companies based in Batam Island and East Java.[568] Many companies are nonetheless focused on increasing the economic value that could be recovered from Indonesia's e-waste. PT. Teknotama Lingkungan Internusa based in West Java recycles used PCBs and recovers fibre waste used in cement factories and industrial grade copper from e-waste.[569] Most of the e-waste that is formally recycled in Indonesia is sourced from businesses. Therefore, most e-waste recycling companies in Indonesia provide B2B services. Two such companies include Ecoberingin and Mukti Mandiri Lestari, the latter recycling around 1,000 tonnes of electronic equipment every month.[570]

  Due to difficulty in its collection, e-waste from households makes up only a small portion of e-waste properly recycled in Indonesia.[571] The share of household e-waste in Indonesia's total e-waste could already be around 30 percent. One Indonesian study estimated that e-waste generated by households could rise from 285,000 tonnes in 2015 to 622,000 tonnes in 2025.[572] The recycling rate of consumer e-waste could be increased in three ways. First, consumers could be encouraged to reduce hoarding of obsolete or broken products at home by providing cash incentives as part of a "take-back programme." A survey in the UK found that an average consumer uses a mobile phone as its primary device for one year and 11 months, but the phone is kept in "dead storage" for three years.[573] Second, consumers could be educated that e-waste should not be disposed of in regular trash. EwasteRJ, a local organisation, is working with other NGOs in Indonesia to bring about this behaviour change among consumers.[574] Third, municipalities or the private sector could be incentivised to develop consumer-oriented collection infrastructure. The Jakarta Sanitation Agency started working with a private company in 2016 to deploy special

560 TechWire Asia (2019), "Is Indonesia finally waking up to the advantages of cloud computing?" Available at: https://techwireasia.com/2019/10/is-indonesia-finally-waking-up-to-the-advantages-of-cloud-computing/
561 Jakarta Post (2019), "More companies migrate to cloud computing to boost efficiency." Available at: https://www.thejakartapost.com/news/2019/09/11/more-companies-migrate-cloud-computing-boost-efficiency.html
562 Closed Loop Foundation, et al (2016), *The electronics recycling landscape*. Available at: https://www.sustainabilityconsortium.org/wp-content/uploads/2017/03/TSC_Electronics_Recycling_Landscape_Report-1.pdf
563 Enri Damanhuri (2018), "Development of e-waste management and technology in Indonesia." Available at: http://202.47.80.50/files/filelibrary/1.4_ED-Perindust-EEE-PDBE-08012018.pdf
564 Enri Damanhuri (2018), "Development of e-waste management and technology in Indonesia." Available at: http://202.47.80.50/files/filelibrary/1.4_ED-Perindust-EEE-PDBE-08012018.pdf
565 WEEE Forum, *European Standards for Treatment and Recycling of E&E Waste and for Monitoring the Processing Companies*. Available at: https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3261&docType=pdf
566 Mairizal et al, *Electronic Waste Generation, Distribution Map, and Possible Recycling Routes in Indonesia*. Forthcoming.
567 Today (2018), "Regulations to be introduced to reduce e-waste here: Masagos". Available at: https://www.todayonline.com/singapore/regulations-be-introduced-reduce-e-waste-here-masagos
568 Haruki Augustina (2010), "The challenges of e-waste/WEEE management in Indonesia." Available at: http://gec.jp/gec/jp/Activities/ietc/fy2010/e-waste/ew_1-3.pdf
569 PT. Teknotama Lingkungan Internusa (2017), "Electronic Waste Recovery System." Available at: https://youtu.be/mVmDiTiaAEY
570 CCTV Video News Agency (2017), "Indonesian Companies Call for Better Disposal of E-waste". Available at: https://www.youtube.com/watch?v=oBoiZolbZE4
571 Based on the expert interview of Chandra Paramita, Manager, TES-AMM Indonesia
572 Pertiwi Andarani and Naohiro Goto (2014), *Potential e-waste generated from households in Indonesia using material flow analysis*. Available at: https://link.springer.com/article/10.1007/s10163-013-0191-0
573 Garrath T. Wilson, et al (2017), *The hibernating mobile phone: Dead storage as a barrier to efficient electronic waste recovery*. Available at: https://www.sciencedirect.com/science/article/pii/S0956053X16307607#s0010
574 Ashoka University, "RJ - Changing consumer behavior to reduce e-waste across Indonesia." Available at: https://www.ashoka.org/en/story/rj-changing-consumer-behavior-reduce-e-waste-across-indonesia

trucks at specific collection points to collect inorganic waste, including e-waste.[575] In 2018, the sanitation agency offered free pick-up of e-waste from residents who had more than five kg of e-waste. To process the e-waste, the agency worked with PT. Prasadha Pamunah Limbah Industri, for electronic gadgets, and PT. Mukti Mandiri Lestari for other e-waste types.[576]

When it comes to better value recovery, technology investments are not always required. Manual removal of motherboards before crushing and sorting e-waste, for example, is one of the single most value-enhancing processing steps.[577] Moreover, electronic manufacturers can facilitate value recovery and processing cost reduction by improving the recyclability of their products. Design-for-disassembly, to speed up and reduce the cost of recycling and remanufacturing, should be part of the product design process, as should be judicious material choices. Apple, for example, has eliminated the use of mercury, lead, beryllium, and PVC from its products, thereby removing various worker health and environmental hazards from the recycling process.[578] To facilitate the formalisation of e-waste recycling, major base-metals smelters across Indonesia could be integrated to form a comprehensive recycling system that supports e-waste processing.[579]

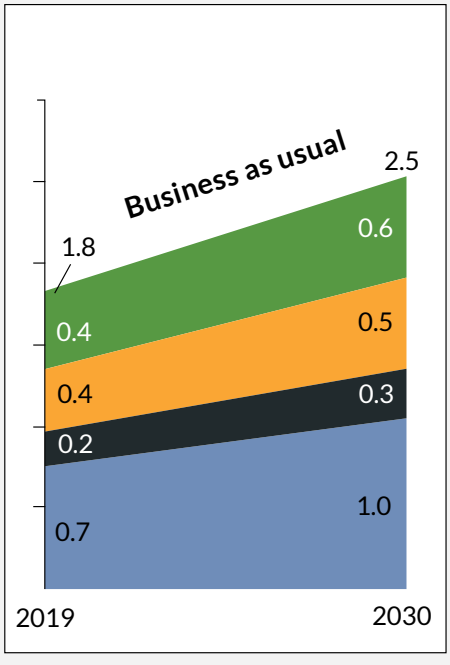
How big could the opportunity be to tackle e-waste in Indonesia? Four opportunities listed below could help reduce e-waste by 13 percent. Indonesia could also increase its e-waste formal recycling rate from the current five percent to 21 percent (Exhibit 67).

Exhibit 67

ELECTRICAL & ELECTRONIC EQUIPMENT

Indonesia could reduce and recycle 24% of its e-waste in 2030 through circular economy opportunities

E-waste in 2030 under a "business-as-usual" scenario1 and circularity opportunities
Thousand tonnes



Circularity opportunities	Circularity target	'000 tonnes saving	% of 2030 BAU E-waste[1]
Increase product lifespan and reduce obsolescence	50% of Indonesia's electronics match the lifespan of electronics in Europe	26	1
Refurbish and reuse products	Indonesia doubles the share of electronics that it refurbishes and reuses to 40%	101	4
Virtualise and dematerialise physical goods	Virtualisation and dematerialisation rate for 10% of electronics based on historical rates[2,3]	194	8
Recycle materials	Indonesia matches India's e-waste recycling rate of 21.3%	290	12
	Total	611	24

1. Percentages are rounded off
2. Sales of CDs in the UK fell by 76% from 2008 to 2018, largely due to music streaming services. Used this as a proxy for the reduction in e-waste due to virtualisation
3. Based on Sustainability Consortium's estimates on change in product weight between 2010 and 2015

SOURCE: ITU; Closed Loop Foundation; The Sustainability Consortium (see annex for more details)

575 The Jakarta Post (2016), "Jakarta starts e-waste collection service in cooperation with PT." Available at: https://www.thejakartapost.com/news/2016/02/12/jakarta-starts-e-waste-collection-service-cooperation-with-pt.html
576 Jakarta Now! (2018), "Jakarta's Answer to the E-Waste Question." Available at: https://nowjakarta.co.id/people/views/jakarta-s-answer-to-the-e-waste-question
577 Chung Duc Tran and Stefan Petrus Salhofer (2018), *Processes in informal end-processing of e-waste generated from personal computers in Vietnam*. Available at: https://link.springer.com/article/10.1007/s10163-017-0678-1
578 Quartz (2016), "Six of the worst toxins Apple says it has phased out of its products." Available at: https://qz.com/663763/six-of-the-worst-toxins-apple-says-it-has-phased-out-of-its-products/
579 Based on inputs from Professor Akbar Ramdhani, Swinburne University of Technology, Australia

Box 17. ***Case studies of circularity in e-waste***

Ecoberingin is an example of an Indonesian company pursuing circular economy opportunities in the electrical and electronic equipment sector in Indonesia. Ecoberingin provides IT Assets Disposition (ITAD) services to businesses. These include shipping, packaging, storage, data destruction, equipment disposal, and e-waste recycling services. Its e-waste recycling services include recycling both unwanted electronic hardware (such as unused computers) and outdated electronic hardware (such as obsolete telephones). Ecoberingin facilitates the e-waste by separating the waste into its component parts such as iron, aluminium, PCB, or plastic.

Asani Indonesia is another example of a company engaged in circular economy activities in Indonesia. Asani Indonesia is a B2B leasing platform that allows businesses to rent electronic equipment such as laptops, computers, and printers for 18 months. Leasing provides a dual advantage to companies. It allows companies to make payments based on a pay-as-you-go-model, which decreases the cash flow needs imposed on a company, while also ensuring that companies do not have to bear any depreciation cost for equipment.

THE ECONOMIC, SOCIAL, AND ENVIRONMENTAL BENEFITS OF CIRCULARITY OPPORTUNITIES

Most of the economic savings generated from this sector are driven by two opportunities: "virtualise and dematerialise electronics, and "recycle e-waste." Virtualising and dematerialising electronics help in reducing e-waste generation. Opportunities that focus on reducing waste tend to generate higher savings as compared to opportunities that focus on reusing resources or recycling waste. However, in the case of electronics, the recycling opportunity also generates significant savings. This is due to the largely untapped potential of recycling e-waste in Indonesia. Indonesia currently formally recycles five percent of its e-waste, whereas in a circular scenario it could match India's e-waste recycling rate of 21 percent.[580]

The savings from these circular opportunities could then be used by businesses and consumers to reinvest in other businesses and sectors. Electronic manufacturers could reinvest their savings into technical and marketing projects to increase the lifespan of their products – where necessary hiring consulting and other services. Electronic retailers could contract or develop in-house technical services that can help them provide refurbishing services to their customers or help them design a strategy to enter the "electronics as a service" market. Whereas to virtualise and dematerialise their products, manufacturers may invest in upgrading their machinery. For consumers, savings could be used in other areas such as education, health, or recreation services.

The economic impact from a circular economy for the electrical and electronic equipment sector could be worth IDR12.2 trillion (USD0.9 billion), which is equivalent to 2.5 percent of the sector's GDP in 2030 (Exhibit 68).[581] The additional IDR12.2 trillion (USD0.9 billion) in economic output under the circular economy scenario could generate nearly 75,000 cumulative net jobs for Indonesia between 2021 and 2030 (Exhibit 69). Based on the analysis of these jobs, 91 percent could be for women. This is driven by the potential job displacement in male-dominant sectors (e.g., waste management, where women make up only 26 percent of the total jobs) due to a circular economy and the likely job creation in female-dominant sectors (e.g., education, where households could reinvest their savings and where women account for 61 percent of all jobs).

It is important to note that all economic benefits may not be captured by the electrical and electronic equipment sector. Some of these benefits could be captured by other sectors in the economy (e.g., waste management if businesses focus on improving e-waste collection or education if households decide to invest their savings - from reducing new purchases of electronics and refurbishing them – on education).

580 The Hindu (2017)," E-waste recycling has doubled, says Centre". Available at: https://www.thehindu.com/news/national/e-waste-recycling-has-doubled-says-centre/article30983383.ece

581 Based on IO table methodology (See the Annex for further details). Based on the ICOR methodology, the economic impact from the electrical and electronic equipment sector is nearly IDR7.2 trillion. The ICOR economic impact is lower than the economic impact estimated using the IO table. The difference could be explained by the lack of data on capital investments required to adopt specific circular opportunities in the electrical and electronic equipment sector (e.g., increase product lifespan and reduce obsolence; or refurbish and reuse products)

From a social standpoint, circularity in the electrical and electronic equipment sector could also lead to annual household savings worth approximately IDR88,000 (USD6) or 0.2 percent of the average current annual household expenditure (Exhibit 70). These household savings are driven mainly by the savings that consumers earn from lower prices due to greater virtualisation and dematerialisation of electronics and due to increased recycling of e-waste, both of which could lower the retail cost of electronics for consumers.

The environmental benefits are also substantial from exercising these circular economy opportunities (Exhibit 71). Circular economy in the electrical and electronic equipment sector can help Indonesia avoid nearly 0.4 million tonnes of CO_2^e emissions and save 0.6 billion cubic metres of water in 2030.

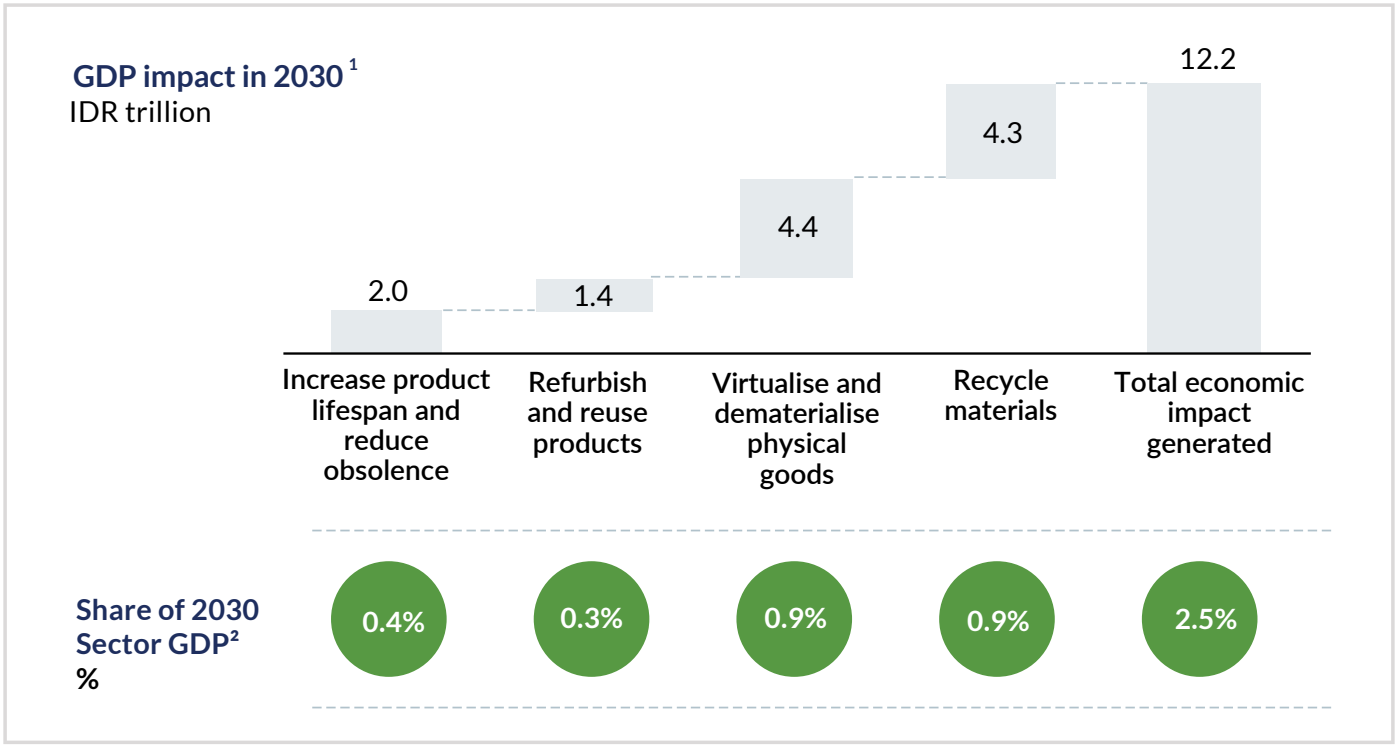
The detailed methodology for quantifying them is outlined in the Annex.

Exhibit 68

ELECTRICAL & ELECTRONIC EQUIPMENT

BASED ON IO METHODOLOGY

A circular electronics sector could generate a net economic impact of IDR12.2 trillion (USD0.9 billion) or 2.5% of the sector GDP in 2030



1. The economic benefits are not all captured by the specific sector where the circularity opportunities exist. In some cases, the savings from a circular economy opportunity are passed through to consumers who may spend them in other sectors such as health, education, and recreational services
2. Share of estimated sector GDP in 2030 is calculated based on a "business-as-usual" scenario growth rate of 4.92%. Percentages are rounded off

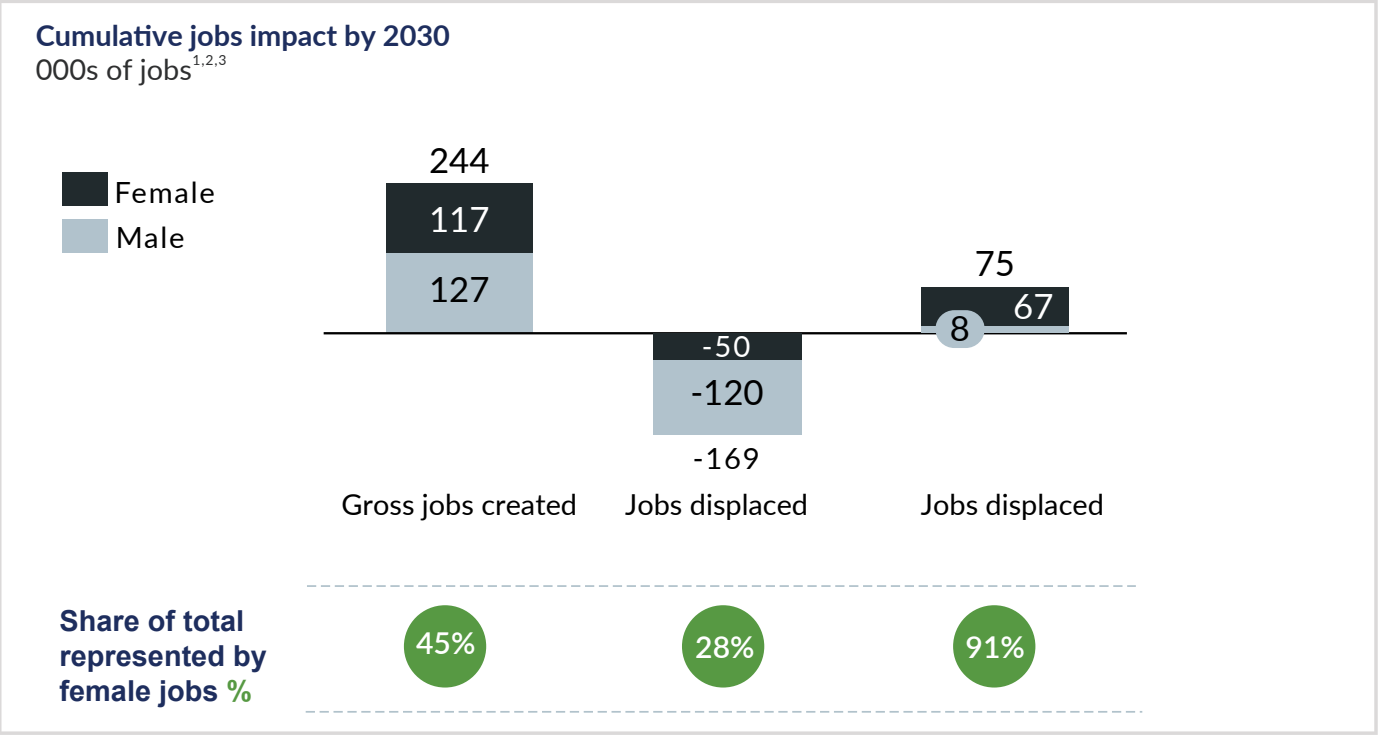
SOURCE: BPS: ITU; World Economic Forum; CSI Market (see annex for more details)

Exhibit 69

ELECTRICAL & ELECTRONIC EQUIPMENT

BASED ON IO METHODOLOGY

A circular electronics sector could add 75,000 net jobs by 2030, of which 91% could be for women



1. The jobs created are not necessarily created in the electronics sector. They are created economy-wide from the savings that are reinvested by consumers and businesses
2. Calculated using data from the UN Population Division and applying Indonesia's labour force participation rate of 2019 and employment rate of 2016. The total estimated jobs in 2030 are inclusive of the net jobs created due to circular economy
3. To estimate the jobs created for women in 2030, it is assumed that the gender share of jobs in each sector in 2018 would remain unchanged till 2030. The data from the Labour Force Situation report published by BPS in February 2018 on the gender share of jobs in each of the 17 sectors of Indonesia's economy was used

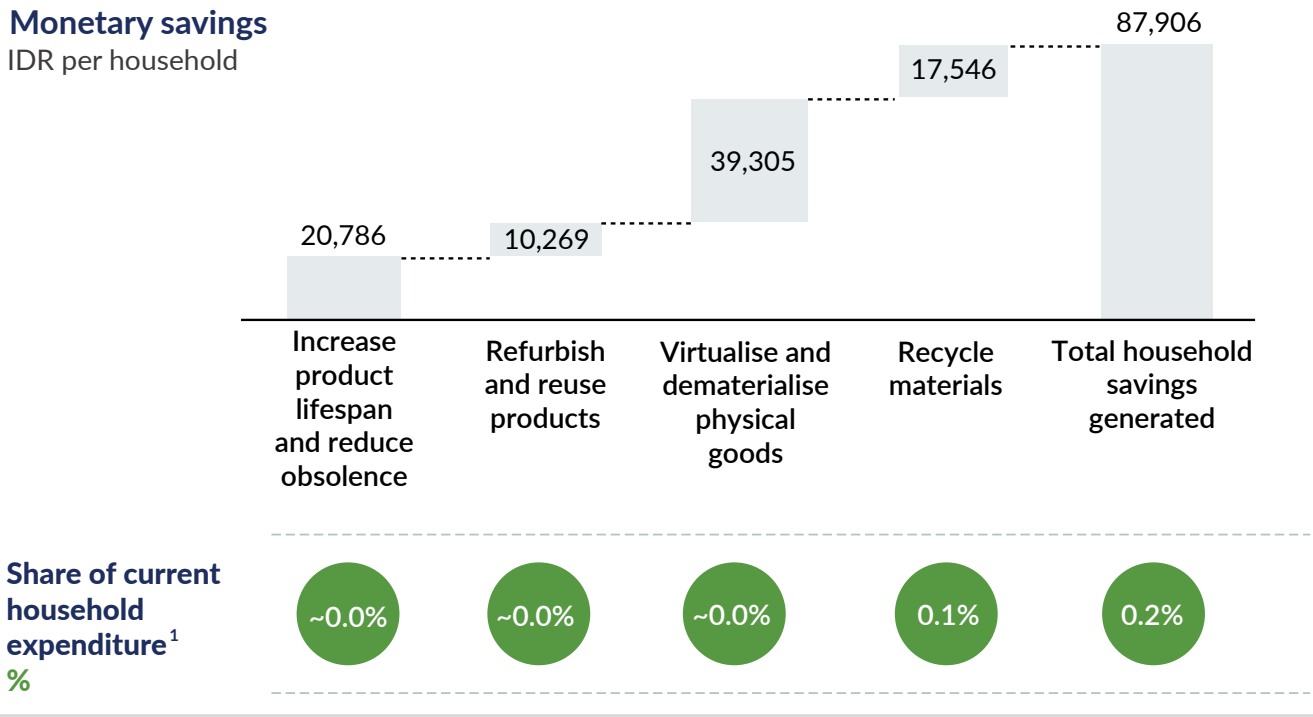
SOURCE: BPS; UN Population Division; IMF; World Bank (see annex for more details)

Exhibit 70

ELECTRICAL & ELECTRONIC EQUIPMENT

BASED ON IO METHODOLOGY

A circular electronics sector could generate household savings worth ~IDR88,000 (USD6) or 0.2% of the current annual household expenditure in 2030

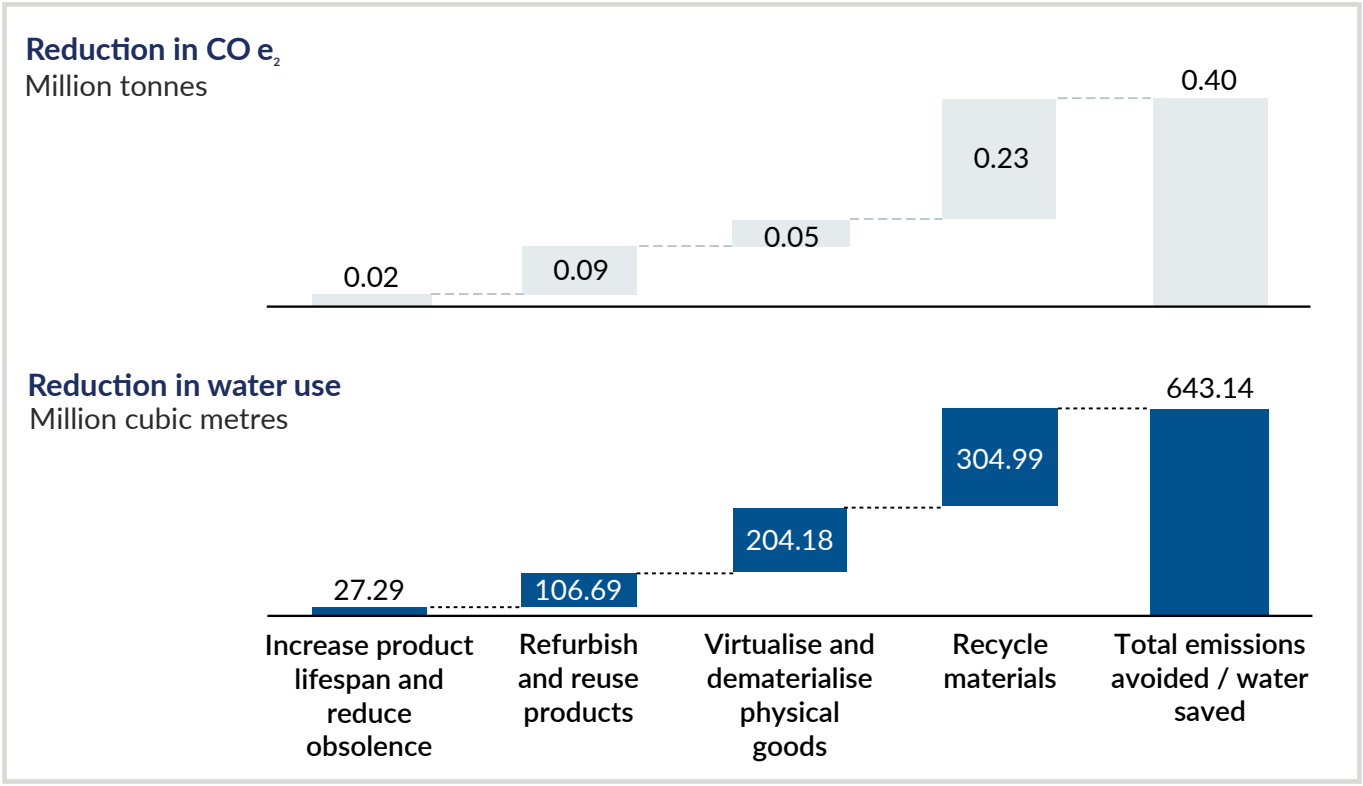


1. Percentages are rounded off
SOURCE: BPS (see annex for more details)

Exhibit 71

ELECTRICAL & ELECTRONIC EQUIPMENT

Indonesia could avoid 0.4 million tonnes of CO_2e emissions and save ~0.6 billion cubic metres of water relative to BAU in 2030



SOURCE: National Geographic; ITU (see annex for more details)

BARRIERS IMPACTING CIRCULAR ECONOMY ADOPTION IN THIS SECTOR

Firms in the electrical and electronic equipment sector are likely to face several barriers in adopting circular economy opportunities (Exhibit 72). While these barriers will be explored in detail in the next phase of this project, an initial synthesis of the barriers along with possible policy responses to address them is outlined below based on consultations with experts and discussions with private sector firms in the sector (Box 18).

Exhibit 72

ELECTRICAL & ELECTRONIC EQUIPMENT

There are a range of potential barriers that could prevent firms from capturing the circularity opportunities in the electronics sector

Highly significant[1]

#	Barrier	Opportunities			
		Increase product lifespan and reduce obsolescence	Refurbish and reuse products	Virtualise and dematerialise physical goods	Recycle materials
1	Difficulty in changing customs and habits of businesses and consumers		■	■	■
2	Unintended consequences of existing regulations				
3	Lack of infrastructure				■
4	Implementation and enforcement failures		■		
5	Poorly defined targets and objectives				
6	Inadequately defined legal frameworks				
7	Not profitable	■			
8	Insufficient end markets		■		
9	Lack of capital	■			
10	Imperfect information			■	■

1. Highly significant refers to barriers that were identified in the sector focus group discussions and expert interviews as being of key concern to stakeholders in Indonesia

SOURCE: Lliterature review; focus group discussions; expert interviews

- **Difficulty in changing customs and habits of businesses and consumers.** While selling refurbished household appliances is commonplace in many "junk" markets in Indonesia,[582] some consumers may have a poor perception of second-hand electrical and electronic equipment, which could present a challenge for businesses trying to sell refurbished products.

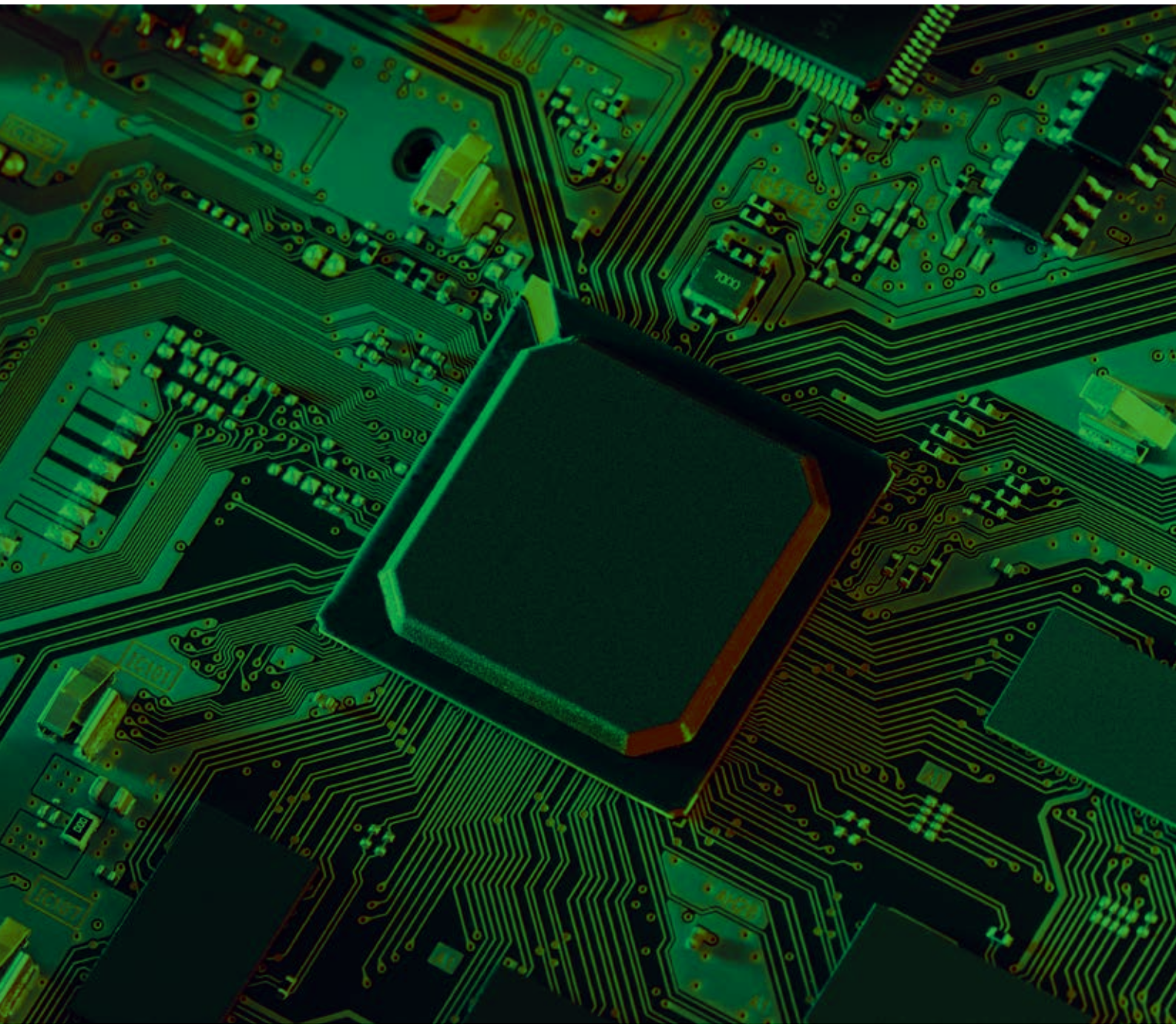
- **Lack of infrastructure.** Increasing the reuse and recycling rates of e-waste would require improving the collection rates of e-waste and incorporating reverse logistics in the supply chain. A survey of 180 respondents in Jakarta concluded that only eight percent of the respondents had recycled their old electronics.[583] While some respondents claimed that they were unaware of the benefits of e-waste recycling, others claimed that it was hard to do, it was time-intensive, or that it was expensive. Inaccessible e-waste collection points could be a driver behind the inability of these respondents to recycle their e-waste.

582 Michikazu Kojima (2010), *3R policies for Southeast and East Asia.* Available at: https://www.eria.org/RPR-2009-10.pdf#page=79
583 Jessica Hanafi et al (2011), *The Prospects of Managing WEEE in Indonesia.* Available at: https://link.springer.com/chapter/10.1007/978-3-642-19692-8_85

- **Implementation and enforcement failures.** Non-enforcement of policies that facilitate the circular economy may create free ridership problems and low compliance. For example, despite existing regulations banning the import of e-waste into Indonesia, a significant quantity of e-waste is imported in the country primarily through Batam.[584]

- **Not profitable.** Reducing lifespan of electronics can reduce waste generation, but it may not align with the incentives of many manufacturers and retailers who have traditionally earned revenue by focusing on selling electronics more frequently instead of providing services related to these products. For example, the life span of central processing units (CPU) has reduced from four to six years in 1997 to two years in 2005.[585]

- **Imperfect information.** Lack of awareness about e-waste could present a challenge in boosting circularity in Indonesia's electrical and electronic equipment sector. According to a survey of more than 350 respondents on e-waste in Jakarta, 60 percent of respondents did not have sufficient knowledge about e-waste, and 56 percent of respondents were unaware about the presence of toxic and hazardous materials in e-waste.[586]



584 Priyono (2017), *Law enforcement of electrical and electronic waste smuggling in Batam, Indonesia*. Available at: https://www.researchgate.net/publication/327340030_LAW_ENFORCEMENT_OF_ELECTRICAL_AND_ELECTRONIC_WASTE_SMUGGLING_IN_BATAM_INDONESIA
585 J Culver (2005, "The life cycle of a CPU." Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3908467/#B1
586 Dino Rimantho et al (2019), *Assessment of knowledge, attitude, practice on households related to e-waste management: a case study in DKI Jakarta 1.*

Box 18. ***Examples of potential policy interventions that could overcome these barriers***

The detailed policy solutions for addressing the barriers to a circular economy in e-waste will be explored in the next phase of the circular economy work. However, this box provides some examples of the type of interventions by policymakers, the private sector, and civil society that could help address the identified barriers.

- **Raise awareness about e-waste.** The Government could consider creating public campaigns that aim at behavioural change. These could be initiated in collaboration with the private sector or the civil society. For example, EwasteRJ, a non-profit focused on e-waste in Indonesia, formed "EwasteRJ agents", a network of young changemakers who aim to raise awareness about e-waste in their communities.[587] Similarly, to change the perception of consumers on refurbished electronics, private sector firms could consider highlighting the lifecycle savings potential that consumers could obtain from using refurbished electronics.
- **Improve the collection of e-waste.** The Government could also consider improving the collection rate of e-waste. The Jakarta Sanitation Agency has previously considered collaborating with a private waste-treatment company to collect e-waste through special trucks.[588] Local Governments in Indonesia could similarly work with the private sector to boost the collection of e-waste that could facilitate greater recycling.
- **Create regulations to govern e-waste management.** Researchers have cited that a lack of regulations on managing e-waste is a significant barrier in recycling and recovering value from e-waste.[589] Developing clear waste management regulations, along with Extended Producer Responsibility (EPR), could facilitate greater adoption of e-waste management system by companies.[590] The Government could also consider introducing environmental labelling standards for electronic and electrical equipment to inform consumers of environmentally friendlier products and incentivise firms to improve their environmental standards.[591]
- **Consider small-scale infrastructure to manage e-waste.** Finally, Indonesia may not need to look at large-scale infrastructure as the only feasible option. Research from Australia has demonstrated that small-scale plants with a capacity of processing 25,000 tonnes of e-waste every year could be economically viable.[592]

587 Ashoka, "RJ - Changing consumer behaviour to reduce e-waste across Indonesia." Available at: https://www.ashoka.org/en/story/rj-changing-consumer-behavior-reduce-e-waste-across-indonesia
588 The Jakarta Post (2016), "Jakarta starts e-waste collection service in cooperation with PT." Available at: https://www.thejakartapost.com/news/2016/02/12/jakarta-starts-e-waste-collection-service-cooperation-with-pt.html
589 I. T. Wilyani et al (2018), *E-waste: An underrated hazardous e-waste in Indonesia.* Available at: https://www.researchgate.net/publication/334280098_E-WASTE_AN_UNDERRATED_HAZARDOUS_WASTE_IN_INDONESIA
590 Pertiwi Andarani and Naohiro Goto (2012), *Preliminary Assessment of Economic Feasibility for Establishing a Households' E-Waste Treating Facility in Serang, Indonesia.* Available at: http://ijesd.org/papers/286-R10012.pdf
591 Jessica Hanafi et al (2011), *The Prospects of Managing WEEE in Indonesia.* Available at: https://link.springer.com/chapter/10.1007/978-3-642-19692-8_85
592 Elsa Dominish et al (2017), *Australian opportunities in a circular economy for metals: Findings of the wealth from waste cluster.* Available at: http://wealthfromwaste.net/wp-content/uploads/2017/11/Wealth_From_Waste_Report_WEB.pdf

8. Road to a circular economy

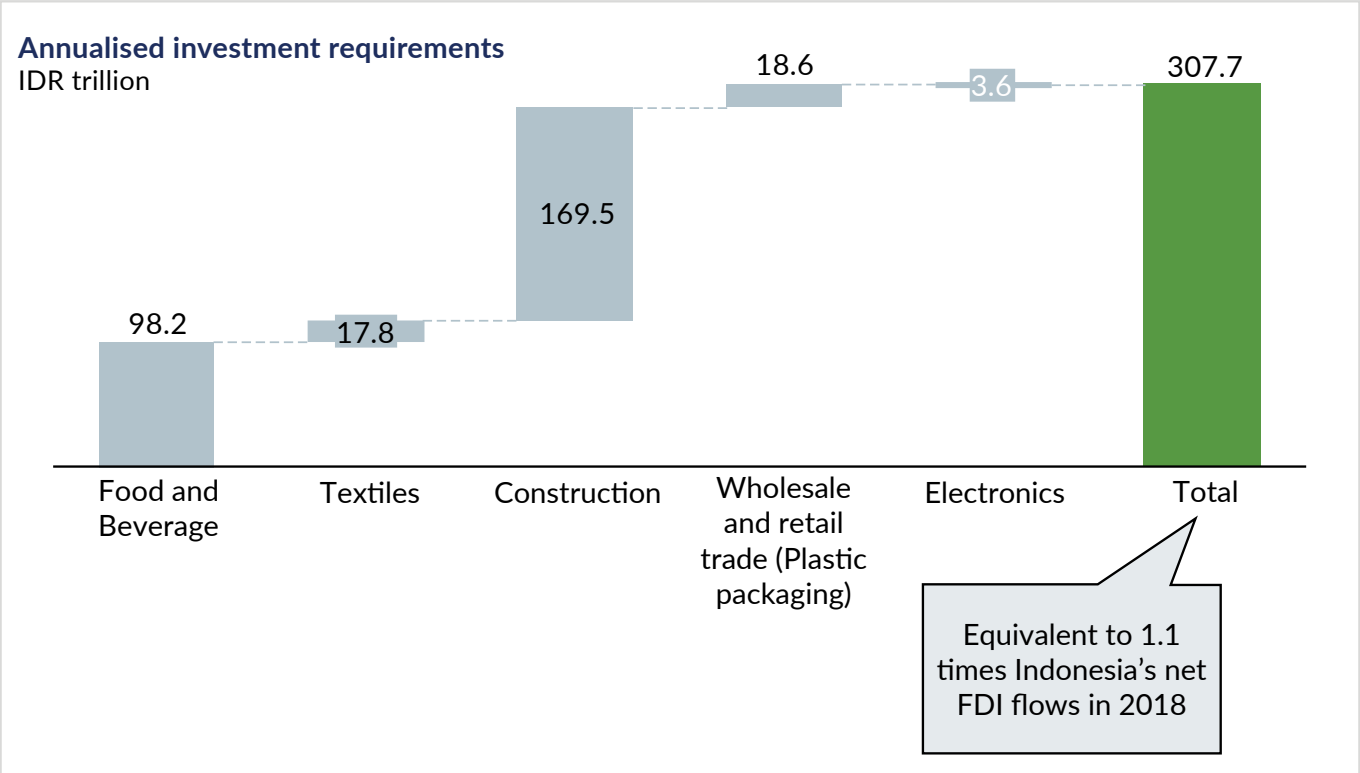
The analysis in the preceding chapters highlights the strong potential for a circular approach in Indonesia. This chapter discusses the next steps in creating and implementing a national circular economy roadmap. Capturing the opportunities will require significant capital investment, finding ways of engaging MSMEs, and also addressing some of the barriers noted in earlier chapters

IDR308 TRILLION (USD21.6 BILLION) OF ANNUAL CAPITAL INVESTMENT IS NEEDED TO SUPPORT THE IMPLEMENTATION OF THE IDENTIFIED CIRCULAR ECONOMY OPPORTUNITIES

Substantial investment is needed to plug infrastructure gaps and create the business models that can unlock the circular economy opportunities outlined in this study. Indonesia would need around IDR308 trillion (USD21.6 billion) of annual investment across the five focus sectors between now and 2030 (Exhibit 73), more than 50 percent of which would be required in the construction sector. Indonesia would need to deploy these capital investments in a variety of channels. For example, in construction, to facilitate the development of more energy-efficient buildings, the investment would be required on on-site energy generation, distribution systems, controls technologies, space heating, lighting, amongst others.[593]

Exhibit 73

Annual capital investment required to capture circular opportunities could be IDR308 trillion (USD21.6 billion) or 1.1 times Indonesia's net FDI flows in 2018



SOURCE: World Bank; Ellen MacArthur Foundation; Business & Sustainable Development Commission; WRI; FAO; World Economic Forum (see annex for more details)

593 Build up (2019), "Overview. Financing energy efficiency in buildings". Available at: https://www.buildup.eu/en/news/overview-financing-energy-efficiency-buildings

A brief summary of how these capital investment requirements were derived in each sector is provided in the Annex in Table A10.

While the required investment could be partly funded by the benefits and savings that business could enjoy as they transition towards circularity, some larger-scale projects will require additional investors. An example is an integrated waste management facility (to collect, sort, store and recycle waste streams) that is more economically feasible at large capacities, hence requires a degree of risk pooling by investors (for example, public-private partnerships). With over USD30 trillion in sustainable investment assets under management globally already, investors seem willing to challenge existing paradigms around what creates a healthy return on investment.[594] What is key, then, is to help investors understand how circular models affect returns. To what degree, for example, do sharing and subscription models influence market risk? How can remanufacturing and recycling reduce supply chain risk? Even if capital is available a key barrier to accessing funding for circular economy-focused business models is how the existing financial system makes financing circular businesses more challenging. For example, since circular businesses are characterised by recurring periodic revenue streams and therefore require longer payback periods, the circular economy-focused businesses may be deemed as risky for investors.[595] The VAT system in the European Union does not favour rent-purchase relationships that are deployed in circular businesses like garment rental companies.[596] Hence, building an understanding of the unique nature of circular businesses and tailoring financial products that suit these models would be important to finance a circular economy.

594 Bloomberg (2019), "Green Finance Is Now $31 Trillion and Growing." Available at: https://www.bloomberg.com/graphics/2019-green-finance/
595 KPMG (2020), *Circular revenue models.* Available at: https://assets.kpmg/content/dam/kpmg/nl/pdf/2020/services/circular-revenue-models_guideline-policymakers.pdf
596 KPMG (2020), *Circular revenue models.* Available at: https://assets.kpmg/content/dam/kpmg/nl/pdf/2020/services/circular-revenue-models_guideline-policymakers.pdf

Box 19. ***Innovative financing approaches to support the circular economy***

Supporting these circular economy opportunities will require a fundamental shift in financing – moving away from "business-as-usual" investment practices that focus on short-term returns and fail to price in related financial, social and environmental risk, into long-term investment solutions that provide innovative approaches to scaling promising business models. Several innovative financing solutions that could support investment in circular economy systems, including:[597]

1. **Supply chain models.** Contractual arrangements between supply chain actors to incentivise sustainability performance or lock-in offtake. An example is Walmart's Sustainability Index Program with HSBC, where global suppliers get improved financing rates tied to their sustainability performance.
2. **Green bonds.** Debt instruments issued by governments, development banks, companies to raise capital to finance new sustainability investment. Green bond issuance almost quadrupled from USD45 billion in 2015 to USD167.6 billion in 2018.[598] Key sub-categories include green project finance, green asset finance, and green technology leasing. As investment scales in this sector, concerns around "greenwashing" (falsely representing a project as being green grow) will need to be addressed through appropriate standards. Indonesia is already very experienced in this area. In March 2018, the Government of Indonesia through the Ministry of Finance (and with technical assistance from the UNDP), issued the very first sovereign green sukuk in US dollars.[599] The five-year issuance raised USD1.25 billion and the issuance was oversubscribed, signalling the growing market demand for sustainable and responsible investments.
3. **Sustainability-linked loans.** Unlike green bonds, sustainability-linked loans are not linked to specific projects. Borrowers simply get rewarded (or penalised) based on their performance on some environmental, social and governance (ESG) measures. One common metric used is carbon emissions. The market for sustainability-linked loans is growing rapidly. The first loan was made in 2017, and by 2019 issuance had reached USD122 billion.[600] Key concerns include the use of self-reported figures, the often opaque methodology for calculating ESG performance by specialist firms, and the potentially wide variations in scores depending on the methodology used.
4. **Blended finance.** This refers to the use of development capital (public or philanthropic) that mitigate particular investment risks (including offtake, access to capital, credit, technical, demand and currency risk) and help support investment. An example is the Africa Agriculture and Trade Investment Fund (AATIF) which has first-loss capital from the German Government (losses have to exceed 50 percent of the AATIF's net asset value before senior investors suffer any harm). Indonesia is already active in leveraging blended finance to support sustainable development. The Government of Indonesia worked with the OECD to launch the Tri Hita Karana (THK) Roadmap for Blended Finance in 2018 - a unifying international framework for mobilising additional commercial capital towards the SDGs.[601] In addition, Indonesia has recently launched its first blended financing platform — SDG Indonesia One — to support large-scale sustainable infrastructure projects through PT Sarana Multi Infrastruktur. The platform has already raised USD2.46 billion in commitments to date and is targeting to reach USD4 billion.[602] The Government of Indonesia has also worked in partnership with the UN Development Program, the National Alms Agency (Baznas) and Bank Jambi to utilise zakat funds (payments made annually under Islamic law on certain kinds of property and used for charitable and religious purposes) to provide access to electricity for over 4,000 villagers through micro-hydropower plants.[603]
5. **Impact investing.** This includes investments made in companies, organisations, and funds with the intention of generating a measurable, beneficial social or environmental impact alongside a financial return. There are currently over 1,340 organisations managing USD502 billion in impact investing assets worldwide.[604] One example is an AUD200 million SLM fund focused on regenerative farming systems in Australia. The UNDP has supported the Government of Indonesia in technical training on how to leverage the USD2.4 trillion global market for Islamic finance to support impact investing.[605]

597 Food and Land Use Coalition [FOLU] (2019), *Growing Better: Ten Critical Transitions to Transform Food and Land Use.* Available at: https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf
598 The Economist Intelligence Unit (2020), "Sustainably green: Creating a sustainable future for finance". Available at: https://eiuperspectives.economist.com/financial-services/sustainably-green-creating-sustainable-future-finance
599 UNDP (2018), "Indonesia's green sukuk: A leap towards financing for the Sustainable Development Goals". Available at: https://www.undp.org/content/undp/en/home/blog/2018/Indonesias-green-sukuk.html
600 The Economist (February 15, 2020), "Companies are tying their loans to measures of do-goodery". Available at: https://www.economist.com/finance-and-economics/2020/02/15/companies-are-tying-their-loans-to-measures-of-do-goodery
601 Aakif Merchant (2020), "Indonesia – A hub for blended finance in the Asia-Pacific". Available at: https://www.convergence.finance/news-and-events/news/2JxHe7gu4yCImhQa4REcRy/view
602 Febrian A. Ruddyard (2019), "Blended finance to help reach development goals in Indonesia". Available at: https://tenggara.id/insights/Blended-finance-to-help-reach-development-goals-in-Indonesia
603 Febrian A. Ruddyard (2019), "Blended finance to help reach development goals in Indonesia". Available at: https://tenggara.id/insights/Blended-finance-to-help-reach-development-goals-in-Indonesia
604 Global Impact Investing Network [GIIN] (2019), *Sizing the impact investing market.* Available at: https://thegiin.org/assets/Sizing%20the%20Impact%20Investing%20Market_webfile.pdf
605 UNDP (2019), "Blending Islamic Finance and Impact Investing to Achieve the SDGs". Available at: https://www.iicpsd.undp.org/content/istanbul/en/home/news-centre/2019/islamicfinance-impactinvesting.html

ENGAGING WITH MSMES WILL BE CRUCIAL FOR THE SUCCESS OF CIRCULAR ECONOMY IN INDONESIA

MSMEs play an important role in the Indonesian economy. In 2018, there were close to 64 million MSMEs in Indonesia, employing approximately 61 million people (representing roughly 90 percent of all employment generated by businesses in the country).[606] Most of the enterprises within MSMEs are micro or small. According to the BPS, micro and small enterprises accounted for close to 98 percent of all MSMEs in 2016.[607] MSMEs also contributed close to 60 percent to Indonesia's GDP in 2017.[608] Recognising the importance of MSMEs to the Indonesian economy, the Government of Indonesia has drafted a number of regulations in the last two decades to support MSMEs.[609] For example, it launched a public non-collateral credit guarantee scheme, well-known as Kredit Usaha Rakyat in 2007.[610] Despite these regulations, the contribution of MSMEs to Indonesia's GDP is disproportionately lower when compared to their contribution to employment generation. Apart from their inability to tap into the efficiency gains from a larger scale of production, limited access to capital, markets, and advanced technology are key factors responsible for their limited economic output.[611] Based on a survey conducted by the Government of Indonesia in 2015, 39 percent of MSMEs said that their main problem in running the business is access to capital; 25 percent said marketing; and 22 percent said access to raw materials.[612]

Despite these barriers, MSMEs could benefit from a circular economy. Cost savings from greater resources efficiency and waste reduction, and development of new business models, such as those focusing on recovery and recycling, could provide significant opportunities to MSMEs.[613]

MSMEs not only stand to gain from a circular economy but in fact, could be better placed than large enterprises to adopt circular economy practices. The smaller size of MSMEs gives them the in-built flexibility that could allow them to prosper in a circular environment. Businesses that succeed in a circular environment have the ability to work across the entire value chain and have business operations that are adaptable to a changing business environment. Large enterprises tend to focus on only one part of the supply chain and due to their size, often lack the flexibility to retool their production systems and supply chains to adapt to a shift in an economic environment. Since MSMEs are more likely to be closer to the end-consumer than large enterprises, they are better placed in adopting circular business models that require decentralised production systems, such as business models focused on reusing, recycling, or repurposing resources locally.[614]

Within MSMEs, there is significant variation in Indonesia. Most enterprises within MSMEs are micro or small. According to the BPS, micro and small enterprises accounted for close to 98 percent of all MSMEs in 2016.[615] The micro and small firms could lack the knowledge and capital to adopt circular opportunities. Hence, the Government would need to draft policies that are cognizant of the variation within the MSMEs. To support micro and small firms, the Government could consider helping such firms become members of supply chain partnerships that have shown to be effective in Europe.[616]

To support MSMEs in the circular transition, the Indonesian Government could take inspiration from international case studies. In the UK, the London Waste and Recycling Board (LWARB) created the Advance London programme to support local SMEs in exploring new circular economy markets, revenue streams, and business models. The programme included organising events to promote collaboration between SMEs and corporates and technical learning workshops on topics, such as access to finance, communications, and design thinking. The programme helped one in three SMEs engaged in the programme secure capital within 18 months of first receiving advice.[617] In the EU, the European Commission launched the Green Action Plan (GAP) for SMEs with the purpose of "enabling SMEs to turn environmental challenges into business opportunities." The GAP lists actions to be taken by the European Commission in order to "help SMEs exploit the business opportunities that the transition to a green economy offers." The actions are grouped in five broad themes (e.g., access to the market for green SMEs); each theme is translated into objectives (e.g., facilitate cross-sectoral collaboration in view of promoting the circular economy); and each objective comprises concrete actions (e.g., the establishment of an expert group to focus on a systemic approach to eco-innovation).[618] In Scotland, the Government created an £18 million fund,

606 Badan Pusat Statistik Republik Indonesia (2016), *Results of Establishment Listing Economic Census 2016*. Available at: https://se2016.bps.go.id/Lanjutan/files/buku/00_Indonesia.pdf
607 BPS (2016), *Result of establishment listing economic census 2016*. Available at: https://se2016.bps.go.id/Lanjutan/files/buku/00_Indonesia.pdf
608 Tulus Tambunan (2019), *Recent evidence of the development of micro, small and medium enterprises in Indonesia*. Available at: https://link.springer.com/article/10.1186/s40497-018-0140-4
609 Tulus Tambunan (2019), *Recent evidence of the development of micro, small and medium enterprises in Indonesia*. Available at: https://link.springer.com/article/10.1186/s40497-018-0140-4
610 Tulus Tambunan (2018). *MSMEs and access to financing in a developing economy: The Indonesian experience*. Available at: https://pdfs.semanticscholar.org/06c8/23507198f733cdb8679e9d160882e85131aa.pdf
611 Tulus Tambunan (2019), *Recent evidence of the development of micro, small and medium enterprises in Indonesia*. Available at: https://link.springer.com/article/10.1186/s40497-018-0140-4
612 Badan Pusat Statistik Republik Indonesia (2015), *Profil Industri Mikro dan Kecil Tahun 2015 (Profile of micro and small enterprises)*. Available at: https://www.bps.go.id/publication/2015/12/03/24f9aa750909904e193d26aa/profil-
613 TNP2K (2020), The Mechanism of Micro, Small, and Medium Enterprise's Data Integration in Indonesia for Targeting Social Assistance and Empowerment Programs. Available at: http://tnp2k.go.id/download/43209The%20Mechanism%20of%20Micro,%20Small,%20and%20Medium%20Enterprise's%20Data%20Integration%20in%20Indonesia%20for%20Targeting%20Social%20Assistance%20and%20Empowerment%20Programs.pdf; Badan Pusat Statistik Republik Indonesia (2016), Results of Establishment Listing Economic Census 2016. Available at: https://se2016.bps.go.id/Lanjutan/files/buku/00_Indonesia.pdf
614 Oliver Wyman (2017), *Supporting the circular economy transition*. Available at: https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2017/sep/CircularEconomy_print.pdf
615 BPS (2016), *Result of establishment listing economic census 2016*. Available at: https://se2016.bps.go.id/Lanjutan/files/buku/00_Indonesia.pdf
616 Rizos et al (2016), *Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers*. Available at: https://www.mdpi.com/2071-1050/8/11/1212
617 Ellen MacArthur Foundation (2019), *Advance London Circular Economy SME Business Support Programme*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/London_-Case-Study_Mar19.pdf
618 Vasileios Rizos et al (2015), *The Circular Economy: Barriers and Opportunities for SMEs*. Available at: https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/GreenEconet_CEPS_SMEs_Circular_Economy.pdf

Circular Economy Investment Fund, administered by Zero Waste Scotland that exclusively supports circular SMEs.[619]

Efforts to promote sustainable business models among MSMEs have also emerged in developing economies. In India, the Government has committed to providing financial support to MSMEs with the Zero Defect Zero Effect (ZED) rating across all manufacturing and service sector industries. The ZED rating promotions production mechanisms whereby products have no defects, as well as production processes have zero adverse environmental and ecological effects.[620] In Vietnam, the Global Green Growth Institute, in 2018, created a handbook on green growth priorities for SMEs. Based on the handbook, local and foreign-owned SMEs are entitled to low-interest loans for their "green" projects in various industries. For example, SMEs in the "water supply, solid waste, and wastewater treatment" sectors are entitled to "green" loans.[621]

A CIRCULAR ECONOMY COULD HELP REDUCE GENDER DISPARITY IN INDONESIA BUT WILL REQUIRE TARGETED POLICY INTERVENTIONS

A circular economy could help minimise the environmental damage created by a linear economy that disproportionally affects women. According to the OECD, poor labour conditions facing the female workforce and greater involuntary exposure to harmful products and chemicals among women are examples of reasons why women are environmentally disadvantaged in a linear economy.[622] Even plastic pollution has a disproportionate impact on women. Women are more exposed to the negative effects of plastic pollution, such as through direct exposure to emissions from waste burning or dumping. Safe exposure levels to chemicals are often lower in women since they have a higher proportion of body fat, which provides a greater reservoir for materials that can accumulate in the body.[623] Moreover, female workers in the informal sector waste system are often exposed to health and safety risks and face workplace violence and discrimination.[624] Health risks in the waste management sector are exacerbated by gender inequality, as the equipment is typically designed for men.[625]

Women also tend to be more impacted than men on average as they tend to shoulder a large burden of household responsibilities, which can be affected by environmental damage. The effects of environmental damage can also undermine women's capacity to provide food and clean water for their families and subsequently, leading to an increase in their domestic workload. For example, they may have to walk greater distances to access water, fuel/wood, or forest products. Environmental pollution from waste from palm oil operations in waterways may make it difficult to source fish.[626] In Riau, Indonesia, women were protesting in 2017 against the environmental damage caused by a nearby oil plantation since they are usually responsible for domestic duties, such as procuring clean water and hence, were at the receiving end of the dust pollution caused by the plantation.[627] Evidence from East Kalimantan has shown that industrial palm oil plantations can curtail the livelihood options and reinforce gender differentiation in terms of access to resources for women in residential communities near such plantations.[628]

While a circular economy could minimise some of the environmental effects described above, it could also create significant economic opportunities for Indonesia's women that empower them. For example, assuming that the share of female workers in each sector remains unchanged till 2030, the adoption of a circular economy could create 3.3 million cumulative net jobs for women in Indonesia between 2019 and 2030 (Exhibit 18). Based on the analysis, 75 percent of the total net jobs created by a circular economy in 2030 could be for women.

A circular economy can generate economic opportunities for women, in particular, in recycling and waste management, while minimising risks associated with waste picking and manual recycling. Evidence from Indonesia has shown how female employment in waste management enables the creation of circular products and upgrades their socio-economic position.[629] Women in developing countries more often work in jobs with low pay, low security, and limited social mobility. According to the ILO, the rise of "green jobs" could offer an opportunity to empower women.[630] This could be especially

619 Oliver Wyman (2017), *Supporting the circular economy transition*. Available at: https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2017/sep/CircularEconomy_print.pdf
620 Teri & Yes Bank (2018), *Circular Economy: A Business Imperative for India*. Available at: http://wsds.teriin.org/2018/files/teri-yesbank-circular-economy-report.pdf
621 Vietnam Investment Review (2017), *Green financing for small businesses*. Available at: https://www.vir.com.vn/green-financing-for-small-businesses-55036.html
622 OCED (2020), *Gender-specific consumption patterns, behavioural insights, and circular economy*. Available at: http://www.oecd.org/env/GFE-Gender-Issues-Note-Session-5.pdf
623 Julvez and Grandjean (2009), *Neurodevelopmental toxicity risks due to occupational exposure to industrial chemicals during pregnancy*. Available at: https://pubmed.ncbi.nlm.nih.gov/19834254/
624 WIEGO (2018), *Violence and Informal Work*. Available at: https://www.wiego.org/sites/default/files/publications/files/ILC_WIEGO_Briefing%20Note%20Violence%20in%20the%20workplace%20EN%20for%20web.pdf
625 Ziraba et al (2016), *A review and framework for understanding the potential impact of poor solid waste management on health in developing countries*. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5184495/
626 Asia Foundation (2015), *Achieving gender justice in Indonesia's forest and land governance sector*. Available at: https://asiafoundation.org/resources/pdfs/IDGenderJusticeForestry.pdf
627 WRI (2017), "In Riau, Indonesia, Women Organize for Environmental Justice." Available at: https://www.wri.org/blog/2017/09/riau-indonesia-women-organize-environmental-justice
628 Toumbourou and Dressler (2020), *Sustaining livelihoods in a palm oil enclave: Differentiated gendered responses in East Kalimantan, Indonesia*. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/apv.12265
629 Rokis and Silaturrahmi (2018), *Empowering Women in Waste Management Work Setting Through Community Recycling-Upcycling Project: Cases of Malaysia and Indonesia*. Available at: http://irep.iium.edu.my/65337/
630 ILO (2015), *Gender equality and green jobs*. Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_360572.pdf

relevant for the textiles sector in Indonesia, where women account for 58 percent of the jobs.[631]

Taking a proactive women-centric approach in policy development related to the circular economy is important for two reasons. First, women could enable greater adoption of circular economy opportunities. Surveys have shown that women tend to be more sustainable consumers and are more sensitive to ecological, environmental, and health concerns.[632] Women are more likely to recycle and minimise wastage. In one Indonesian survey, more women identified themselves as "binners" (proper disposers) of waste while more men identified themselves as "litterers".[633] Women also place a higher value on energy-efficient transport and in general are more likely to use public transport than men.[634] Hence, women can be important enablers of circular economy in Indonesia.

One lever to enable this change could be to facilitate the creation of more women-led circular economy businesses. There are several such women-led companies in the textile sector in Indonesia. Examples include Threadapeutic, SukkhaCitta, and Tri Upcycle (Box 20). Enabling more women-led companies would require appropriate targeting measures. According to the World Bank, programs targeting women entrepreneurs in Indonesia in the past have yielded sub-optimal results because of their inability to target the right firms.[635] The World Bank suggests targeting "growth-oriented" entrepreneurs in Indonesia. Amongst 20 to 30 million women entrepreneurs, 15 percent can be classified as "growth-oriented" entrepreneurs, who are likely to expand their businesses, and as they do, to hire female employees. Some of the World Bank's recommendations to target these entrepreneurs include tailoring credit products, helping financial institutions enter the lending market for women, and stimulating women's insurance market.

The second reason why a proactive women-centric approach is needed in policy development in this area is that a circular economy could be used as an opportunity to reduce gender disparity in Indonesia's society. Beyond environmental damage, the impacts of land-based and extractive industry expansion on other aspects can also be more pronounced on women. For example, the payment of compensation to men for land displacement denies women access to and control over the financial benefits of development, increasing the gender divide in household bargaining power.[636] Moreover, since women are traditionally responsible for meeting the subsistence needs of families, and can no longer do so due to loss of land, they can be forced to become economically reliant on men. Research from West Kalimantan highlighted how women are excluded from participation during negotiations and contestations around land acquisition for the development of oil palm plantations, which often leads to outcomes that disempower women.[637]

Women-focused economic opportunities in a circular economy could increase the bargaining power of women, which could lead to better social outcomes. Evidence from international research shows that if female bargaining power in households increases, households tend to make better decisions on budgets. Hence, whether the household savings created from the circular economy in this report lead to better welfare outcomes depend on the extent to which the share of female bargaining power could be increased in Indonesian households.

631 ILO (2017), *Indonesia garment and footwear bulletin*. Available at: https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-jakarta/documents/publication/wcms_625195.pdf
632 Khan and Trivedi (2015), *Gender differences and sustainable consumption behavior*. Available at: http://www.eajournals.org/wp-content/uploads/Gender-Differences-and-Sustainable-Consumption-Behavior.pdf
633 Ocean Conservancy (2019), *The Role of Gender in Waste Management*. Available at: https://oceanconservancy.org/wp-content/uploads/2019/06/The-Role-of-Gender-in-Waste-Management.pdf
634 OCED (2020), *Gender-specific consumption patterns, behavioural insights, and circular economy*. Available at: http://www.oecd.org/env/GFE-Gender-Issues-Note-Session-5.pdf
635 World Bank (2016), *Women entrepreneurs in Indonesia*. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/24751/Women0entrepre0ng0shared0prosperity.pdf?sequence=1&isAllowed=y
636 Asia Foundation (2015), *Achieving gender justice in Indonesia's forest and land governance sector*. Available at: https://asiafoundation.org/resources/pdfs/IDGenderJusticeForestry.pdf
637 Vos and Delabre (2018), *Spaces for participation and resistance: gendered experiences of oil palm plantation development*. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0016718518302434

Box 20. ***Case study of SukkhaCitta***

Founded by Denica Flesch, SukkhaCitta is a circular economy-focused social enterprise in the textiles sector in Indonesia. It sells fashion products for both men and women, which include dresses, pants, and masks. It creates its dyes from food or industrial waste. For example, to create a coating for the red tannin in its fabric, it uses waste banana trees. Its packaging is plastic-free, upcycled using its own scraps or training fabrics. Each packaging is hand-knotted with waste threads from the company's own handwoven fabrics.

SukkhaCitta directly works with rural women craftswomen in the villages instead of relying on a factory for two reasons. First, it recognises the challenges for women to work outside their homes. According to the founder, up to 60 percent of handcrafted pieces made by women are typically made at their homes since they cannot leave their villages because of domestic duties.[638] For example, its plastic-free packaging is made by women in Medono village in West Java. Second, it aims to shorten the supply chain. Between the end consumer and the artisans, there generally is a complex subcontracting layer of factories and middlemen, which erodes the incomes of the female artisans. Hence, SukkhaCitta creates social impact by investing in the training and capacity building of rural craftswomen for at least one year and ensuring that the women earn a living wage.

THERE ARE SEVERAL ONGOING CIRCULAR ECONOMY INITIATIVES IN INDONESIA

Several initiatives in Indonesia are already promoting the adoption of circularity in the country. For example, civil society-led initiatives to raise awareness about waste management in Indonesia; private sector-led initiatives that demonstrate that circular models present economically feasible opportunities; and multilateral and government organisations that provide capital to facilitate the adoption of a circular economy. For example, Waste4Change, an Indonesian NGO, has organised many events to highlight the consequences of textile waste.[639] There are also ongoing multi-stakeholder efforts on reducing waste in the five focus efforts. For instance, the Indonesia Post-Harvest Loss Alliance for Nutrition is a consortium of various stakeholders, including the Global Alliance for Improved Nutrition (GAIN), is undertaking feasibility studies in food losses in the fisheries sector in Indonesia.[640] To reduce post-harvest fish losses, GAIN has also rolled out its I-PLAN program, where it would assist SMEs and award cash prizes to innovators.[641]

Leading consumer goods companies, like Unilever, Nestle, Indofood, Coca-Cola, Danone, and Tetra Pak have formed PRAISE, an organisation that aims to accelerate the adoption of circular economy among the private sector in Indonesia. Ongoing efforts are also encouraging entrepreneurs to build circular businesses. The Incubation Network launched a Circular Innovation Jam in South and Southeast Asian countries, including Indonesia, inviting participants to present ideas that could improve waste management and recycling in the region, whereby winners stand to gain USD5000 in financial and technical support to scale their ideas.[642] Countries that have demonstrated the adoption of the circular economy are also providing technical and financial support to Indonesia. Denmark, Netherlands, and Norway have helped organise events to raise the understanding of circularity in Indonesia.[643]

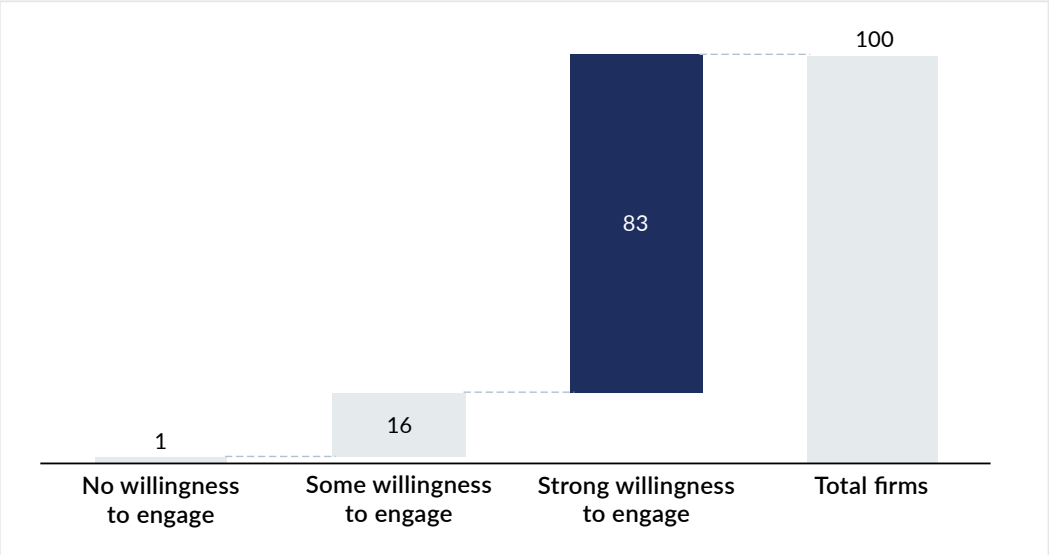
Due to these effects, the Indonesian private sector has become more aware of the circular economy and is showing its commitment to adopt circular business models. A survey of 57 Indonesian firms conducted as part of this research highlighted that the vast majority (almost 80 percent) have a strong willingness to engage in the development of a national circular economy strategy (Exhibit 74).

638 Darling Magazine (2019), "Denica Flesch Is Bringing Back Pride to Local Artisans With SukkhaCitta." Available at: https://darlingmagazine.org/denica-flesch-is-bringing-back-pride-to-local-artisans-with-sukkhacitta/
639 Waste4Change, "Waste4Change on Jakarta Fashion Week 2019 (October 20-26th, 2018) – a Less Waste Event". Available at: https://waste4change.com/waste4change-on-jakarta-fashion-week-2019-october-20-26th-2018-a-less-waste-event/
640 GAIN, "Reducing Postharvest Loss." Available at: https://www.gainhealth.org/impact/programmes/reducing-postharvest-loss
641 The Jakarta Post (2020), "Tackling food loss, waste could benefit Indonesia on many fronts: Experts." Available at: https://www.thejakartapost.com/news/2020/09/29/tackling-food-loss-waste-could-benefit-indonesia-on-many-fronts-experts.html
642 Circular Innovation Jam (2020), "Circular Innovation Jam 2020." Available at: https://tin.agorize.com/en
643 JakartaGlobe (2020), "Indonesia Launches Circular Economy Initiative With Denmark, UNDP." Available at: https://jakartaglobe.id/business/indonesia-launches-circular-economy-initiative-with-denmark-undp/; ICEL (2019), "ICEL, IDLO, KLHK and the Dutch Embassy in Indonesia held a Circular Economy Seminar." Available at: https://icel.or.id/en/news/activities/icel-idlo-klhk-and-the-dutch-embassy-in-indonesia-held-a-circular-economy-seminar/; Jakarta Globe (2018), "Indonesia Begins Efforts to Curb Marine Waste." Available at: https://jakartaglobe.id/news/indonesia-begins-efforts-curb-marine-waste/

Exhibit 74

A majority of sampled firms in Indonesia are interested in understanding more about circularity

Q. What is your company's willingness to engage during the development of this national circular economy strategy? % of firms



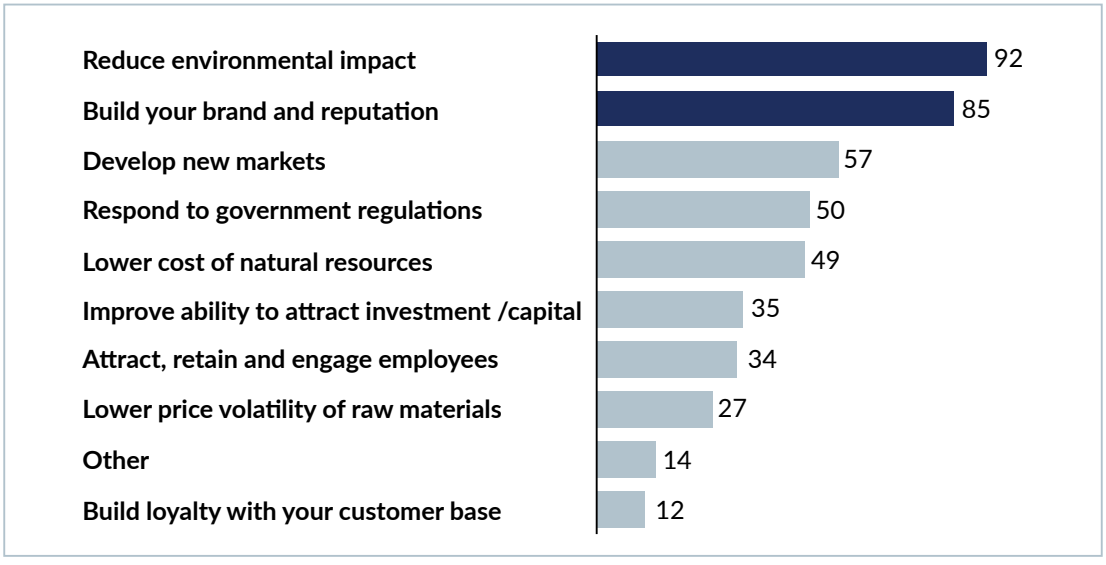
SOURCE: Online survey of firms in Indonesia carried out in February and June 2020 (sample size = 57)

There appear to be multiple drivers of this. However, the desire to reduce the environmental impact of one's activities seems nearly universal, as is the interest in improving one's brand and reputation (Exhibit 75).

Exhibit 75

Sampled firms are most motivated by reducing environmental impact and building their brand and reputation in adopting circular actions

Q. What is the main motivation for you in implementing circular economy opportunities? *(tick all that apply)* **% of firms**



SOURCE: Online survey of firms in Indonesia carried out in February and June 2020 (sample size = 57)

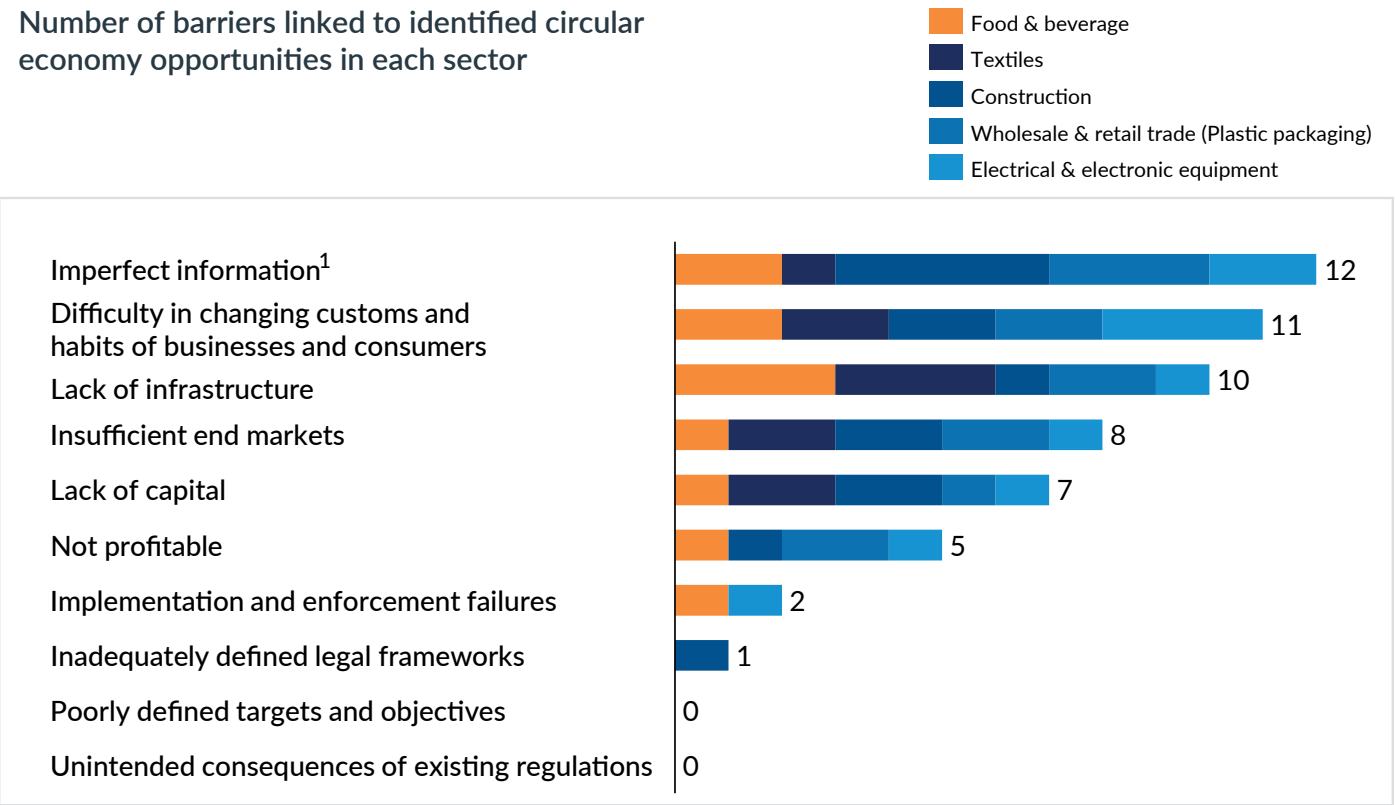
A NUMBER OF BARRIERS IMPACTING CURRENT CIRCULARITY EFFORTS MUST ALSO BE ADDRESSED

Based on discussions with representatives of private-sector firms and sector experts in Indonesia, several barriers against circular economy adoption were identified (Exhibit 76). The top three barriers identified across the five sectors were: "Imperfect information"; "Difficulty in changing customs and habits of businesses and consumers", and "Lack of infrastructure". These are discussed in greater detail in chapters 3-7 above. For example, the practice of "gifting" and storing excessive food in refrigerators among upper-class Indonesians is considered a significant barrier in reducing food waste at the consumer stage.[644] Policy interventions that could overcome these barriers are also noted in the individual chapters. For example, to change consumer and businesses behaviour toward food loss and waste, the Government could collaborate with the private sector and civil society organisations to create information campaigns that highlight the economic, social, and environmental impact of food loss and waste. However, to create systemic change, the Government of Indonesia would need to create a circular economy roadmap. In formulating the roadmap, the Government could consider creating a multi-stakeholder governance structure (Box 21).

Exhibit 76

Based on discussions with private sectors firms and sector experts, several barriers against circular economy adoption were identified

Number of barriers linked to identified circular economy opportunities in each sector



1. Imperfect information refers to both lack of information and asymmetry of information

SOURCE: Team analysis based on surveys and sector-specific discussions

644 Tammara Soma (2018), *Planning from "Table to Dump": Analyzing the Practice of Household Food Consumption and Food Waste in Urban Indonesia*. Available at: https://tspace.library.utoronto.ca/bitstream/1807/95706/1/Soma_Tammara_R_201806_PhD_thesis.pdf

Box 21. ***Governance structures to develop a multi-stakeholder approach***

Transitioning to a circular economy requires the public and private sector to act hand in hand. The Government could provide the enabling framework, and the private sector could be the engine driving the circular economy forward. Consequently, the project of establishing a national circular economy strategy requires commitment and active participation by the Government, academia, the private sector, and the civil society.[645]

There are some valuable examples from other countries that could inform Indonesia's future approach. For example, the Ellen MacArthur Foundation worked extensively with the Danish Business Authority and the Danish Environmental Protection Agency to develop a toolkit for policymakers in transitioning toward a circular economy. The OECD also identified several policy recommendations to implement a circular economy in Umeå, Sweden, with a strong focus on effectively engaging with stakeholders.[646] Some lessons emerge from these case studies:

- **Crucial to have representation across the full value chain and with different sizes of firms**. One of the key aspects of success is representation across the full value chain of priority sectors and the inclusion of MSMEs. For example, the Thailand PPP Plastics includes representatives from production through to retail. It also includes civil society and international organizations: Thailand Environment Institute Foundation, Thai Creation Society, and the International Union for Conservation of Nature (IUCN). The Government of Indonesia could similarly consider creating working groups comprising business associations, civil society representatives, and academics to develop a roadmap for the circular economy.
- **Close engagement with the relevant government ministries**. It is crucially important that the Government is actively engaged in the partnership, rather than just being periodically consulted, and that there is representation from a variety of the key sectors impacting a circular economy. Government of Indonesia could implement approaches that it has previously deployed for other multi-stakeholder efforts. For example, the expert panel for the National Plastic Action Partnership (NPAP), which aims to achieve a 70 percent reduction in Indonesia's marine plastic debris by 2025, included representatives from key ministries (Coordinating Ministry of Maritime Affairs and Investment, the Ministry of Environment and Forestry, and the Ministry of Public Works).[647]
- **Create taskforces to remove regulatory barriers**. To accelerate circular economy adoption, many governments have set up taskforces to remove regulatory barriers and initiate a change in the policy environment. For example, Denmark created the Taskforce on Resource Efficiency, with the objective of identifying barriers to circular economy practices in existing regulations and proposing options to overcome them.

USING THIS REPORT DURING THE CIRCULAR ECONOMY JOURNEY OF INDONESIA

This report is part of the first phase of this project that aims to develop a National Circular Economy Roadmap for Indonesia. The analysis in this report could play a key role in Indonesia's circular economy journey, which could have a significant impact on Indonesia's economy and the environment in the future. Adoption of a circular economy could also allow Indonesia to demonstrate leadership in Southeast Asia. Indonesia could be the first country in the Southeast Asia region to have a National Circular Economy Roadmap. The process Indonesia undertakes while designing, implementing, monitoring, and evaluating its circular economy would provide many useful case studies not only for the country itself but also for Southeast Asia as a whole, and potentially shape the design of a proposed ASEAN roadmap on sustainable resources management.[648]

The Government, the private sector, and the civil society could use this analysis to build an understanding of a circular

645 Ellen MacArthur Foundation (2017), *Delivering the circular economy: a toolkit for policymakers*. Available at: https://www.ellenmacarthurfoundation.org/resources/apply/toolkit-for-policymakers
646 OECD (2020), *The Circular Economy in Umeå, Sweden*. Available at: https://www.oecd-ilibrary.org/sites/99bf4f5e-en/index.html?itemId=/content/component/99bf4f5e-en
647 World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan; National Plastic Action Partnership*. Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf
648 UNESCAP and ASEAN Secretariat (2018), *Complementarities between the ASEAN Community Vision 2025 and the United Nak 2030 Agenda for Sustainable Development: A Framework for Acton*. Available at: https://asean.org/storage/2017/11/FINAL_Complementarities-Report-no-graphic-on-cover.pdf

economy and its potential benefits among Indonesians. The report could encourage the Government to initiate behaviour change among consumers, to encourage businesses to adopt circular economy practices, and draft regulations that facilitate this adoption. Private sector leaders could use it to make a case to their senior management to adopt circular economy-focused business models. Civil society could use it to encourage the Government to initiate policy changes that support the circular economy and the private sector to expedite their adoption of circular economy practices. The economic, social, and environmental impacts estimated in the report show the potential of a circular economy in Indonesia. Realising this potential, however, will depend upon effective collaboration between all stakeholders of Indonesian society in the upcoming phases of this project. The COVID-19 pandemic has underlined the importance of improving resource security, prioritising environment conservation, and improving socio-economic equity in Indonesia. The pandemic could be an opportunity for Indonesia to accelerate its transformation toward a circular economy and help build a more resilient economy, society, and environment.

Annex

This Annex includes an overview of the methodology used in this report. It contains three sections:

1. *Analysis using a system dynamics approach*
2. *Impact of COVID-19 on estimates in the report*
3. *Methodology for selecting priority sectors for analysis*
4. *Methodology for sizing the environmental impact in each sector*
5. *Methodology for sizing the socio-economic impact*

Annex 1: Analysis using a system dynamics approach

A. Introduction

System dynamics is a method which has been developed to implement a systems thinking paradigm. Systems thinking is a discipline for seeing an object as a system or the structures that underline a complex situation.[649] Application of system dynamics aims to learn and understand the complex system, based on theories of non-linear dynamics and feedback control.[650] The object of system dynamics is a closed-loop system or feedback loop system,[651] where the main components of the systems have interconnections and construct feedback loops.

System dynamics is a systems approach to policy analysis and design, which can be applied to problems arising in social, managerial, economic, or ecological systems.[652] This approach begins by defining problems and then proceeds by mapping and modelling the different stages of the system, which are often dynamic and interconnected. System dynamics approach differs from linear modelling processes since it considers the (often lagged) feedback loops that arise in complex systems.[653]

A system dynamics modelling approach has been and is being applied in several economic and environmental contexts. In Indonesia, it was used to develop a low carbon development plan.[654] In Cambodia, it was used to understand the economic, social, and environmental impacts of greening the industrial sector.[655] In Europe, it is being used to understand the territorial consequences of a circular economy.[656] In China, researchers demonstrated its use to plan for a circular economy in Sichuan Province.[657] The system dynamics approach was also deployed in the Circular Economy study to complement the analysis carried out by the Input-Output and the Incremental Capital Output Ratio approaches.

649 Senge (1990), *The Fifth Discipline: The Art and Practice of the Learning Organization.*
650 Sterman (2004), *Business Dynamics: System Thinking and Modelling for A Complex World.*
651 Forrester (1971), *Principles of Systems.* Pegasus Communication.
652 System Dynamics Society. "Introduction to system dynamics." Available at: https://www.systemdynamics.org/what-is-sd
653 Francesca Ricciardi et al (2020), *System dynamics modeling as a circular process: The smart commons approach to impact management.* Available at: https://www.sciencedirect.com/science/article/pii/S0040162519310923
654 Bappenas (2019), *Low Carbon Development: A Green Economy in Indonesia.* Available at: https://www.greengrowthknowledge.org/national-documents/low-carbon-development-report-paradigm-shift-towards-green-economy-indonesia
655 Global Green Growth Institute (2018), *The Economic, Social and Environmental Impacts of Greening the Industrial Sector.* Available at: http://gggi.org/site/assets/uploads/2018/10/GGGI_Greening-the-Industrial-Sector-in-Cambodia_FULL-REPORT.pdf
656 ESPON, "CIRCTER - Circular Economy and Territorial Consequences." Available at: https://www.espon.eu/circular-economy
657 Jiuping Xu et al (2010), *Optimizing Circular Economy Planning and Risk Analysis Using System Dynamics.* Available at: https://www.tandfonline.com/doi/abs/10.1080/10807030902761361?scroll=top&needAccess=true&journalCode=bher20

B. Study scope

The system dynamics analysis not only varies with the Input-Output (IO) approach used in the report in terms of methodology but also in terms of the scope of the analysis. The system dynamic analysis looked at the impact of a circular economy on only the five focus sectors. For the purpose of this report, it did not look at the impact on other economic sectors. For instance, scenario 1 (described below) assumed a reduction in household consumption leading to a decrease in waste generation, which could increase household savings. The analysis did not consider how these savings might be invested and the economic impact they could generate. This approach differs from that of the IO methodology, which estimates where could businesses and households invest their savings generated by a circular economy and the economic impact the investments could create. The system dynamics approach is useful however to complement the main economic analysis shown in the report as it can help us better understand the direct economic impacts on the five focus sectors, which is important given that adoption of a circular economy could create significant overall benefits to the economy, but certain sectors may not necessarily benefit if it leads to reduced demand for their products.

All estimates in this section are in 2010 constant prices.

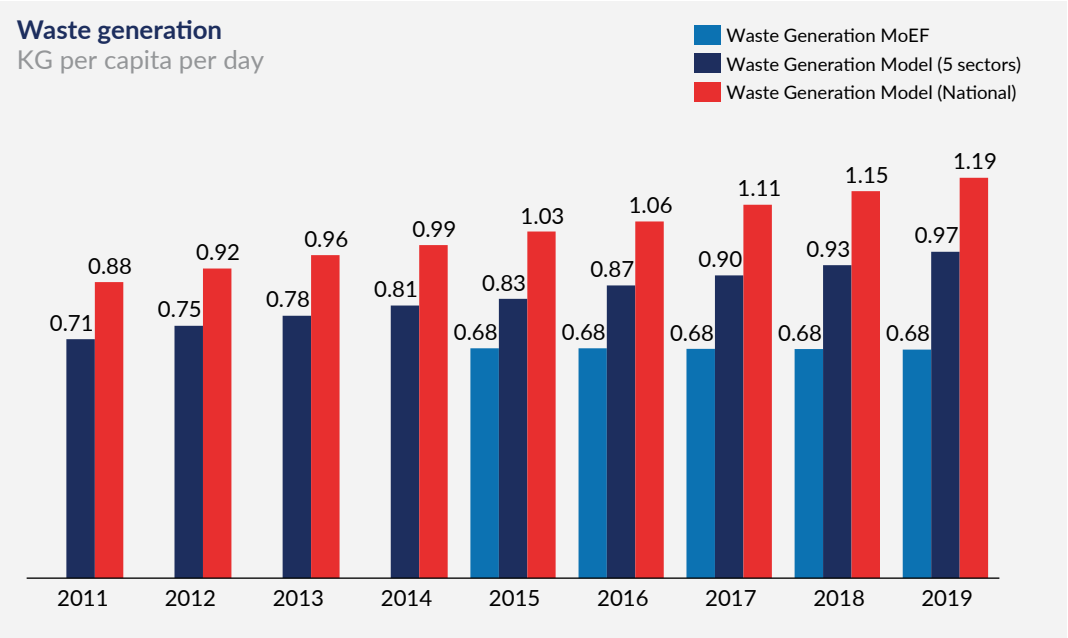
C. Waste Generation in the Economic System

Total waste generated by society is determined by its population and the economy. Besides population, waste generation in Indonesia is also affected by the level of income. According to the World Bank, the amount of waste produced in low-middle income countries is approximately 0.53 tonnes per capita, while the average production of upper-middle-income countries is at 0.69 tonnes per capita. In 2020, Indonesia became an upper-middle-income country, while in previous years Indonesia was categorised as a low-middle income country.

According to the JAKSTRANAS document published by the Ministry of Environment and Forestry (MoEF), the amount of total waste generated in 2019 was 67.1 million tonnes nationwide. This number was estimated using the assumption that the average waste generation of an Indonesian resident is 0.68 kilogram/day per capita, excluding electrical and industrial waste. In this model, as previously estimated in the IO and ICOR models, the total waste generation of the five focus sectors was estimated at 95.9 tonnes in 2019 or 0.97 kilogram/day per capita including electrical and industrial waste. Hence, the total waste generation nationwide was estimated to be 1.19 kilogram/day per capita or 117.6 million tonnes (Exhibit A2).

Exhibit A1

Waste generation estimates using system dynamics were compared with those published by the Ministry of Environment and Forestry



SOURCE: Team Analysis; Ministry of Environment and Forestry

The scope of waste in this model includes various types of household waste and related household waste. The analysis prioritised waste from five sectors, namely waste from the food & beverage, textile, construction, wholesale and retail trade, electrical and electronic equipment sectors. Waste volume from the five sectors totalled 95.9 million tonnes in 2019 based on the results of a preliminary study. This model does not include paper and other kinds of waste, which account for 19 percent of the total waste as classified by MoEF. Hence, the total national waste based on this model in 2019 was 117.6 million tonnes (Exhibit A2).

Exhibit A2

Scope of waste for system dynamics analysis

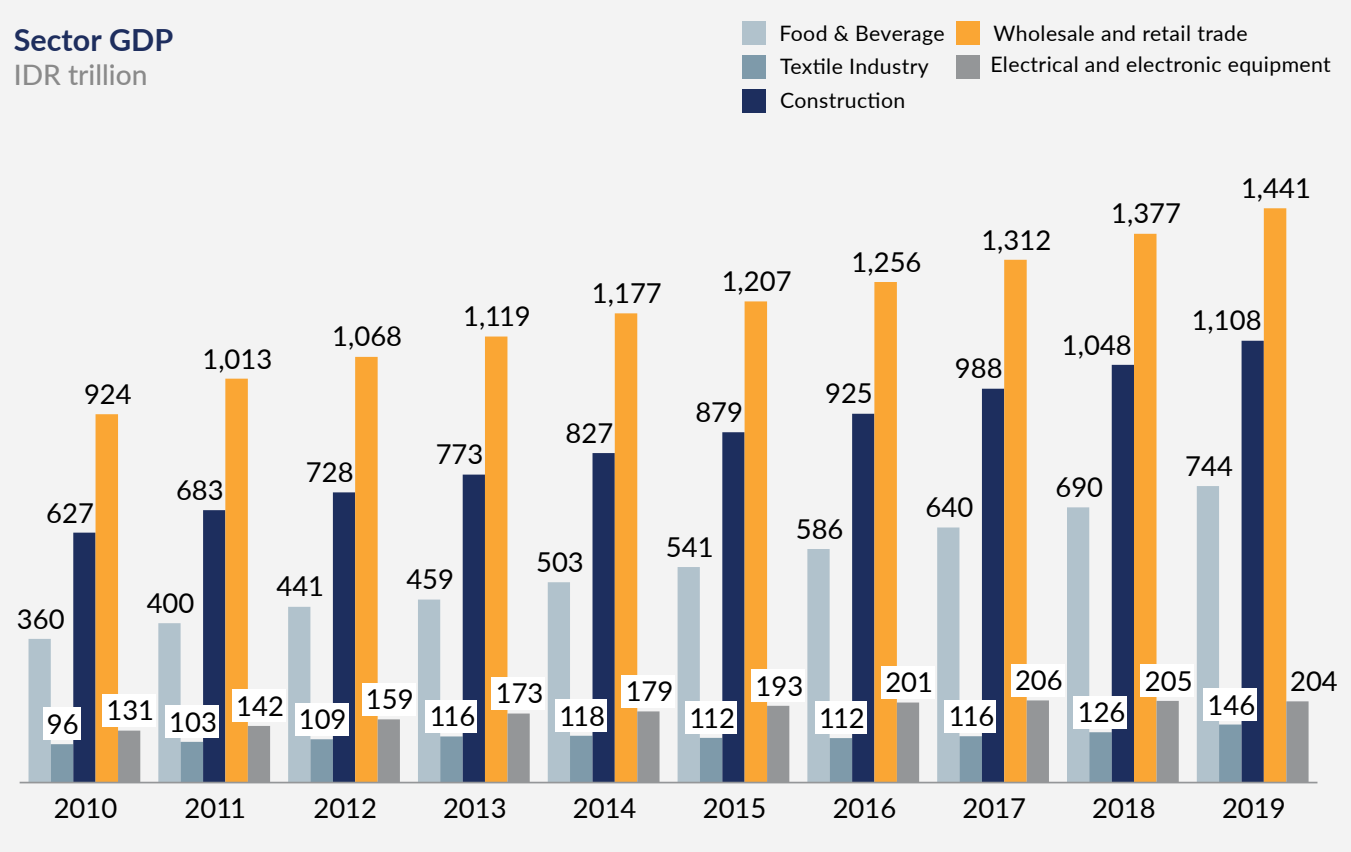
No.	Economic Sector	Waste Composition (Model)	Waste Model 2019 (million tonnes)	Type of Waste (MoEF)	Waste Composition (MoEF)	Waste MoEF 2019 (million tonnes)
1	Food & Beverage	49%	57.4	Food & Beverage	44%	29.5
2	Textile	2%	2.3	Textile	3%	2.0
3	Construction	25%	29.0	Wood	13%	8.7
				Metal	2%	1.3
				Rubber/Leather	2%	1.3
				Glass	2%	1.3
4	Wholesale and Retail Trade	5%	5.4	Plastic	15%	10.1
		-	-	Paper	11%	7.4
5	Electrical & electronic equipment	1%	1.8	-	-	-
6	Others	18%	21.7	Others	8%	5.4
Total		**100%**	**117.6**	**Total**	**100%**	**67.1**
Total 5 Sectors		**82%**	**95.9**			

SOURCE: Team Analysis; Ministry of Environment and Forestry

The GDP of the five key sectors (food & beverage, textile, construction, wholesale and retail trade and electrical and electronic equipment) shows an increasing trend (Exhibit A3), which has been accompanied by a rising volume of waste (Exhibit A4). In 2011, national GDP based on 2010 constant prices was at IDR6,864 trillion (USD755 billion), and it increased to IDR10,425 trillion (USD1.15 trillion) in 2019. Wholesale & retail trade sector had the highest GDP during the 2011-2019 period, followed by the construction sector.

Exhibit A3

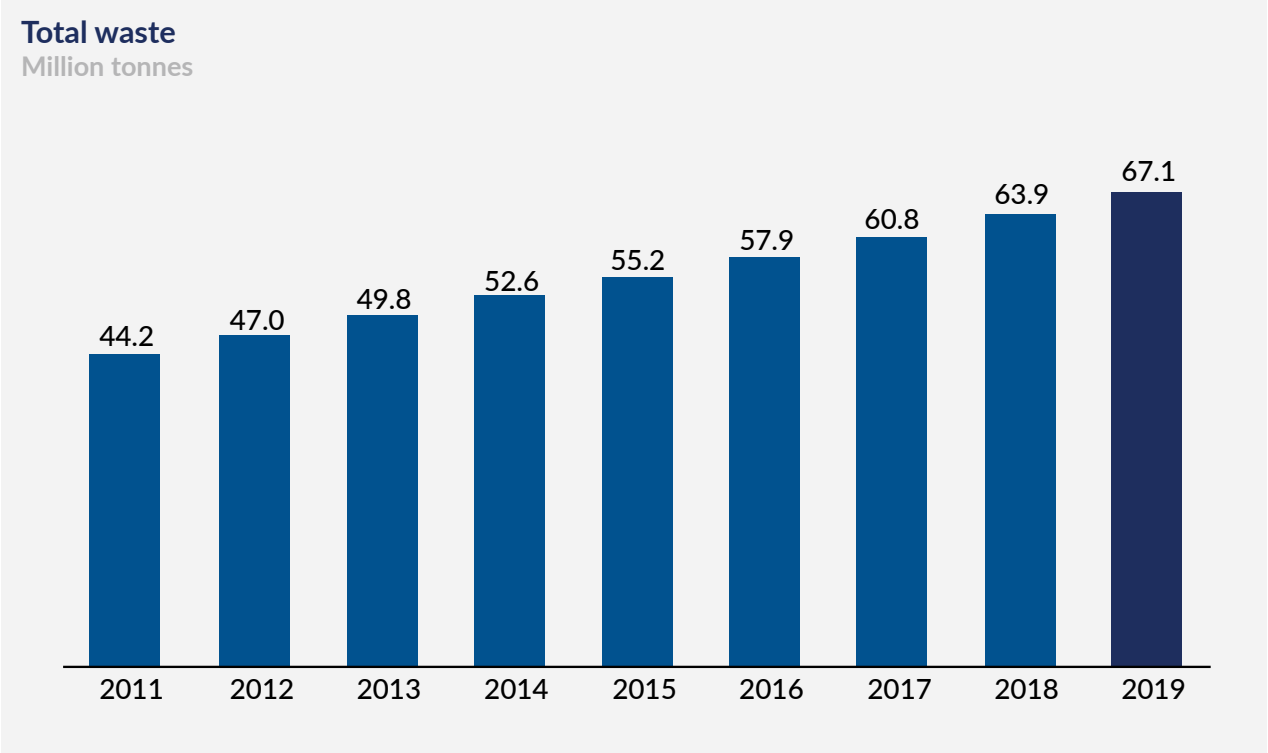
Historical sectoral GDPs were estimated for the five focus sectors



SOURCE: Team Analysis; BPS

Exhibit A4

According to the Ministry of Environment and Forestry, 67.1 million tonnes of waste was generated in 2019

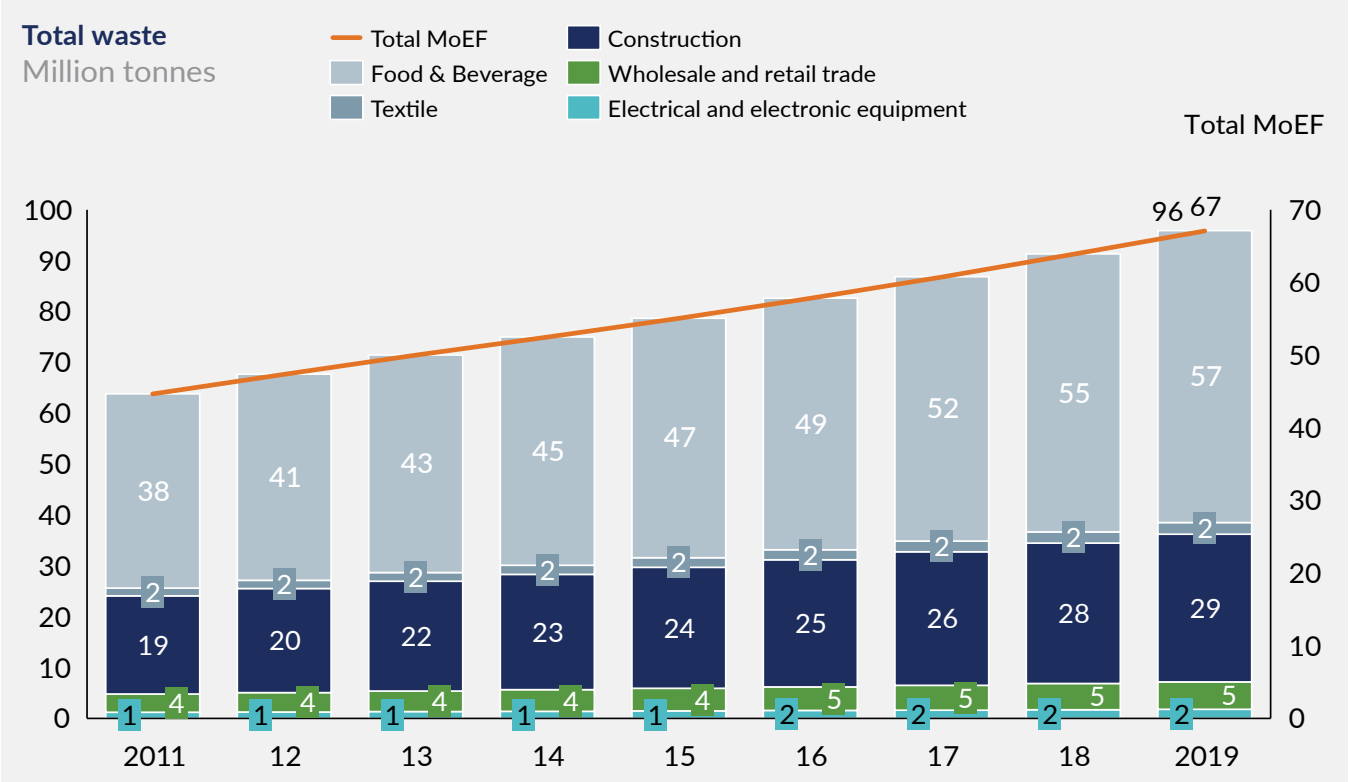


SOURCE: Team Analysis; Ministry of Environment and Forestry

This model estimated the total waste in 2019 to be 96 million tonnes (Exhibit A4) based on national waste data (67 million tonnes) and the additional estimated waste in the food and beverage sector, waste in the construction sector, and waste from the electrical and electronic equipment sector, which were not included in the MoEF data.

Exhibit A5

There is a difference in waste generation between the model estimates and those produced by the Ministry of Environment and Forestry

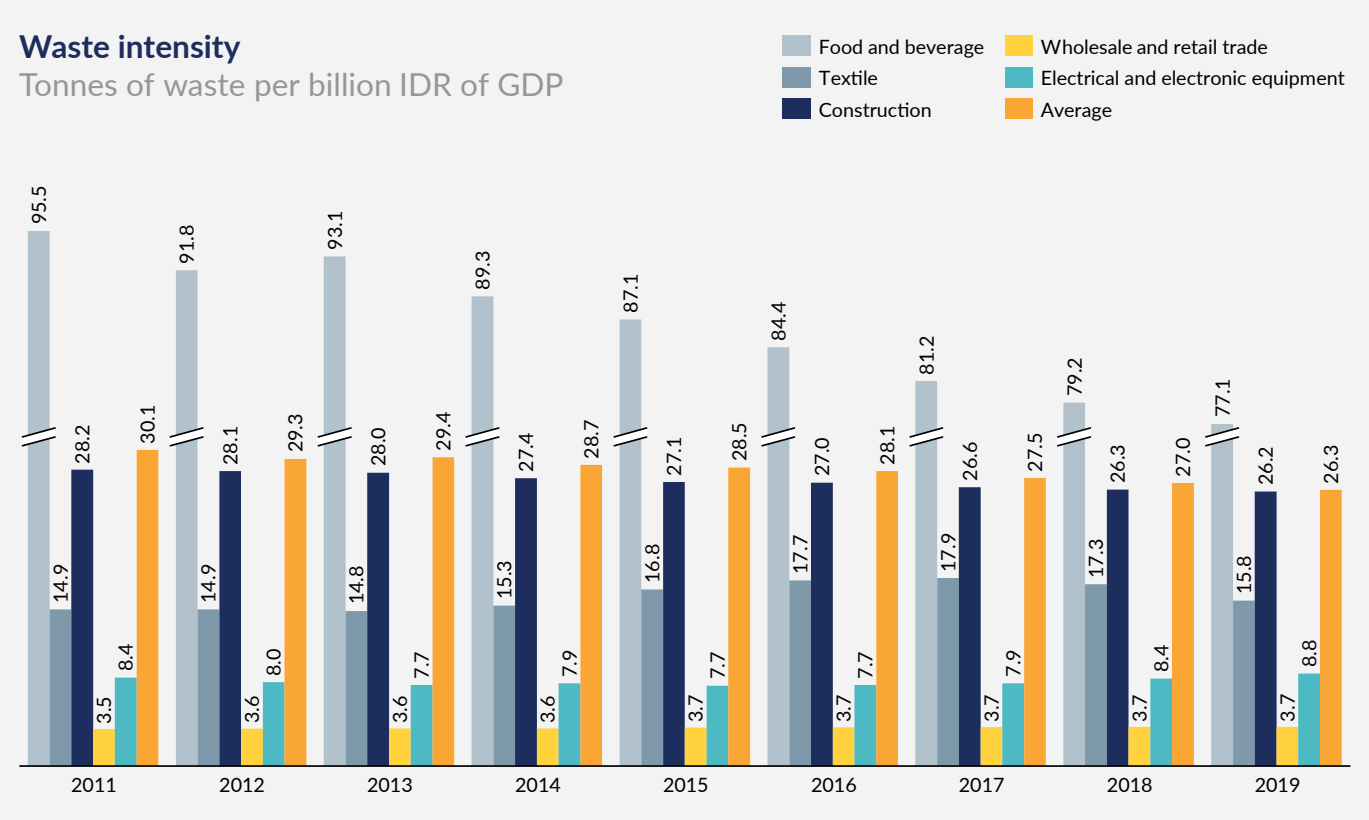


SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

The complexity of the economic system results in different waste intensities of the five sectors, as shown in Exhibit A6. Three sectors (textiles, wholesale and retail trade, and electrical and electronic equipment) show increasing waste intensities, but on average, the waste intensity of the five sectors has declined.

Exhibit A6

The historical waste intensity was calculated for each focus sector

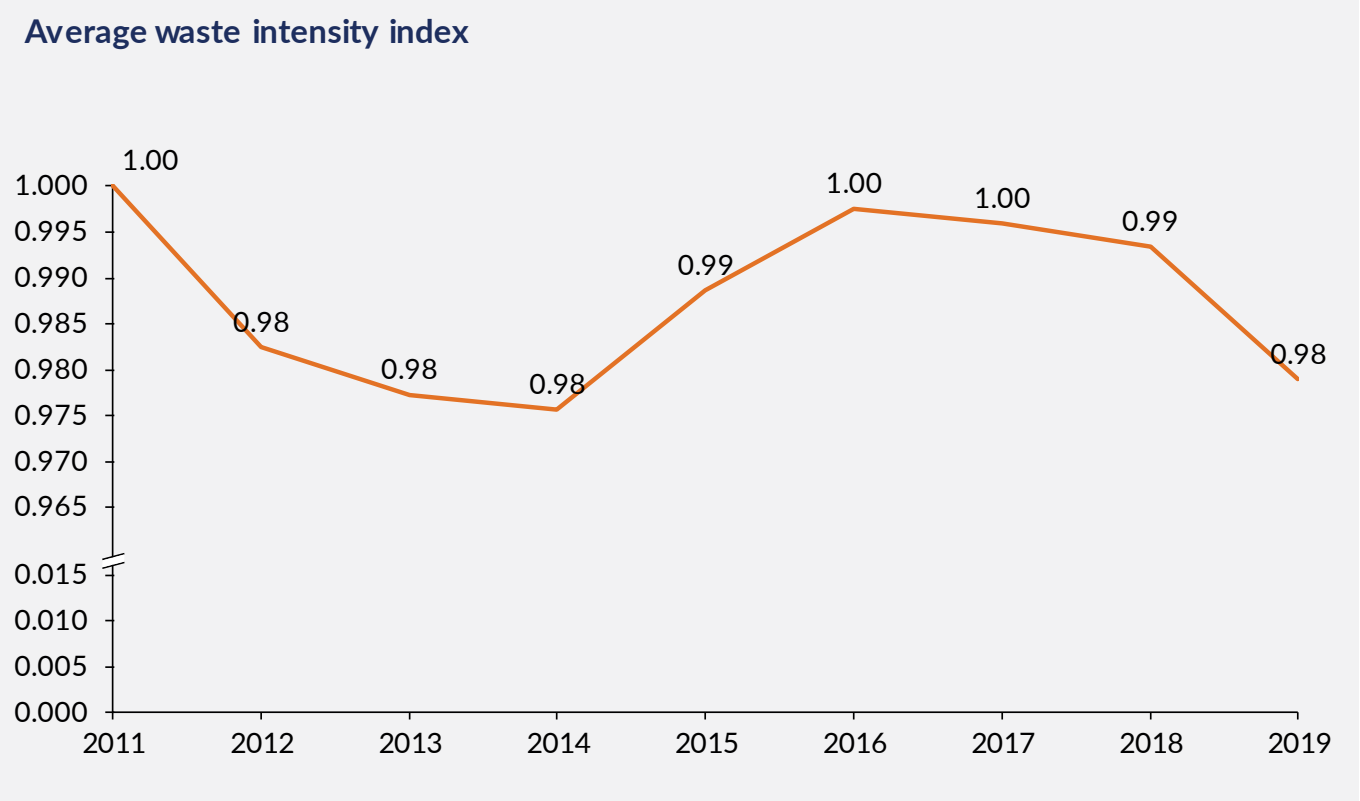


SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

Using 2011 as a reference year, a Waste Intensity (WI Index) was developed to indicate the dynamics of the waste intensity of the sectors. This index also helps us to understand the behaviour of each sector in the context of a circular economy. On average, the WI Index has decreased since 2011 (Exhibit A7), indicating a declining trend in waste generation. A lower value of the WI Index indicates the economy generates less waste per unit of GDP which could be caused by a single or a combination of the 5R approaches (reduce, reuse, recycle, refurbish, or renew).

Exhibit A7

The historical average waste intensity index was calculated

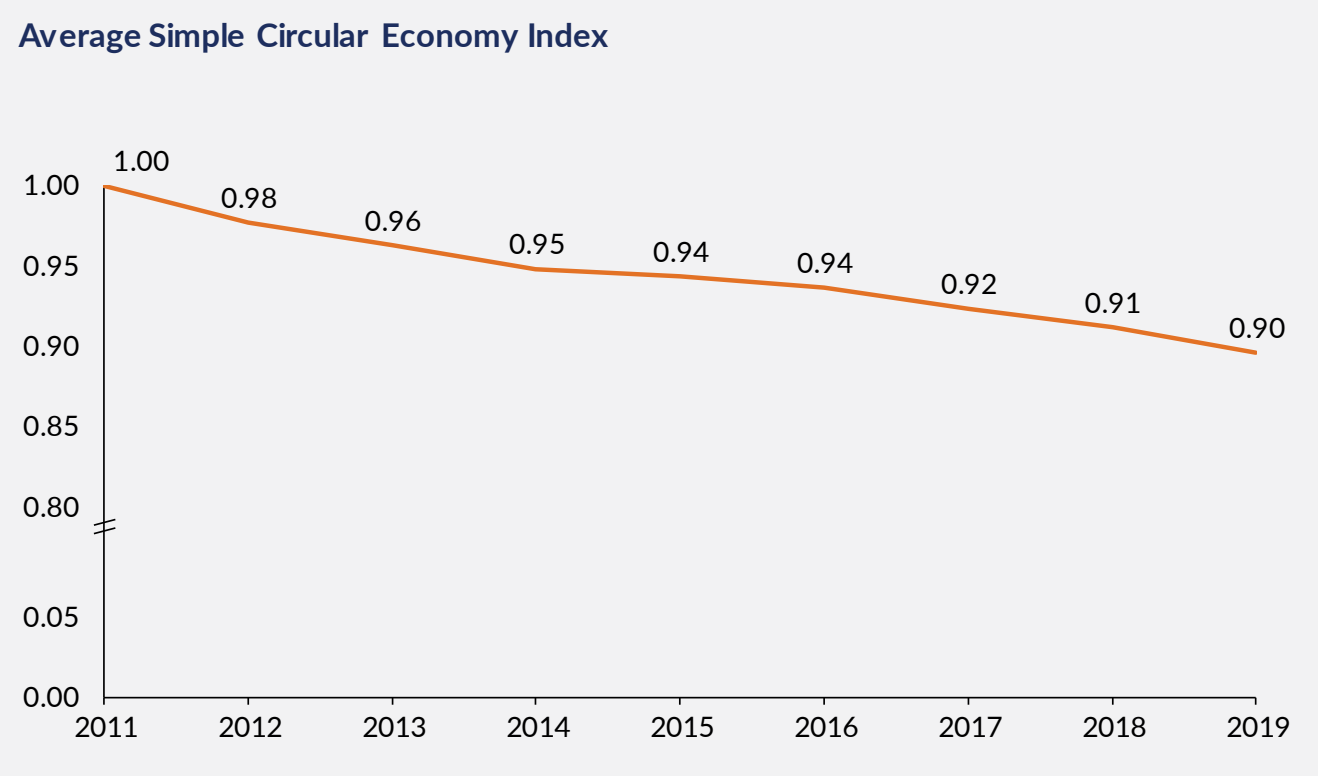


SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

This study proposed a Simple Circular Economy Index (SCE Index) that was created by integrating WI Index, income per capita index, and economic trade-off index. The income per capita index was created by using 2011 as the reference year. The SCE index was estimated by calculating the ratio of income per capita 2011-income per capita year "y". The economic trade-off was defined as a ratio between GDP under a "business as usual" scenario with GDP under scenario "s". It was found that the SCE index was decreasing during the 2011-2019 period, which indicates the positive trend of income per capita and lower waste intensity in that economic system"

Exhibit A8

The historical average simple circular economy index was calculated



SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

D. Model for Indonesia's circular economy

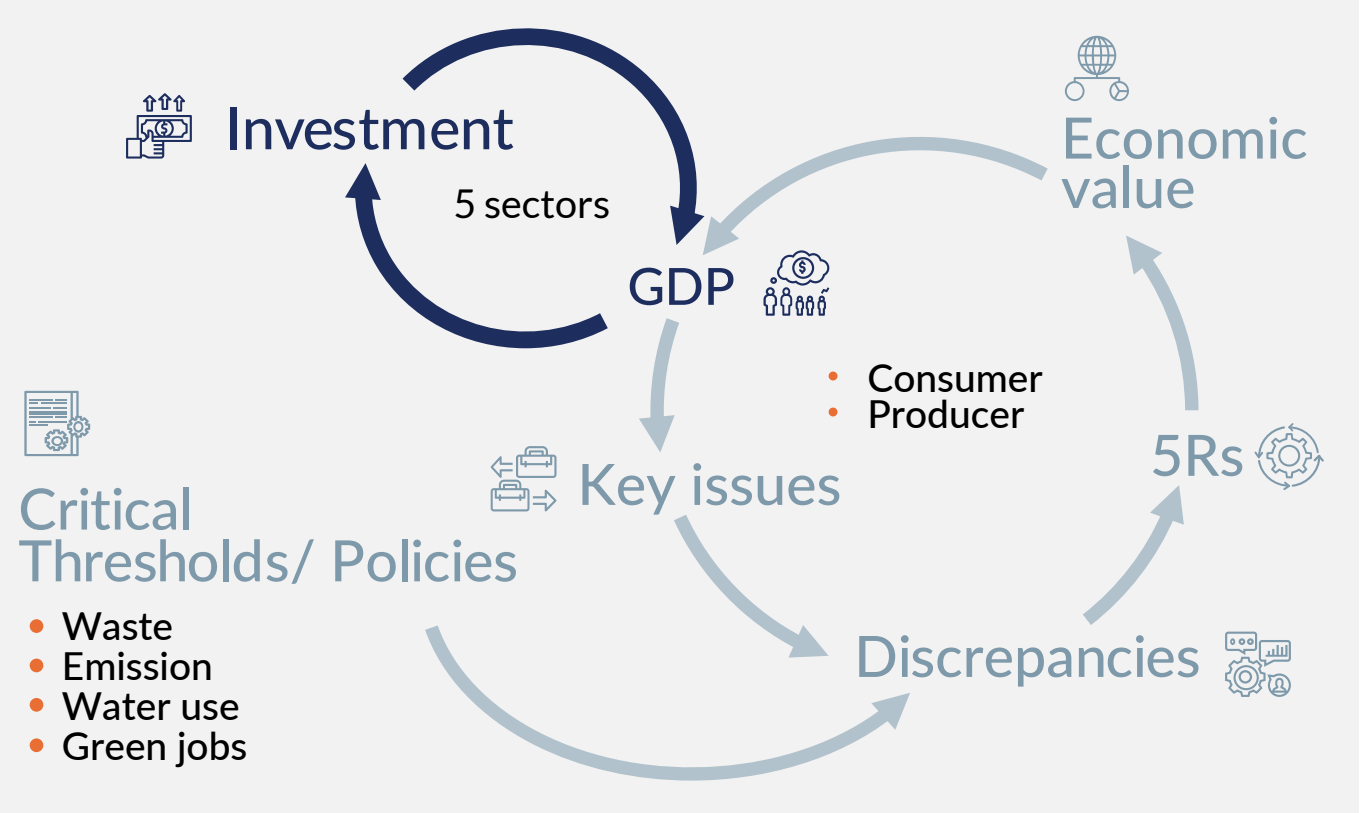
A model is built based on a story that describes the real-world system to be imitated. The role of stakeholders is important in building a description of the current real-world system. The circular economy model is intended to simulate the real system of the circular economy system. However, based on the results of several Focus Group Discussions (FGDs), there was no explicit identification of the existence of a circular economy in Indonesia. Therefore, the model was built based on the current "business-as-usual" economic system, particularly economic behaviour and its implications for waste in the 2011-2019 period.

The modelling objective is the initial step to create a model and the objective helps determine the boundary system and important system elements. Through various discussions with the stakeholders, two expected conditions were identified, which were then used as critical thresholds. These conditions were: the JAKSTRANAS policy in 2025 and the Low Carbon Development (LCDI) policy to achieve the NDC (Nationally Determined Contribution) target, especially the emission reduction of the waste sector by 2030.

The FGDs also helped identify key variables that could help us measure the impact of a circular economy, namely GDP, waste generation, emission, water use, and employment (including green jobs). Related to the 5R framework (reduce, reuse, recycle, refurbish, and renew), consumer and producer domains were identified implementation approaches for Indonesia. Based on the systems thinking paradigm, five key sectors, key issues, and 5Rs implementation domains were modelled (Exhibit A9), as a basis for developing a Causal Loop Diagram (CLD) as shown in Exhibit A11.

Exhibit A9

Systems thinking approach in the model



SOURCE: Team analysis; LCDI – NDC; JAKSTRANAS

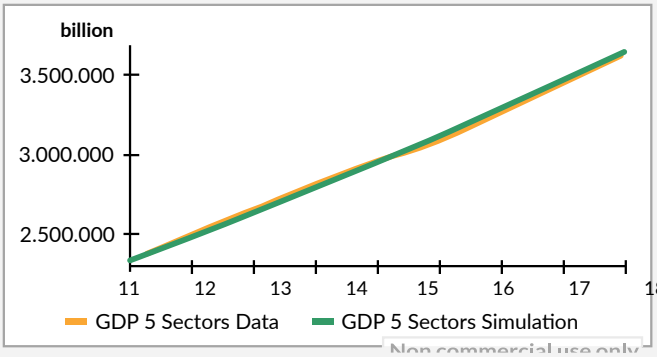
Business as Usual Behaviour on Waste and the Economy

Based on the growth trend of GDP and waste during 2011-2019, these variables represent the basis for predicting the BAU scenario for 2020-2030 using the system dynamics method. Visual validations show that the results of the model simulation and data references (i.e., sector GDP and waste volume) demonstrate similar behaviour (Exhibit A10). Absolute Mean Error (AME) of two variables are 0.0008 and 0.0017 respectively lower than 0.3, the maximum AME value. These results validated the model used in the analysis.

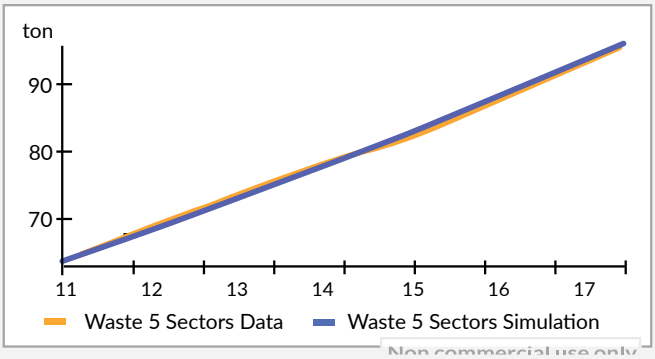
Exhibit A10

Visual validation of the circular economy model by comparing model simulations and data references

Sector GDP
IDR billion



Waste volumes
million tonnes

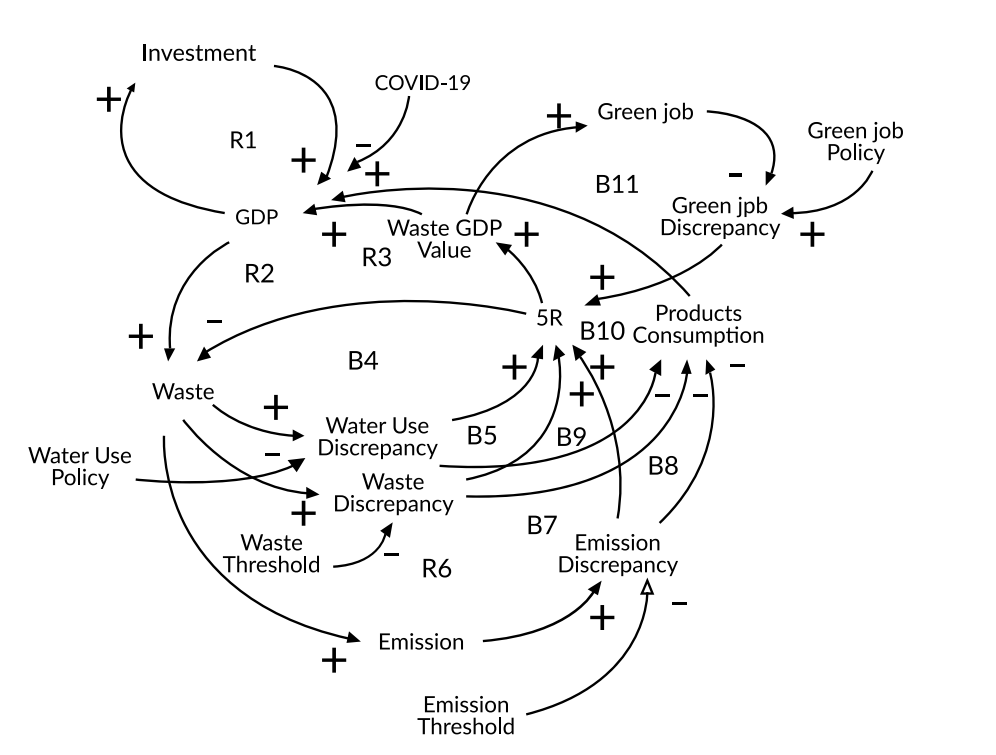


SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

The Causal Loop Diagram used for the analysis is provided in Exhibit A11.

Exhibit A11

The following Causal Loop Diagram was created for this analysis

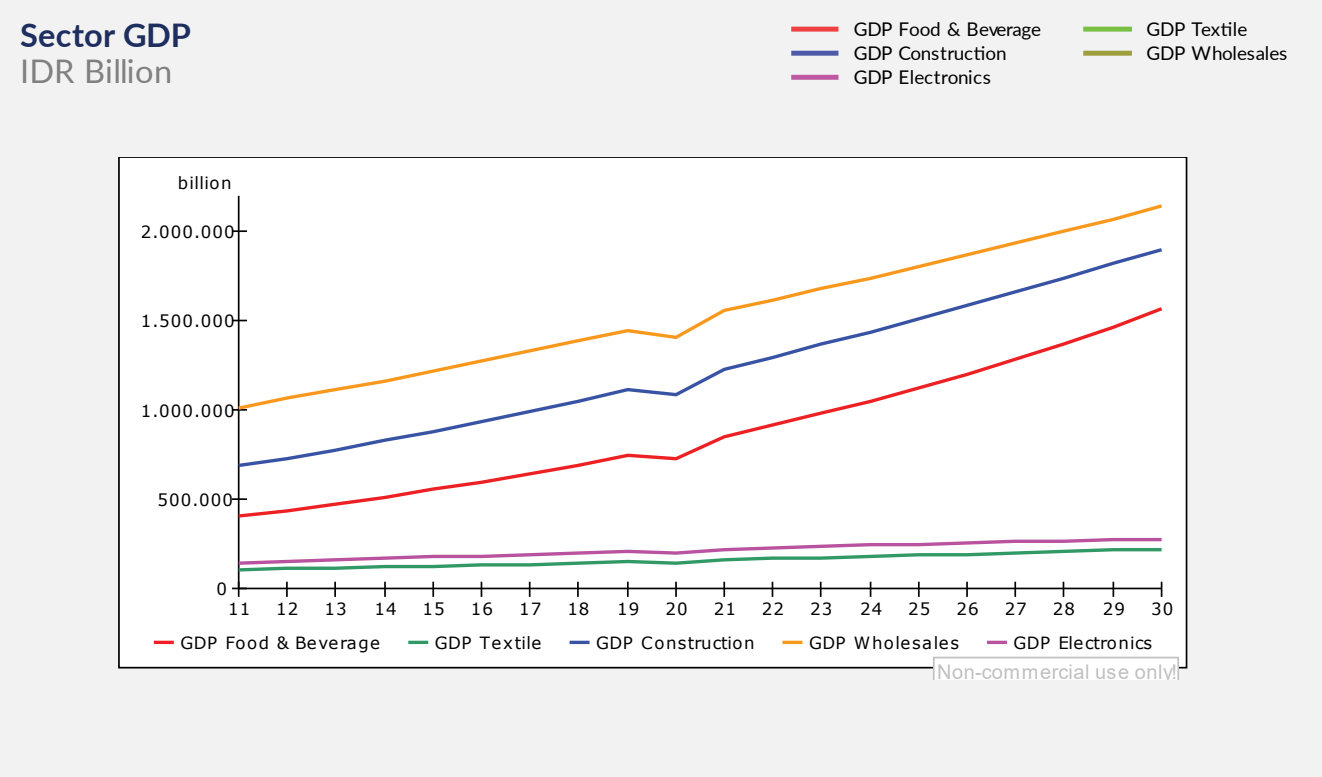


SOURCE: Team analysis

The results of the BAU scenario show that the GDP of the main sectors is likely to increase and could be accompanied by an increase in the associated waste (Exhibit A12). It is predicted that the GDP from the five sectors could reach IDR6,098 trillion (USD674 billion) in 2030, largely contributed by the wholesale and retail trade, construction, and food & beverage sectors.

Exhibit A12

Business as usual GDP estimates of the five sectors

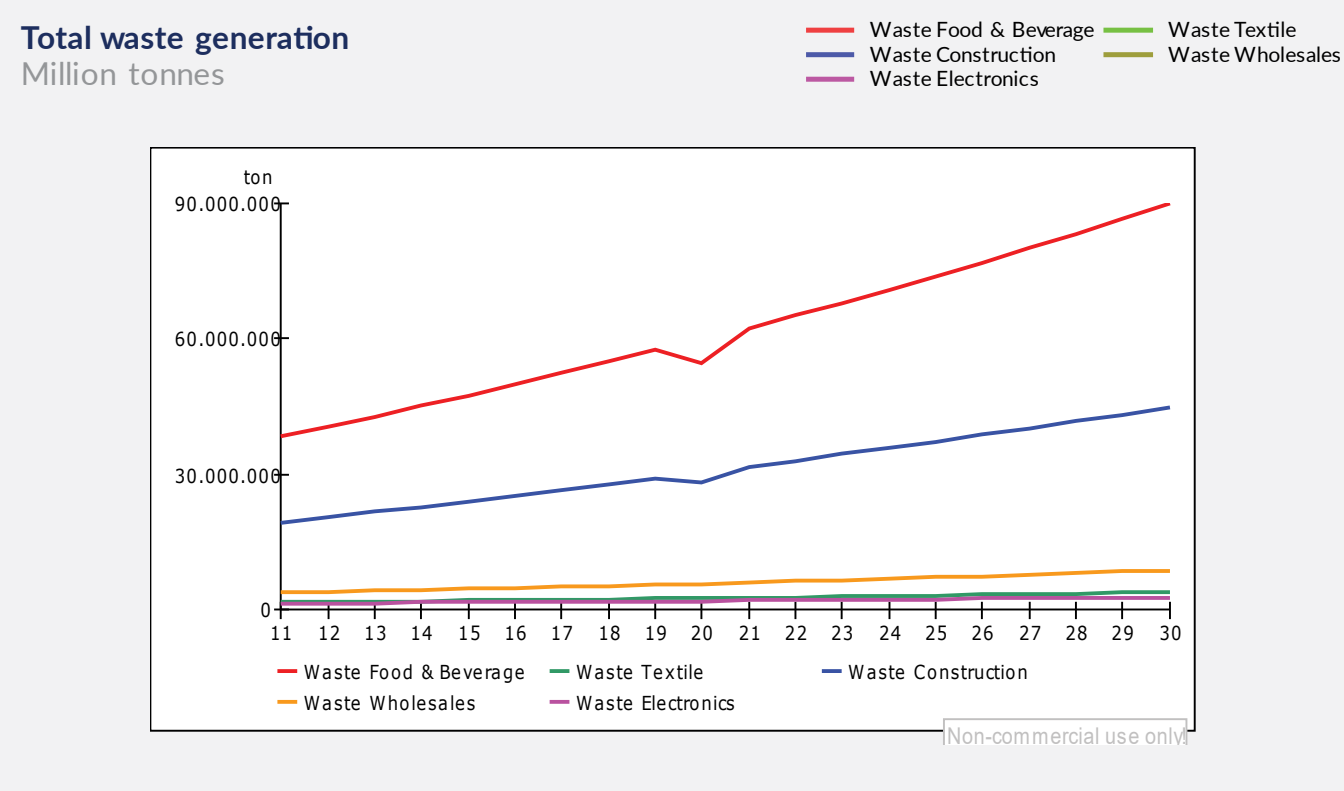


SOURCE:Team Analysis; BPS; Bank Indonesia (see annex for more details)

This analysis predicts that growth in these sectors could generate 149.6 million tonnes of waste in 2030 in a BAU scenario, whereas the total for all type of waste could reach 184.7 million tonnes. Waste volume for the MoEF waste classification could reach 104.7 million tonnes (Exhibit A13). Waste from the food and beverage sector will dominate the waste composition and could increase to 89.9 million tonnes in 2030.

Exhibit A13

Business as usual estimates on waste generation in the five sectors



SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

The model also considered Indonesia's economic contraction in 2020 caused by COVID-19, which was estimated between 1.7 and 2.2 percent in 2020 and was expected to recover to the positive territory of 5 percent by 2021. Related key sectors such as industry, construction, trading, and accommodation (including food and beverage) were estimated to grow between -11.86 to -4.32 percent by the third quarter in 2020. The model assumed that the construction sector declined by 2.2 percent in 2020 as estimated by the Ministry of Finance.

This analysis predicted that growth in these sectors could generate 149.6 million tonnes of waste in 2030 in a BAU scenario, whereas the total for all type of waste could reach 184.7 million tonnes. Waste volume for the MoEF waste classification could reach 104.7 million tonnes (Exhibit A13). Waste from the food and beverage sector will dominate the waste composition and could increase to 89.9 million tonnes in 2030.

Exhibit A14

Business as usual scenario on waste generation and carbon emissions was estimated

	Scenario 1: 2030					
Economic Sector	GDP (IDR trillion)	Waste (million tonnes)	Emission (million tonnes CO_2e)	Water Use (billion m^3)	Employment (million jobs)	Household Consumption (IDR million)
Food & Beverage	1,564	89.9	98.0	5.2	19.2	42.9
Textile	219	3.7	90.6	6.4	2.1	4.3
Construction	1.899	44.7	98.0	1.3	10.2	15.7
Wholesale and Retail Trade	2,141	8.7	16.0	0.6	20.4	12.3
Electrical & electronic equipment	275	2.6	4.3	2.6	1.9	31.3
Total Sectors	6,098	149.6	306.9	16.1	53.8	106.5
Total National		184.7	376.4			
Total MoEF		104.7	207.2			
COVID-19 impact	-31	-0.9	-1.6	0	-0.3	-0.6

SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

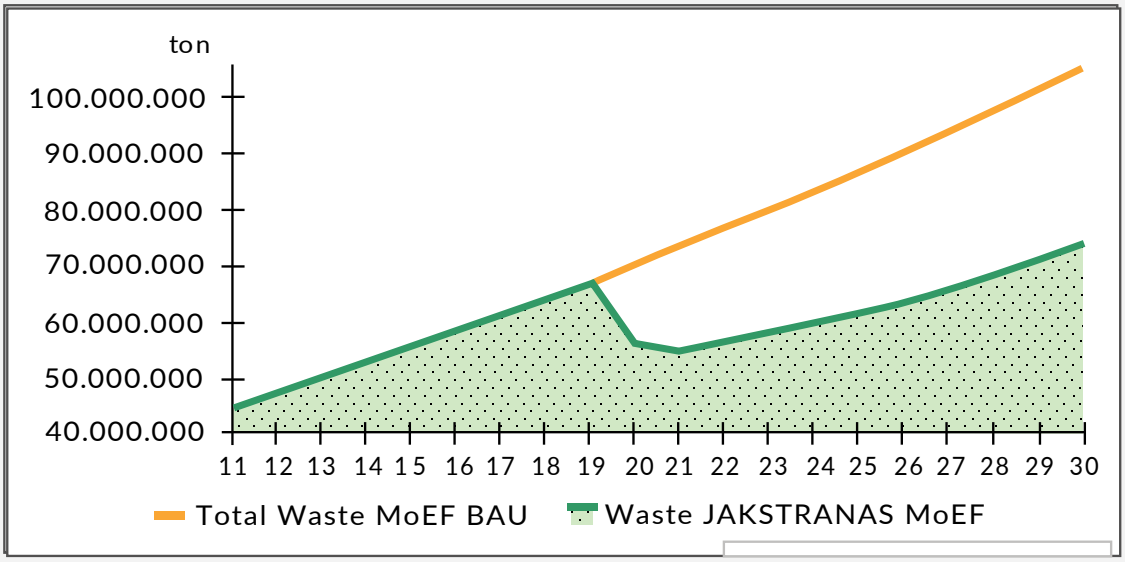
The results of BAU scenario prediction, particularly in the aspects of waste volume and emissions can be compared with the critical thresholds for waste and emissions. The JAKSTRANAS policy, which includes a waste handling target of 70 percent by 2025, is defined as the critical threshold for waste volumes. This analysis assumed that the JAKSTRANAS targets would apply till 2030. Compared to the JAKSTRANAS policy, the BAU waste volume in 2030 is depicted in Exhibit A15. Based on this result, it can be concluded that the volume of waste during the 2020-2030 period is above the expected conditions in the JAKSTRANAS policy.

Exhibit A15

Comparing waste generation with the critical threshold of the JAKSTRANAS targets

Total waste generation

Million tonnes

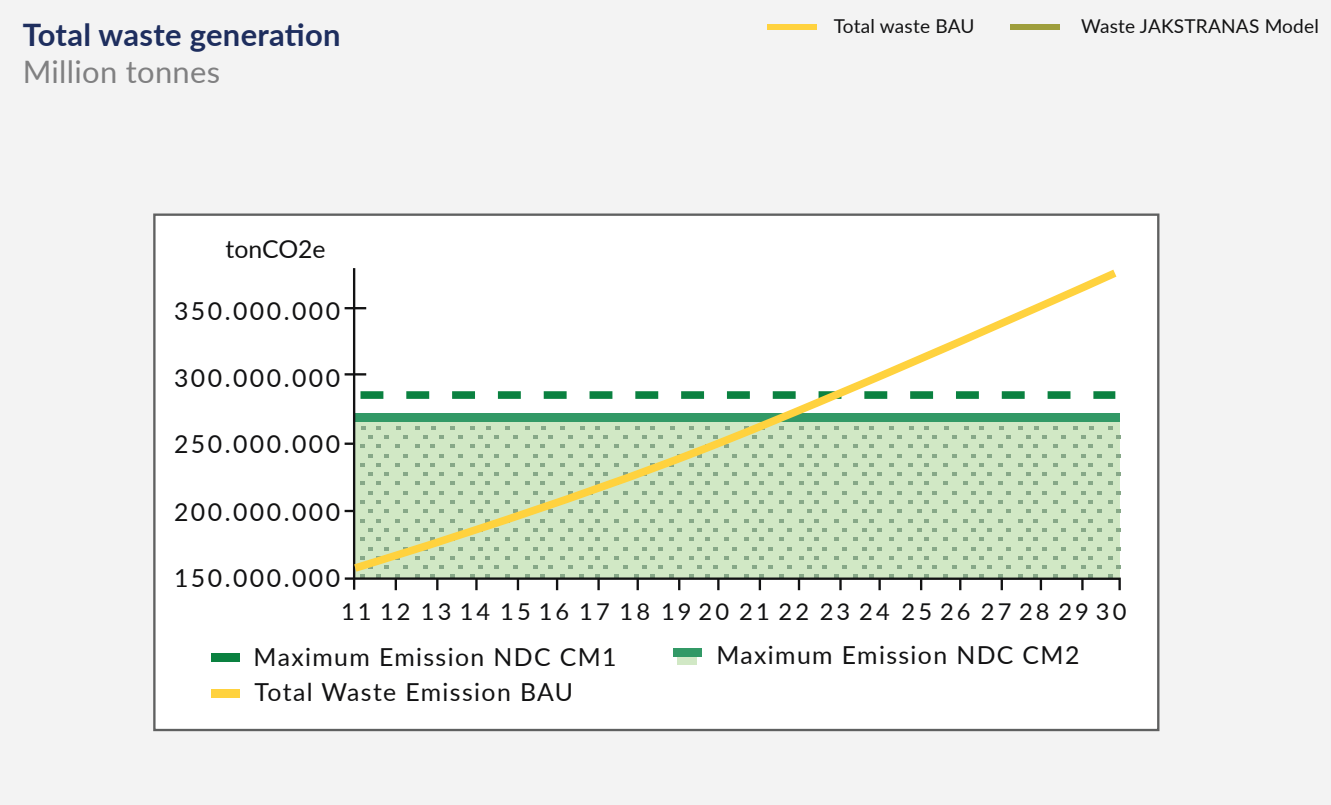


SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

The critical threshold for carbon emissions is identified in the First Nationally Determined Contribution (First NDC) document, which includes Indonesia's commitment to achieving its emission reduction target by 2030. Greenhouse gas mitigation scenarios in the First NDC consist of Counter Measure 1 (CM1) or the unconditional mitigation scenario, and CM2 (the conditional mitigation scenario). The maximum total target of emissions in 2030 is 2.03 gigatonnes of CO_2e for CM1 and 1.79 gigatonnes of CO_2e in the CM2 scenario. While in the waste NDC sector, the CM1 emission target in 2030 is 285 million tonnes of CO_2e and CM2 of 270 million tonnes of CO_2e. Based on the First NDC target, the BAU conditions exceed the Waste NDC sector target (Exhibit A16).

Exhibit A16

Comparing CO_2e emissions with the critical threshold of the National Determined Contribution (NDC)



SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

Intervention scenarios for system design of a circular economy

According to the World Economic Forum (WEF), the definition of a circular economy is "an industrial system that is restorative or regenerative by intention and design". It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems, and business models."

Relative to the BAU scenario, three intervention scenarios were prepared, taking into account the policy experiences, potential policies, and scenario planning to meet critical thresholds (Exhibit A17):

- **Scenario 1:** Reduce product consumption (at the consumer level) by an average of 2 percent per year starting in 2021 (equivalent to reducing product consumption by 20 percent by 2030).
- **Scenario 2:** Improve waste intensity (i.e., lower waste relative to output) in the production process by 3.5 percent per year starting in 2021 by combining the 5Rs method, which is expected to produce an economic value of waste amounting to IDR 3-21 million/tonne.
- **Scenario 3:** Reduce product consumption (at the consumer level) through the 3Rs by an average of 0.5 percent per year starting in 2021 (equivalent to reducing product consumption by five percent by 2030).and improve waste intensity in the production process (i.e., lower waste relative to output) by 3.5 percent per year by combining the 5Rs method which is expected to produce an economic value of waste amounting to IDR 3.3-23.1 million/tonne.

Furthermore, the prediction of each scenario and its implications for the critical threshold and several important indicators are described in the following sections.

Exhibit A17

Three different scenarios were defined for the analysis

Scenario	Variables	Parameters	Planning
BAU	Product consumption	BAU	-
	Waste intensity	Annual reduction rate 0.27% (average of 5 sectors)	
	Waste economic value	BAU	
Scenario 1	Product consumption	80% BAU by 2030 (average annual rate - 2%)	Customer approach - Achieve CM1 NDC Target
	Waste intensity	BAU	
	Waste economic value	BAU	
Scenario 2	Product consumption	BAU	Producer approach - Achieve CM1 NDC Target - Improve GDP
	Waste intensity	Additional reduction at 3.5% annual average rate	
	Waste economic value	BAU + IDR3 21 million of GDP per tonne	
Scenario 3	Product consumption	95% BAU by 2030 (average annual rate of 0.5%)	Customer and producer approach - Achieve CM2 NDC Target - Improve GDP - Achieve JAKSTRANAS
	Waste intensity	Additional reduction at 3.5% annual average rate	
	Waste economic value	BAU + IDR3.3 -23.1 million of GDP per tonne (+10% scenario 2)	

SOURCE: Team analysis

Scenario 1: Reducing product consumption

Scenario 1 results show that the GDP from the five sectors is lower than the BAU scenario in 2030 due to reduced product consumption. Meanwhile, the amount of waste in this scenario is predicted to decline relative to the BAU scenario. This amount of waste is still higher than the conditions expected in 2030, which is capped at 70 percent of the BAU scenario, either using the waste classification from the MoEF or model calculations. An important aspect of this prediction scenario is the achievement of the NDC target in the waste sector by 2030. This scenario predicts that Indonesia could meet the Counter Measure 1 (CM1) target but not the CM2 emission reduction target (Exhibit A18).

Exhibit A18

Scenario 1 prediction for GDP, waste generation, and emissions

SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

Based on scenario 1, it was estimated that GDP could reach IDR4,535 trillion (USD499 billion), which is lower than the BAU GDP of IDR6,098 trillion (USD671 billion) due to a decline in product consumption in 2030 (Exhibit A19). Compared to BAU conditions, water usage will reach 12.1 billion m^3 which is lower than BAU usage of 16.1 billion m^3. Employment and household consumption in scenario 1 will also be lower relative to the BAU scenario.

Exhibit A19

System dynamics analysis for scenario 1 in 2030

	Scenario 1: 2030					
Economic Sector	GDP (IDR trillion)	Waste (million tonnes)	Emission (million tonnes CO_2e)	Water Use (billion m^3)	Employment (million jobs)	Household Consumption (IDR million)
Food & Beverage	1,140	65.5	71.4	3.8	14.0	31.9
Textile	166	2.8	68.5	4.9	1.6	3.2
Construction	1,412	33.3	72.8	1.0	7.6	11.7
Wholesale and Retail Trade	1,611	6.5	12.1	0.5	15.3	9.1
Electrical & electronic equipment	206	1.9	3.2	1.9	1.4	23.3
Total Sectors	4,535	110.0	228.0	12.1	39.9	79.2
Total National		135.8	279.1			
Total MoEF		77.0	152.4			
COVID-19 impact	-23	-0.7	-1.2	0	-0.2	-14

SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

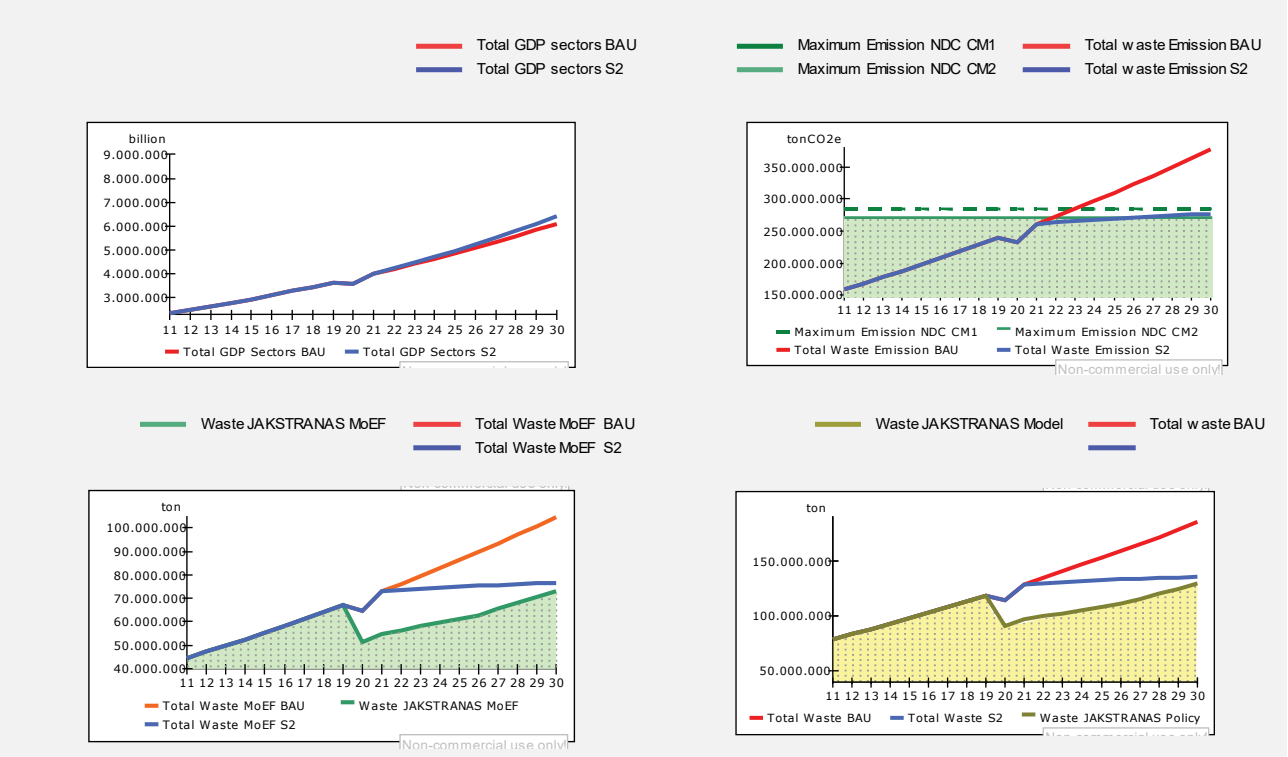
In scenario 1, total emissions are expected to reach 279.1 million tonnes of CO_2e, lower than the Waste Sector NDC target in 2030 of 285 million tonnes of CO_2e (CM1) but higher than the CM2 target of 270 million tonnes of CO_2e. In the context of achieving the NDC in the waste sector, scenario 1 is able to meet the emission reduction commitments of the sector. In the context of achieving the JAKSTRANAS targets, the volume of waste in 2030 would not be able to achieve the targets.

Scenario 2: Improving waste intensity

In scenario 2, the intervention was based on improving waste intensity at the business level) at 3.5 percent annually (i.e., reducing waste relative to output). This improvement in waste intensity will be able to produce a higher GDP than the BAU scenario in 2030. Similar to scenario 1, scenario 2 estimated that Indonesia could produce a lower volume of waste and emissions relative to the BAU scenario. The volume of waste and emissions produced is higher than scenario 1 and the JAKSTRANAS target cannot be achieved. Nevertheless, the emission level in 2030 under this scenario can achieve the NDC CM1 target (Exhibit A20).

Exhibit A20

Scenario 2 prediction for GDP, waste generation, and emissions



SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

In scenario 2, the total GDP of the five sectors is expected to reach IDR6,410 trillion (USD705 billion) in 2030 and could provide additional IDR312 trillion (USD34.3 billion) of GDP value compared to the BAU scenario. This scenario also estimated the employment of 56.3 million people and household consumption of IDR112 million per household (Exhibit A21). Both employment and household consumption in scenario 2 are higher than the BAU scenario. This better economic condition is caused by an improvement in waste intensity, which does not reduce product consumption (as assumed in scenario 1). In fact, the implementation of 5R at the business level will produce more economic value from waste than under the BAU scenario. It is predicted that scenario 2 will not achieve the target in JAKSTRANAS with maximum waste handled estimated to be 129.3 million tonnes in 2030.

Exhibit A21

System dynamics analysis for scenario 2 in 2030

	Scenario 2: 2030					
Economic Sector	GDP (IDR trillion)	Waste (million tonnes)	Emission (million tonnes CO_2e)	Water Use (billion m^3)	Employment (million jobs) / Green jobs (%)	Household Consumption (IDR million)
Food & Beverage	1,661	65.7	71.6	3.8	20.4 / 4.3	45.1
Textile	242	2.8	67.0	4.7	2.3 / 8.0	4.6
Construction	2,068	32.9	72.1	0.9	11.1 / 6.6	16.5
Wholesale and Retail Trade	2,152	6.3	11.7	0.5	20.5 / 0.4	12.9
Electrical & electronic equipment	287	1.9	3.2	1.9	2.0 / 3.4	32.9
Total Sectors	6,410	109.6	225.6	11.8	56.3 / 3.5	112.0
Total National		135.3	276.5			
Total MoEF		76.7	151.8			
COVID-19 impact	-34	-0.7	-1.2	-0.1	-0.3	-0.6

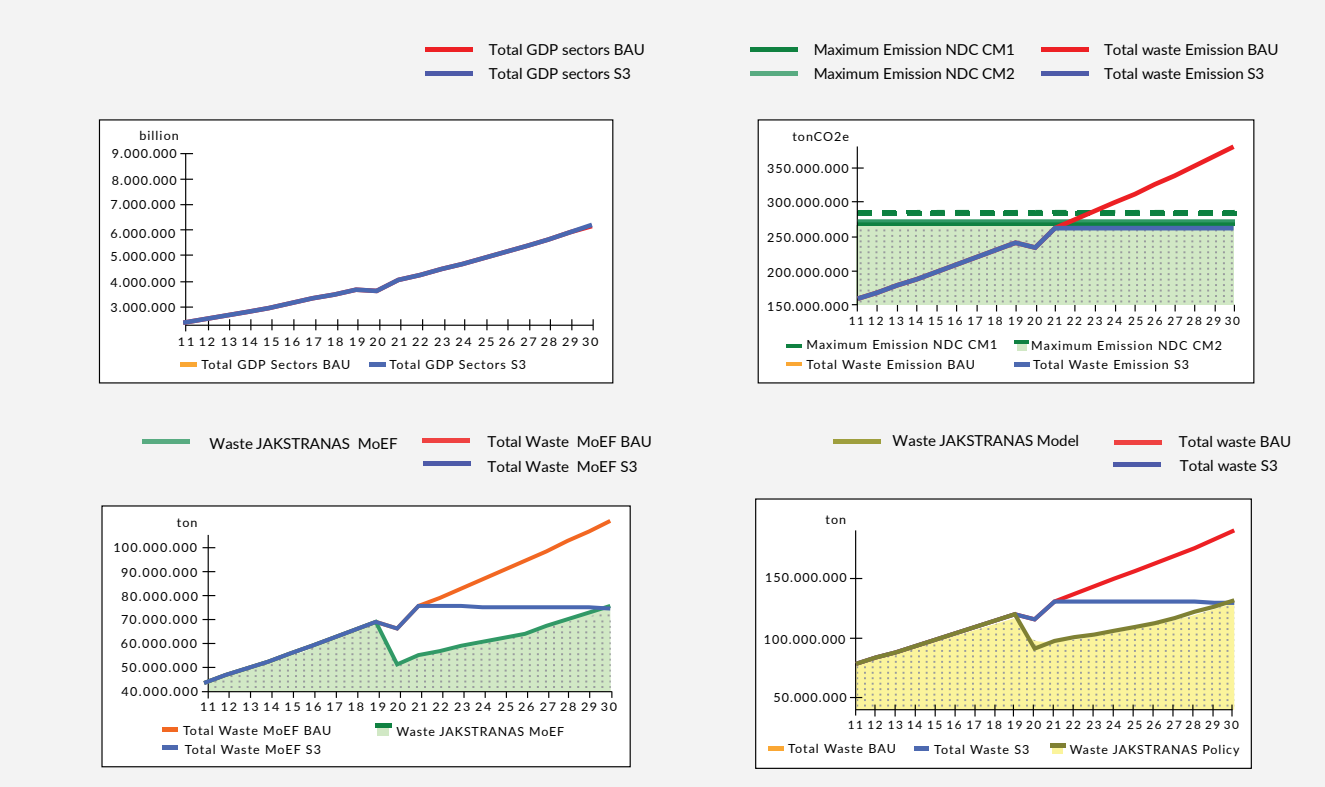
SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

Scenario 3: Reducing product consumption and improving waste intensity

In scenario 3, product consumption (at the consumer level) is reduced at 0.5 percent per annum through the 3Rs (equivalent to reducing product consumption by five percent by 2030) and waste intensity in the production process improves at 3.5 percent annually by combining the 5Rs starting in 2021. The reduced waste was assumed to generate an economic value of IDR 3.3-23.1 million/tonne. This combination of interventions will result in a lower GDP for the five sectors than the BAU scenario in 2030 (Exhibit A22).

Exhibit A22

Scenario 3 prediction for GDP, waste generation, and emissions



SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

This combination of interventions could generate higher GDP for the five sectors in 2030 relative to the BAU scenario. In scenario 3, the volume of waste is predicted to be lower than the maximum volume in 2030 based on the JAKSTRANAS assumption – that is, it will be able to achieve the waste handling target of 70 percent. Likewise, the emission impact is much lower than the NDC target in both the CM1 and CM2 schemes (Exhibit A23).

This scenario also predicts that the total GDP of the five sectors is IDR6,119 trillion (USD673 billion) which is higher than the BAU GDP. The lower waste generation and positive GDP impact are accompanied by a reduction in water use, increase in job creation, and an increase in household consumption.

Exhibit A23

System dynamics analysis for scenario 3 in 2030

	Scenario 3: 2030					
Economic Sector	GDP (IDR trillion)	Waste (million tonnes)	Emission (million tonnes CO_2e)	Water Use (billion m^3)	Employment (million jobs) Green jobs (%)	Household Consumption (IDR million)
Food & Beverage	1,586	61.8	67.3	3.6	19.5 / 5.7	43.0
Textile	236	2.6	63.4	4.5	2.2 / 10.5	4.4
Construction	1,966	31.0	68.0	0.9	10.7 / 8.7	15.8
Wholesale and Retail Trade	2,028	5.9	11.0	0.4	19.3 / 0.5	12.3
Electrical & electronic equipment	273	1.8	3.0	1.8	1.9 / 4.5	31.4
Total Sectors	6,119	103.1	212.7	11.2	53.6 / 4.6	106.9
Total National		127.3	260.6			
Total MoEF		72.2	142.9			
COVID-19 impact	-32	-0.7	-1.1	0	-0.3	-0.6

SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

Simple Circular Economy Index (SCE Index) 2020-2030

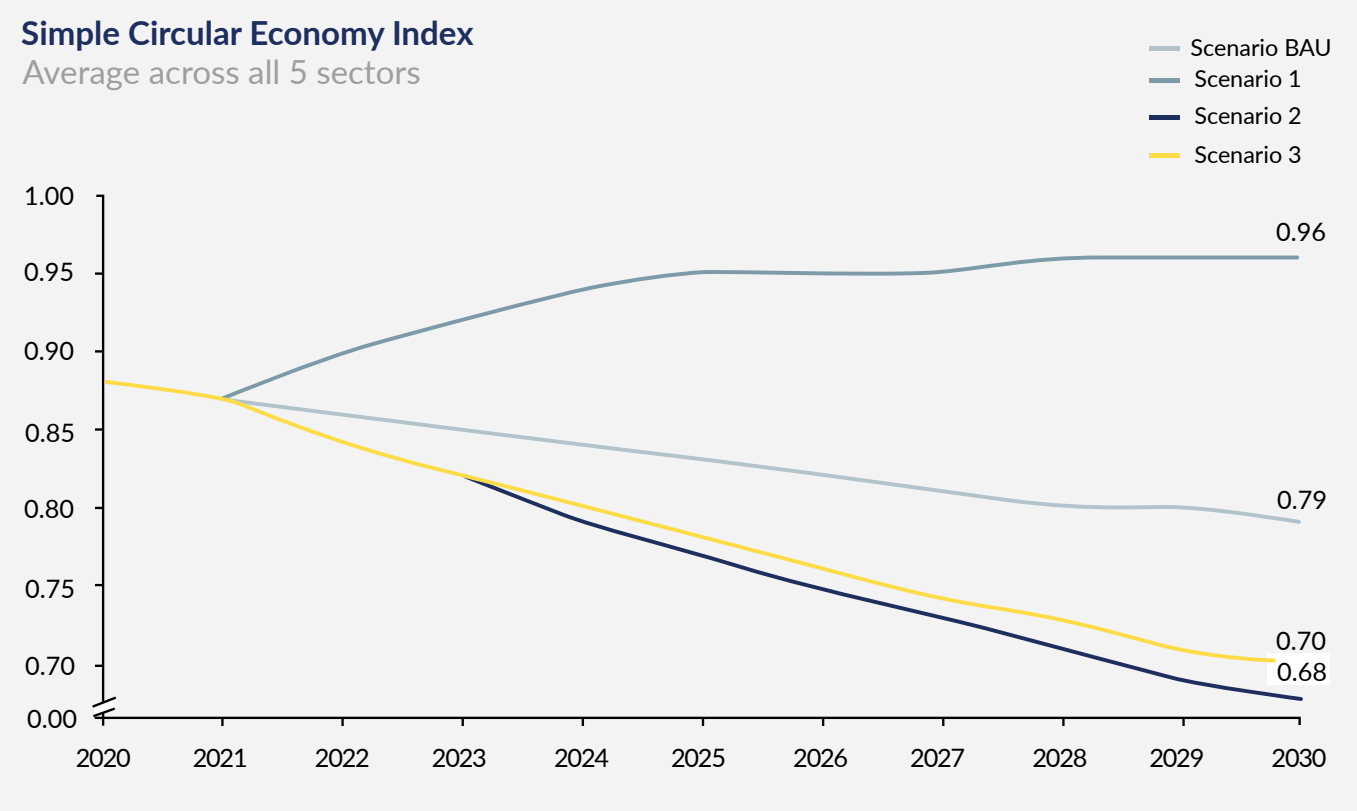
Using the SCE Index method, the three circular economy scenarios outlined above can be compared with the BAU scenario. Scenario 1 has a higher SCE index during the 2020-2030 period relative to the BAU scenario. Hence, scenario 1 could be excluded as a policy response to develop a circular economy in Indonesia. Meanwhile, scenario 2 and 3 have a lower SCE Index relative to the BAU scenario and could be considered as policy responses to develop a circular economy in Indonesia (Exhibit A24).

Two key aspects for implementing the scenario 2 are (i) a need to accelerate waste intensity reduction at the business level and (ii) design the implementation of a circular economy without a trade-off in the economy. First, to implement scenario 2, the waste intensity in the production process needs to be reduced by at least 3.5 percent average every year, starting in 2021 by implementing the 5Rs. Second, an additional economic value of IDR3-21 million per tonne needs to be created at the business level. For scenario 3, an even greater value of economic impact (IDR3.3-23.1 million per tonne) would be required.

Using scenario 2 to develop a circular economy in Indonesia would require reviewing the JAKSTRANAS concept and contextualise it into an integrated or holistic perspective to avoid any economic trade-off. In addition, scenario 2 could achieve the CM1 target under the NDC policy. Hence it could be used as a basis to design international partnerships for reducing waste emissions and improving the economy at the same time.

Exhibit A24

The Simple Circular Economy Index was estimated for the different scenarios



SOURCE: Team Analysis; Ministry of Environment and Forestry; BPS; WRI; World Economic Forum; expert interviews (see annex for more details)

Recommendation

Based on this analysis, three recommendations are suggested:

1. The policy to reduce the consumption of products should be planned along with the objective of increasing GDP growth;
2. To improve the economic value generated from waste a circular economy should be designed with a focus on the producer domain; and
3. Recognising that a circular economy is a concept under the green economy umbrella, the national circular economy design should be integrated into the overall green economy development plans of the country.

Annex 2: Impact of COVID-19 on estimates in the report

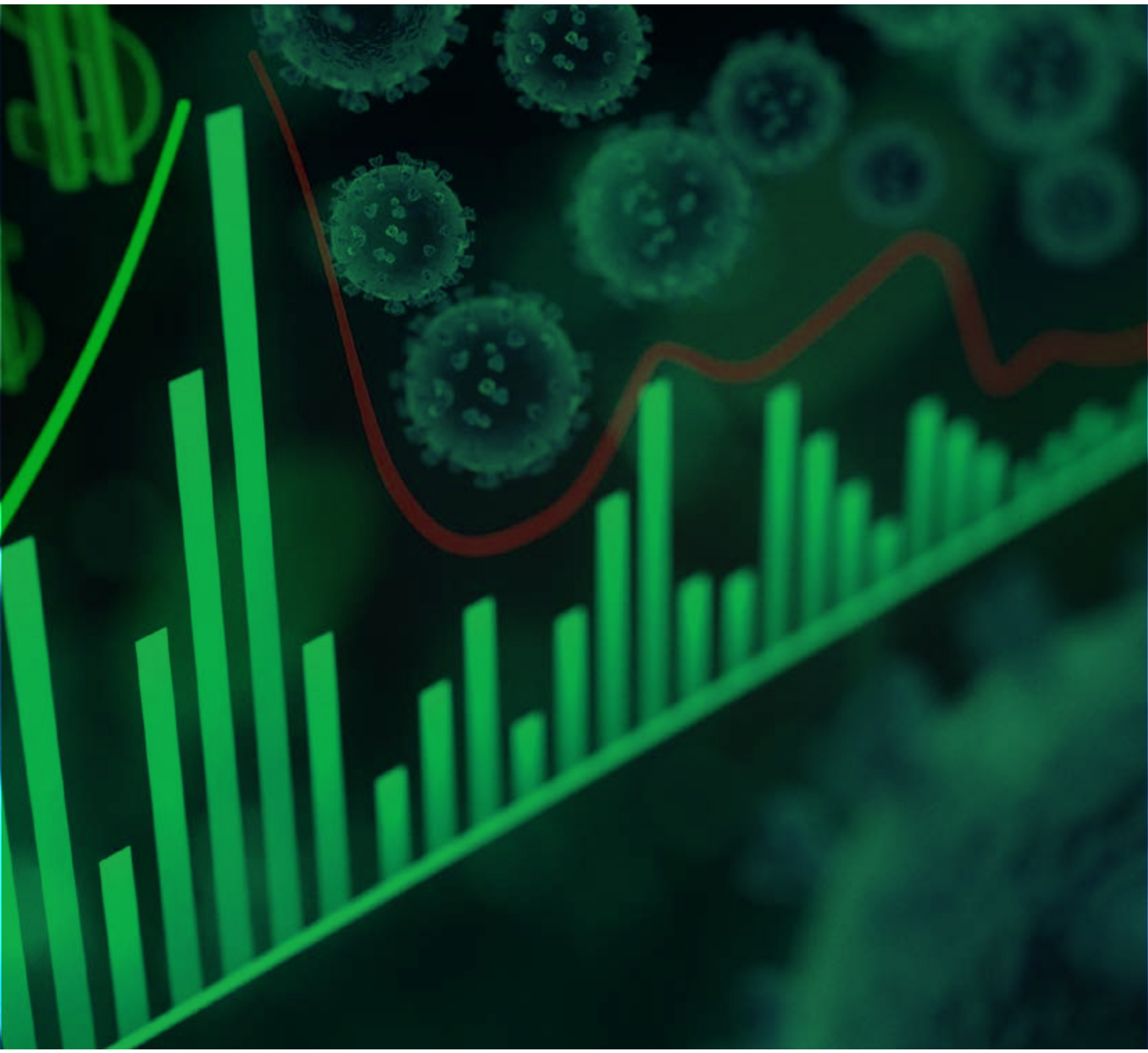
The estimates in this report were not adjusted for the COVID-19 crisis due to a lack of clarity on the long-term impact of COVID-19 on Indonesia's economy, but also the links to waste volumes in Indonesia. Based on the latest government estimates, Indonesia's GDP is expected to shrink by 1.6 to 2.2 percent in 2020.[658] The IMF projects that the GDP could rebound to 6.1 percent growth in 2021.[659] However, as explained below, the link between GDP growth and waste volumes for the five prioritised sectors is not straightforward, and COVID-19 could have impacts on waste and circularity opportunities (which are hard to quantify) beyond its impact on the economy:

- **Food loss and waste.** A report by the World Economic Forum highlighted the increase in food loss at the supply chain stage due to the pandemic (linked to restaurant closures and supply chain disruptions).[660] However, at the consumption stage of the value chain, the food waste may decrease in the short-term due to a fall in household incomes and as more households choose to dine at home (bearing in mind that consumers are more likely to generate food waste outside their homes).[661] This fall in demand for F&B services was evident from reports that suggest that the food and beverage sector in Indonesia was one of the hardest-hit sectors due to the COVID-induced lockdown.[662] In Jakarta, close to 400,000 restaurant workers were furloughed.[663] However, in the long-term, a fall in household income may not result in a proportionate fall in food loss and waste volumes. Due to the relative inelasticity of food demand relative to income, the food consumption among households may not change significantly, adding to the complexity of how food loss and waste volumes could change due to the pandemic.
- **Textile waste.** In the United States, apparel retail sales dropped by 88 percent in April 2020, compared to the same month in 2019.[664] Several brands, including Adidas, GAP, and H&M, witnessed significant drops in their sales.[665] Lack of global apparel demand had a significant impact on Indonesia's textile sector, forcing some factories to close.[666] 63,000 workers in textile factories faced job losses by March 2020.[667] In the short-term, textile waste generation at the production stage could decrease due to the contraction in the sector. Moreover, textile waste produced by the consumers could shrink due to lower household incomes. In the long-term, it is unclear if textile waste would increase or decrease. A rise in household incomes 2022 onwards is likely to increase waste volumes at the consumption stage. At the same time, a focus on "nearshoring" – when factories are closer to their final sales markets – could see lower production in Indonesia to export markets (and the associated production waste), but this could be offset by the growing domestic market for textiles.[668]
- **Construction and demolition (C&D) waste.** The construction sector has significantly slowed down due to the pandemic. The value added by the construction sector in Indonesia grew by 2.9 percent year-on-year during the first quarter of 2020 – the slowest quarterly growth rate since the first quarter of 2002.[669] Experts estimate that the pandemic would have a negative impact on the revenues of the construction sector, including state-owned companies in 2020.[670] The expected decline in new construction projects is likely to reduce the volume of C&D waste in the short-term. However, the Government's focus on using construction projects as a tool to enable Indonesia's growth recovery could counter the short-term decline in waste volumes.[671]
- **Plastic packaging waste.** Experience from other countries, such as Thailand, demonstrates that the plastic packaging waste generation has increased due to greater food deliveries.[672] However, the Jakarta Environment Agency reported in April 2020 that Jakarta's daily trash output decreased by over 40 percent since local residents began working from home due to COVID-19.[673] Environmental experts in Indonesia though warn that an increase in e-commerce transactions, driven by a consumer shift toward "working from home" could see plastic packaging waste volumes increase substantially, countering the initial decline.[674]

658 The Jakarta Post (2020), "Govt again revises down 2020 GDP amid year-end surge of COVID-19 cases." Available at: https://www.thejakartapost.com/news/2020/12/22/govt-again-revises-down-2020-gdp-amid-year-end-surge-of-covid-19-cases.html
659 IMF (2020), *A Crisis Like No Other, An Uncertain Recovery*. Available at: https://www.imf.org/en/Publications/WEO/Issues/2020/06/24/WEOUpdateJune2020
660 World Economic Forum (2020), "Here's how COVID-19 creates food waste mountains that threaten the environment." Available at: https://www.weforum.org/agenda/2020/06/covid-19-food-waste-mountains-environment/
661 WRAP (2013), *Understanding out of home consumer food waste*. Available at: https://wrap.org.uk/sites/files/wrap/OOH%20Report.pdf
662 The Jakarta Post (2020), "Food & Beverage industry hit hardest by COVID-19: Report." Available at: https://www.thejakartapost.com/news/2020/03/27/food-beverage-industry-hit-hardest-by-covid-19-report.html
663 CNBC (2020), "Pilih Tutup Gerai, Restoran Rumahkan 400 Ribu Karyawan." Available at: https://www.cnbcindonesia.com/news/20200918173121-4-187859/pilih-tutup-gerai-restoran-rumahkan-400-ribu-karyawan
664 Statista (2020), "Monthly retail sales of U.S. clothing stores from 2017 to 2020 (in million U.S. dollars)." Available at: https://www.statista.com/statistics/289783/us-retail-apparel-store-sales-on-a-monthly-basis/
665 ILO (2020), COVID-19 and the textiles, clothing, leather and footwear Industries. Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/briefingnote/wcms_741344.pdf
666 The Jakarta Post (2020), "COVID-19 fallout exacerbates noncompetitive, outdated textile industry: Experts." Available at: https://www.thejakartapost.com/news/2020/08/27/covid-19-fallout-exacerbates-noncompetitive-outdated-textile-industry-experts.html
667 The Straits Times (2020), "Coronavirus: Retrenchments accelerate in Indonesia's textile sector." Available at: https://www.straitstimes.com/asia/se-asia/retrenchments-accelerate-in-indonesias-textile-sector
668 World Economic Forum (2020), "How the textile industry can help countries recover from COVID-19." Available at: https://www.weforum.org/agenda/2020/08/how-the-textile-industry-can-help-countries-recover-from-covid-19/
669 GlobalData (2020), "Construction industry growth in Indonesia to slow down to 0.5% in 2020, says GlobalData." Available at: https://www.globaldata.com/construction-industry-growth-in-indonesia-to-slow-down-to-0-5-in-2020-says-globaldata/
670 The Jakarta Post (2020), "Analysis: COVID-19 impact on construction sector." Available at: https://www.thejakartapost.com/news/2020/05/06/analysis-covid-19-impact-construction-sector.html
671 The Straits Times (2020), "Indonesia eyes growth rebound with exit from coronavirus lockdowns." Available at: https://www.straitstimes.com/asia/se-asia/indonesia-eyes-growth-rebound-with-exit-from-coronavirus-lockdowns
672 World Economic Forum (2020), "The plastic pandemic is only getting worse during COVID-19." Available at: https://www.weforum.org/agenda/2020/07/plastic-waste-management-covid19-ppe/
673 The Jakarta Post (2020), "COVID-19: Jakarta's trash output decreases as residents stay at home." Available at: https://www.thejakartapost.com/news/2020/04/09/covid-19-jakartas-trash-output-decreases-as-residents-stay-at-home.html
674 The Jakarta Post (2020), "Jakarta's trash output down during COVID-19 but environmentalists warn of possible increase." Available at:

- **E-waste.** A fall in household income could lead to lower demand for consumer electronics, thereby, decreasing the generation of e-waste. However, a greater share of formal workers working from home and an accompanying shift toward digitisation could increase e-waste volumes.[675] It is unclear whether the fall in e-waste due to lower incomes could offset the expected rise in e-waste due to greater digitisation.

As demonstrated above, it is unclear how waste volumes could change in the short-term and especially in the long-term for the five focus sectors due to COVID-19. While lower household incomes could decrease waste volumes, sector-specific shifts (e.g., the move toward "working from home") could increase waste volumes. Apart from waste volumes, COVID-19 could also decrease recycling rates, at least in the short-term. For example, as of June 2020, only 60-80 percent of plastic waste recyclers were operating in Indonesia.[676] Hence, due to the complexity and lack of robust estimates, this report did not take into account the effect of COVID-10 on the waste volumes in Indonesia in 2030 and hence, on the impact of the circular economy on Indonesia in 2030.



https://www.thejakartapost.com/news/2020/05/01/jakartas-trash-output-down-during-covid-19-but-environmentalists-warn-of-possible-increase.html
675 The Rising (2020), "Will Social Distancing Increase E-Waste? Here's How This IT CEO Is Preparing For The Possibility." Available at: https://therising.co/2020/04/23/social-distancing-increase-e-waste-sagent-ceo-preparing-for-possibility/
676 Circulate Capital (2020), *Safeguarding the Plastic Recycling Value Chain: Insights from COVID-19 impact in South and Southeast Asia.* Available at: https://1b495b75-5735-42b1-9df1-035d91de0b66.filesusr.com/ugd/77554d_6464ccce8ff443b1af07ef85f37caef5.pdf

Annex 3: Methodology for selecting priority sectors for analysis

A consistent approach to the Ellen Macarthur Foundation was used to prioritise sectors of focus for this analysis.[677] This considered three main areas:

- **Economic potential.** This measures the importance of the sector for Indonesia's economic development, including GDP and jobs.

- **Circularity potential.** This measures the potential of the sector to benefit from a circular economy approach. It considers factors such as the material intensity of production, the waste volumes, the unrecovered waste, and whether there are international examples of successful circular approaches in that sector.

- **Level of stakeholder support.** This measures the degree of Government and private sector support for a circular approach in that sector. From a government perspective, government strategy documents were analysed, and interviews with key policymakers were carried out, to understand the importance of the sector for future development plans. From a private sector perspective, the existing levels of business engagement on circularity issues were assessed, which included interviews with various business groups such as the Indonesia Business Council for Sustainable Development (IBCSD).

Ten indicators within these three areas were used to prioritise sectors (Exhibit A25), with a clear scoring methodology used for each criterion (Exhibit A26). Based on this methodology, five sectors were prioritised (Exhibit A27).

677 Ellen Macarthur Foundation (2017), *Delivering the circular economy: a toolkit for policymakers*. Available at: https://www.ellenmacarthurfoundation.org/resources/apply/toolkit-for-policymakers

Exhibit A25

Sector potential to benefit from circularity was based on 10 indicators in three areas

Indicator	Definition / rationale	Source
1. Economic potential		
5Y average Gross Value Added (GVA)	Measures sector's contribution to GDP net of input costs - 5Y average taken to smooth out volatilities, 2014-2018	Statistics Indonesia
4Y CAGR of GVA	Compound annual growth rate of GVA over 4 years, 2014-2018	Statistics Indonesia
5Y average total employment	Measures sector's importance in providing jobs - 5Y average taken to smooth out volatilities	Statistics Indonesia
4Y CAGR of total employment growth	Compound annual growth rate of sector's total employment over 5 years	Statistics Indonesia
2. Circularity potential		
Material intensity	Qualitative assessment of materials as a share of the sector's turnover to reflect how dependent the sector is on physical resources	Qualitatively assessed
Waste volumes	Reflection of amount of waste generated by the sector annually	Ellen MacArthur - Denmark pilot as proxy[1]
Share of waste unrecovered	Indication of proficiency to recover waste material in the sector and potential to improve	Ellen MacArthur - Denmark pilot as proxy[1]
Circularity potential	Based on Ellen MacArthur Foundation's assessment of ReSOLVE action areas by sectors in Europe. "High" priority is given a score of 10, "Middle" priority is given a score of 5, and "Low" priority is given a score of 1	Ellen MacArthur – Europe assessment as proxy[1]
3. Level of stakeholder support		
Government priority	The more important the sector is to the government, the likelier the potential for public funding in the sector going forward	Qualitatively assessed through desktop research, interviews with officials
Private sector	Measures the level of private sector involvement on sustainbility / circular economy within each sector through company or industry wide initiatives. The more engaged the private sector, the more opportunities for partnerships and risk sharing in investments	Qualitatively assessed through desktop research, interviews with industry

1 Ellen MacArthur (2015), Delivering the circular economy, a toolkit for policymakers
SOURCE: Ellen MacArthur Foundation

Exhibit A26

Each sector in Indonesia was assessed based on the following scoring criteria

Indicator	High = score of 10	Medium = score of 5	Low = score of 1	Weight
Economic potential (a)				
5Y average Gross Value Added (GVA)	>7% of total GVA	3 - 7% of total GVA	<3% of total GVA	0.25
4Y CAGR of GVA	>7%	3 - 7%	<3%	0.25
5Y average total employment	>5% of total employment	2 - 5% of total employment	<2% of total employment	0.25
4Y CAGR of total employment growth	>7%	3 - 7%	<3%	0.25
Circularity potential (b)				
Material intensity	High material intensity	Medium material intensity	Low material intensity	0.25
Waste volumes	Waste generated >10% of total	Waste generated 1-10% of total	Waste generated <1% of total	0.25
Share of waste unrecovered	>50% unrecovered	20 - 50% unrecovered	<20% unrecovered	0.25
Circularity potential[1]	Average score in the 6 areas >35	Average score in the 6 areas between 28 and 35	Average score in the 6 areas <28	0.25
Level of stakeholder support (c)				
Government priority	Mentioned more than once in future govt. plans	Mentioned once in future govt. plans	Not mentioned in future govt. plans	0.5
Private sector	Strong evidence of initiative by firms or industry associations	Some evidence of initiative by firms or industry associations	No evidence of initiative by firms or industry associations	0.5
Overall assessment				
Sum of sector's weighted scores (a + b + c)	Sectors are then ranked based on their total weighted scores			

1. Based on Ellen MacArthur Foundation's assessment of ReSOLVE action areas by sectors in Europe. "High" priority is given a score of 10, "Middle" priority is given a score of 5, and "Low" priority is given a score of 1. See page 55 of Ellen MacArthur (2015), Delivering the circular economy, a toolkit for policymakers.

SOURCE: Ellen MacArthur Foundation; expert interviews; focus group discussions

Exhibit A27

5 priority sectors were identified

Sector	GVA	GVA growth	Employment	Employment growth	Material intensity	Waste volume	Unrecovered waste	Circularity potential	Government priority	Private sector	Overall rank
Food and beverage											1
Textile, apparel, footwear, leather											2
Construction											3
Wholesale and retail trade											4
Electronics and computers											5
Agriculture, Forestry, and Fisheries											6
Transport equipment											7
Wood, paper products											8
Information and Communications											9
Rubber, plastic, basic metals											10
Medicinal chemical and pharmaceuticals											11
Provision of Accommodation and Eating Drinking											12
Transportation and Warehousing											13
Mining and Quarrying											14
Government Administration, Defense and Social Security											15
Electricity and gas procurement											16
Coke, refined petroleum, chemical products											17
Machinery and equipment + repairs											18
Water Supply, Waste Management, Waste and Recycling											19
Furniture											20
Health Services and Social Activities											21
Educational Services											22
Financial Services and Insurance											23
Real Estate											24

SOURCE: BPS; Bank Indonesia; Ellen MacArthur Foundation; expert interviews; focus group discussions

Annex 4: Methodology for sizing environmental impact in each sector

For the purpose of this report, the reference years for the analysis were 2019 and 2030. All monetary estimates were based on 2018 prices.

ESTIMATING ENVIRONMENTAL IMPACTS

Environmental impacts were quantified in three areas: core resource savings, CO_2e emissions avoided, and water savings.

(i) Quantifying core resource savings

Core resource savings for each opportunity were defined as the *difference* in savings in 2030 between a circular economy scenario and one where the relevant stakeholders do not actively pursue the opportunity ("business-as-usual" scenario). The "business-as-usual" (BAU) scenario was defined as the scenario where waste generation in Indonesia grows based on historical rates and its recycling, refurbishment, and reuse rates of resources (wherever applicable) remain unchanged until 2030.

The core resource savings and units of measurement for each focus sector were standardised for comparability and aggregation purposes, namely: food loss and waste (Food & beverage sector), textile waste (Textile sector), construction and demolition or C&D waste (Construction sector), plastic packaging waste (Wholesale and retail trade sector), and e-waste (Electrical and electronic equipment sector).

The general approach involved defining the total opportunity space in the "business-as-usual" scenario, such as obtaining an estimation of the total food loss in the post-harvest stage in 2030, and applying adoption rates on the reduction, reuse, or recycling of the core resource.

Since benefits from exercising circular economy opportunities can potentially overlap, the team has calculated the sizing of resource savings by making sure that the benefits from the opportunities were as mutually exclusive as possible.

The resource savings were sized in the same order for each sector. The "Reduce" opportunities were sized first. After the "Reduce" opportunities the "Reuse", "Renew", and "Recycle" opportunities were sized in this order. This order ensured that the savings were as mutually exclusive as possible, and it prioritised "Reduce" over "Recycle". For example, in the textile sector, the order of opportunities is: "Reduce waste in production", "Reuse products", "Use more sustainable materials", and finally "Recycle products".

A range of data sources, including existing literature, academia, and expert interviews from both the public and private sectors, were used in the process. Table A1 summarises the sizing approach and data sources for each identified opportunity.

Table A6

Sizing approach
FOOD & BEVERAGE
Total food loss and waste in 2030 under the "business-as-usual" (BAU) scenario
▪ The Ministry of Environment and Forestry estimated that the total waste generated in Indonesia in 2019 could be 67.1 million tonnes.[678] This waste refers to household and household-related waste. Apart from households (62 percent), this waste generated includes waste from other sources. For instance, traditional markets (13 percent), commercial centres (7 percent), and offices (5 percent). This waste does not include industrial waste. ▪ According to Indonesia's waste composition in 2018,[679] food waste represents 44 percent of the total waste. According to the Ministry of Environment and Forestry, this food waste includes only the food loss and waste at the supply chain and consumption stages.[680] This implies that the supply chain and consumption stage food loss and waste totalled to 29.5 million tonnes in 2019. ▪ The World Resources Institute's (WRI) estimated that food loss and waste at the supply chain and consumption stages makes up 35 percent of all food loss and waste in South and Southeast Asia.[681] Hence, the total food loss and waste in 2019 in Indonesia was estimated to be 84 million tonnes. ▪ It was assumed that food loss and waste would grow at the same rate as the growth in food demand. Based on a joint study published by FAO, WFP, and Bappenas, Indonesia's food demand was estimated to grow at 4.03 percent[682]. Therefore, the total food loss and waste under a BAU scenario in 2030 was estimated to be 130 million tonnes respectively. ▪ WRI states that 32 percent of the food loss is generated under agricultural production in South and Southeast Asia.[683] Since this report was not concerned with food loss at the production stage, this number was excluded. The total food waste relevant for this analysis in 2019 and 2030 under the BAU scenario was therefore 57 million tonnes and 89 million tonnes respectively. ▪ Rising incomes could imply that a greater share of food loss and waste in Indonesia could be generated during the supply chain and consumer-stages of the value chain in 2030. Analysis from WRI shows that countries with higher income per capita tend to generate a greater share of their food loss and waste in the supply chain and consumer-stages of the value chain.[684] For the purpose of this analysis, due to uncertainty on how the food loss and waste pattern may change in Indonesia, it was assumed that the share of waste produced in the value chain in Indonesia would remain unchanged between 2019 and 2030. This implies that the economic impact of a circular economy could also be an under-estimate since the value of food loss and waste is the highest at the consumer stage.
Opportunity 1: Reduce post-harvest food loss
▪ WRI estimated that the share of food loss generated at the post-harvest stage in South and Southeast Asia could be 33 percent.[685] This implies that Indonesia's potential food loss under BAU in the post-harvest stage could be around 43 million tonnes. ▪ **Circular economy (CE) scenario**: Pilot efforts in Benin, Cape Verde, India, and Rwanda have documented reductions of food loss by more than 60 percent during field trials of a variety of low-cost storage techniques and handling practices.[686] Assume that Indonesia will achieve 50 percent reduction in food loss and waste at the post-harvest stage and meet its 2030 target set by the Food Loss and Waste Action Partnership of reducing its food loss and waste by 50 percent by 2030.[687] This implies Indonesia could reduce food loss by 21.5 million tonnes.

678 Ministry of Environment & Forestry (2020), Pengelolaan Sampah Indonesia.
679 Tahar, Novrizal, Dr. (2019), *Pengelolaan Sampah Plastik*. Available at https://tppkk-pusat.org/wp-content/uploads/2019/03/Kementerian-Lingkungan-Hidup-dan-Kehutanan-RI.pdf
680 Based on input provided by the Ministry
681 WRI (2019), *Reducing food loss and waste*. Available at: https://wriorg.s3.amazonaws.com/s3fs-public/reducing-food-loss-waste-global-action-agenda_1.pdf
682 FAO (2018), *Modeling the Future of Indonesian Food Consumption: Final Report*. Available at: https://docs.wfp.org/api/documents/WFP-0000073426/download/?_ga=2.46106605.892631223.1602655951-1604445244.1602655951
683 WRI (2019), *Reducing food loss and waste*. Available at: https://wriorg.s3.amazonaws.com/s3fs-public/reducing-food-loss-waste-global-action-agenda_1.pdf
684 WRI (2019), Reducing food loss and waste. Available at: https://wriorg.s3.amazonaws.com/s3fs-public/reducing-food-loss-waste-global-action-agenda_1.pdf
685 WRI (2019), *Reducing food loss and food waste*. Available at: https://wriorg.s3.amazonaws.com/s3fs-public/reducing-food-loss-waste-global-action-agenda_1.pdf
686 World Food Logistic Organization (2010), *Identification of appropriate postharvest technologies for improving market access and incomes for small horticultural farmers in Sub-Saharan Africa and South Asia. Part 2: Postharvest Loss Assessments.*
687 WBCSD (2018), "New Partnership Aims to Drastically Cut Food Loss and Waste in Indonesia". Retrieve from: https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/News/New-Partnership-Aims-to-Drastically-Cut-Food-Loss-and-Waste-in-Indonesia

Opportunity 2: Reduce food loss and waste in the supply chain

- The supply chain stage includes processing, distribution, and market stages. The WRI estimated that the average share of total food loss and waste which is generated at the supply chain stage in South Asia and Southeast Asia could be 24 percent.[688] This implies that Indonesia's potential loss and waste under BAU in the supply chain stage could be around 31.3 million tonnes.
- **Circular economy (CE) scenario**: Pilot efforts in Ireland have shown that food loss and waste during the supply chain stage could be reduced by up to 90 percent.[689] Researchers have also demonstrated that countries can decrease food loss and waste in supply chains by at least 50 percent.[690] Assume that Indonesia matches the reduction seen in global case studies and achieves the 50 percent reduction in food loss and waste at the supply chain stage and meet its 2030 target set by the Food Loss and Waste Action Partnership of reducing its food loss and waste by 50 percent by 2030[691,692]. This implies Indonesia could reduce food loss and waste by 15.7 million tonnes.

Opportunity 3: Reduce consumer food waste

- The WRI estimated that the average share of food waste which is generated at the consumption stage in South Asia and Southeast Asia could be 11 percent.[693] This implies that Indonesia's potential waste under BAU in the consumption stage could be around 14.3 million tonnes.
- **Circular economy (CE) scenario**: Global studies have shown that food waste during the consumer-stage could be reduced by 12 to 57 percent through the adoption of levers, such as creating information campaigns, changing nutritional guidelines, improving hotel signage, and reducing plate size.[694] Assume that Indonesia will achieve 50% reduction in food waste at the consumption stage and meet its 2030 target set by the Food Loss and Waste Action Partnership of reducing its food loss and waste by 50 percent by 2030[695]. This implies Indonesia could reduce food waste by 7.2 million tonnes.

Opportunity 4: Process food loss and waste

- Total food loss and waste (from the post-harvest, supply chain and consumption stages) remaining for processing is around 44.3 million tonnes – based on Indonesia's total potential food loss and waste in 2030, net of CE scenarios in opportunities 1,2, and 3.
- **Circular economy (CE) scenario**: Current share of waste in Indonesia used for composting and biogas/fuel purposes was used as a proxy for its current food loss and waste recycling rate (11 percent).[696] The current food waste recycling rate for composting and energy purposes in the US is 25 percent.[697] The current food waste recycling rate in Singapore is 18 percent.[698] Since the context in the US and Singapore are different from that in Indonesia, it was assumed that Indonesia would be able to increase its food loss and waste recycling rate from 11 percent to 15 percent. Hence, incremental food loss and waste recycled could be nearly 1.8 million tonnes.

688 WRI (2019), *Reducing food loss and food waste*. Available at: https://wriorg.s3.amazonaws.com/s3fs-public/reducing-food-loss-waste-global-action-agenda_1.pdf
689 PAC Food Waste (2015), *Food waste reduction case studies*. Available at: http://www.pac.ca/Programs/FW/Documents/2014-foodwaste-casestudies.pdf
690 Kummu et al (2012), *Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use*. Available at: https://www.sciencedirect.com/science/article/pii/S0048969712011862
691 Packaging Consortium (2015). Available at: https://www.pac.ca/Programs/FW/Documents/2014-foodwaste-casestudies.pdf
692 WBCSD (2018), "New Partnership Aims to Drastically Cut Food Loss and Waste in Indonesia". Retrieve from: https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/News/New-Partnership-Aims-to-Drastically-Cut-Food-Loss-and-Waste-in-Indonesia
693 WRI (2019), *Reducing food loss and food waste*. Available at: https://wriorg.s3.amazonaws.com/s3fs-public/reducing-food-loss-waste-global-action-agenda_1.pdf
694 Christian Reynolds et al (2019), *Review: Consumption-stage food waste reduction interventions – What works and how to design better interventions*. Available at: https://www.researchgate.net/publication/330564419_Review_Consumption-stage_food_waste_reduction_interventions_-_What_works_and_how_to_design_better_interventions
695 WBCSD (2018), *New Partnership Aims to Drastically Cut Food Loss and Waste in Indonesia*. Retrieve from: https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/News/New-Partnership-Aims-to-Drastically-Cut-Food-Loss-and-Waste-in-Indonesia
696 Tahar, Novrizal, Dr. (2019), *Pengelolaan Sampah Plastik*. Available at https://tppkk-pusat.org/wp-content/uploads/2019/03/Kementerian-Lingkungan-Hidup-dan-Kehutanan-RI.pdf
697 United States Environmental Protection Agency, *Facts and Figures about Materials, Waste and Recycling*. Available at: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/food-material-specific-data
698 NEA, "Food Waste Management." Available at: https://www.nea.gov.sg/our-services/waste-management/3r-programmes-and-resources/food-waste-management

TEXTILES AND APPAREL

Total textile waste in 2030 under the BAU scenario

- According to Indonesia's Ministry of Environment and Forestry, in 2018, textile waste represented three percent of Indonesia's household and household-related waste.[699] Since household and household-related waste does not include industrial waste, the post-consumer textile waste in Indonesia in 2019 was estimated to be two million tonnes.
- According to the Ellen MacArthur Foundation, pre-consumer textile waste accounts for 12 percent of total textile waste.[700] Due to lack of Indonesia-specific data, this number was used as a proxy for the share of the pre-consumer textile waste in the total textile waste. Hence, the pre-consumer textile waste in Indonesia in 2019 was estimated to be 0.28 million tonnes and the total textile waste in Indonesia in 2019 was 2.3 million tonnes.
- It was assumed that Indonesia's pre-consumer textile waste would grow at the same rate as the expected growth in the textile sector. By using the projected growth rate of 5.1 percent for Indonesia's textile sector as a proxy for growth in waste volumes, pre-consumer textile waste was estimated at around 0.5 million tonnes in 2030.[701]
- The remaining 88 percent of textile waste is post-consumer waste. It was assumed that post-consumer waste is likely to grow at the country's forecasted GDP growth rate of 4.92 percent. This amounted to 3.5 million tonnes in 2030.[702]
- Total estimated textile waste (sum of pre and post-consumer waste) in 2030 is around 3.9 million tonnes under the BAU scenario.

Opportunity 1: Reduce waste in production

- **Circular economy (CE) scenario**: SMART Myanmar's case studies show that it is possible to achieve up to 20 percent resource savings through simple changes in textile production, such as removing unnecessary dummy stitches, removing measurement hand-cut check points, arranging storage system.[703] Assuming Indonesia can reduce its pre-consumer textile waste by 20 percent this implies Indonesia could reduce pre-consumer textile waste by 95,000 tonnes.

Opportunity 2: Reuse products

- It was estimated that 60 percent of textiles are reusable in principle, but 7.5 percent of textiles are lost during the collection process.[704] The current global average reuse rate for clothing is 12 percent. Germany is the best-in-class example of textiles reuse among developed countries – having a collection rate of 70 percent,[705] and 30 percent reuse of the collected textiles. The effective reuse rate in Germany is hence 21 percent. However, the context of Germany is significantly different from Indonesia since Germany is a textile importer and many of the clothes meant for reuse are exported to developing countries for second-hand use.[706] Moreover, there is a lack of data on Indonesia's textile reuse rate. In developing countries, textile reuse tends to be predominant. For example, according to a survey of close to 7,000 respondents in Indonesia, more than half Indonesians pass on their unwanted clothes to their friends/family or donate to charity.[707] Hence, it was assumed that Indonesia's current textile reuse rate is 50 percent.

699 Tahar, Novrizal, Dr. (2019), *Pengelolaan Sampah Plastik*. Available at https://tppkk-pusat.org/wp-content/uploads/2019/03/Kementerian-Lingkungan-Hidup-dan-Kehutanan-RI.pdf
700Ellen MacArthur Foundation (2017), *A new textiles economy: Redesigning fashion's future*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report.pdf
701 Ishaque (2019), "Indonesian textile industry." Available at: http://textilefocus.com/indonesian-textile-industry/
702 Knoema, "Indonesia GDP Growth Forecast 2019-2024 and up to 2060, Data and Charts." Available at: https://knoema.com/yubthm/indonesia-gdp-growth-forecast-2019-2024-and-up-to-2060-data-and-charts
703 Smart Myanmar (2015), *Smart Myanmar: Garment factories improvement program*. Available at: https://www.acmfn.com/wp-content/uploads/2015/09/SMART-Myanmar-Garment-Factories-Improvement-Program.pdf
704Fabricoftheworld, "Why should we recycle". Available at: http://www.fabricoftheworld.com/textile-recycling-understanding-why-and-how/
705 Bartl, Andreas, *Textile Waste*. Available at: https://www.cec4europe.eu/wp-content/uploads/2018/09/Chapter_3.6_Bartl_Fibers.pdf
706 European Environment Agency (2019), Textiles and the environment in a circular economy. Available at: https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-reports/textiles-and-the-environment-in-a-circular-economy/@@download/file/ETC-WMGE_report_final%20for%20website_updated%202020.pdf
707 YouGov (2017), "Fast fashion: 3 in 10 Indonesians have thrown away clothing after wearing it just once." Available at: https://id.yougov.com/en-id/news/2017/12/06/fast-fashion/

- **Circular economy (CE) scenario:** Due to lack of data on textile reuse rates in the developing world, it is assumed that Indonesia would be able to increase its reuse rate from 50 percent to 75 percent in 2030. This implies that Indonesia could reduce post-consumer textile waste by 0.3 million tonnes in 2030.

Opportunity 3: Use more sustainable materials

- This scope of this opportunity was limited to two components: (i) replacing virgin cotton with recycled cotton; and (ii) replacing virgin polyester with recycled polyester.
- For (i), the average global share of cotton used in textiles (25 percent) to Indonesia's textile waste in 2030 was applied,[708] and it was assumed that the amount of waste generated by different textile materials (e.g., virgin cotton) is proportional to the amount of material used in textile production. The current global adoption rate of recycled cotton close to one percent.[709] Due to lack of data for Indonesia, it was assumed that the global averages also apply to Indonesia. IKEA's adoption rate of recycled cotton is 17 percent. [710] Case studies have shown that H&M can produce 20 percent recycled cotton garments,[711] greater than the current average global adoption rate of recycled cotton of one percent. Since overall country adoption rates cannot be compared with those of leading global fashion brands, it was assumed that Indonesia could replace five percent of virgin cotton with recycled cotton. This implies that Indonesia could reduce textile waste by 44,000 tonnes.
- For (ii), it was assumed that the usage of textile fibres in Indonesia is proportional to global averages. Hence, the average global share of polyester in plastic-based fibres (64 percent) to Indonesia's textile waste in 2030 was applied,[712] and it was assumed that there are no supply constraints of recycled polyester. The use of recycled polyester among leading brands such as Adidas and GAP is at 25 percent – greater than the average global adoption rate of recycled polyester at seven percent.[713] Since overall country adoption rates cannot be compared with those of leading global fashion brands, it was assumed that Indonesia could replace 15 percent of virgin polyester with recycled polyester. This implies Indonesia could reduce textile waste by 112,000 tonnes of textile waste.
- **Circular economy (CE) scenario**: Total reduction in textiles waste is 0.16 million tonnes in 2030.

Opportunity 4: Recycle materials

- It was assumed that Indonesia was able to capture opportunities 1, 2, and 3 and the remaining textile waste could be recycled. EMF estimated that 7.5 percent of the textile volume could be lost during textile waste collection.[714] The current global average recycling rate for clothing of 14 percent. [715] However, based on data from the Ministry of Environment and Forestry, 12 percent of all waste is recycled in Indonesia.[716] It was assumed that this rate also applies to textile waste.
- **Circular economy (CE) scenario:** Germany is the best-in-class example of textiles recycling among developed countries – having a collection rate of 70 percent,[717] and 50 percent recycling of the collected textiles. The effective recycling rate in Germany is 35 percent. However, due to the difference in contexts and lack of data in developing countries, it was assumed that Indonesia would be able to achieve its recycling target of 20 percent for municipal solid waste based on the 3R framework.[718] This implies that Indonesia could reduce textile waste by around 0.17 million tonnes in 2030.

708 Ellen MacArthur Foundation (2017), *A new textiles economy: Redesigning fashion's future*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report.pdf
709 Organic Trade Association, "Get the facts about Organic Cotton". Available at: https://ota.com/advocacy/fiber-and-textiles/get-facts-about-organic-cotton
710 IKEA, "100% committed to sustainable cotton". Available at: https://www.ikea.com/us/en/this-is-ikea/sustainable-everyday/100-committed-to-sustainable-cotton-pub7f285ad1
711 Li-Carrillo et al (2016), *Final Report – Recycled Cotton for Gap Inc.* Available at: https://mitsloan.mit.edu/sites/default/files/inline-files/Gap-Report-2016.pdf
712 Ellen MacArthur Foundation (2017), *A new textiles economy: Redesigning fashion's future*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report.pdf
713 Textile Exchange (2017), *Preferred fiber & materials* market report 2017. Available at: https://store.textileexchange.org/wp-content/uploads/woocommerce_uploads/2019/04/Textile-Exchange_Preferred-Fiber-Materials-Market-Report_2017-1.pdf
714 Ellen MacArthur Foundation (2017), *A new textiles economy: Redesigning fashion's future*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report.pdf
715 Ellen MacArthur Foundation (2017), *A new textiles economy: Redesigning fashion's future*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report.pdf
716 Tahar, Novrizal, Dr. (2019), *Pengeloaan Sampah Plastik*. Available at https://tppkk-pusat.org/wp-content/uploads/2019/03/Kementerian-Lingkungan-Hidup-dan-Kehutanan-RI.pdf
717 Bartl, Andreas, *Textile Waste*. Available at: https://www.cec4europe.eu/wp-content/uploads/2018/09/Chapter_3.6_Bartl_Fibers.pdf
718 Damanhuri (2017), *Country chapter: State of the 3Rs in Asia and the Pacific: The Republic of Indonesia*. Available at:

CONSTRUCTION

Total construction and demolition waste in 2030 under the BAU scenario

- Due to the lack of data on the C&D waste in Indonesia, estimates were computed based on waste volumes from other comparable countries. In this case, Vietnam was used as a comparison. The total municipal solid waste (MSW) generated in Vietnam in 2015 was estimated to be 22.4 million tonnes.[719] 13 percent of this waste was C&D waste. Hence, Vietnam generated 2.8 million tonnes of C&D waste in 2015.
- The gross value added (GVA) by the construction sector in Vietnam in 2015 was USD11 billion and that in Indonesia was USD92 billion.[720,721] Based on the assumption that C&D waste is proportional to the GVA in the construction sector, the total C&D waste in Indonesia in 2015 was estimated to be 23.3 million tonnes. It was assumed that Indonesia's C&D waste would grow at the rate of its construction sector. This rate was estimated to be 5.6 percent.[722]
- This implies that Indonesia's C&D waste in 2019 was estimated to be 29 million tonnes and in 2030 to be 52.8 million tonnes.

Opportunity 1: Generate less construction waste through existing processes (Construction)

- This opportunity only applies to new construction and renovations.
- The Environmental Protection Agency (EPA) in the US estimated the breakdown of construction waste as: constructions (10 percent) and demolitions (90 percent).[723] However, developed countries tend to produce greater C&D waste from demolitions due to a greater stock of building that they possess. Hence, data from a developing country was used as a proxy for Indonesia due to the absence of country-specific data. Based on C&D waste in Bangkok in 2005, constructions and demolitions contributed 26 percent and 74 percent to C&D waste, respectively.[724] Thus, the total C&D waste due to new constructions in Indonesia in 2030 was estimated to be 13.6 million tonnes.
- WRAP UK estimated that up to 30 percent of construction materials that end up as waste is never actually used on a construction site.[725] It was assumed that this percentage holds for construction sites globally.
- **Circular economy (CE) scenario:** Assuming that Indonesia can match the reduction in construction waste as seen in best practice case studies (e.g., by implementing a stepwise-incentive system by 23 percent[726]), the construction waste avoided could be around 0.9 million tonnes.

Opportunity 2: Generate less construction waste through new processes (Construction)

- This opportunity only applies to new construction and renovations.
- This opportunity quantifies the potential benefits of three increasingly popular construction processes – (i) 3D printing, (ii) modular construction, and (ii) building information modelling (BIM). The sizing of each new process was done sequentially – in other words, the effort was taken to ensure that the total benefits do not exceed the available opportunity space.
- This opportunity only applies to new construction and renovations.

https://www.uncrd.or.jp/content/documents/5689[Nov%202017]%20Indonesia.pdf
719 Nguyen (2018), *Current status of construction and demolition waste management in Vietnam: Challenges and opportunities*. Available at: https://www.geomatejournal.com/sites/default/files/articles/23-29-7194-Ken-Dec-2018-52-g1.pdf
720 General Statistics Office of Vietnam. "Gross domestic product at current prices by types of ownership and by kinds of economic activity."
721 Bank Indonesia. "Gross Domestic Product by Industrial Origin at Current Price." Available at: https://www.bi.go.id/en/iru/economic-data/real-sector/Contents/Default.aspx
722 ResearchandMarkets (2020), Construction in Indonesia - Key Trends and Opportunities to 2024. Available at: https://www.researchandmarkets.com/reports/5006614/construction-in-indonesia-key-trends-and
723 U.S. Environmental Protection Agency (2017), "Sustainable Management of Construction and Demolition Materials." Available at: https://www.epa.gov/smm/sustainable-management-construction-and-demolition-materials
724 Thongkamsuk et al (2017), *Waste generated in high-rise buildings construction: A current situation in Thailand*. Available at: https://isiarticles.com/bundles/Article/pre/pdf/150858.pdf
725 Steel Construction Info, *Construction and demolition waste*. Available at: https://www.steelconstruction.info/Construction_and_demolition_waste#Waste_and_Resources_Action_Programme_.28WRAP.29
726 Vivian Tam & C.M. Tam (2007), Waste reduction through incentives: a case study. Available at: https://www.tandfonline.com/doi/abs/10.1080/09613210701417003?src=recsys&journalCode=rbri20

- This opportunity quantifies the potential benefits of three increasingly popular construction processes – (i) 3D printing, (ii) modular construction, and (ii) building information modelling (BIM). The sizing of each new process was done sequentially – in other words, the effort was taken to ensure that the total benefits do not exceed the available opportunity space.
- For (i), studies have shown that 3D printing can reduce material waste by 30 percent.[727] Based on interviews with Indonesian construction experts and literature review, it was assumed that the current adoption rate of 3D printing is close to zero. For the CE scenario, due to the difference in contexts, it was assumed that Indonesia could match one-fifth of the ambitious target set by Dubai to deploy 3D printing in 25 percent of new construction activities by 2030 (i.e., the effective adoption rate of five percent in new constructions for Indonesia).[728] The effective construction waste savings for Indonesia would be around 1.5 percent (30 percent savings of waste at five percent adoption).
- For (ii), studies have shown that modular construction can reduce construction waste by 50 percent.[729] Our interviews with Indonesian construction experts and literature review also revealed that existing modular construction adoption is negligible in Indonesia. For the CE scenario, it was assumed that Indonesia could match half of China's current adoption rate of six percent.[730]
- For (iii), studies have shown that BIM can reduce construction waste by 45 percent.[731] Our interviews with Indonesian construction players and literature review further revealed that current BIM adoption is nearly zero in Indonesia[732]. In developed countries like the US, UK, Singapore, and South Korea, the adoption rate of BIM is close to 70 percent.[733] Due to the difference in contexts between Indonesia and these countries, for the CE scenario, it was assumed that Indonesia could achieve an adoption rate of 20 percent by 2030.[734]
- **Circular economy (CE) scenario:** Totalling the three processes described above implies that Indonesia could save 1.5 million tonnes of construction waste.

Opportunity 3: Use more sustainable materials (Construction)

- This opportunity only applies to new construction and renovations.
- C&D waste could be reduced by replacing (i) concrete with timber, and (ii) steel with higher strength steel.
- For (i), research shows that concrete waste represents around 66 percent of all construction waste.[735] Based on a survey in Pondokrejo village, 47 percent of all residents were living in *joglo*, or traditional wooden-based houses.[736] This rate is likely to be lower for urban areas. Hence, it was assumed that across Indonesia, the current share of construction materials occupied by wood is 10 percent. Moreover, it was assumed that it matches the share of residential builds that use wood construction in Germany of 15 percent in 2030,[737] the amount of concrete waste that could be avoided is 0.06 million tonnes. It was assumed that the reduction in concreted-related construction waste is proportional to the reduction in the use of concrete and that the wood used in place of concrete could be repurposed, thus avoiding further waste generation. Despite the difference in contexts between Indonesia and Germany, due to the prevalence of use of wood-based materials in construction in Indonesia, it was assumed that Indonesia could match Germany's adoption rates in 2030.

727 Ghaffar, et al (2018), *Additive manufacturing technology and its implementation in construction as an eco-innovative solution.* Available at: https://www.sciencedirect.com/science/article/pii/S0926580517309731
728 3D Printing Industry, "Immensa Technology Labs files patent for 3D printed construction in Dubai." Available at: https://3dprintingindustry.com/news/immensa-technology-labs-files-patent-3d-printed-construction-dubai-134247/
729 WRAP, *Waste Reduction Potential of Offsite Volumetric*, Available at: https://www.wrap.org.uk/sites/files/wrap/VOLUMETRIC%20-%20Full%20case%20study.pdf
730 McKinsey & Company (2019), *Modular construction: From projects to products.* Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/modular-construction-from-projects-to-products
731 Immotef (2019), *BIM as a waste reduction solution.* Available at: https://www.immotef.com/news/2019/8/27/bim-as-a-waste-reduction-solution
732 Noor Akmal Adillah Ismail et al (2017), *An overview of BIM uptake in Asian developing countries.* Available at: https://aip.scitation.org/doi/pdf/10.1063/1.5011596
733 Kim et al (2020), *Building Information Modelling Feasibility Study for Building Surveying.* Available at: https://www.mdpi.com/2071-1050/12/11/4791/pdf
734 Geospatial World (2018), "BIM adoption around the world: how good are we?" Available at: https://www.geospatialworld.net/article/bim-adoption-around-the-world-how-good-are-we/
735 Begum, et al, *A benefit–cost analysis on the economic feasibility of construction waste minimisation: The case of Malaysia. Available at:* https://www.researchgate.net/publication/223914276_A_benefit_cost_analysis_on_the_economic_feasibility_of_construction_waste_minimisation_The_case_of_Malaysia
736 Wibawa (2020), *The existence of joglo houses owned by Javanese farmers: A case of Pondokrejo village, Rembang.* Available at: https://iopscience.iop.org/article/10.1088/1755-1315/402/1/012019/pdf#:~:text=Based%20on%20the%202009%20Pondokrejo,to%20live%20with%20its%20characteristics.
737 Hildbrandt, et al (2017), *The contribution of wood-based construction materials for leveraging a low carbon building sector in Europe.* Available at: https://www.sciencedirect.com/science/article/pii/S2210670716305923

- For (ii), around one percent of construction waste is steel.[738] The use of high-strength steel could reduce the weight of total steel used by 30 percent.[739] Currently, the amount of high-strength steel usage is very low in Indonesia (i.e., assumed to be 0 percent). The share of high-strength steel to total steel market is around five percent.[740,741] It was assumed that the share of value is proportional to the share of usage. Assuming Indonesia achieves five percent usage of high-strength steel, this implies a reduction of 218 tonnes in the construction waste associated with steel usage in 2030. It was assumed that a reduction in steel leads to a proportional reduction in construction waste associated with steel usage.
- **Circular economy (CE) scenario:** The total construction materials saved is (i) + (ii) = 0.36 million tonnes.

Opportunity 4: Reuse and recycle materials (Construction)

- The remaining construction waste could be recycled and reused, reaping further resource savings. A study estimated that 95 percent of construction and demolition waste could be reused and recycled.[742]
- **Circular economy (CE) scenario:** Due to lack of data, the reuse and recycling rate of construction and demolition waste for high-rise buildings in Malaysia, at 15 percent, is used as a proxy for the current recycling rate in Indonesia.[743] The C&D rate in China is considered to be around 10 percent and that in developing countries was assumed to be between 70 to 90 percent.[744] Due to the lack of data on developing countries, which could be used as benchmarks, it was assumed that Indonesia would be able to double its current C&D recycling rate to 30 percent. This implies that Indonesia could potentially reduce C&D waste by 7.5 million tonnes in 2030.

Opportunity 5: Optimise building usage (Operational)

- This opportunity quantifies the potential savings in total floor space demanded if Indonesia optimises building usage in the residential, office, and commercial/retail markets.
- **BAU office vacant floor space.** Colliers International estimated that Jakarta had an office supply of 10 million square metres (sqm) in 2019. Indonesia's total office supply is determined by scaling up based on Jakarta's share of national GDP. National office supply in 2030 was estimated based on the CAGR of Jakarta's office supply of 10.1 percent.[745] Using the current vacancy rate in Grade B office space outside CBD in Jakarta (19.7 percent) as a national proxy, the estimated office vacant floor space in 2030 was estimated to be 32 million sqm.
- **BAU residential vacant floor space.** Colliers International estimated that Jakarta had a total stock of 8,860 residential apartment units in 2018. Indonesia's total residential supply is determined by scaling up based on Jakarta's share of national GDP. Colliers International estimated that 847 new residential apartment units will be added in Jakarta between 2019 and 2022. This growth rate was used to estimate the national number of new residential apartment units in 2030. It was assumed that each residential apartment unit has an average floor space of 55 sqm and hence, the estimated residential vacant floor space in 2030 could be two million sqm.
- **BAU retail vacant floor space.** Colliers International estimated that Jakarta had a retail space supply of 4.8 million sqm in 2019. Indonesia's total commercial space supply is determined by scaling up based on Jakarta's provincial GDP. The annual growth rate in retail space supply in Jakarta between 2010 and 2019 is 2.3 percent - this rate is used as a proxy for growth at the national level. It was assumed that Jakarta's current commercial vacancy rate of 24 percent applies country-wide and that it remains unchanged till 2030. This implies that the estimated vacant retail floor space in 2030 in Indonesia is 8.4 million sqm.
- **Circular economy (CE) scenario:** It was assumed that Indonesia could reduce residential, office, and commercial vacant floor space by 50 percent in 2030 and can reduce vacant floor space by 21.2 million sqm.

738 Begum, et al, *A benefit–cost analysis on the economic feasibility of construction waste minimisation: The case of Malaysia. Available at:* https://www.researchgate.net/publication/223914276_A_benefit cost_analysis_on_the_economic_feasibility_of_construction_waste_minimisation_The_case_of_Malaysia
739 BSDC and AlphaBeta (2017), *Valuing the SDG Prize.* Available at: http://s3.amazonaws.com/aws-bsdc/Valuing-the-SDG-Prize.pdf
740 Markets and Markets, *High-strength steel market.* Available at: https://www.marketsandmarkets.com/Market-Reports/high-strength-steel-market-4627428.html
741 Market Research Future (2018), *Steel Market* Research Report - Global Forecast till 2023. Available at: https://www.marketresearchfuture.com/reports/steel-market/toc
742 Chinda and Doan, *Modelling construction and demolition waste recycling program in Bangkok: Benefit and cost analysis.* Available at: https://www.researchgate.net/publication/303889493_Modeling_Construction_and_Demolition_Waste_Recycling_Program_in_Bangkok_Benefit_and_Cost_Analysis
743 Esa et al (2017), *Strategies for minimizing construction and demolition wastes in Malaysia.* Available at: https://www.sciencedirect.com/science/article/abs/pii/S0921344916303901
744 Zhang and Tan (2020), *Demolition waste recycling in China: New evidence from a demo*lition project for highway development. Available at: https://journals.sagepub.com/doi/abs/10.1177/0734242X20904440
745 Colliers International (2018), Jakarta Property Market Report. Available at: https://www.colliers.com/-/media/files/marketresearch/apac/indonesia/Q2-2018-ColliersQuarterly-Jakarta.pdf?la=en-GB

Opportunity 6: Design and build more resource-efficient buildings (Operational)

- This opportunity quantifies the potential energy savings through more efficient energy use in buildings. The International Energy Agency (IEA) estimated that buildings in Indonesia consumed 425 petajoules of energy in 2012.[746] This could grow to nearly 1000 petajoules in 2030, based on IEA estimates of energy demand in Southeast Asia between 2015 and 2030.[747]
- **Circular economy (CE) scenario:** IEA estimated that a "sustainable development scenario" could reduce energy demand by 28 percent in Southeast Asia in 2030. This number was used as a proxy for the reduction in building energy demand under a circular economy scenario in Indonesia in 2030, implying energy savings of almost 80,000 million kWh.

WHOLESALE AND RETAIL TRADE (PLASTICS)

Total plastic packaging waste in 2030 under the BAU scenario

- The Global Plastic Action Partnership (GPAP) estimated that Indonesia will generate 8.7 million tonnes of plastic in 2025 and estimated that the annual growth of plastic waste generated in Indonesia between 2025 and 2040 could be three percent.[748] It should be noted that for the scope of this research, only plastic waste from MSW was considered. Plastic waste from land-based and sea-based sources was not considered. Moreover, the volumes of plastic packaging waste were calculated based on dirty plastic waste weight and therefore included impurities such as dirt and water. It is likely that 20-30 percent of the total weight of plastic waste is affected, leading to a larger than industry-reported plastic consumption in Indonesia. As a result, actual pure plastic waste generation – and subsequently, plastic leakage - could be lower than this research.
- Using the growth rate to estimate plastic waste growth to 2030, and estimates that packaging accounts for 74 percent of the total plastic use, this implies that total plastic packaging waste in 2030 under the BAU scenario is 7.5 million tonnes.

Opportunity 1: Reduce and reuse plastic packaging

- **Circular economy (CE) scenario:** By eliminating and reusing plastic packaging and adopting new delivery models, GPAP estimated that Indonesia can reduce one million tonnes of plastic packaging waste in 2030.

Opportunity 2: Replace with more sustainable packaging

- **Circular economy (CE) scenario:** By replacing plastic with more sustainable packaging, GPAP estimated that Indonesia can reduce 0.52 million tonnes of plastic packaging waste in 2030.

746 IEA (2015), *Building Energy Performance Metrics*: Available at: https://webstore.iea.org/download/direct/522
747 IEA (2019), *Southeast Asia* Energy Outlook 2019. Available at: https://www.iea.org/reports/southeast-asia-energy-outlook-2019
748 Global Plastic Action Partnership (2020). Based on GPAP's estimates presented in: World Economic Forum (2020), *Radically reducing plastic pollution in Indonesia: A multistakeholder action plan*; National Plastic Action Partnership. Available at: https://globalplasticaction.org/wp-content/uploads/NPAP-Indonesia-Multistakeholder-Action-Plan_April-2020.pdf

Opportunity 3: Redesign plastic packaging for improved recycling

- The plastic packaging waste available for this opportunity is the total BAU amount (6 million tonnes) net of savings under Opportunities 1 and 2. The share of multi-material plastic packaging was estimated to be 23 percent by GPAP.
- **Circular economy (CE) scenario:** The reduction in the share of multi-material packaging in plastic packaging increases the amount of plastic packaging waste available for recycling. Based on GPAP's analysis, the share of multi-materials could fall by 6.32 percent in 2030 due to redesign of plastic. This reduction of 6.32 percent was multiplied with the BAU plastic packaging recycling rate of Indonesia of 12 percent, implying an additional potential to recycle 0.04 million tonnes of plastic packaging waste.

Opportunity 4: Increase recycling rates of recyclable packaging

- The plastic packaging waste available for recycling is the total BAU amount (5.97 million tonnes) net of savings under Opportunities 1,2 and 3. Indonesia's recycling rate for plastic packaging waste was estimated to be 27 percent in 2030.
- **Circular economy (CE) scenario**: This was quantified by applying the difference in current plastic recycling rates (12 percent) and the estimated recycling rate of 27 percent in 2030, to the plastic packaging waste available for recycling. This implies an additional 1.13 million tonnes of plastic packaging waste could be recycled in 2030.

ELECTRICAL AND ELECTRONIC EQUIPMENT

Total e-waste waste in 2030 under the BAU scenario

- Mairizal et al. in a forthcoming paper estimate that Indonesia generated 5.1 kg per capita of e-waste in 2010.[749] This is likely to increase to 8.62 kg per capita by 2030. These estimates imply that Indonesia could generate total e-waste of 2.5 million tonnes in 2030.

Opportunity 1: Increase product lifespan and reduce obsolescence

- A research study surveyed 181 mobile phone owners, aged between 18–25 years old, in the UK. The study suggested that three percent of the mobile phone owners replace their phones because the phone "broke beyond repair".[750] This number could be higher for Indonesia due to the lower quality of mobile phones used by the country's consumers. However, due to lack of country-specific data, it was assumed that this number could be applied to Indonesia's context. Therefore, the amount of e-waste generated due to products reaching the end of their lifespan is around 80,000 tonnes. Research shows that the improvement in the lifespan of electronics by one year leads to a reduction of e-waste by 10 percent.[751]
- **Circular economy (CE) scenario.** The difference in lifespans of mobile phones between those in Europe and Indonesia is 6.2 years.[752] If Indonesia's electronics lifespan matches Europe's by 2030, this implies an e-waste reduction of 25,930 tonnes.

749 Mairizal et al, *Electronic Waste Generation*, Distribution *Map, and Possible Recycling Routes in Indonesia*. Forthcoming.
750Lee, et al (2016), *The hibernating mobile phone: Dead storage as a barrier to efficient electronic waste recovery*. Available at: https://www.sciencedirect.com/science/article/pii/S0956053X16307607
751Kleijn, et al (2002), *Dematerialisation for urban waste reduction: Effectiveness and side-effects*. Available at: https://www.leidenuniv.nl/cml/ssp/publications/wp2001-014.pdf
752Santoso, et al (2019), *Estimating the Amount of Electronic Waste Generated in Indonesia*: Population Balance Model. Available at: https://iopscience.iop.org/article/10.1088/1755-1315/219/1/012006/pdf

Opportunity 2: Refurbish and reuse products

- The current share of electronics thrown away due to a lack of a refurbishment and reuse market is 20.3 percent - implied by a consumer survey in the UK based on responses of mobile phone users who replace their phones because "the technology is worn out" or the phone was "no longer clean, shiny or new" or "it cost too much to repair".[753] The same share was applied to Indonesia due to lack of data.
- **Circular economy (CE) scenario.** In the US, refurbished consumer electronics have a market share of 14.5 percent. This is likely to be higher in developing countries like Indonesia, where second-hand electronic goods are widely used. It was assumed that this rate is 20 percent in Indonesia currently and Indonesia can double the rate under the CE scenario to 40 percent. This implies the e-waste reduction could be 101,380 tonnes.

Opportunity 3: Virtualise and dematerialise physical goods

- The potential to virtualise electronics is net of realising Opportunities 1 and 2. In theory, most electronics could be virtualised. However, since cloud computing is the most practical application of virtualisation, it was assumed that this opportunity would apply only to servers and hard drives. Based on the category of electrical and electronic waste under EU-6, it was assumed that servers make up nearly 7% of "Large equipment" and hard drives make up 5% of "Small IT equipment". These equipment make up around 2.2 percent of all electronics.[754]
- The weight of mobile phones has reduced by 10 percent over the last ten years and the weight of TVs has reduced by 110 percent over the same time period.[755] These were used as proxies for the potential dematerialisation of electronics between 2019 and 2030.
- **Circular economy (CE) scenario**. Based on industry interviews, it was reasonable to apply a 10 percent adoption rate to dematerialisation in Indonesia by 2030. In the circular economy scenario, it was assumed that the rate of virtualisation and dematerialisation would equal the historical rate when it might be expected to slow down in the BAU scenario.[756] This implies that the total e-waste reduction could be around 194,000 tonnes.

Opportunity 4: Recycle materials

- The remaining e-waste (net of Opportunities 1,2, and 3) could be recycled. Our modelling shows that around 81 percent of e-waste can be recycled. This percentage was obtained by multiplying the composition of the e-waste with the recyclability of each component of the e-waste. [757]
- E-waste comprises of non-ferrous metals (13 percent), plastics (21 percent), iron & steel (50 percent), and other components and materials (16 percent), such as glass, wood, plywood, PCB, concrete, rubber.[758] In terms of recyclability, 100 percent of non-ferrous metals, 70 percent of plastics, 100 percent of iron & steel, and 20 percent of other components could be recycled.
- **Circular economy (CE) scenario.** Indonesia's increases its current e-waste recycling rate of five percent[759] to match India's e-waste recycling rate of 21 percent.[760] Increased e-waste recycling could reduce an additional 289,000 tonnes of e-waste in Indonesia in 2030.

753 Lee, et al (2016), *The hibernating mobile phone: Dead storage as a barrier* to efficient electronic waste recovery. Available at: https://www.sciencedirect.com/science/article/pii/S0956053X16307607
754 UNU and ITU (2020), *The Global E-waste Monitor* 2020. Available at: https://www.itu.int/myitu/-/media/Publications/2020-Publications/Global-E-waste-Monitor-2020.pdf
755 Closed Loop Foundation and The Sustainability Consortium (2016), *The Electronics Recycling Landscape*. Available at: https://www.sustainabilityconsortium.org/wp-content/uploads/2017/03/TSC_Electronics_Recycling_Landscape_Report-1.pdf
756 The New York Times (2015), "Moore's Law Running Out of Room, Tech Looks for a Successor." Available at: https://www.nytimes.com/2016/05/05/technology/moores-law-running-out-of-room-tech-looks-for-a-successor.html
757 Pinto, Violet, *E-waste hazard: The impending challenge*. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2796756/#!po=35.7143
758 Pinto, Violet, *E-waste hazard: The impending challenge*. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2796756/#!po=35.7143
759 Mairizal et al, *Electronic Waste Generation, Distribution Map, and Possible Recycling Routes in Indonesia*. Forthcoming.
760 The Hindu (2017)," E-waste recycling has doubled, says Centre". Available at: https://www.thehindu.com/news/national/e-waste-recycling-has-doubled-says-centre/article30983383.ece

Core resource savings in their respective units were then expressed in current USD terms. As far as possible, local prices or globally established benchmarks were used, and price discrepancies that may arise in different parts of the sector value chain were accounted for. For example, food loss at the post-harvest stage was priced lower than the food waste at the consumption stage. Moreover, the value gained per tonne of resource from "Reduce" opportunities was higher than "Reuse" and "Recycle" opportunities. This is because the value gained from reuse or recycling of a resource equals the price difference between the virgin and the reused or recycled resource. For the purpose of this analysis, it was assumed that demand is not a constraint. For instance, it was assumed that all recycled plastic packaging waste could be sold in 2030.

Table A2 summarises the prices used.

Table A7

Sector (Opportunity)	Price (USD)	Source
Food (Reduce post-harvest food loss)	166.51 per tonne of food loss saved	BPS and Jensen et al. (2016). Based on the average annual expenditure per tonne of food in Indonesia in 2018 using data from BPS.[761] Used the ratio of post-harvest and retail prices of food in Europe as a proxy (12 percent)[762]
Food (Reduce supply chain food loss and waste)	873.43 per tonne of food loss and waste saved	BPS and Jensen et al. (2016). Assumed that supply chain prices are 60 percent of retail food prices
Food (Reduce consumer food waste)	1393.25 per tonne of food waste saved	BPS
Food (Process food loss and waste)	599.30 per tonne of food loss and waste saved	PwC and Intech. Weighted average of the price of electricity generated from waste-to-energy plants (0.12USD per kWh)[763] and of composts (0.9USD per kg)[764]
Textile (Reduce waste in production)	3000.56 per tonne of textile waste saved	BPS and Techpacker. Based on the average annual expenditure of Indonesians on textiles per tonne using data from BPS[765] and used the ratio of fabric cost to the total textile cost as a proxy (65 percent)[766]
Textile (Reuse materials)	2308.12 per tonne of textile waste saved	BPS. Assumed that the cost of reused textiles is 50 percent of that of new textiles
Textile (Use more sustainable materials)	3000.56 per tonne of textile waste saved	BPS and Techpacker
Textile (Recycle materials)	2308.12 per tonne of textile waste saved	BPS. Assumed that the cost of recycled textiles is 50 percent of that of virgin textiles
Construction (Reduce waste through existing processes)	67.62 per tonne of construction waste saved	Based on the composition of construction waste[767] and the local prices from Statista and Indonesia Investments, the value of one tonne of aggregate construction waste was calculated
Construction (Reduce waste through new processes)	67.62 per tonne of construction waste saved	Statista and Indonesia Investments

761 BPS. "Average Monthly Expenditure per Capita by Commodity Group (rupiahs), 2013-2018."
762 Jensen et al (2016), *Estimates of European food waste levels*. Available at: https://www.researchgate.net/figure/Cost-per-tonne-of-edible-food-waste_tbl5_301216380
763 PwC (2017), *Power in Indonesia: Investment and taxation guide*. Available at: https://www.pwc.com/id/en/energy-utilities-mining/assets/power/power-guide-2017.pdf
764 Intech (2012), *Household Solid Waste Management in Jakarta, Indonesia: A* Socio-Economic Evaluation. Available at: https://core.ac.uk/download/pdf/29223557.pdf
765 BPS. "Average Monthly Expenditure per Capita by Commodity Group (rupiahs), 2013-2018."
766 Techpacker, "Everything You Need To Know About Garment Costing And Pricing". Available at: https://www.techpacker.com/blog/everything-you-need-to-know-about-garment-costing-and-pricing/
767 Rawshan Ara Begum et al (2006), *A benefit–cost analysis on the economic feasibility of construction waste minimisation: The case of Malaysia.*

Sector (Opportunity)	Price (USD)	Source
Construction (Substitute to more sustainable material)	33.81 per tonne of construction waste saved	Statista and Indonesia Investments. Based on weighted average of prices of concrete, sand, steel, and timber. Assumed that sustainable materials are 50 percent cheaper than virgin materials
Construction (Reuse and high-value recycling of components)	33.81 per tonne of construction waste saved	Statista and Indonesia Investments. Assumed that recycled construction materials are 50 percent cheaper than virgin materials
Construction (Optimise building usage)	254.43 per sqm of floor space saved	Colliers International. Based on weighted average of rental prices of offices, residential apartments, and retail space
Construction (Efficient energy consumption for heating and lighting)	0.12 per kWh of energy saved	PwC[768]
Wholesale & retail (Reduce and reuse plastic packaging)	239.1 per tonne of plastic packaging saved	GrandViewResearch and OurWorldinData. Based on average global value of plastic packaging, which was verified by industry representatives, and the estimates from Pew Research for GPAP on the share of value saved by reducing and reusing plastics.
Wholesale & retail (Substitute to more sustainable packaging)	5.88 per tonne of plastic packaging saved	GrandViewResearch, OurWorldinData and Pew Research.
Wholesale & retail (Redesign plastic packaging to improve recyclability)	967.47 per tonne of plastic packaging saved	GrandViewResearch and OurWorldinData. Based on the ratio of the prices of recycled and virgin plastic (there is a difference of 73 percent between price of virgin and reused plastic)
Wholesale & retail (Increasing recycling rate of recyclable packaging)	967.47 per tonne of plastic packaging saved	GrandViewResearch and OurWorldinData. Based on the ratio of the prices of recycled and virgin plastic (there is a difference of 73 percent between price of virgin and reused plastic)
Electrical and electronic equipment (Increase product lifespan and reduce obsolescence)	2128.62 per tonne of e-waste saved	ITU, APEC, and CSI Market. ITU estimates that the global value of raw materials from e-waste is 26.4 billion.[769] Based on the share of material costs in the profit margin of consumer electronics calculated from APEC[770] and CSI Market[771] were calculated to estimate the retail price equivalent of one tonne of e-waste
Electrical and electronic equipment (Refurbish and reuse products)	1064.31 per tonne of e-waste saved	ITU, APEC, and CSI Market. Assumed that reused electronics are 50 percent cheaper than new electronics
Electrical and electronic equipment (Virtualise and dematerialise physical goods)	2128.62 per tonne of e-waste saved	ITU, APEC, and CSI Market.
Electrical and electronic equipment (Recycle materials)	1064.31 per tonne of e-waste saved	ITU, APEC, and CSI Market. Assumed that recycled electronics could be 50 percent cheaper than new electronics

768 PwC (2017), *Power in* Indonesia: Investment and taxation guide. Available at: https://www.pwc.com/id/en/energy-utilities-mining/assets/power/power-guide-2017.pdf
769 UNU and ITU (2020), *The Global E-waste Monitor 2020*. Available at: https://www.itu.int/myitu/-/media/Publications/2020-Publications/Global-E-waste-Monitor-2020.pdf
770 San Andres (2015). *Manufacturing of Consumer Electronic Appliances in Indonesia*. Available at: https://www.apec.org/-/media/APEC/Publications/2015/11/Services-in-Global-Value-Chains-Manufacturing-Related-Services/TOC/Chapter-20-Manufacturing-of-Consumer-Electronic-Appliances-in-Indonesia.pdf
771 CSI Market. "Consumer Electronics Industry Profitability." Available at: https://csimarket.com/Industry/industry_Profitability_Ratios.php?ind=1012

(ii) Estimating carbon emissions avoided and water savings

Consuming fewer resources produces positive environmental impacts. For this assessment, the effects on carbon emissions avoidance and water savings were prioritised, over soil health and other related environmental impacts, and calculated by applying data on carbon emissions and water usage to core resource savings for each circular economy opportunity. Again, an effort was taken to account for discrepancies that could occur in different parts of the sector value chain. Table A3 summarises the environmental data used.

Since not all resources are produced in Indonesia, reducing the use of resources will lead to a reduction of carbon emissions and generate water savings for countries other than Indonesia. For example, if Indonesia were to eliminate its e-waste, some of the emissions reduction would accrue to countries outside Indonesia since many electronics and their sub-components may have been imported from other countries. However, those emission reductions were ignored in this report, i.e., only CO_2e emissions avoided and water savings accrued to Indonesia were considered. These were calculated by the assumed share of resources that were produced and consumed in Indonesia. To calculate the CO_2e emissions avoided, the emissions released during the production of the various products in the five focus sectors (e.g., food, textile, plastic) were estimated. The emissions released during the lifecycle of the products were not used to estimate the impact on the CO_2e emissions due to limited data availability.

It should be noted that only the first-order impact on the CO_2e emissions and water use was estimated in the analysis. For example, the consumer and business savings generated from adopting circular economy opportunities in the F&B sector could be reinvested in other sectors (e.g., in the transportation sector by the businesses or recreation sector by the consumers). The analysis did not estimate the impact on emissions and water use of the reinvestments in those sectors.

Table A8

Resource	CO_2e (tonnes)	Water (m^3)	Source
Food (Reduce post-harvest food loss)	1.5 tonnes per tonne of food loss saved	221 m^3 per tonne of food loss saved	FAO[772]
Food (Reduce supply chain food loss and waste)	2.8 tonnes per tonne of food loss and waste saved	151 m^3 per tonne of food loss and waste saved	FAO
Food (Reduce consumer food waste)	4.7 tonnes per tonne of food waste saved	104 m^3 per tonne of food waste saved	FAO
Food (Process food loss and waste)	0.05 tonnes per tonne of coal production avoided	7.2 m^3 per tonne of coal production avoided	World Nuclear Association[773]
Textile (Reduce waste in production)	20 tonnes per tonne of textile saved	1341 m^3 per tonne of textile saved	EMF[774]
Textile (Reuse products)	20 tonnes per tonne of textile saved	1341 m^3 per tonne of textile saved	EMF
Textile (Use more sustainable materials)	0.3 tonnes per tonne of virgin cotton saved and 0.6 tonnes per tonne of virgin polyester saved	4200 m^3 per tonne of cotton saved and 10 m^3 per tonne of virgin polyester saved	EMF
Textile (Recycle materials)	7 tonnes per tonne of textile saved	473 m^3 per tonne of textile saved	EMF
Construction (Generate less construction waste through existing processes)	0.36 tonnes per tonne of cement saved	4.5 m^3 per tonne of construction waste saved	Scientific American[775] and The Architect's Newspaper[776]

772 FAO (2014), *Food wastage footprint: Full-cost accounting.* Available at: http://www.fao.org/3/a-i3991e.pdf
773 World Nuclear Association. *Comparison of lifecycle greenhouse gas emissions of various electricity* generation sources. Available at: https://www.world-nuclear.org/uploadedFiles/org/WNA/Publications/Working_Group_Reports/comparison_of_lifecycle.pdf
774 Ellen MacArthur Foundation (2017), *A new textiles economy: Redesigning fashion's future.* Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf
775 Scientific American (2019), "CO2 Emissions Will Break Another Record in 2019." Available at: https://www.scientificamerican.com/article/co2-emissions-will-break-another-record-in-2019/
776 The Architect's Newspaper (2019), "Concrete production produces eight percent of the world's carbon dioxide emissions." Available at: https://www.archpaper.com/2019/01/concrete-production-eight-percent-co2-emissions/

Resource	CO_2e (tonnes)	Water (m^3)	Source
Construction (Generate less construction waste through new processes)	0.36 tonnes per tonne of cement saved	4.5 m^3 per tonne of construction waste saved	Scientific American and The Architect's Newspaper
Construction (Use more sustainable material)	0.36 tonnes per tonne of concrete saved and 0.55 tonnes per conventional steel saved	4.5 m^3 per tonne of concrete saved	Scientific American; The Architect's Newspaper; and World Steel
Construction (Reuse and recycle materials)	0.32 tonnes per tonne of cement saved	2.3 m^3 per tonne of construction waste saved	Scientific American and The Architect's Newspaper
Construction (Optimise building usage)	0.36 tonnes per tonne of cement saved	27 m^3 of water per sqm of floor space saved	Scientific American and The Architect's Newspaper
Construction (Design and build more resource-efficient buildings)	150 tonnes per TJ of energy saved		International Energy Agency
Wholesale & retail (Reduce and reuse plastic packaging)	2.150 per tonne of plastic packaging waste saved	183 per tonne of plastic packaging waste saved	SYSTEMIQ and Water Calculator
Wholesale & retail (Replace with more sustainable packaging)	2.150 per tonne of plastic packaging waste saved	183 per tonne of plastic packaging waste saved	SYSTEMIQ and Water Calculator
Wholesale & retail (Redesign plastic packaging to improve recyclability)	1.700 per tonne of plastic packaging waste saved	114 per tonne of plastic packaging waste saved	Plastics Europe and WRAP UK[777]. Subtracted the emissions released and the water used during the production of one tonne of recycled PET
Wholesale & retail (Increasing recycling rate of recyclable packaging)	1.700 per tonne of plastic packaging waste saved	114 per tonne of plastic packaging waste saved	Plastics Europe and WRAP UK. Subtracted the emissions released and the water used during the production of one tonne of recycled PET
Electrical and electronic equipment (Increase product lifespan and reduce obsolescence)	5 per tonne of e-waste saved	2.1 per tonne of e-waste saved	ITU[778]; NatGeo (Based on the amount of water used to manufacture a phone)
Electrical and electronic equipment (Refurbish and reuse products)	5 per tonne of e-waste saved	2.1 per tonne of e-waste saved	ITU; NatGeo (Based on the amount of water used to manufacture a phone)
Electrical and electronic equipment (Virtualise and dematerialise physical goods)	5 per tonne of e-waste saved	2.1 per tonne of e-waste saved	ITU; NatGeo (Based on the amount of water used to manufacture a phone)
Electrical and electronic equipment (Recycle materials)	1 per tonne of e-waste saved	2.1 per tonne of e-waste saved	ITU; NatGeo (Based on the amount of water used to manufacture a phone)

777 WRAP UK, "Plastic". Available at: https://www.wrap.org.uk/content/plastic
778 UNU and ITU (2020), *The Global E-waste Monitor 2020*. Available at: https://www.itu.int/myitu/-/media/Publications/2020-Publications/Global-E-waste-Monitor-2020.pdf

Economic impacts were quantified in two areas: (i) impact on GDP, (ii) impact on jobs, and (iii) impact on household savings.

(i) Modelling for the impact on GDP

Selection of modelling approach to quantify the economic impact

The existing literature documents a range of possible modelling approaches to estimate the impact on GDP, all of which have inherent strengths and weaknesses. Exhibit A28 provides a snapshot of the different approaches. In this analysis, the team has used three approaches (input-output modelling, incremental capital output ratios and system dynamics modelling). The main results presented in the report were based on the input-output modelling approach. Further details are provided below.

Exhibit A28

Three approaches have been used for the economic modelling in this phase

Approaches used in this phase of work

	Partial equilibrium modelling	Econometric modelling	Input-output (IO) modelling	Computational general equilibrium modelling	System dynamics	Agent-based modelling	Incremental capital output ratio (ICOR)
Description	Supply-and-demand models representing a specific sector or market	Statistical model representing based on historical Relationships	Representation of all inputs and outputs for all agents in the economy, including the linkage across different agents	Static or dynamically optimised representation of economic flows across all agents in the economy	Solves the problem of simultaneity (multi causation) by updating all variables in small time increments with positive and negative feedbacks and time delays structuring the interactions and control	Integrated and dynamic representation of decision making of all economic agents	Understands the impact on capital investment and capital productivity to generate GDP estimates
Modelling complexity	Low	Medium	Medium	High	High	High	Medium
When to use this approach	Assessment of single sector only, no need for cross-sector impacts	Short-term forecasting where scenario changes are within historical variations	Assessment of economy-wide impacts is needed through understanding cross sector linkages	Comprehensive assessment of economy-wide impacts including time, price and associated indirect impacts	Very good data availability, including historical data to test insights	When it is important to model explicit behavioural aspects of agents such as government, producers and consumers	Access to data on capital investment rates

SOURCE: Literature review; expert interviews

Annex 5: Methodology for sizing the socio-economic impacts

Econometric modelling and agent-based modelling were ruled out as these approaches have not been used in any recent circular economy impact assessment studies. With circular economy economic impact analysis still very much a nascent field, it is important to build upon and refine existing approaches in order to encourage accounting standardisation. The partial equilibrium model is not ideal because it cannot capture cross-sector impacts nor indirect impacts (e.g., the impact of monetary savings re-invested into another sector).

The computation general equilibrium (CGE) approach accounts for the structure of an economy and behavioural response of its agents (firms, households, government) to provide a comprehensive assessment of the impacts of policies or shocks in the economy.[779] Unfortunately, CGE models are highly complex – the number of variables (e.g., datasets, assumptions of production and consumption functions) required increases exponentially with every additional interdependency the model aims to capture. This poses problems in the context of this study because of data incompleteness, while key modelling parameters such as the responses of economic agents to circularity-induced shocks are not well understood. The consequence is the need to use an excessive number of assumptions and approximations which have resulted in these models often being referred to as "black boxes".[780]

An IO table shows the relationship between an initial shock (e.g., reduced spending on raw materials) and final output across the whole economy. It provides detailed information about the supply and disposition of commodities in an economy and about the structure of inter-relationships between sectors within the economy. The impacts of these inter-relationships between sectors could be measured through output multipliers which are derived from Indonesia's official IO table.[781] An output multiplier refers to the total value of production by all industries of the economy required to satisfy one extra dollar worth final demand for that industry's output. The advantage of this approach is that the derivation and use of these multipliers are transparent and can be communicated effectively. Overall, the IO approach is more transparent and easily understood than the GCE modelling; it is more robust given data availability; and conceptually it is a better method for understanding the impact of a circular economy (as explained in further detail below).

The Incremental Capital Output Ratio (ICOR) is a frequently used tool that explains the relationship between the level of investment made in the economy and the consequent increase in GDP. ICOR indicates the additional unit of capital or investment needed to produce an additional unit of output. It is a useful approach for understanding the impact of a circular economy as a circular economy approach should seek an improvement in capital productivity, driven by raw materials, components, and products retaining their value as much as possible.

System dynamics is a method developed to implement a systems thinking paradigm. Systems thinking is a discipline for seeing an object as system or the structures that underline a complex situation.[782] Application of system dynamics is aimed to learn and understand the complex system, based on theories of non-linear dynamics and feedback control.[783] The object of system dynamics is a closed-loop system or feedback loop system,[784] where the main components of the systems have interconnections and construct feedback loops. This approach and the results are shown in the Annex.

Deep dive on the input-output approach to quantify GDP impact

Indonesia's input-output (IO) model is used to quantify the GDP impact. As explained, this approach is chosen because of several advantages in the Indonesian context, particularly the ease of communication with key stakeholders and greater availability of information. However, since the latest government released IO table is for 2010 (https://www.bps.go.id/statictable/2019/07/08/2057/tabel-input-output-185-produk-2010.html), there are concerns that this may potentially affect the analysis. For example, recent trends such as digitalisation and increased automation of production may have altered the structure of the sector linkages within supply chains. Fortunately, the OECD maintains a database of IO tables for all OECD countries and 28 non-member economies, including Indonesia, covering the years 2005 to 2015.[785] The OECD obtains input-output or supply and use tables from respective national statistical offices and then processes the data to harmonise the structure and sectoral coverage.[786]

779 https://www.gov.scot/publications/cge-modelling-introduction/
780 Queensland Productivity Commission (2018), *Whole-of-economy modelling: beyond the black box*. Available at:
https://qpc.blob.core.windows.net/wordpress/2018/04/Whole-of-economy-modelling.pdf
781 The following publication provides an introduction to the construction, interpretation and usage of IO multipliers: Australian Bureau of Statistics (n.d.), *Information Paper Australian National Accounts: Introduction of Input-Output Multipliers*. Catalogue No. 5246.0. Available at:
http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/FFD0BAE851EDCB8BCA2570C9007ECE04/DFile/52460+-+Information+Paper+-+Introduction+to+Input+Output+Multipliers.pdf
782 Senge, P. (1990), The Fifth Discipline: *The Art and Practice of the Learning Organization*. Random House. London
783 Sterman, J, D. (2004), *Business Dynamics: System Thinking and Modelling for A Complex World*. Intl Edition. Mc Graw Hill.
784 Forrester, J, W. (1971), *Principles of Systems*. Pegasus Communication, Inc. Waltham.
785 Available at:
https://stats.oecd.org/Index.aspx?DataSetCode=IOTSI4_2018
786 Ferrarini and Hummels (2014), *Asia and Global Production Networks: Implications for Trade, Incomes and Economic Vulnerability*.

Furthermore, the analysis of supply chain linkages shows that these relationships are structurally robust over time – in other words, they do not change significantly over the short and medium terms. As such, it is reasonable and realistic to use the 2015 IO table by OECD for modelling purposes. Two further pieces of empirical checks were conducted to show the resiliency of these supply chain linkages using Malaysia's Government released IO tables which are available for 2015 and 2017:

- First, how each of the 34 industries' (in Malaysia's IO table) share of total intermediate consumption changed over time is observed. Only four industries have variations of +/- one percent between 2015 and 2017.
- Second, how, within each industry, the various shares of intermediate inputs to total industry consumption changed over time is analysed. Again, it was found that a very small number of data points shifted by more than +/- one percent between 2015 and 2017.

The economic impact of a circular economy on GDP was estimated by understanding how resource savings from the identified circular economy opportunities affect aggregate output through the substitution of production across sectors. The input-output model not only allows users to understand how the final output in each sector is generated by a series of intermediate outputs from other sectors (i.e., direct and indirect impacts) but also how it could be manipulated to capture the impact of wages generated by that sector on further production in the economy (i.e., consumption induced impact). In short, the IO approach estimated the economic impact of a circular economy by understanding how resources can be shifted from less productive uses to more productive uses. Further elaboration is provided later in this section.

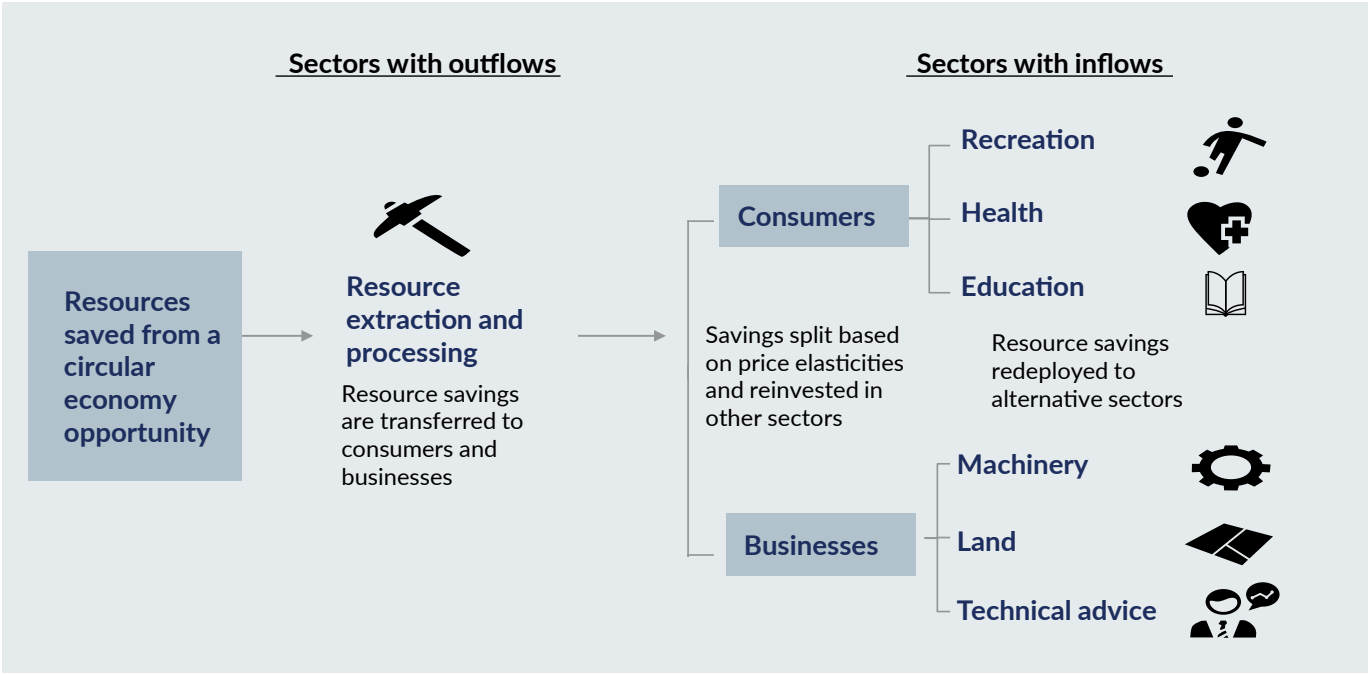
As with all economic and financial models, important assumptions must be made for this study:

- Resource savings do not escape the economic system and are represented by production outflows from related sectors. These outflows are typically coming from less productive sectors (measured by the sector's output multiplier) and are substituted into more productive sectors.
- Both businesses and consumers benefit from these resource savings. Their specific share depends on the economic agents' relative demand elasticities of that particular resource. In other words, if the good is highly price elastic (i.e., a small change in price leads to a large change in demand), then the majority of savings are likely to be captured by consumers.
- This model assumed that businesses redeploy their savings into more productive activities such as machinery, retooling, technical advice, R&D, more efficient waste collection systems, among other activities
- Similarly, consumers redeploy their share of the savings into other sectors to optimise their wellbeing. These include spending on areas such as recreation, health services and education.
- The net economic impact is thus the difference in the product of the production shifts and their respective output multipliers.

Exhibit A29 illustrates the quantification method diagrammatically, where potential resource savings are generated due to reduced extraction and processing. These outflows represent monetary savings that are spent in areas such as recreation, health and education in the services sector (by consumers), and capital investment in machinery, land, and technical advice (by businesses).

Exhibit A29

Economic impact from a circular economy is created by transferring resources previously wasted into higher productivity activities



Economic impact = (total outflows * output multipliers) - (total inflows * output multipliers)

SOURCE: Expert interviews; focus group discussions

For the purpose of this study, the output multipliers for each sector derived include (i) ***direct and indirect impacts*** which measure the sector's own output as well as the supporting contribution of other sectors through intermediate inputs; and (ii) ***consumption induced impact*** which measures the output to satisfy additional demand generated by the increased wages and salaries from the increase in output from (i).

Price elasticity of demand

To split the economic savings generated by circular economy across consumers and businesses, the price elasticity of demand for each sector was used as a proxy. Price elasticity of demand is the degree to which demand for a good or service changes as its price changes. If a good is price elastic, then small movements in price can lead to large changes in demand. In such instances, the savings from circularity may be more likely to be passed through to consumers. If a good is price inelastic, then large movements in price tend to lead to smaller changes in demand. In these instances, the savings from circularity may be more likely to be captured by producers.

A range of factors influences price elasticity. For example, whether a good/service is a luxury item or necessity item or whether a good/service has the availability of substitutes. Further compounding the challenge of estimating price elasticities is that the elasticities will depend on the exact type of good/service and at which stage of the value chain is the good/service consumed.

Despite these challenges, based on a review of international price elasticity data for the focus sectors[787], plus Indonesia-specific information[788], each opportunity was categorised as either inelastic, unitary elastic (i.e., price and demand change in a proportional manner), or elastic. The categorisation is listed in table A4 below. For inelastic opportunities, it was assumed that producers capture most of the savings (70 percent of total savings); for unitary elastic opportunities, it was assumed

787 Anderson et al (1997), *Price elasticity of demand*. Available at: https://scholar.harvard.edu/files/alada/files/price_elasticity_of_demand_handout.pdf
788 Gibson et al (2003), *Unit Value Biases in Price Elasticities of Demand for Meat in Indonesia*. Available at: https://www.researchgate.net/publication/254385870_Unit_Value_Biases_in_Price_Elasticities_of_Demand_for_Meat_in_Indonesia

that the producers and consumers share the savings in an equal proportion (50 percent each); for elastic opportunities, it was assumed that the consumers capture most of the savings (70 percent of total savings).

Table A9

No.	Sector	Opportunity	Elasticity
1	F&B	Reduce post-harvest food loss	Inelastic
2	F&B	Reduce supply chain food loss and waste	Unitary
3	F&B	Reduce consumer food waste	Unitary
4	F&B	Process food loss and waste	Inelastic
5	Textiles	Reduce waste in production	Inelastic
6	Textiles	Reuse products	Elastic
7	Textiles	Replace with more sustainable materials	Inelastic
8	Textiles	Recycle materials	Unitary
9	Construction	Generate less construction waste through existing processes	Inelastic
10	Construction	Generate less construction waste through new processes	Inelastic
11	Construction	Use more sustainable material	Unitary
12	Construction	Reuse and recycle materials	Inelastic
13	Construction	Optimise building usage	Elastic
14	Construction	Design and build more resource-efficient buildings	Elastic
15	Wholesale & retail (Plastic packaging	Reduce and reuse plastic packaging	Unitary
16	Wholesale & retail (Plastic packaging	Replace with more sustainable packaging	Inelastic
17	Wholesale & retail (Plastic packaging	Redesign plastic packaging to improve recyclability	Inelastic
18	Wholesale & retail (Plastic packaging	Increase the recycling rate of recyclable packaging	Unitary
19	Electrical and electronic equipment	Increase product lifespan and reduce obsolescence	Elastic
20	Electrical and electronic equipment	Refurbish and reuse products	Unitary
21	Electrical and electronic equipment	Virtualise and dematerialise physical goods	Unitary
22	Electrical and electronic equipment	Recycle materials	Inelastic

Sanity check approach: Incremental Capital Output Ratio (ICOR)

As a sanity check of the IO analysis, the team has used a second method based on the ICOR. The ICOR is a frequently used tool that explains the relationship between the level of investment made in the economy and the consequent increase in GDP. ICOR indicates the additional unit of capital or investment needed to produce an additional unit of output. It is a useful approach for understanding the impact of a circular economy as a circular economy approach should seek an improvement in capital productivity, driven by raw materials, components and products retaining their value as much as possible.

The approach has several steps:

- The capital investment associated with each of the circular economy opportunities identified was sized based on industry reports and expert interviews.
- The GDP impact of this capital investment was sized based on the ICOR of several leading countries with circular economy approaches such as Korea and Japan (note: Indonesia has quite a high ICOR, implying low capital productivity). Indonesia's ICOR was estimated at 5.5, while that of Malaysia was estimated at 4.6.[789]

789 ADB (2016), *Sector assessment (summary): Industry and trade.* Available at: https://www.adb.org/sites/default/files/linked-documents/48134-006-ssa.pdf

- This was then compared to the GDP impact of the "lost" capital investment in upstream industries from reduced demand. This was based on the capital investment ratios in Indonesia and Indonesia's current ICOR.

Encouragingly, both the IO method and the ICOR method show similar ranges of GDP impact for Indonesia from the adoption of a circular economy (Exhibit E6).

(ii) Modelling the impact on jobs

The impact on jobs has been sized by understanding the net GDP contribution of a circular economy across the five sectors (based on the IO methodology), divided by sector-wise labour productivity. The following approach was used to calculate the net jobs created by each circular economy opportunity:

- The sector-specific labour productivities in 2030 were estimated. To estimate these, the sector-specific labour productivity in 2019 – calculated using data from BPS – was grown with the estimated growth in the national labour productivity for Indonesia between 2020 and 2030, i.e., 3.6 percent.
- For each opportunity, the direct jobs lost, the indirect jobs lost, the direct jobs created, and the indirect jobs created due to the circular economy were calculated to estimate the net jobs created by circular economy for each opportunity
- The direct jobs lost were estimated by dividing the economic savings generated from reducing waste in an opportunity and dividing the savings by the weighted average labour productivity of sectors from where these savings are generated. The indirect jobs lost were calculated by dividing the multiplier effect of these economic savings – calculated using the Input-Output table – with the economy-wide labour productivity.
- The direct jobs created were estimated by dividing the direct economic impact generated from adopting the circular economy opportunity and dividing the impact by the weighted average labour productivity of sectors where consumers and producers reinvest their savings. The indirect jobs created were calculated by dividing the multiplier effect of the economic impact – calculated using the Input-Output table – with the economy-wide labour productivity.
- The difference between the total jobs created and total jobs lost for each opportunity gives us the net jobs created by the adoption of the circular economy for each opportunity.

This is a simplified approach given the limited data availability and complexity in understanding specific job shifts. It is a net job figure (i.e., taking account of jobs created and jobs displaced from the adoption of the circular economy opportunities). However, the specific job impacts will depend on factors such as:

- **Labour productivity.** The job creation impact from a given level of GDP will vary depending on the exact labour productivity of workers in each sector and sub-sector in 2030. For example, agriculture tends to have lower labour productivity than other sectors, so opportunities that may reduce the demand for agriculture may have a higher impact on jobs than in sectors which have higher labour productivity.
- **Capital intensity.** The job creation impact from a given level of GDP will also vary by the capital intensity of the operations. For example, electronic manufacturing tends to be capital intensive, and therefore, fewer jobs are created for a given level of production. So, for opportunities in electronics like switching to prolonging the lifespan of goods through refurbishment, there may be a higher impact on net job creation as refurbishment tends to be less capital intensive than manufacturing.

Across the opportunities and sectors, these two factors tend to move in different directions, and it is not clear that the net employment estimate in this report is either an over or underestimate of the total job impact. The labour productivity data is limited at the sub-sectoral levels and the structural shifts in sectoral employment in the next ten years are highly uncertain, particularly with the onset of major trends such as the Industry 4.0. Regardless, what is clear is that the displaced workers may not seamlessly move into the new jobs created due to different geographies, areas of the value chain, and skill requirements. As such, it will be crucial to ensure there is proper reskilling of displaced workers to help them transition into new job opportunities.

(iii) Modelling the impact on household savings

Social impact on household savings was quantified through monthly savings in household expenditure on items in the focus sectors.[790] Annual savings for each focus sector were assumed to benefit both companies and households – the exact split was based on the specific price elasticities of the resource in each sector.

ESTIMATING THE CAPITAL EXPENDITURE REQUIRED

Table A10

Sector / Opportunity	Methodology	Source
F&B Sector		
Reduce post-harvest food loss	Share of global investment requirement scaled by Indonesia's share of food loss and waste	BSDC
Reduce supply chain food loss and waste	Share of global investment requirement scaled by Indonesia's share of food loss and waste	BSDC
Reduce consumer food waste	Share of global investment requirement scaled by Indonesia's share of food loss and waste	BSDC
Process food loss and waste	Investments in anaerobic digestion plants required based on Indonesia's waste volumes	EMF
Textile		
Reduce waste in production	Indonesia's share of global production multiplied by global financing requirements in "processing" and "cut and trim"	Fashion for Good
Reuse products	Indonesia's share of global production multiplied by global financing requirements in "retail and use"	Fashion for Good
Replace with more sustainable materials	Indonesia's share of global production multiplied by global financing requirements in "raw materials", "transparency and traceability", and "supply chain innovations"	Fashion for Good
Recycle materials	Indonesia's share of global production multiplied by global financing requirements in "end of use"	Fashion for Good
Construction		
Generate less construction waste through existing processes	Share of global investment requirement scaled by Indonesia's GDP	BSDC
Generate less construction waste through new processes	Based on country-specific case studies that note investment required which was scaled based on Indonesia's waste reduction in 2030	MDPI, BSDC
Use more sustainable material	Share of global investment requirement scaled by Indonesia's GDP	BSDC
Reuse and recycle materials	Investment required per tonne of recycling capacity multiplied by volume of material available for recycling in Indonesia	EMF
Optimise building usage	Share of global investment requirement scaled by Indonesia's GDP	BSDC

790 Available at Badan Pusat Statistik: bps.go.id

Sector / Opportunity	Methodology	Source
Design and build more resource-efficient buildings	Share of global investment requirement scaled by Indonesia's GDP	BSDC
Wholesale & retail packaging		
Reduce and reuse plastic packaging	Based on Global Plastic Action Partnership's (GPAP) estimates for the investment required in Indonesia	SYSTEMIQ
Use more sustainable packaging	Based on Global Plastic Action Partnership's (GPAP) estimates for the investment required in Indonesia	SYSTEMIQ
Redesign plastic packaging to improve recyclability	Based on Global Plastic Action Partnership's (GPAP) estimates for the investment required in Indonesia	SYSTEMIQ
Increase recycling rate of recyclable packaging		
Electrical and electronic equipment		
Increase product lifespan and reduce obsolescence	Share of global investment requirement scaled by Indonesia's GDP	BSDC
Refurbish and reuse products	Share of global investment requirement scaled by Indonesia's GDP	BSDC
Virtualise and dematerialise physical goods	Share of global investment requirement scaled by Indonesia's GDP	BSDC
Recycle materials	Based on the investment required in Singapore to recycle e-waste, adjusted for the status of e-waste recycling in Indonesia	Straits Times

COMPARISON OF FINDINGS ON THE CIRCULAR ECONOMY POTENTIAL TO THOSE IN OTHER COUNTRIES

Chapter 1 provided an overview of the findings of past research on the potential impact of a circular economy in other countries. The model used in this report did not include the value of CO_2 and water in the economic impact. The objective of this analysis was to quantify the economic impact of a circular economy to facilitate economic planning, so to avoid blurring the picture, too many additional elements were not added. The report also looked at the economic impact on only the five key sectors. Notwithstanding these differences, the initial analysis indicates that the impact of a circular economy on GDP (2.3 percent) is in the range of what other studies have shown; the jobs created (4.4 million net jobs) is higher than what is shown in other studies; the GHG reduction (9 percent) is on the lower end than what is shown in other studies (Exhibit 6).

Kementerian PPN/ Bappenas

EMBASSY OF DENMARK Jakarta

UNDP

SUPPORTED BY:

alphabeta strategy x economics

SYSTEMIQ

Landscape Indonesia

ibcsd Indonesia Business Council For Sustainable Development

INDONESIA CIRCULAR ECONOMY FORUM