Climateworks CENTRE

Decarbonising Indonesia's manufacturing sector

Case studies from the food and beverage, textile and chemical industries

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ABOUT US

Climateworks Centre bridges the gap between research and climate action, operating as an independent not-for-profit within Monash University. Climateworks develops specialist knowledge to accelerate emissions reduction, in line with the global 1.5°C temperature goal, across Australia, Southeast Asia and the Pacific.

AUTHORS

Petra Christi

Fikri Muhammad

Dinda Maharani

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Executive summary

For Indonesian manufacturing companies, the need to become more sustainable comes from two urgent priorities: decarbonising production and more efficient energy use. In Indonesia, the manufacturing sector plays a leading role in the economy as it constitutes 18 per cent of GDP.

The manufacturing sector accounts for approximately 28 per cent of Indonesia's emissions, with the top emitting subsectors including chemical, cement, pulp and paper, food and beverage, iron steel, plastic, soap and detergent and textile. With today's technologies, these sectors can reduce emissions and transition to low-carbon operations even while guiding national policies are still being consolidated.

For this report, Climateworks Centre analysed energy efficiency technologies and interviewed experts in the chemical, textile and food and beverage industries, which are the focus of this report. We found that while most energy efficiency technologies have matured, their application is still varied. This presents a significant opportunity: sectors, where energy consumption is high (e.g. chemical, textile and food and beverage), stand to benefit most from adopting mature technologies. These sectors can achieve substantial energy savings by upgrading to energy-efficient equipment and processes, which reduces operational costs and improves competitiveness.

Decarbonisation and energy efficiency strategies rely on adopting efficient technologies, optimising processes and minimising energy use during non-productive times. Although these technologies require upfront investment, they offer significant long-term financial gains by reducing utility costs and reliance on fossil fuels. For industries such as cement, steel and chemicals, transitioning to energy-efficient processes and low-carbon technologies can improve productivity and lower operational expenses. Moreover, energy savings realised over time can create a robust financial foundation for future reinvestment in additional low-carbon technologies.

Small businesses often struggle to access financing for these technologies. While upfront costs can be a barrier, policy and financial solutions exist to support such efforts. Policies like tax incentives, energy efficiency standards and renewable energy certificates can help reduce upfront costs and encourage investment. Public-private partnerships, green bonds and low-interest loans are increasingly available to provide capital for low-carbon business investment. These mechanisms can ensure that both large and small enterprises can access the resources required to implement energy-efficient technologies and decarbonise operations.

Many manufacturers require significant capital investment to upgrade equipment, transition to lower-carbon alternatives such as biofuels and improve energy efficiency. Key strategies for these sectors include optimising HVAC systems, upgrading to LED lighting and improving compressed air systems – each an opportunity to reduce energy consumption and enhance operational efficiency. Investing in more efficient technologies will help industries meet regulatory requirements and position themselves for long-term sustainability and competitiveness in an increasingly low-carbon global economy.

Balancing initial capital expenses with their potential return on investment is crucial for businesses considering energy efficiency upgrades. While achieving the desired returns may require larger upfront investments, the long-term savings in utility costs and operational efficiencies often justify the expense. To ease the upfront cost of technologies, businesses can explore alternative funding sources beyond the capital budget to accelerate their transition to energy-efficient technologies while ensuring a sustainable and cost-effective path toward decarbonisation.

The International Financial Reporting Standard for climate-related disclosures (IFRS S2) and Climateworks' four pillars of decarbonisation, described in detail in this report, share common components around energy efficiency, renewable electricity and electrification. International standards such as IFRS S2 are key to getting businesses to consider climate change. They require companies to publicly share information about climate-related risks and opportunities, including emissions, targets and transition plans. This increased transparency helps investors and other stakeholders make informed decisions about the company. Indonesia is preparing to implement similar standards, with the Indonesian Financial Services Authority (*Otoritas Jasa Keuangan* [OJK]) developing regulations to align with international standards.

The chemical industry faces strict IFRS S2 requirements across all decarbonisation pillars, while IFRS S2 for the processed foods industry focuses primarily on energy efficiency and renewable energy. In the textile industry, which contributes significantly to global carbon emissions, IFRS S2 emphasises identifying sustainable, genuinely eco-conscious companies, as the industry's energy use disclosures are still evolving. The International Sustainability Standards Board (ISSB), which develops the IFRS, continually refines these standards by considering industry-specific sustainability challenges and aligning metrics with business models and economic activities.

Using the Transition Plan Taskforce framework can also improve corporate attractiveness to sustainable investors, linking decarbonisation efforts to funding opportunities. Transition planning involves setting climate targets and strategically adjusting business models for a low-carbon future, and it is critical for companies, especially in economies where technical and data limitations are barriers. Companies able to codify their emissions reduction plans in a 'transition plan' are better candidates for government and financial support, such as green financing, which can drastically accelerate their decarbonisation efforts. Sector-specific decarbonisation guidance can help companies implement practical, impactful decarbonisation measures and transition to low-carbon operations in a financially feasible way.

This report highlights ready-to-implement measures manufacturing companies can use to decarbonise while supporting broader business goals. This report also includes a framework for decarbonisation efforts broadly, which can help guide companies as they develop transition plans and communicate their decarbonisation plans to stakeholders in Indonesia and globally through disclosure that follows international sustainability disclosure standards.

This report presents decarbonisation measures for three top-emitting subsectors in Indonesia's manufacturing industry – food and beverages, textile and chemical. The analysis shows how readily available technology can support companies' decarbonisation plans across four pillars of decarbonisation: improving energy efficiency, using renewable electricity, electrification and fuel switching and reducing non-energy emissions. The report evaluates practical short- to medium-term actions, available technologies and their respective emissions reduction potential given the increasing importance of comprehensive transition plans for businesses complying with climate-related disclosure mandates like IFRS S2.

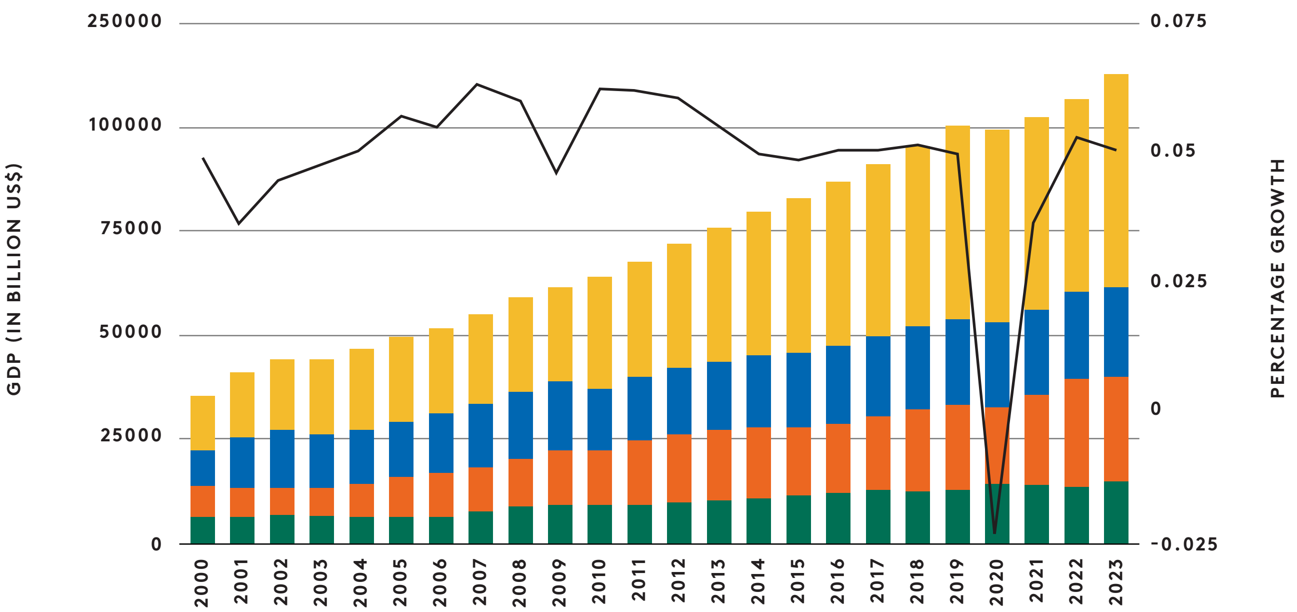
Chapter 1: Indonesian industry growth and energy intensity

Indonesia has sustained stable economic growth over the last two decades, growing from US$395 billion in 2000 to US$1.18 trillion in 2023. Growth continued through the 2008 global financial crisis, only slowing during the COVID pandemic before recovering the year after.

The manufacturing sector, in particular, has grown from US$89.5 billion in 2000 to US$220.7 billion (The World Bank 2024). A shift-share analysis found that this was driven by a structural change in the Indonesian economy from a traditionally agricultural-based economy to one dominated by industrial and services sectors. Industrialised regions in Indonesia saw a shift towards more energy-intensive industries such as steel or cement (Andriansyah and Rifai 2023).

The structural shift in Indonesia's economy also led to increased emissions. The development of energy-intensive industries increased energy demand, driving up energy-related emissions from power generation for industrial use. Empirical evidence exists on the causal relationship between this structural shift and GHG emissions (Jung et al. 2000).

FIGURE 1: INDONESIA'S GDP AND GDP GROWTH BY SECTOR



Source: The World Bank (2024)

GROWTH (YOY)

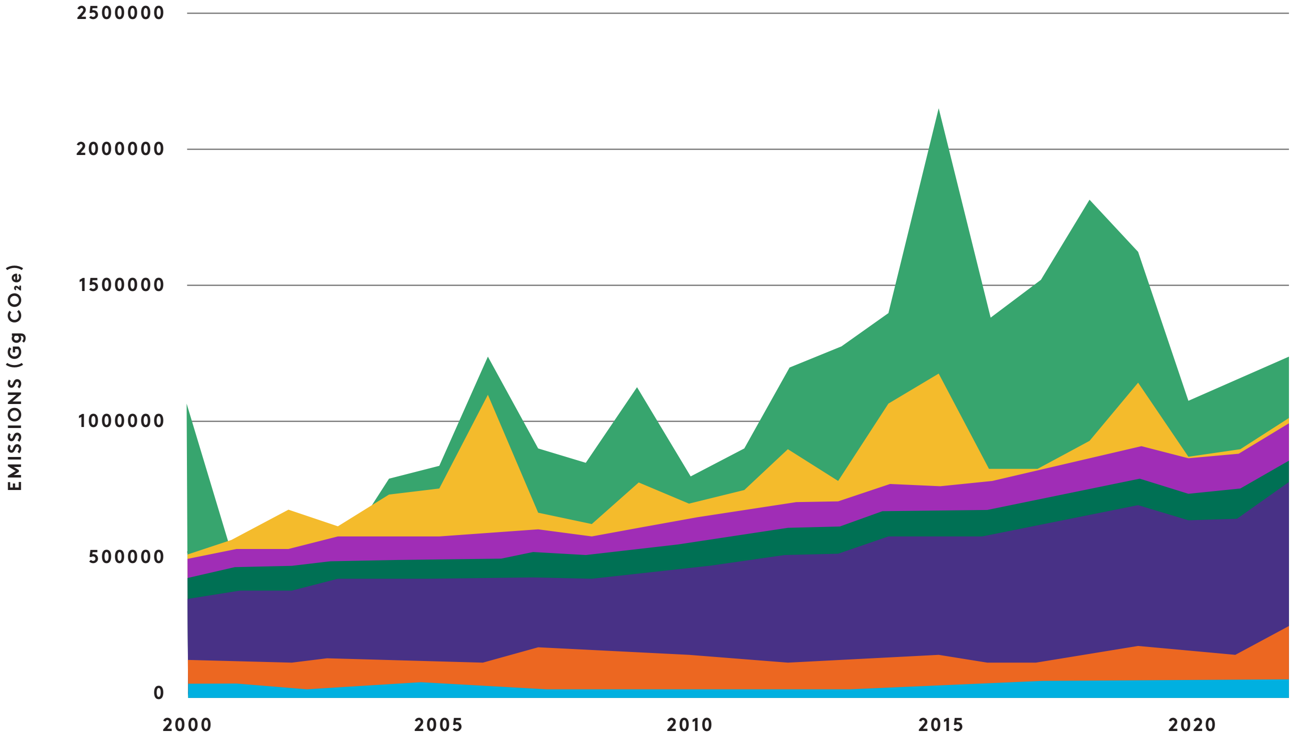
SERVICES

INDUSTRY (NON-MANUFACTURING)

INDUSTRY (MANUFACTURING)

AGRICULTURE

FIGURE 2: GREENHOUSE GAS EMISSIONS IN INDONESIA, BY SECTOR



Ministry of Environment and Forestry (2024b)

FOREST AND OTHER LAND USE

PEAT FIRE

WASTE

AGRICULTURE

ENERGY (NON-MANUFACTURING)

ENERGY (MANUFACTURING)

INDUSTRIAL PROCESSES AND PRODUCT USE

Energy-related emissions have grown consistently and overtaken land-use change as the country's largest source from 2020. This change was primarily driven by increasing energy use from the manufacturing industry.

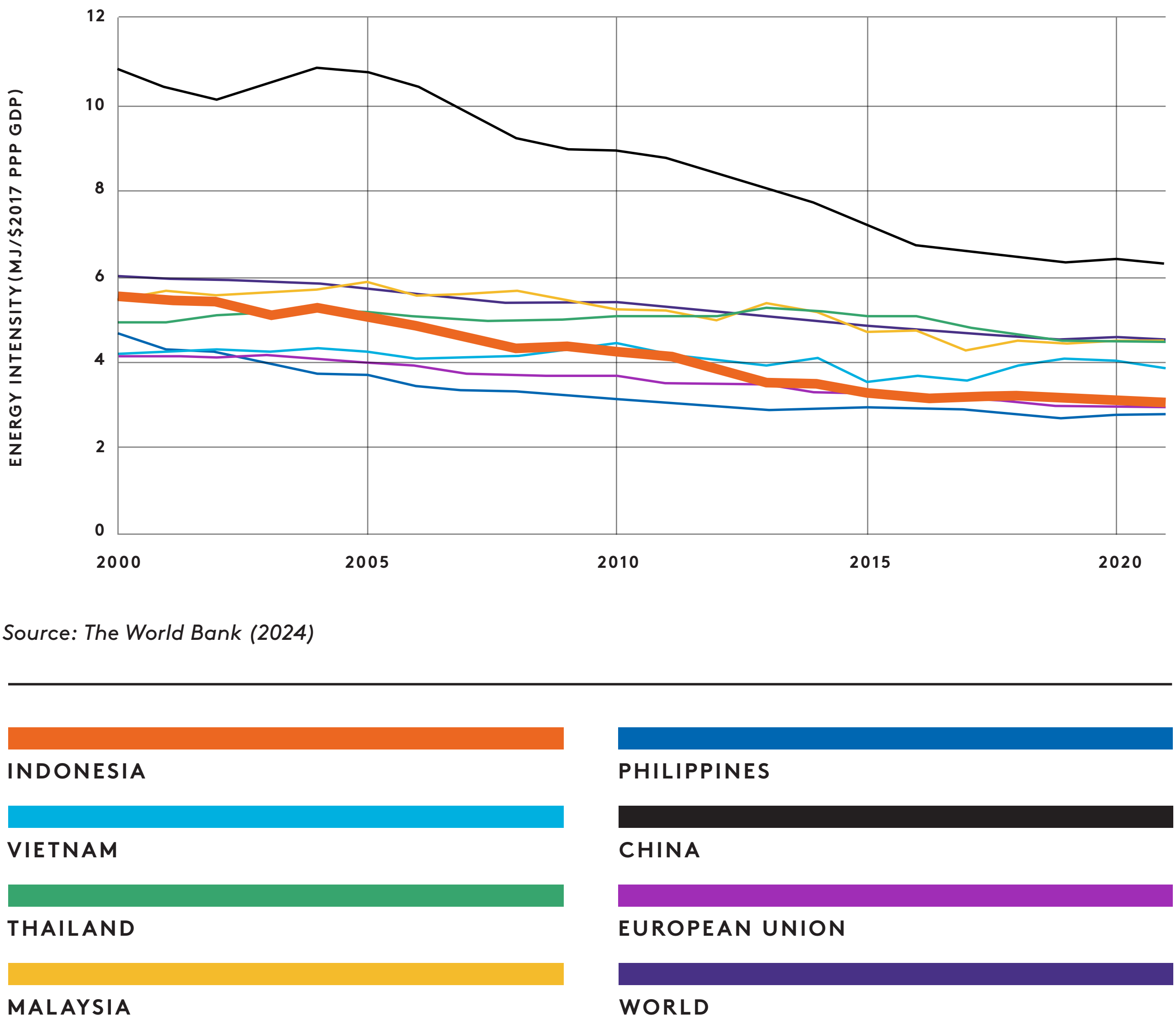
The Indonesian manufacturing sector – particularly subsectors like chemicals, cement, pulp and paper, food and beverage, iron and steel, plastics and soap and detergent – is a major contributor to the nation's carbon emissions, accounting for approximately 28 per cent of total emissions (Ministry of Environment and Forestry 2022; Ministry of Environment and Forestry 2024a).

The country is challenged by its dual goals for economic development and emissions reduction targets. Indonesia has declared its vision to be a high-income country through structural economic transformation by 2045. One of its strategies to escape the middle-income trap is through massive industrialisation, especially in chemicals and textiles.

At the same time, Indonesia is committed to decreasing emissions by 31.89 per cent, as described in both *Indonesian Vision 2045* (Ministry of National Development Planning 2025) and its *Enhanced Nationally Determined Contribution* (Ministry of Environment and Forestry 2022). These strategies include energy efficiency measures, widespread renewable energy adoption and improved energy consumption patterns.

Indonesia's emissions targets are not aligned with the 1.5 degrees Celsius temperature goals described in the Paris Agreement. Instead, Indonesia is on a trajectory aligned with global temperature rise of 4 degrees (Climate Action Tracker 2024). While there have been improvements in some sectors, off-grid coal plants in energy-intensive industries have worsened the country's progress against the 1.5°C goal.

FIGURE 3: ENERGY INTENSITY OF PRIMARY ENERGY IN ASEAN COUNTRIES



Source: The World Bank (2024)

Indonesia has made slow progress in reducing energy intensity. Figure 3 shows primary energy intensity in megajoule (MJ) for every dollar of GDP converted to 2017 international dollars using purchasing power parity (PPP) rates ($2017 PPP GDP), which allows for more meaningful comparisons of economic output between countries by accounting for differences in price levels. Primary energy refers to energy that has not been transformed into secondary or tertiary energy forms (U.S. Energy Information Administration n.d.). For example, China decreased its energy intensity by 4.61 MJ/$2017 PPP GDP between 2000 and 2020. In the same time frame, Indonesia decreased its energy intensity by 2.46 MJ/$2017 PPP GDP.

Indonesia has made commitments nationally (Indonesian Vision 2045) and internationally (the Paris Agreement) to decrease its emissions. As it pursues manufacturing-driven economic development, it must also accelerate decarbonisation efforts in the sector to tackle its dual economic development and climate mitigation goals.

State of industrial decarbonisation in Indonesia

Indonesia has taken steps towards decarbonising its industry sector with its 'green industry initiative', which incentivises sustainable industrial practices. The initiative facilitates decarbonisation by encouraging assistance from 'green' industry service companies and through certification, such as the Green Industry Certification.

Apart from assistance and certification efforts, industry players are left to implement decarbonisation measures independently. Fully decarbonising entails measures to address the four pillars of decarbonisation as well as material efficiency.

FIGURE 4: FOUR PILLARS OF DECARBONISATION

ENERGY EFFICIENCY

Usage of best available technology to increase energy intensity.

RENEWABLE ELECTRICITY

Decarbonisation of electricity generation through the replacement of existing fossil fuel based generation with renewable energy, nuclear power, and/or CCS.

ELECTRICITY AND FUEL SWITCHING

Switching end-use energy supplies from highly carbon-intensive fossil fuels to lower carbon fuels such as low carbon electricity, hydrogen, or sustainable biomass.

NON-ENERGY EMISSIONS REDUCTION

Process improvements, material substitutions, best practice farming and implementation of carbon and storage.

Source: ClimateWorks Australia (2014)

Chapter 2: Technology readiness level

Technologies to decarbonise industry vary in levels of 'readiness' across sectors and decarbonisation pillars. Many industries in Indonesia still rely on older, less efficient technologies that are hard to replace due to high costs or lack of expertise in adopting advanced alternatives. Decarbonising industries, especially energy-intensive ones, requires significant capital investments for upgrading equipment, transitioning to low-carbon alternative fuels and enhancing energy efficiency.

Many businesses struggle to access affordable financing for decarbonisation projects, as domestic financial institutions lack incentives to make large-scale 'green' investments (Cordonnier and Saygin 2023). Offering tax breaks or subsidies for companies investing in renewable energy, energy efficiency and carbon capture technologies could reduce the financial burden and make decarbonisation more competitive.

Below is an evaluation of the current state of technological readiness across key areas of decarbonisation in Indonesia.

TABLE 1: SUSTAINABLE TECHNOLOGY APPLIED IN TEXTILE, FOOD AND BEVERAGE AND CHEMICAL SUBSECTORS

Decarbonisation Pillars	Sub-sector and production/ support processes	Conventional equipment
ENERGY EFFICIENCY	Textile: weaving	Thermal energy using fossil fuel
	Chemical: Paint cooling process	No thermal control cooling system
	Food and beverage: Food drying	Spray drying, hot air drying, and freeze-drying
	All industries	Lighting, non-LED
RENEWABLE ENERGY	Textile: Dyeing	Coal or gas water heater
	Food and beverage: All processes	Fossil fuel energy source
	Chemical: All processes	Fossil fuel energy source for lighting
ELECTRIFICATION AND FUEL SWITCHING	Chemical: All paint processes	Diesel tractor/forklift
	Food and beverage: Cooking	Gas-powered ovens and boiler

Mature technologies: Energy efficiency and some renewable energy technologies are the most technologically ready for widespread implementation in Indonesia. These technologies have been deployed in various sectors, though there is still room to improve adoption rates.

Emerging technologies: These are theoretically feasible but require further development, significant investment and supportive policies to become economically viable and scalable.

Sources: Agarwal et al. 2023; Andrei et al. 2024; Farhana et al. 2022

Equipment with emissions reduction potential (non-exhaustive list)	Technological readiness (mature, emerging, nascent)	Note
Thermal using biogas	Mature	
Energy-efficient cooling tower - free cooling ventilation	Mature	
Heat recovery	Mature	
LED Lighting	Mature	
Solar thermal for water heater	Mature	In dyeing processes, a significant amount of hot water is required for different purposes and this area has the most potential for the application of solar thermal to heat the water.
Biomass – feedstock needs to be sourced sustainably, such as through agricultural residues or urban waste, not from deforestation.	Emerging	100% biomass use is not currently possible without changes to boiler designs. In addition, biomass is more expensive than coal and gas, which makes it less attractive to buyers.
Solar PV for lighting, refrigeration, air conditioning	Mature	
Solar PV for lighting	Mature	Regulatory hurdles and unattractive tariffs for excess electricity sales further hinder widespread solar PV adoption, despite the country's high solar potential.
Electric tractor/forklift	Mature	
Electric ovens and boiler	Mature	Condensing boilers and steam optimisation technologies are available and increasingly being adopted in food and beverage manufacturing sectors.

Applying low-carbon technology

Pillar 1: Energy efficiency

Decarbonising textile, food and beverage, and chemical industries can start with improved energy efficiency for manufacturing processes and existing equipment as well as implementing the latest technologies in new facilities. Energy efficiency measures not only result in significant cost savings but also promote sustainable manufacturing practices. Studies by the International Energy Agency (IEA) have shown that energy efficiency improvements in manufacturing can lead to substantial cost savings, often exceeding the initial investment costs (IEA 2019).

Manufacturing often uses a lot of energy for HVAC, lighting, and compressed air systems, making them apt for energy efficiency upgrades. Additionally, retrofitting equipment such as motors and boilers is a common energy efficiency strategy. Policies like minimum energy performance standards and energy labelling can also help drive adoption of energy-efficient technologies and equipment retrofits (Lu et al. 2024).

HVAC MANAGEMENT

For many manufacturers, HVAC systems are a primary focus for energy efficiency. HVAC systems are essential for maintaining optimal working conditions and ensuring product quality. For instance, a food processing plant or textile company might implement advanced HVAC controls to maintain precise temperature and humidity levels, which are crucial for food safety and product quality. By using variable-speed drives and efficient motors, a plant can reduce HVAC energy consumption significantly during non-peak hours.

In Indonesia, the food and beverage industry can significantly improve energy efficiency by recovering waste heat and pressure, particularly from cooking processes. Updating insulation and heating equipment, as well as freezing equipment, could further improve energy efficiency. Heat recovery technologies, particularly heat exchangers and combined heat and power, are available and are used in larger food manufacturing facilities. These technologies are promoted through energy audits and efficiency programs but are still underutilised in smaller operations.

The flammable substances used in chemical plants require reducing electricity use. Centrifugal pumps, diaphragm pumps and more efficient solvent recovery in HVAC systems are beneficial in chemical industries, specifically paint manufacturing.

LED AND SMART LIGHTING

Manufacturers often upgrade to LED lighting systems, which consume less energy and have a longer lifespan than traditional lighting solutions. For example, smart lighting systems that adjust brightness based on occupancy and natural light availability can lead to substantial energy savings. These systems reduce energy use and enhance worker productivity and safety by providing better lighting conditions.

COMPRESSED AIR SYSTEMS

Compressed air systems are widely used in manufacturing processes and can consume significant energy. Energy-efficient compressed air systems, incorporating leak detection and optimised storage, offer significant energy savings potential. Studies indicate 20–60 per cent reductions are achievable through pressure reduction, inlet temperature optimisation and heat recovery. With an average return on investment of under two years, these systems are increasingly attractive to manufacturers seeking to enhance energy efficiency and reduce costs (Hernandez-Herrera 2020). Adoption is growing as businesses become more aware of their potential energy savings.

Manufacturers can improve energy efficiency by maintaining and optimising these systems. In a textile manufacturing facility, for example, regular maintenance of air compressors and installing leak detection systems can prevent energy waste. Additionally, using energy-efficient compressors and optimising the air pressure settings to match the specific needs of different production stages can further enhance efficiency.

In the food and beverage industry, compressed air systems are used in almost all stages of production (Australian Alliance for Energy Productivity 2021). However, certain processes, such as process cleaning and blow-off, are inefficient uses of these systems (Cullum and Brown 2024; Taylor 2022). Instead, these systems can be used for processes for which there are no other alternatives.

By focusing on these key areas – HVAC management, lighting and compressed air systems – manufacturers across various subsectors can achieve significant energy savings and contribute to a more sustainable industry. Implementing these measures helps reduce costs and supports broader environmental goals, making energy efficiency a win-win for manufacturers and their decarbonisation efforts.

Challenges remain in the effort to implement energy efficiency solutions due to the uneven adoption of these technologies across sectors. While large corporations may be more advanced, small- and medium-sized enterprises face challenges in terms of capital and technical expertise to implement energy efficiency improvements.

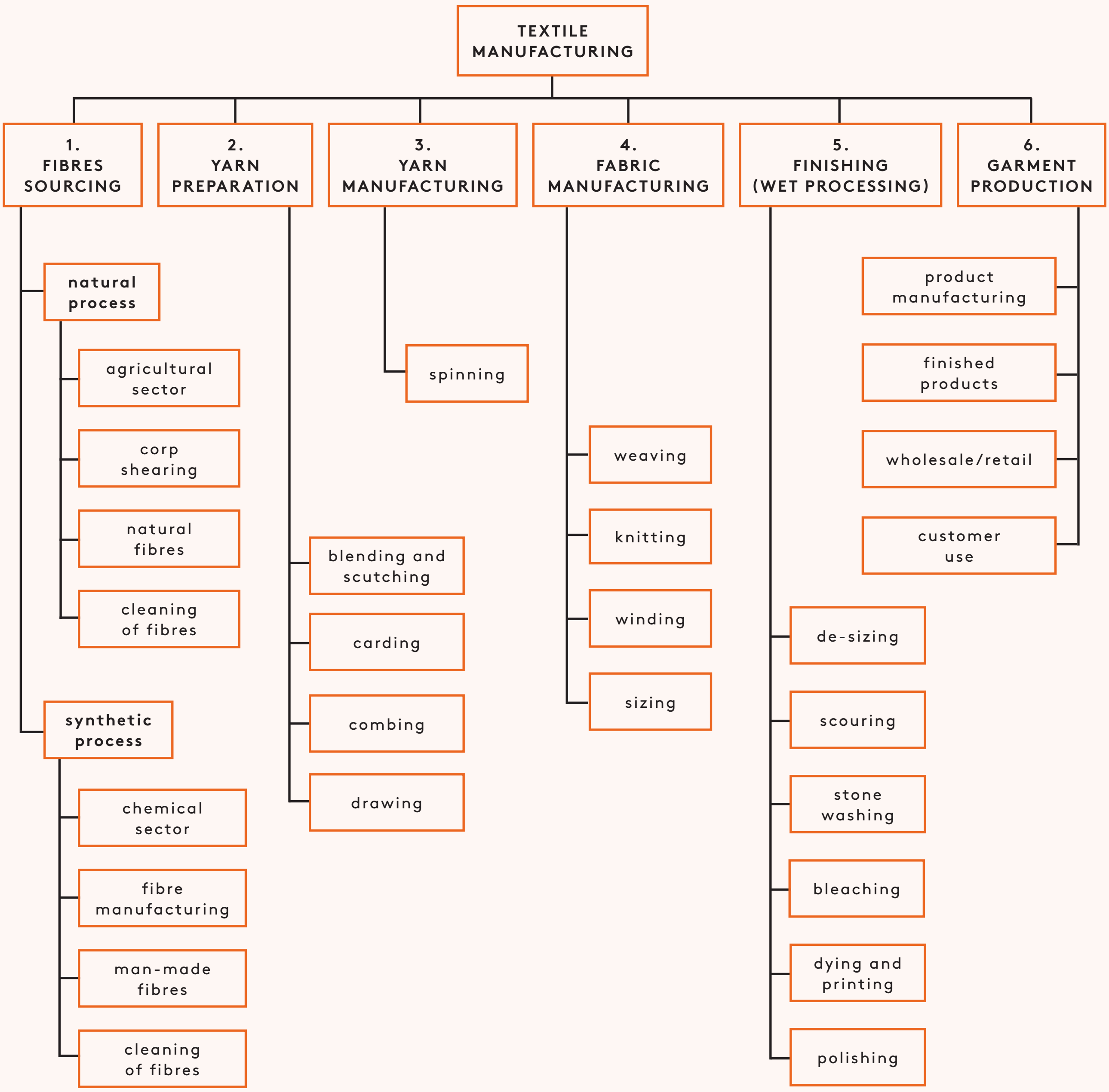
BOX 1:

Energy efficiency in textile manufacturing

FIGURE 5: PRODUCTION PROCESS OF TEXTILE AND GARMENT

Interviews with textile industry experts reveal that while some textile processes are already almost entirely electrified, the significant thermal energy requirements of certain energy-intensive processes pose a challenge for transitioning to low-carbon energy sources. Most energy consumption occurs in end-stage processes, particularly fibre/yarn manufacturing and finishing (see Figure 5), which rely heavily on thermal energy. Energy-intensive processes like dyeing, printing and finishing are key contributors to textile manufacturing's high energy demand. However, the transition to renewable energy, while complex, is not insurmountable.

The comprehensive textile and garment production process is as follows:



Electricity for textile production is predominantly supplied by the National Electricity Company (*Perusahaan Listrik Negara* [PLN]), with approximately 25 per cent generated by fossil fuels, mainly diesel. While the spinning process can run entirely on electricity, carbon offsets through renewable energy certificates are used as a means of mitigating emissions instead. Garment manufacturing processes like sewing and heating via boilers still depend heavily on fossil fuels, especially coal, though many facilities are transitioning to gas as coal reserves dwindle.

The main sources of energy for textile production processes are grid electricity and fossil fuel. Measures have been taken to reduce emissions somewhat by co-firing coal with biomass, such as oil palm grafting, urban waste and wood pellets. However, in the textile industry, biomass is not widely used due to higher costs and associated infrastructure adjustments.

A Green Industry Standard is currently in the works for the textile industry, with special attention on energy consumption limits. The industry is aware of energy-efficient technologies that could help plants meet these standards, but cost and reputation concerns with clients deter investment in these technologies.

Pillar 2: Renewable electricity

Integrating renewable electricity generally involves renewable generation from solar photovoltaic (PV), for example.

Solar panels are used to generate electricity for production facilities, according to industry experts. Solar energy is gaining traction in Indonesia’s manufacturing sector, especially in industries with large rooftop spaces like textile and garment facilities. Companies are installing solar PV systems on factory roofs to generate electricity, which helps reduce their reliance on grid electricity. Some notable manufacturers in Indonesia – Unilever Indonesia and Nestlé Indonesia – have installed large solar arrays to meet part of their energy demand (Britcham Indonesia 2023; D Insights 2022). The variable nature of renewable energy sources requires proper management. Renewable energy sources, such as solar and wind, only produce energy in certain conditions. This can be managed through battery storage, trading between regions and the use of renewable technologies.

Fossil fuel-generated electricity paired with carbon capture and storage (CCS) technology would also fall into this category of decarbonisation. Technologies to use or store industrial carbon emissions are still in the early stages of development and deployment in Indonesia. While there is interest in these technologies, particularly for sectors like cement and petrochemicals, CCS projects are capital-intensive and face technical and economic challenges.

If implemented, industrial CCS by-products could be used to produce solvents and heat transfer fluids or be converted to various fuels, chemicals and building materials (Gratham Research Institute on Climate Change and the Environment 2023).

Pillar 3: Electrification and fuel switching

Electrifying activities in the manufacturing sector typically involve integrating electric power into various production processes, either by replacing fossil fuel-based systems or by enhancing efficiency through automation. For instance, electrified heating systems that use induction, resistive and infrared technology can replace fossil fuel-based heating. Many manufacturers are adopting these systems due to their lower emissions and higher efficiency, particularly in sectors such as food manufacturing (Kim et al. 2022). Electrification is often coupled with automation, which uses advanced technologies like sensors and control systems to streamline operations, reduce energy consumption and increase productivity.

Electrification technologies, such as electric heat pumps, induction furnaces and electric motors, are available but have not been widely adopted in Indonesia's heavy industrial sectors. In the textile industry, electrification efforts often target key production areas such as spinning, weaving and dyeing. Previously, these processes relied on mechanical or fossil fuel-powered systems, but modern electrification initiatives have introduced electric looms, electric dyeing machines and automated spinning systems.

The food and beverage industry has implemented electrification activities in processes like cooking, pasteurisation and packaging. For example, manufacturers may replace gas-powered ovens and boilers with electric ones, which provide more consistent heating and reduce greenhouse gas emissions. In pasteurisation, electric systems are used to heat and cool products more efficiently, ensuring food safety while minimising energy consumption (Başaran et al. 2018)

Electric vehicles including automated guided vehicles, such as automated guided forklifts, are also increasingly used in logistics and material handling within manufacturing facilities. The market for electric vehicles is expanding as manufacturers seek automation to reduce labour costs and minimise emissions (Nanjundaswamy et al. 2023).

Some companies have turned to fuel switching as an interim step to reduce emissions. For manufacturers, this often includes switching to biodiesel, bioethanol or biomass from coal to power machinery, heating and other processes.

Fuel-switching mechanisms replace high-carbon fossil fuels with lower-carbon alternatives, such as biomass and biofuels, to achieve more immediate and low-cost emissions reductions. This approach is a gradual shift away from fossil fuels while infrastructure and technology for fully renewable energy sources are further developed. It is important to distinguish this fuel switching from a broader energy source transition; in this context, it does not refer to electrification, but rather the substitution of one fuel type with another. While electrification projects contribute to decarbonisation, biofuel use represents a separate transitional strategy.

With increasing policy support from the government, several private companies have invested in biomass projects (da Costa 2022). For instance, some companies have collaborated on wood pellet production from waste wood and forest residues to fuel power plants domestically. The government has been working on regulations to ensure biomass feedstock comes from certified and sustainably managed sources, especially for palm oil residues and forestry by-products.

Indonesian state-owned enterprises have engaged in partnerships to advance biomass energy technologies. For instance, Marubeni Corporation and Japan Petroleum Exploration Co. Ltd. entered into a joint study agreement with PT Pertamina in August 2024 to assess the feasibility of bioenergy with carbon capture and storage in South Sumatra (Marubeni Corporation 2024).

BOX 2:

Electrification in paint manufacturing

We interviewed paint industry experts within the chemical industry. The interviews revealed that most production processes, from pre-mixing to packaging, use electricity. However, fossil fuels are still used for heating, in the filtration process, and for the heavy equipment that transports goods around the factory complex.

The experts highlighted a gap in sustainability awareness between smaller and larger factories. Larger factories are aware of sustainability efforts and run their own research and development facilities to increase their efficiency, but smaller factories are largely uninformed and unmonitored.

The paint industry currently has a voluntary Green Industry Standard that covers energy efficiency and carbon emissions. The standard limits emissions to 58 kg CO_2/tonne. Our interviews revealed that some large paint producers operate under the voluntary limit.

Further electrification efforts in the paint industry could involve replacing diesel-operated equipment with electric counterparts – electric forklifts are readily available. The possibility of using electricity for heating in the filtration process could also be explored.

Pillar 4: Non-energy emissions reduction

RENEWABLE ENERGY CERTIFICATE AND CARBON OFFSET

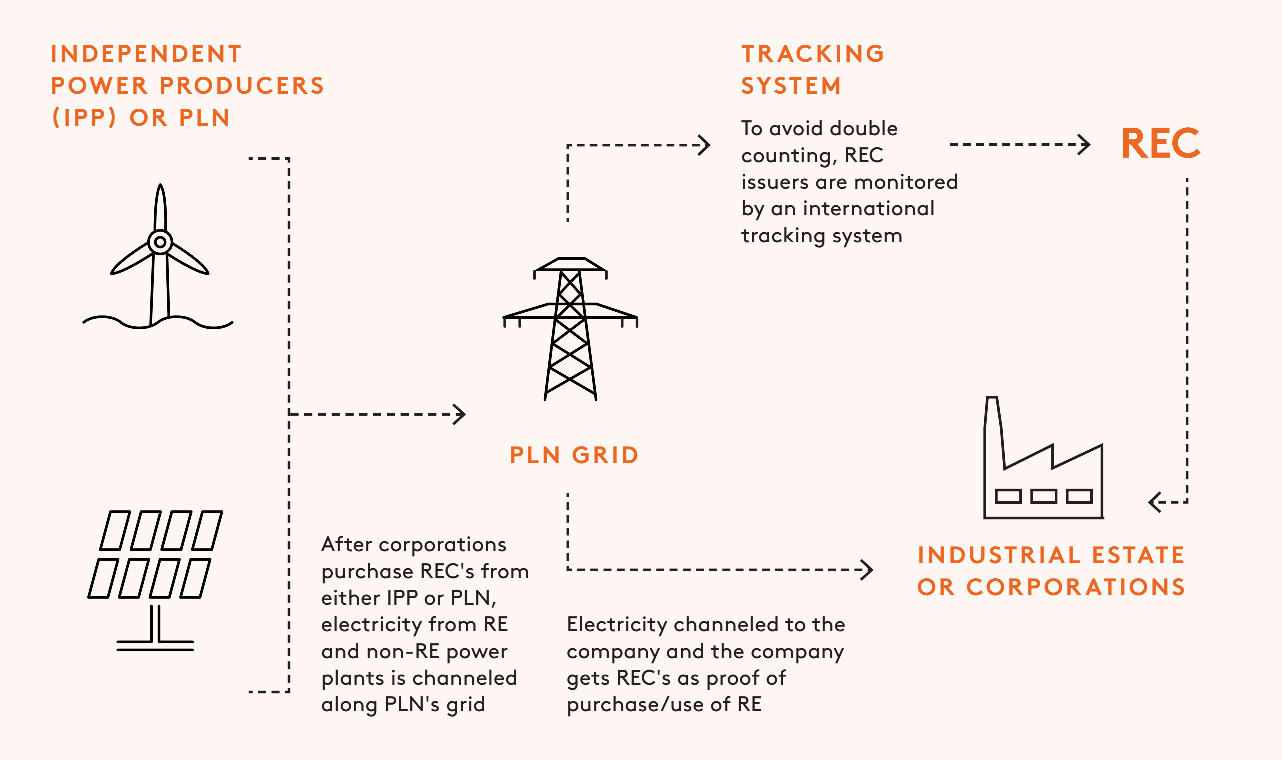
Non-energy emissions reduction is achieved through carbon management in industry, agriculture and forestry. Decarbonising industry requires managing processes and fugitive emissions from production. This includes optimising production processes, minimising waste and maximising resource utilisation, alongside identifying and addressing leaks in equipment and systems. Therefore, industry should prioritise emissions reduction through technological advancements and sustainable farming practices, using offsets only as a last resort for unavoidable emissions.

While offsets can play a limited role in achieving net zero emissions, the Science Based Target initiative (SBTi) calls for companies to prioritise emissions reductions and minimise their dependence on offsets. The SBTi recommends using offsets for a maximum of 10 per cent of emissions removals and, when necessary, using jurisdictionally backed carbon credits (SBTi 2024). Climate Bonds Initiative also supports this approach and mentions that offset dependence should not exceed 10 per cent of total emissions reduction efforts and only be used in the 'last mile' for residual emissions (Climate Bonds Initiative 2020).

Renewable energy certificates (RECs) are tradable certificates that prove a specific amount of renewable energy has been generated and fed into the electricity grid, see Figure 6. For manufacturers, RECs provide a way to demonstrate their commitment to using renewable energy, even if they are not directly sourcing renewable energy for their operations.

Through RECs, the Indonesian government is increasingly promoting renewable energy as an important input for manufacturers aiming to enhance their sustainability and reduce carbon footprints.

FIGURE 6: RENEWABLE ENERGY CERTIFICATE USE IN INDONESIA'S INDUSTRIAL SECTOR



Sources: Clean Energy Investment Accelerator 2021

Chapter 3: Technology for emissions reduction

Emissions reduction and energy efficiency cost optimisation

As seen in the four pillars, decarbonisation includes adopting efficient technologies, optimising procedures and avoiding energy use during non-productive phases. These technologies, while requiring upfront investments, offer substantial long-term financial benefits. As technological advancements continue to drive down costs and improve efficacy, companies find that integrating emissions reduction technologies and energy efficiency measures supports their environmental goals and enhances their financial performance.

Lighting and HVAC system

A switch to LED lighting systems is the most beneficial improvement in terms of both cost and emissions reductions (Khan 2011). Table 2 shows lighting efficacy and lifetime, compiled from multiple sources (Khayam et al. 2021; Putra et al. 2022; Irman et al. 2020; Husnayain et al. 2023; Khayam et al. 2023; Clasp and PWC 2020). It shows that LED lights are generally superior, followed by fluorescent and incandescent. Lighting efficacy refers to how well a unit produces light – a higher value indicates the unit is more efficient at producing light.

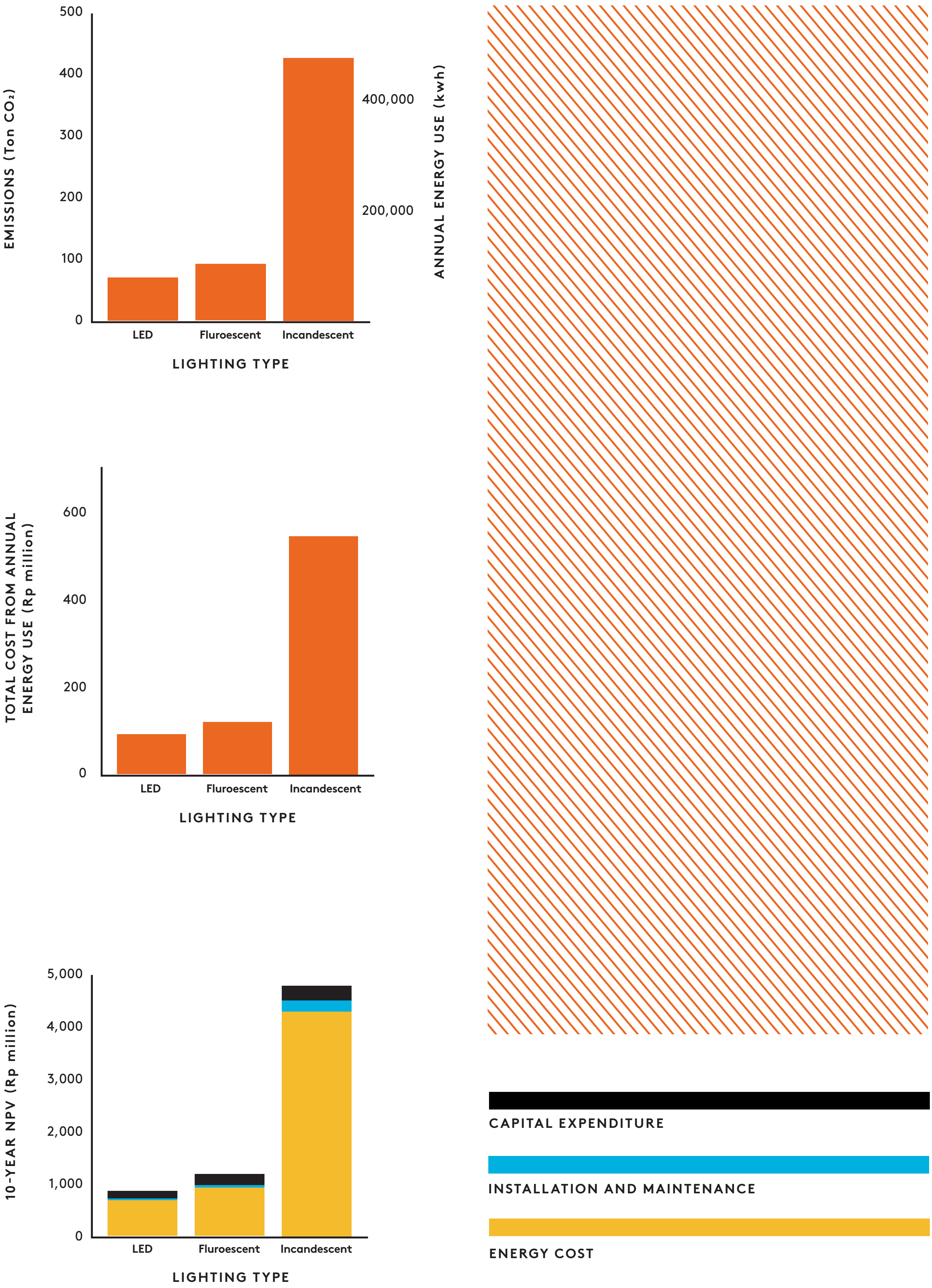
TABLE 2: EFFICACY AND LIFETIME OF DIFFERENT TYPE OF LAMPS

LIGHTING TYPE	LIGHTING EFFICACY (LM/W)	LIFETIME (HOURS)
Incandescent	14.7	1,000–2,000
Fluorescent	69.4	9,000–20,000
LED	94.5	50,000–100,000

Sources: Khayam et al. 2021; Putra et al. 2022; Irman et al. 2020; Husnayain et al. 2023; Khayam et al. 2023; Clasp and PWC 2020

From these multiple sources, we simulated the energy use, emissions, annual cost and net present value (NPV) of various lighting sources. In a hectare area requiring 350 lumens and operating for 1,920 hours annually, LED lighting can achieve the same luminescence as incandescent and fluorescent lamps for 15 and 65 per cent of the energy, respectively (Pereira et al. 2017; Islam et al. 2015). In terms of emissions, LED lighting emits around 70 tonnes CO_2e per hectare, meanwhile fluorescent and incandescent lighting emits around 92 and 422 tonnes CO_2e per hectare, respectively.

FIGURE 7: EMISSIONS, ENERGY USE, ANNUAL COST AND NPV OF VARIOUS LIGHTING SOURCES



Correspondingly, total energy costs follow the same pattern. Climateworks estimates that LED lights have the lowest annual cost of between Rp 200 and 300 million. Meanwhile, incandescent lights cost at least twice as much for the same luminescence. Capital expenditure is a minor part of total lighting costs. Most of the cost comes from energy use, further emphasising the benefits of switching to LED lights. LEDs are more efficient and effective in terms of cost and emissions reductions.

Exact emissions reduction and cost savings figures vary depending on industry, area size, operations and lighting needs. The textile industry might need higher lumens for colour examination, which would require more energy and consequently drive up costs. The source of energy also contributes to differences in cost and emissions reduction. For example, the above simulation utilised emissions factors from PLN's coal-dependent electricity grid. A company might achieve more emissions reduction if the lighting replacement is combined with solar power utilisation.

Combining lighting and HVAC improvements could provide more substantial benefits. Table 3 shows how businesses in the food and beverage, chemical and textile sectors can save energy and reduce their carbon footprint with lighting and HVAC improvements.

TABLE 3: COST SAVINGS FROM SEVERAL LIGHTING AND HVAC IMPROVEMENT MEASURES

SECTOR AND AREA	IMPROVEMENT	IMPACT		SOURCE
		ENERGY EFFICIENCY	FINANCIAL SAVINGS	
Food and beverage: Production area	Switch reconfiguration, replacing with Indonesian National Standard LED light	4,938 kWh/ month	Cost savings: Rp 59 million/year Payback period: 2.36 months	Fitria et al. (2017)
	Install efficient AC units	9,881 kWh/ month	Cost savings: Rp 119.5 million/year Payback period: 10 months	
Food and beverage: Aquaculture, indoor and outdoor	Replace fluorescent lights with LED	~700 kWh/ month	Cost savings: Rp 15.2 million/year	Duanaputri et al. (2024)
Textile: Polyester yarn manufacturer, factory area	Replace fluorescent lights with LED	296,438 kWh/ year	Cost savings: Rp 300 million/year Payback period: 0.74 years ROI: 436%	Kasliani (2021)
Textile: Production area	Reconfigure chiller operating time (delay start and early stop)	46,548 kWh/ month	Cost savings: Rp 617 million/year	Nuha (2018)
	Replace fluorescent lights with LED, adjusting with room needs	73,327 kWh/ month	Cost savings: Rp 972 million/year Payback period 1.3 years	

KEY BENEFITS:

+ **Financial savings:** Many energy efficiency upgrades, such as LED lighting and optimised HVAC schedules, provide cost savings and see rapid payback schedules. For example, it is estimated that investments in lighting and HVAC in a textile manufacturer's production area break even in 1.3 years or earlier (Nuha 2018).
+ **Minimal disruption to operations:** These improvements often require minimal changes to production processes, ensuring smooth operations.
+ **Scalable impact:** Energy efficiency measures can be tailored to meet specific needs and budgets of small businesses or large corporations. Longer operating hours and process-specific energy use for manufacturing increase the positive impact of energy efficiency measures.

PRACTICAL STEPS TO GET STARTED:

1. **Conduct an energy audit:** Identify areas with the highest energy consumption potential, such as lighting, HVAC systems and production processes.
2. **Upgrade lighting systems:** Replace outdated lighting fixtures with energy-efficient LED lights. Our simulation above shows that a switch from incandescent to LED lights could reduce energy costs by 65 per cent, while a switch from fluorescent lights may reduce energy costs by 15 per cent (Pereira et al. 2017; Islam et al. 2015).
3. **Optimise HVAC systems:** Adjust thermostat settings, improve insulation and implement regular maintenance schedules. For example, HVAC improvements could be achieved by adjusting the operational schedule of existing chillers. By strategically timing the start-up and shutdown of these units, and maximising the use of residual cooling capacity, significant cost savings can be realised (Vahid et al. 2014).
4. **Explore innovative technologies:** To further reduce energy consumption, consider advanced technologies like smart thermostats and demand-side management.
5. **Collaborate with energy experts:** Consult with energy efficiency experts to develop a customised plan and access available incentives and rebates.

TABLE 4: EXAMPLES OF SECTOR-SPECIFIC IMPROVEMENT MEASURES

SECTOR AND AREA	IMPROVEMENT	IMPACT		SOURCE
		ENERGY EFFICIENCY	FINANCIAL SAVINGS	
Textile: Finishing process	Convert thermic fluid heating system to direct gas firing system for stenters and dryers	120 MWh/year/ plant	Capital cost: ~Rp 468 million/plant Payback period: 1 year	Hasanbeigi et al. (2012)
Textile: Wet-processing	Install heat recovery equipment for stenter machine	~30% reduction of stenter energy use	Capital cost: ~ Rp 721–4,308 million/system Payback period: 1.5–6.6 years	Hasanbeigi et al. (2012)
Textile: Industrial processes	Install solar industrial process heating systems	Energy use reduction up to 14.7%	Payback period: ~ 13 years	Rahman et al. (2023)
Textile: Batik tulis	Replace kerosene and gas stoves with electric stoves for micro-scale/ individual artisan	–	Energy cost saving up to Rp 3.9 million/year	Syahputra and Mujahid (2019)
Food and beverage: Tofu industry	Replace unprocessed firewood with wood pellet for tofu manufacturing	Fuel efficiency up to 34%	Energy cost saving up to 50%	Sakuri et al. (2023)
Food and beverage: Monosodium glutamate	Replace spiral coil refrigerant systems with plate and frame heat exchanger	Energy reduction up to 13,000 kWh	Energy cost saving up to Rp 19 billion	Anara and Azis (2023)
Food and beverage: Meat processing industry	Audit energy use and adjust machinery operating time to improve efficiency	Energy reduction around 540 kWh/day	Energy cost saving around Rp 587,000/day	Pratama, Hartati, and Kumara (2017)

Efficient technology, fuel switching and electrification

Compared to lighting and HVAC systems, improvements in efficient technology, fuel switching, and electrification vary between sectors. These measures look different depending on their specific production processes due to differences in technology and energy sources but are equally critical to decarbonising.

Emissions reduction measures in the textile industry primarily focus on adopting more efficient energy sources for heating processes. Currently, the industry heavily relies on fossil fuels, particularly diesel, to power stenters and dryer machines; meanwhile, our discussions with experts showed that electrification can be applied in such processes. Integrating heat recovery into industrial processes could also significantly reduce energy use (Luo et al. 2015).

Electrification in the textile sector is often seen in large-scale operations with industrial machinery. Small traditional industries, such as batik tulis production, can also benefit by shifting from kerosene or gas stoves to electric ones, lowering energy costs (Mujahid, 2019). Electric stoves are relatively expensive, which may be difficult for micro industries. However, energy cost savings could quickly cover the upfront costs. In the food and beverage industry, where boilers are commonly used, interim switches from fossil fuels to wood pellets could boost energy efficiency by 30 per cent, potentially halving energy costs (Sakuri et al. 2023).

Efficiency improvements in production processes do not always require significant investment. For instance, an energy audit in the meat processing industry revealed inefficiencies in machinery operating times (Pratama, Hartati and Kumara 2017). By optimising these operating hours, the industry could cut energy consumption by up to 540 kWh per day without affecting productivity or incurring additional costs. This underscores the critical role of energy audits in identifying efficiency opportunities.

It is important to note that the examples above are case studies, and the outcomes of implementing energy-efficient technologies are context-dependent, varying with each company's specific conditions. However, research indicates that many Indonesian manufacturing companies do not meet energy efficiency standards (Pranolo et al. 2018). This highlights the substantial potential for improvement, even through small-scale initiatives.

Initiatives around performance standards and energy labelling can be instrumental. Minimum energy performance standards can set clear benchmarks for energy efficiency, encouraging manufacturers to adopt advanced technologies and optimise their operations. Additionally, mandatory energy labelling for products can empower consumers to make informed choices and drive demand for energy-efficient products.

THE ROLE OF CARBON OFFSETS

Before delving into carbon offsetting, industries should adopt efficient technologies and switch to lower-carbon fuels. These approaches offer tangible benefits such as lower operational costs, improved productivity, and reduced reliance on fossil fuels. For instance, the meat processing industry can significantly reduce energy consumption by optimising machine operating times, while the textile industry can explore the potential of solar-powered industrial process heating systems.

Once industries have implemented significant energy efficiency and fuel-switching measures, carbon offsets can be considered a complementary strategy to reduce emissions further. However, it is important to approach carbon offsets with caution. While they offer a way to neutralise residual emissions, concerns about their effectiveness and environmental integrity persist. To ensure offsets are credible, companies will need to source high-quality offsets from verifiable projects that deliver real and additional emissions reductions (Valiergue and Ehrenstein 2023). Therefore, offsets should be used as a last resort and only after exhausting all other opportunities for direct emissions reductions.

NAVIGATING THE COMPLEX LANDSCAPE OF RENEWABLE ENERGY CERTIFICATES

Industries can consider RECs if it is currently too expensive to invest in their own renewable infrastructure. Many firms depend on PLN’s RECs due to their affordability (Rp 35,000 per 1,000 kWh) though supply constraints remain a challenge. By 2023, PLN's renewable energy capacity stood at just 8,768 MW – insufficient to meet the growing energy demands of the industrial sector (PLN 2024b). Increasing demand for PLN’s RECs, which rose by 75 per cent from 2022 to 2023, highlights the growing interest in sustainable practices (PLN 2024a). While challenges exist, they also signal a market ripe for innovation.

While RECs can provide a convenient way to offset emissions, it is important to recognise their limitations. As demand for RECs grows, it is crucial to address supply constraints and pricing volatility. By investing in on-site renewable energy generation, such as solar or wind power, industries can reduce their reliance on RECs and achieve greater energy independence.

By proactively investing in renewable energy projects and exploring innovative financing mechanisms, companies can secure long-term, reliable sources of clean energy. This proactive approach can help mitigate the risks associated with RECs and ensure a sustainable energy future. Installing off-grid solar panels to power production processes may be a more reliable and sustainable alternative to relying on PLN’s RECs. While a 10–15 per cent cap was previously imposed on rooftop solar panels, the latest regulation removed this limitation and opens up more opportunities (Karyza 2024).

Cost-effective transition

The key to a cost-effective transition is the efficient use of readily available technology. To achieve a cost-effective transition to a low-carbon economy, businesses must prioritise practical and affordable solutions. By focusing on readily available technologies, Indonesian companies can significantly reduce emissions without massive financial restructuring. These technologies offer significant emissions reduction potential and deliver substantial cost savings in a relatively quick payback period.

FIGURE 8: COST-EFFECTIVE DECARBONISATION FOR FOOD AND BEVERAGE, TEXTILE AND CHEMICAL INDUSTRIES

	Food and beverage	Textile	Chemical
ENERGY EFFICIENCY	+ Upgrade to energy-efficient equipment like refrigeration units, ovens, and lighting systems. + Optimise cooking processes to reduce energy consumption. + Implement energy management systems to monitor and control energy usage.	+ Upgrade to energy-efficient textile machinery and equipment. + Optimise production processes to reduce energy consumption. + Implement energy management systems to monitor and control energy usage.	+ Upgrade to energy-efficient pumps, compressors, and other equipment. + Optimise production processes to reduce energy consumption. + Implement energy management systems to monitor and control energy usage.
RENEWABLE ELECTRICITY	+ Install rooftop solar panels to generate clean energy. + Purchase renewable energy certificates (RECs) to offset emissions from grid electricity.	+ Install rooftop solar panels to generate clean energy. + Purchase renewable energy certificates (RECs) to offset emissions from grid electricity.	+ Install rooftop solar panels to generate clean energy. + Purchase renewable energy certificates (RECs) to offset emissions from grid electricity.
ELECTRIFICATION AND FUEL SWITCHING	+ Electrify equipment and vehicles where feasible, such as electric delivery vehicles. + Explore opportunities to use electric heating and cooling systems.	+ Electrify machinery and equipment where feasible, such as electric motors and pumps.	+ Electrify equipment and vehicles where feasible, such as electric forklifts.
NON-ENERGY EMISSIONS REDUCTION	+ Reduce food waste through improved inventory management and portion control. + Implement waste reduction and recycling programs for packaging materials. + Source sustainable ingredients and packaging materials.	+ Reduce water consumption through efficient water management practices. + Minimise chemical usage and waste generation. + Source sustainable and recycled materials.	+ Reduce solvent emissions by using water-based and low-VOC paints. + Implement waste minimisation and recycling programs. + Source sustainable raw materials.

Balancing ambition with financial reality

While transitioning to 100 per cent renewable energy is the ultimate goal, it is important to consider the financial implications. For some businesses, a more gradual approach, such as switching to lower-emitting fuels or investing in energy-efficient technologies, may be a more practical first step and cost-effective option before committing to larger-scale renewable energy projects.

For Indonesian companies, fuel switching — replacing high-carbon fossil fuels with lower-carbon alternatives like biomass and biofuels — and small-scale electrification projects, can be an immediate and cost-effective step towards reducing emissions. For example, by blending biodiesel with conventional diesel, companies can significantly reduce greenhouse gas emissions in the short term without requiring major infrastructure changes. Other such switches include swapping coal with liquefied natural gas for heating processes, where feasible. These interim steps can pave the way for more ambitious decarbonisation initiatives in the future.

Larger decarbonisation initiatives, especially those needing significant financing require careful consideration of upfront costs and long-term benefits. By strategically managing capital expenditures and exploring various funding options, companies can maximise their return on investment while achieving their sustainability goals. Robust financial planning can bridge the gap between technical experts and financial decision-makers and ensure that decarbonisation projects are adequately funded (Accounting for Sustainability 2024).

Often, financing decisions are delayed or hindered by gaps in understanding between technical experts and financial decision-makers. Bridging this gap through detailed financial projections and scenario analysis can help highlight the potential cost savings, making a strong case for funding.In evaluating financing options, a detailed return on investment analysis that incorporates direct cost savings and the broader benefits of decarbonisation is essential. Such an analysis would allow companies to weigh the value of enhanced resilience to climate risks, potential revenue from carbon credits and other long-term financial impacts. By presenting a comprehensive return on investment model, decision-makers can better assess the full value of decarbonisation investments.

Furthermore, investors' increasing appetite for sustainable investments means corporations can broaden their investor base by integrating decarbonisation efforts into their business processes.

Decarbonisation projects offer the potential for significant long-term savings and revenue generation, which often justify these upfront costs. These potential benefits are shown in Table 4. Additionally, companies could consider not only direct financial returns but also broader benefits, such as improved brand reputation, compliance with regulatory standards and risk mitigation related to carbon pricing. By framing decarbonisation as a strategic investment, companies can demonstrate that the long-term financial and operational benefits outweigh the initial expenditures.

Beyond internal capital budgets, corporations can leverage alternative funding sources that align with sustainability goals.

GREEN FINANCING AND SUSTAINABILITY-LINKED LOANS:

'Green' financing refers to financing instruments that are earmarked to support environmentally friendly activities, including investment in low-carbon technology. Recently, sustainability-linked loans (SLLs) emerged as a way for financial institutions to expand their green financing. SLLs often come with favourable interest rates and terms for companies that achieve predetermined environmental targets. Such financial products allow companies to fund projects with minimal impact on their cash flow while showcasing their commitment to sustainable development.

Indonesian banks have introduced several green financing schemes, including the examples shown in Table 5.

GOVERNMENT GRANTS AND SUBSIDIES:

In many regions, governments provide grants, tax credits and subsidies for projects aimed at reducing greenhouse gas emissions. Leveraging these programs can reduce the effective cost of decarbonisation projects, increasing their attractiveness for internal approval. At the moment, Indonesia does not have specific financial incentives for low-carbon industry development, besides the green industry standard (*Standard Industri Hijau*), which includes non-fiscal incentives and EV subsidies. Nevertheless, the Ministry of Industry has been deliberating on the possibility of fiscal incentives to foster more low-carbon investment. (Yandwiputra 2023)

TABLE 5: GREEN FINANCING AND SUSTAINABILITY-LINKED LOANS

BANK	PROGRAM	DESCRIPTION
PT Bank UOB Indonesia	U-Energy	Integrated financing platform for energy efficiency projects for buildings (partnering with four local energy service companies), including solar panel installation, HVAC improvement, LED installation, and energy and electricity management among others. The program offers two schemes: hardware/equipment purchase loans or energy efficiency financing.
PT Bank Central Asia Tbk (BCA)	Sustainability-linked loans	BCA and borrower agree on key performance indicators (KPIs) and sustainability performance targets (SPTs) and borrowers will be rewarded with incentives if they achieve the pre-agreed SPTs.
	Green financing	Covers renewable energy, energy efficiency, sustainable management of bioresources and sustainable land use, eco-efficient products, 'eco-friendly' transportation and 'environmentally friendly' buildings.
PT Bank Mandiri Tbk	Retail and wholesale green financing	Financing for electric vehicles, solar panel and green mortgages.
	Corporate-in-transition financing	Comprehensive financing aimed at companies intending to significantly transform their business to align with climate targets. Companies interested in this scheme will need to have developed a measurable transition strategy.
PT Bank DBS Indonesia	Sustainability-linked loans	The loans are structured so that borrowers pay variable interest depending on their achieving a set of pre-agreed ESG performance targets.
	Green and sustainable trade financing	Financing support for renewable or sustainability-linked projects from bidding until contract fulfilment; enable suppliers to access lower cost credit.
	Green loans	Finance for eligible 'green' projects with clear environmental benefits.

Chapter 4: Forward outlook

Decarbonisation pillars and international disclosure standards

International disclosure standards, such as IFRS S2, are crucial for driving the integration of climate-related considerations into business practices by requiring companies to transparently disclose their climate-related risks and opportunities. These standards mandate companies disclose information on their greenhouse gas emissions, climate-related targets and transition plans. The result is greater transparency, accountability, and inform decision-making among investors, stakeholders, and the broader public.

Indonesia is actively preparing for the implementation of these standards. The Indonesian Financial Services Authority (OJK) is currently developing its own regulatory framework that could align with international best practices such as the IFRS. Recent announcements from the OJK regarding mandatory sustainability reporting for listed companies indicate a move towards greater transparency and accountability in climate-related disclosures (Aziz 2024). This approach by the OJK will likely play a significant role in facilitating the adoption of robust climate-related disclosures by Indonesian companies.

By embracing IFRS S2 and other relevant standards, Indonesian companies can improve their environmental performance, enhance their financial transparency and attract responsible investors. This fosters a more sustainable and resilient economy while contributing to Indonesia's global commitments to climate action.

IFRS S2 provides a framework for companies to report on their climate-related risks and opportunities. This framework aligns with the four pillars of decarbonisation: energy efficiency, renewable electricity, electrification and fuel switching and carbon management. IFRS S2 requires companies to disclose information relevant to investors and other stakeholders, enabling them to assess a company's climate-related risks and opportunities and make informed decisions.

While the current version of IFRS S2 does not explicitly cover carbon offsets and credits, the ISSB is actively exploring how to incorporate them into the standard. As these accounting treatments are still under development, carbon offsets and credits are currently not deducted from a company's total greenhouse gas emissions within the scope of IFRS S2.

The chemicals industry faces more stringent disclosure requirements under IFRS S2, encompassing all four pillars of decarbonisation. These requirements extend beyond energy use to include emissions management plans and the company's performance against these plans.

By contrast, the textile industry, despite accounting for 10 per cent of global carbon emissions, is not explicitly covered by IFRS S2's industry-specific disclosure requirements for energy use. As the first sustainability standard for the industry, IFRS S2 primarily focuses on identifying companies that are genuinely pursuing sustainable profits while addressing greenwashing concerns rather than solely focusing on energy use. While energy use is indirectly linked to climate-related risks and opportunities, IFRS S2 for the textile industry does not have detailed requirements for energy use disclosure.

IFRS S2 disclosure requirements for the food and beverage industry intersect with the energy efficiency and renewable energy pillars. The industry-specific standard focuses on energy usage and self-produced electricity.

It must be noted that the IFRS is an evolving standard that is constantly improving. The ISSB has recently announced that it will enhance the existing Sustainability Accounting Standards Board (SASB) standards, the foundation of the IFRS S2, by further identifying industry-specific sustainability-related challenges.

The ISSB exposure draft acknowledges that climate transition plans vary by industry. IFRS S2 will require organisations to consider industry-specific metrics that align with their business models, economic activities, or other shared industry characteristics. These metrics may also relate to the entity's transition plan.

TABLE 6: OVERLAPPING METRICS IN IFRS S2 AND FOUR PILLARS OF DECARBONISATION

<table>
<tr><th></th><th>IFRS S2 & Pillar 1: Energy efficiency</th><th>IFRS S2 & Pillar 2: Renewable electricity</th><th>IFRS S2 & Pillar 3: Electrification and fuel switching</th><th>IFRS S2 & Pillar 4: Non-energy emissions reductions</th><th>IFRS S2: Non-direct emissions reductions</th></tr>
<tr><td>TEXTILE</td><td>Not available</td><td>Not available</td><td>Not available</td><td>Not available</td><td>Responsible sourcing of raw materials</td></tr>
<tr><td rowspan="2">FOOD AND BEVERAGE</td><td>Total energy consumption</td><td rowspan="2">Percentage of renewable electricity used in the production process</td><td rowspan="2">Not available</td><td rowspan="2">Not available</td><td rowspan="2">Responsible sourcing of raw materials</td></tr>
<tr><td>Grid electricity used in production</td></tr>
<tr><td rowspan="4">CHEMICALS</td><td colspan="4">Disclosure of emission management plan, emission reduction targets, and performance against targets</td><td rowspan="4">Responsible sourcing of raw materials</td></tr>
<tr><td>Total energy consumption</td><td>Percentage of renewable electricity used in the production process</td><td>Not available</td><td rowspan="3">Not available</td></tr>
<tr><td colspan="3">Percentage of self-generated electricity used in production</td></tr>
<tr><td>Grid electricity used in production</td><td>Not available</td><td>Not available</td></tr>
</table>

Climate transition plans

The growing pressure on businesses to decarbonise their operations is intrinsically linked to the rapidly evolving landscape of climate-related disclosure. Requirements to disclose climate-related risks and opportunities are driving a critical need for companies to develop comprehensive climate transition plans. These plans articulate a company's strategy for achieving climate goals and adapting to a low-carbon future; they are shifting from voluntary exercises to essential components for navigating the changing regulatory environment, attracting sustainable finance and building stakeholder trust. Transition plans, which outline how a company plans to decarbonise, are typically developed after a company has conducted thorough scenari o analysis and risk assessments to understand its unique climate-related vulnerabilities and opportunities.

Mandates for disclosure of climate-related risks and opportunities are driving companies to develop transition plans that will hold up to investor scrutiny. By understanding how the four pillars of decarbonisation – energy efficiency, renewable electricity, electrification and fuel switching and carbon management – can be applied to their industry, companies are better equipped to create transition plans, meet their disclosure obligations to OJK in line with IFRS S2 and achieve their climate targets in a cost-effective and credible manner.

'"Transition planning" is the process a firm undertakes to (i) develop a strategy for meeting climate targets, whether voluntarily adopted or mandated, and/or (ii) prepare a long-term response to manage risks and adapt business models for a low-emission, climate-resilient economy' (NGFS 2023).

As new climate disclosure standards and frameworks demand more detailed climate transition plans, limitations in technical capacity and data availability become significant barriers for businesses in economies where these are not readily available. However, these barriers can be overcome with tailored support from policy-makers, enabling these economies to present or build up the necessary data.

A 'credible' transition plan, as Climateworks defines it, demonstrates a company's commitment to a low-carbon future backed by clear, measurable and achievable goals and the specific actions and investments needed to achieve them.

Companies can view transition planning as a potential avenue for securing sustainable finance and green project financing. The Transition Plan Taskforce framework provides guidance for companies to develop and disclose credible climate transition plans, outlining how they will reduce emissions and adapt to a low-carbon future. The framework emphasises ambition, concrete actions and accountability, aligning with disclosure standards like IFRS S2 to drive effective climate action.

Financial institutions wanting to make more sustainable investments can use the TPT framework to assess companies and their transition plans' credibility, prompting the financial sector to prioritise funding for companies with well-defined and credible transition plans. Companies aligning their transition plans with the TPT framework may be more attractive to investors and lenders seeking to align their portfolios with sustainability goals.

The four pillars of decarbonisation provide a foundation for companies developing decarbonisation strategies and transition plans. By focusing on these key areas, companies can identify the most efficient and affordable pathways to reduce their emissions, minimising the financial burden of the transition while maximising environmental benefits.

Our study found that while larger companies are generally aware of the benefits of low-carbon technologies and their long-term cost-effectiveness, short- to medium-term financial concerns often hinder their immediate adoption. Tailored technical support, such as access to financing mechanisms, capacity-building programs and technology transfer initiatives, can help these companies overcome these barriers and successfully integrate low-carbon technologies into their operations as part of their transition plans.

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For further information please contact:

PETRA CHRISTI
Senior Analyst
petra.christi@climateworkscentre.org

FIKRI MUHAMMAD
Senior Analyst
fikri.muhammad@climateworkscentre.org

DINDA MAHARANI
Analyst
dinda.maharani@climateworkscentre.org

Climateworks Centre
CEO Suite, One Pacific Place,
15th floor, Jl. Jend. Sudirman Kav.
52-53, Jakarta Selatan 12190,
Indonesia.

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