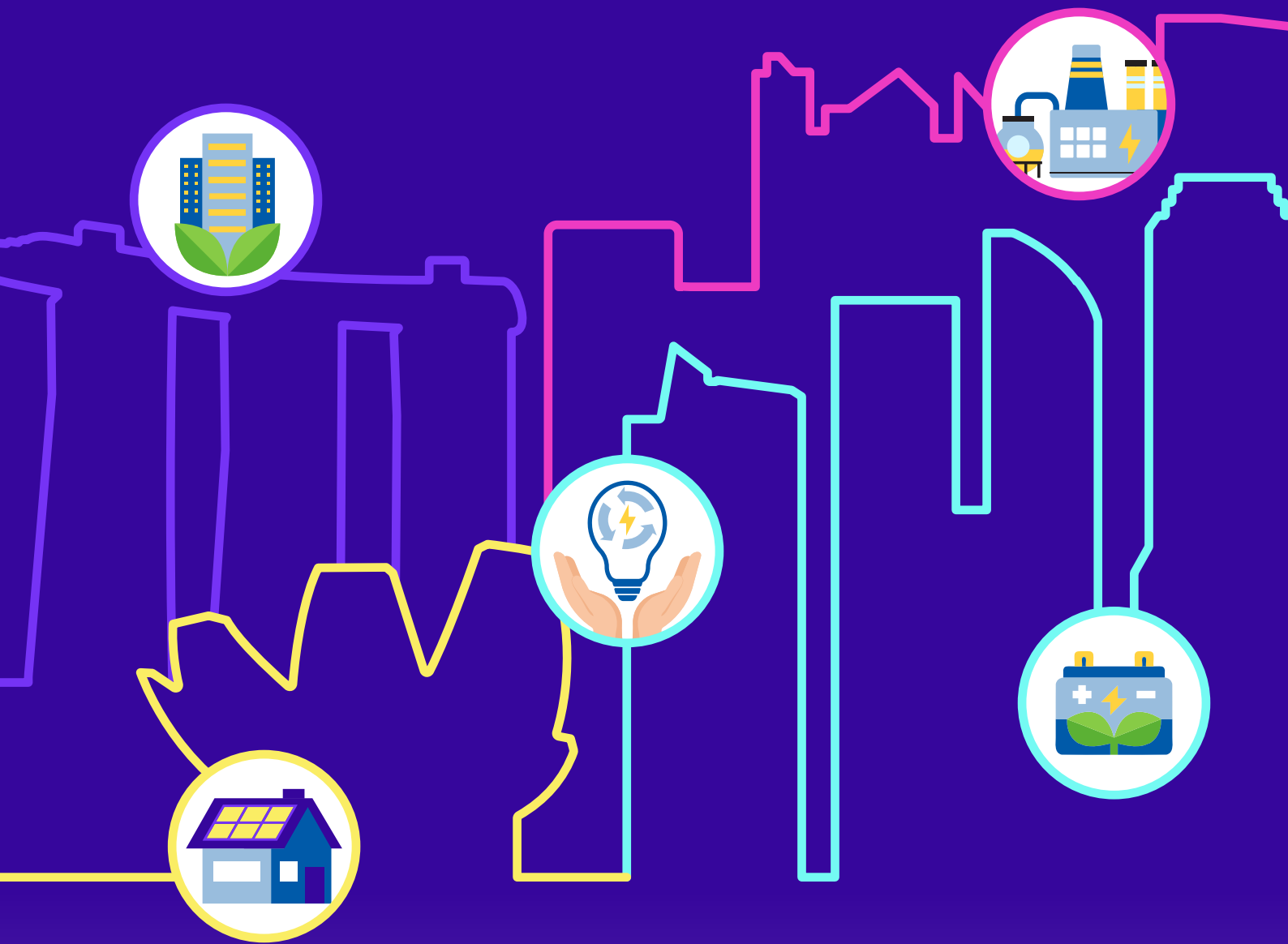


POWERING A SUSTAINABLE FUTURE

A Playbook on Scope 2 Emissions Reduction for Singapore Businesses



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Note: This abridged version only includes Sections A and B, and an executive summary of Section C. The finalised playbook will be released later.

Executive Summary

Businesses play a crucial role in the fight against climate change by managing and reducing their carbon emissions. For businesses, focusing on their Scope 2 emissions offers a clear goal to reduce their overall carbon footprint. An improved understanding of where Scope 2 emissions originate and how Scope 2 emissions can be reduced is fundamental in accelerating the decarbonisation journey. Companies

can not only meet international carbon reduction targets, but also foster sustainable business practices. This playbook focuses on strategies to reduce Scope 2 emissions, offering practical approaches to help companies decrease their reliance on carbon-intensive electricity through energy efficiency measures, renewable energy adoption, and other innovative technologies.

Overview of Scope 2 Emissions in Singapore

Background

Singapore has made firm commitments towards addressing climate change, recognising the need to transition into a low-carbon world while preparing for a climate-impaired world. This includes setting ambitious goals to reduce its carbon footprint, in line with global efforts to combat climate change. In 2022, we raised our national climate target to achieve net-zero emissions by 2050 as part of our Long-Term Low-Emissions Development Strategy (LEDS) and announced that we would reduce emissions to around 60MtCO_{2e} in 2030 after peaking emissions earlier as part of our revised 2030 Nationally Determined Contribution (NDC)¹. This involves an all-of-society approach, with various sectors—including government, businesses, and individuals—working together.

Under the Greenhouse Gas (GHG) Protocol, there are three types of emissions:

- **Scope 1:** Direct emissions from owned or controlled sources.
- **Scope 2:** Indirect emissions from purchased electricity, steam, heating, and cooling.
- **Scope 3:** Other indirect emissions from a company's supply chain and value chain activities.

Power Sector Emissions

The power sector accounts for a large proportion of the country's GHG emissions. Decarbonising our energy grid and reducing electricity consumption are therefore crucial steps towards realising Singapore's net-zero ambitions. In 2021, power sector made up 39.2% of total emissions in Singapore (excluding hydrofluorocarbon (HFC) emissions). Resulting scope 2 emissions in Singapore are driven by industry first and foremost, followed by buildings and households (see Figure 1).

Emissions Profile (2021)

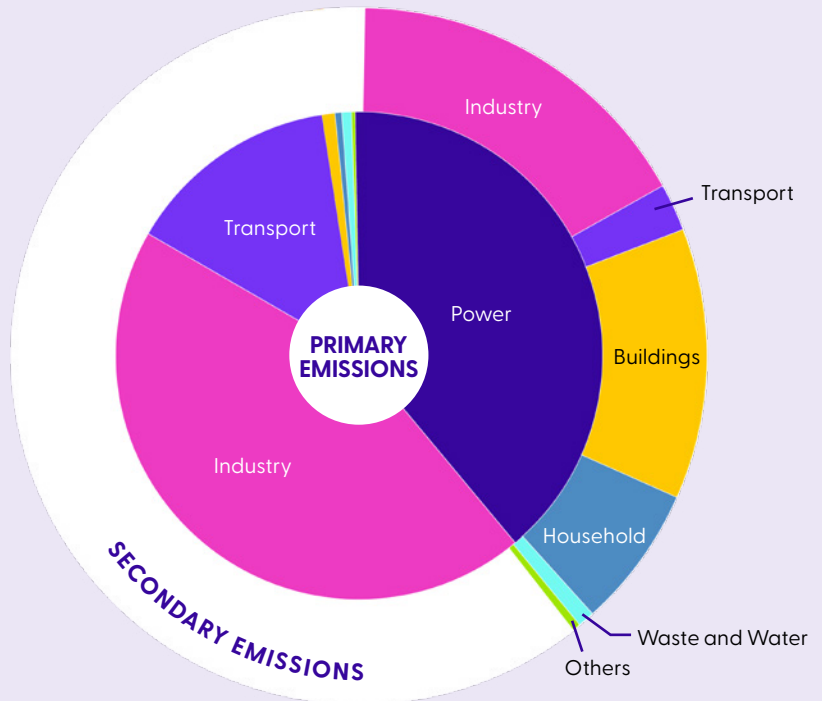
Emissions: 53.7 MtCO_{2e}

PRIMARY EMISSIONS

Power	39.2%
Industry	44.4%
Transport	14.2%
Buildings	0.9%
Household	0.4%
Waste and Water	0.6%
Others	0.2%

SECONDARY EMISSIONS

Industry	16.6%
Transport	2.2%
Buildings	12.6%
Household	6.6%
Waste and Water	0.8%
Others	0.4%



The emissions profile above excludes estimated HFCs emissions of around 4.0 MtCO_{2e} from the Refrigeration and Air-conditioning (RAC) sector in 2021. When more robust estimates are established, the national emissions profile will be updated in accordance with the United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC) guidelines on continual improvement of national GHG inventories.

Figure 1: Singapore's emission profile²

Over the years, electricity demand has increased in Singapore with about 95% of Singapore's electricity produced from imported natural gas—contributing to Singapore's emission profile. Therefore, the energy transition, focused on cleaner sources of electricity and improved energy efficiency, is central to the nation's strategy for reducing emissions. Given Singapore's use of natural gas for electricity production, Scope 2 emissions—the indirect emissions associated with electricity consumption—represent a significant portion of the country's carbon footprint. Singapore's energy transition has been largely supply-centric, focusing on decarbonising the energy supply mix to lower the Grid Emissions Factor (GEF), enabling consumers to access low-carbon electricity. However, decarbonising the power sector presents complex challenges due to technological limitations, geopolitical uncertainties and Singapore's nature resource constraints. As a result, there is a growing recognition that the demand side must also play a critical role in reducing emissions.

Electricity demand is expected to grow over the medium to long term as industries electrify to reduce carbon emissions, and with the growth of electricity-intensive sectors such as advanced manufacturing and the digital economy. Over the coming decade (2024–2032), the system peak demand is projected to grow at Compound Annual Growth Rate (CAGR) of between 3.1% to 5.5%³. The growth is driven by factors such as population, temperature, economic activities, and new and emerging electricity-intensive sectors. The key consumers of electricity include the industry, buildings, and households, leading to high levels of Scope 2 emissions (see Figure 1). Despite these challenges, there are numerous opportunities to reduce emissions through innovative technologies and practices.

Energy is essential for Singapore's survival and economic competitiveness. We have to achieve a balance in the energy trilemma—energy security and resilience, environmental sustainability, and cost-competitiveness—as we work towards net-zero emissions. The energy trilemma is exacerbated by Singapore being an alternative-energy disadvantaged country, with limited land area and constraints on deploying large-scale renewable projects like solar, as well as the lack of potential for wind or hydro-electric power. As a densely populated island with minimal natural resources, Singapore's climate strategies must navigate these limitations while remaining adaptable to global supply chain fluctuations and climate impacts.

Singapore's Ongoing Efforts to Reduce Emissions

Singapore has made significant commitments to reducing carbon emissions as part of its national sustainability agenda. The government has introduced a range of policies and regulations on this front. The Singapore Green Plan (SGP) provides a guide on whole-of-nation efforts to advance Singapore's national agenda on sustainable development until 2030. Singapore's Energy Reset is one pillar under the SGP/LEDS that drives the decarbonisation of the power sector and consists of the four switches to green our energy supply⁴. At the same time, the government has also put in place regulations, incentives/grants, and capability building programmes to support energy users on their decarbonisation journey (see Infographic A). The Singapore government, through its various ministries and agencies, has been actively working on multiple initiatives to report and reduce emissions across all sectors. The Energy Market Authority (EMA) and other regulatory bodies play a pivotal role in guiding and enforcing these initiatives, ensuring that Singapore stays on track to meet its carbon reduction goals.



Singapore's Policies and Regulations to Support Energy Users Towards Decarbonisation

Singapore Green Plan 2030

The launch of SGP 2030 aims at advancing Singapore's national agenda towards sustainable development, and the plan is spearheaded by five ministries. The main pillars include Energy Reset, Green Economy, City in Nature, Sustainable Living, and Resilient Future.

Standards and Regulations

Carbon Tax⁵

Singapore is the first Southeast Asian country to introduce a carbon tax, which was initially set at \$5/tCO_{2e} between 2019–2023. In 2024, the carbon tax was raised to S\$25/tCO_{2e}. It will be raised to S\$45/tCO_{2e} in 2026 and 2027, with a view to reaching S\$50–80/tCO_{2e} by 2030. This strengthens the price signal and impetus for businesses and individuals to reduce their carbon footprint in line with our national climate goal.

Mandatory Climate-Related Disclosure (CRD)⁶

Singapore is introducing mandatory climate-related disclosure in a phased approach. All listed companies are required report CRD aligned with the International Sustainability Standards Board (ISSB) standards from FY2025 (including Scope 1 and 2 emissions). More time will be given for the mandatory reporting of Scope 3 emissions. Large non-listed companies will be required to do the same from FY2027. External limited assurance will also be required for listed and large non-listed companies from FY2027 and FY2029 respectively. This responds to investor demand to use CRD to understand companies' environmental strategies and make their investment decisions. Select Singapore-incorporated companies may tap on the Sustainability Reporting Grant (SRG) for funding support⁷.

Energy Conservation Act⁸

The act requires energy efficiency requirements and energy management practices for companies, to improve energy efficiency, encourage energy conservation, and reduce the carbon emissions. The act mandates companies to conduct regular energy efficiency opportunity assessments and introducing minimum energy performance standards for common industrial equipment and systems.

Building Control (Act and Regulations)⁹

The act and regulations require new buildings as well as existing buildings undergoing major retrofitting works or major energy use change to meet minimum environmental sustainability standards. Owners of prescribed buildings are required to carry out periodic energy audits. Existing building owners are also required to submit information in respect of energy consumption and other related information as required by the Commissioner of Building Control. These requirements apply to buildings with a Gross Floor Area (GFA) of 5,000m² and above.

Green Mark (GM) by Building Construction Authority (BCA)¹⁰

The BCA GM is a leading green building certification scheme tailored for the tropical climate. The latest edition, Green Mark 2021 (GM:2021), is an all-in-one framework for New and Existing, Non-Residential and Residential Buildings. Under GM: 2021, buildings can be certified by meeting pre-requisites under the Energy Efficiency section, and achieving the performance under the Sustainability sections which cover Maintainability, Whole Life Carbon, Intelligence, Resilience, and Health and Wellbeing.

Emissions Standards for Power Generation Units¹¹

EMA is placing emission standards for new and repowered fossil fuel-fired power generation units to facilitate the deployment of clean and efficient power generation units in Singapore. Under the new two-tier emission standards, generation units which are expected to run regularly will need to meet the Tier 1 standard (within 0.355 tCO_{2e}/MWh emission intensity limit). Generation units that run only periodically can opt to fall under the Tier 2 standard. Under this standard, EMA will also require both Tier 1 and Tier 2 units to be at least 30% hydrogen-ready by volume, with the ability to be retrofitted to become 100% hydrogen-ready in future.

Programmes and Initiatives

● Solar Renewable Adoption Programmes¹²

As part of Singapore's effort to decarbonise the power sector, Singapore rooftop solar programmes such as SolarNova programme led jointly by Housing & Development Board (HDB) and the Economic Development Board (EDB) as well as the SolarRoof programme by JTC Corporation¹³, aim to accelerate the solar deployment in Singapore. Both programmes help to aggregate demand for solar energy across different stakeholders, in an effort to drive the Singapore PV industry.

● Regional Power Grids¹⁴

Singapore has made steady progress in its plans to import low-carbon electricity to meet one-third of our electricity needs by 2035. As of September 2024, Conditional Approvals have been granted to import up to 5.6 GW of low-carbon electricity from Cambodia, Indonesia and Vietnam. Among those projects, five Indonesia-based projects to import a total of 2 GW have advanced to Conditional Licences.

● Emerging Low-Carbon Alternatives

Singapore is studying emerging low-carbon technologies that have the potential to reduce Singapore's carbon footprint. For instance, in March 2024, the Government appointed a lead developer to study the feasibility of developing a cross-border Carbon Capture and Storage (CCS) project from Singapore¹⁵. The Government is also in the latter stages of a Request for Proposal (RFP) to develop a low- or zero-carbon ammonia solution for power generation and bunkering by the end of the decade¹⁶. Singapore has also set aside over \$180mil for the Low-Carbon Energy Research (LCER) programme, to support research and development investments to expand the range of technological solutions available to Singapore and improve their technoeconomic viability¹⁷.

Driving Down Scope 2 Emissions

More than 50% of Singapore's GDP is contributed by non-heavy industries like wholesale trade, finance and services, information and communications, and other sectors¹⁸—of which, most are tapping on grid electricity for their operations and contributing towards Scope 2 emissions. A study done by LowCarbonSG programme on more than 50 local firms between 2020 and 2022, found that Scope 2 emissions are the largest contributors to the companies' carbon emissions—making up more than 50% in terms of absolute emissions and emission intensity by revenue¹⁹. Hence, it is imperative for businesses to take proactive steps in addressing their Scope 2 emissions, contributing to a sustainable future for Singapore and beyond.

The impetus to drive down Scope 2 emissions is in part due to the evolving regulatory landscape for sustainability reporting. Starting from FY 2025, all listed companies in Singapore are required to make climate-related disclosures aligned with ISSB standards²⁰. This requirement will also apply to large non-listed corporates with revenue more than S\$1 billion and total assets more than S\$500 million from FY 2027. For Scope 2 emissions, ISSB requires companies to disclose both location-based and market-based emissions, following the Greenhouse Gas Protocol (GHGP) methodology²¹. The location-based method reflects the emissions intensity of the local electricity grid, while the market-based method accounts for emissions based on specific energy procurement choices, such as renewable energy certificates or power purchase agreements. Dual reporting is essential for transparency and comparability, enabling stakeholders to assess both a company's regional grid exposure and its active energy procurement efforts. Small- and Medium-sized Enterprises (SMEs) should prepare for this dual disclosure requirement to comply with future mandatory reporting standards and demonstrate their commitment to sustainability. Considering the evolving landscape of carbon disclosure, there will be increased visibility on companies' strategies and ability to attain climate goals and thus, companies will need to explore solutions to reduce Scope 2 emissions.

There are other standards, guidelines, and frameworks for both carbon accounting and reporting frameworks, depending on the specific requirements of investors and stakeholders, buyers, and the international and local markets companies operate in. For example, Singapore Exchange has recommended a list of international sustainability reporting frameworks that local companies could adopt when doing sustainability reporting. The requirements/standards/frameworks for carbon accounting/assessment and sustainability reporting, specifically for Scope 2-related emissions or consumption, are summarised in Table 1 and 2 below.

Table 1

Carbon Accounting Requirements

Carbon Accounting Standards/Frameworks	Details
ISO 14064 ²²	<p>An international standard that addresses the quantification and reporting of GHG, which includes accounting of Scopes 1, 2 and 3 emissions. There are three parts of this standard, which includes:</p> <ul style="list-style-type: none"> • ISO 14064-1:2018 specifies principles and requirements at the organisation level for quantification and reporting of GHG emissions and removals. It includes requirements for the design, development, management, reporting and verification of an organisation's GHG inventory. • ISO 14064-2:2019 specifies principles and requirements and provides guidance at the project level. • ISO 14064-3:2019 specifies principles and requirements and provides guidance for those conducting or managing the validation and/or verification of GHG assertions. It can be applied to organisational or GHG project quantification, including GHG quantification, monitoring and reporting carried out in accordance with ISO 14064-1 or ISO 14064-2.

Table 2

Sustainability Reporting Requirements

Sustainability Reporting Frameworks	Details
<p>Global Reporting Framework (GRI) 302²³</p> <hr/> <p>GRI 305²⁴</p> <hr/> <p>Task Force for Climate Related Disclosures (TCFD)²⁵</p> <hr/> <p>Sustainability Accounting Standard Board (SASB)²⁶</p>	<p>302-1: Energy consumption within the organisation which includes</p> <ul style="list-style-type: none"> • Electricity consumption • Heating consumption • Cooling consumption • Steam consumption <p>302-2: Energy consumption outside the organisation</p> <p>302-3: Energy intensity</p> <hr/> <p>305-2: Energy Indirect (Scope 2) GHG Emissions</p> <hr/> <p>Recommended Disclosures:</p> <ol style="list-style-type: none"> Disclose the metrics used by the organisation to assess climate-related risks and opportunities in line with its strategy and risk management process. Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 GHG emissions, and the related risks. Describe the targets used by the organisation to manage climate-related risks and opportunities and performance against targets. <hr/> <p>For indirect emissions, SASB Standards capture the operational and/or strategic factors that give rise to such emissions. For the industries that indirectly contribute to GHG emissions through significant use of purchased electricity (i.e., Scope 2), SASB Standards contain metrics related to understanding the amount, type (conventional or renewable) and source (self-generated or purchased) of energy.</p>

In Singapore, listed SMEs preparing for mandatory climate reporting from the financial year of 2025 must align with the ISSB standards²⁷. For Scope 2 emissions, ISSB requires companies to disclose both location-based and market-based emissions, following the GHGP methodology. The location-based method reflects the emissions intensity of the local electricity grid, while the market-based method accounts for emissions based on specific energy procurement choices, such as renewable energy certificates or power purchase agreements. Dual reporting is essential for transparency and comparability, enabling stakeholders to assess both a company's regional grid exposure and its active energy procurement efforts. SMEs should prepare for this dual disclosure requirement to comply with future mandatory reporting standards and demonstrate their commitment to sustainability. Considering the evolving landscape of carbon disclosure, there will be increased visibility on companies' strategies and ability to attain climate goals and thus, companies will need to explore solutions to reduce Scope 2 emissions.

Challenges Ahead

The road ahead is not without challenges. Decarbonising Scope 2 emissions in Singapore presents significant challenges due to the nation's unique energy landscape, shaped by the Four Switches: natural gas, solar energy, regional power grids, and emerging low-carbon technologies²⁸. While solar power holds promise, land constraints limit its potential to meet only about 10% of electricity demand by 2050. Singapore is also looking to import clean energy from neighbouring countries, but this strategy introduces uncertainties related to geopolitics and price fluctuations. Natural gas, which currently generates 95% of the country's electricity, remains essential for energy security, further complicating the transition to cleaner energy. Businesses must focus on energy efficiency and reducing electricity consumption as immediate steps to decarbonise their Scope 2 emissions. While emerging technologies like hydrogen and geothermal energy are being explored, they are not yet viable for widespread use.

Given these constraints, enterprises play a crucial role in Singapore's energy transition by adopting efficient practices and exploring renewable energy procurement options to help reduce their carbon footprint while supporting the nation's sustainability goals. Most SMEs are also unsure about the pathways towards decarbonisation via the use of low carbon technologies. Overall, these challenges slow down the decarbonisation journeys of companies and necessitate alternative options to drive down Scope 2 emissions.

Private Sector Taking the Lead Towards Decarbonisation

The business case for reducing carbon emissions

Businesses are increasingly setting ambitious decarbonisation goals, driven by the rising demand for sustainability and compliance with evolving regulatory requirements. Companies may aim to power a specific percentage of their operations with renewable energy sources, such as wind, solar, or hydroelectric power, or commit to achieving net zero or carbon neutrality by a particular year by balancing their emitted greenhouse gases with equivalent reductions or offsets. Some organisations are also pursuing a more aggressive strategy by pledging to use carbon-free energy sources around the clock, even before the grid is fully decarbonised.

Net-zero targets, in particular, are gaining prominence as they increasingly influence investor decisions and stakeholder expectations. Investors are prioritising organisations that demonstrate strong environmental, social, and governance (ESG) credentials, with net-zero commitments often viewed as a key indicator of long-term resilience and responsible management. Moreover, adherence to net-zero targets helps businesses comply with tightening regulations and reporting standards, mitigating risks related to regulatory changes and potential carbon pricing. To achieve these decarbonisation goals, many companies are aligning their efforts with recognised frameworks and initiatives that provide guidance and benchmarks. Below is a non-exhaustive list of key initiatives:

1. Science-Based Targets Initiative (SBTi)

- Provides a framework for companies to set GHG emission reduction targets that are in line with climate science and aligned with the Paris Agreement.

2. UN Sustainable Development Goals (SDGs)

- A set of 17 global goals established by the United Nations, which include specific targets related to climate action and affordable, clean energy.

3. Net-Zero Initiative

- Encourages commitments by organisations and governments to achieve net-zero emissions in their operations, aligning with the goals of the Paris Agreement.

4. CDP

- A global system that enables cities and companies to measure, manage, and disclose environmental impacts, fostering transparency and accountability.

5. RE100

- A global initiative that brings together businesses committed to achieving 100% renewable electricity in their operations, promoting the transition to a sustainable energy system.

By adopting these frameworks, businesses can enhance their sustainability performance, meet stakeholder expectations, and position themselves competitively in a rapidly evolving marketplace. In short, sustainability and decarbonisation plans, need to be an integral part of businesses, and have to be seamlessly integrated into the business growth strategy and operations accordingly.

The role of private sector in accelerating emission reductions and drive net-zero goals

Businesses, particularly SMEs, play a vital role in accelerating the transition to a low-carbon economy and achieving net-zero emissions. As Singapore prepares for more stringent ESG standards and higher carbon tax rates in the coming years, companies need to be proactive in developing strong sustainability strategies. With the government and leading financial institutions prioritising sustainability, such strategies can create new business opportunities, reduce costs, and enhance resilience against climate risks (see Infographic B).

Key Benefits of Decarbonisation for Businesses

Mitigate Risks (Operational, Regulatory, Reputational)

- 1. Operational Risks**
 - **Climate Resilience:** Businesses will be more motivated to adopt low carbon technology and services, in an effort to mitigate the operational risks from the physical impacts of climate change like extreme weather events and the rise in sea level.
 - **Business Continuity:** Adoption of sustainable technologies like energy efficient technology or renewables, could enhance business continuity and attract more clients who are more environmentally conscious.
- 2. Regulatory Risks**
 - Companies need to adapt to the latest environmental regulations and emission reduction targets. By staying ahead with the latest regulations and policies, companies could plan ahead to minimise or avoid hefty fines, legal issues and damages due to non-compliance with local regulations. In Singapore, such regulations include the Carbon Pricing Act and mandatory climate disclosures for listed and big non-listed companies.
- 3. Reputational Risks**
 - **Trust From Stakeholders:** Companies should have ongoing transparent communication to their stakeholders, specifically on their sustainability-related implementations and activities. These include customers, investors and employees, which is important to maintain the trust of the stakeholders on their commitment towards decarbonisation.
 - **Brand Integrity:** Consumers are placing high importance on sustainability-related products and services, as most clients value environmentally responsible businesses.

Minimise Operational Costs (Utility, Regulatory, Insurance)

- 1. Utility Costs:**
 - **Energy Efficiency Measures:** Through the use of energy efficient technologies like light-emitting diode and energy efficient heating, ventilation, and air conditioning systems, businesses could reduce their overall energy consumption and lower their utility bills.
 - **Renewables Adoption:** Transitioning to renewables like photovoltaics (PV), could reduce the dependencies of businesses on grid electricity, hence making them less prone to the fluctuations in oil and electricity prices. Hence, businesses could achieve significant cost savings and at the same time, reducing their emissions, through their own clean energy generation.
- 2. Regulatory Costs:** Companies that actively address their emissions, could help reduce the costs of carbon taxes, fines or penalties associated with exceeding regulatory limits for excess consumption or emissions. Hence, the adoption of low carbon technology, could help businesses to reduce these regulatory costs and adapt to the local environmental regulations.
- 3. Insurance Costs:** Insurers viewed greener businesses favorably and have considered climate-related risks during their evaluation when assessing the insurance coverage costs for businesses. Businesses that demonstrate commitment to decarbonisation, are usually subjected to a lower insurance premiums or costs.



Capture Opportunities (Remain Business Competitive, Better Access to Green Financing)

- **1. Competitive Advantages for Businesses:** Businesses could remain competitive in the market by meeting the growing customer demands for sustainable services and products. This allows business to penetrate into markets where green business opportunities are available.
- **2. Better Access to Green Financing:** Local financial institutions have provided higher preference or preferential interest rates to companies that are greener in their operations. For example, UOB fleet-transitioning solution provides a much lower loan rate to companies that could lower their emissions or meet their emission targets.

Decarbonising business operations is a key area where companies can make a significant impact. Many local businesses are already setting ambitious targets, such as science-based targets, to reduce emissions within their operations and value chains. According to a recent carbon emission study conducted by the LowCarbonSG programme on over 50 local firms in sectors like customer services, engineering services, manufacturing, and transportation, Scope 2 emissions (indirect emissions from purchased electricity) emerged as the largest contributor to both absolute carbon emissions (measured in kgCO₂e) and emissions intensity by revenue (measured in kgCO₂e per SGD 1,000)²⁹. The manufacturing industry had the highest emissions profile, with Scope 2 emissions contributing the most to its overall carbon footprint.

Industry transformation through the adoption and development of low-carbon technologies is another critical area for businesses. SMEs and private companies are in a unique position to foster innovation by embracing emerging technologies that support a green transition. By developing or adopting low-carbon solutions—such as renewable energy, hydrogen technology, and energy storage systems—businesses can create value in markets that increasingly prioritise sustainability and decarbonisation. For example, the Sustainability Open Innovation Challenge organised by Enterprise Singapore is one platform which unifies industry partners and seeks innovative minds to devise sustainable solutions spanning various sectors³⁰.

Collaboration and partnerships are also essential for businesses, especially SMEs, to achieve net-zero goals. By working with large corporations, government agencies, and institutions, SMEs can gain access to resources, expertise, and networks that support their decarbonisation efforts. These could also include access to grant schemes, training workshops, and other initiatives designed to help businesses reduce their emissions.

Through these actions—decarbonising operations, fostering industry transformation through low-carbon technologies, and engaging in strategic partnerships—businesses can strengthen their sustainability performance and play a transformative role in driving global net-zero ambitions while positioning themselves competitively in an evolving regulatory environment. This could include the adoption of existing standards and certifications that help with Scope 2 emissions management such as ISO 14001, which is an internationally recognised standard for environmental management systems³¹.

Current Gaps and Pain Points for Sg Businesses to Decarbonise (Scope 2-Focused)

Despite growing awareness and commitment to sustainability, many businesses in Singapore face significant challenges in their journey towards decarbonisation. While aligning with global net-zero goals has become a strategic priority, several gaps and barriers continue to impede progress in achieving meaningful emission reductions. Companies are grappling with regulatory complexities, financial constraints, and limited access to technology, which can make understanding their emissions profile and implementing effective reduction strategies difficult. Aligning with Singapore's effort to decarbonise all industries in order to meet their 2030 NDC, more and more businesses are starting to take crucial actions towards decarbonising their operations to align with SGP 2030. Local institutions like DBS, UOB, Singapore Business Federation (SBF), have conducted surveys among SMEs to identify their sustainability goals and the respective challenges in achieving them. Based on these studies, the key challenges faced by companies, could be categorised into five main buckets.

- **Cost:** Insufficient financing, high technology investment cost and low return on investment to implement sustainability-related strategies and technologies (DBS, SBF and UOB)
- **Guidance:** Lack of guidance for companies on how to achieve sustainability and decarbonisation (DBS, SBF and UOB)
- **Knowledge:** Lack of sustainability-related knowledge and relevant manpower/ESG specialists (DBS, SBF and UOB)
- **Standards:** Lack of clarity on reporting standards (DBS)
- **Balance with company's growth:** Difficulty of business to balance ESG with growth targets (DBS)

The typical asks from companies based on the three surveys from DBS³², UOB³³ and SBF³⁴ are:

- Financial support/incentives
- Support on ESG consultancy
- Access to technologies for ESG implementations

As the urgency to combat climate change intensifies, Singapore businesses must navigate a complex landscape of evolving compliance requirements, high costs, and technological readiness, all of which create substantial pain points in their pathways to reducing carbon emissions. In part to address these challenges, the next section will review available technologies, including the likes of technical solutions for renewable energy generation, demand management and energy efficiency improvement, which companies can adopt in the near-, mid-, and long-term to reduce Scope 2 emissions.

Section C

Decarbonisation Solutions to Reduce Scope 2 Emissions

Executive Summary of Decarbonisation Solutions

This section provides an executive summary of the key solutions that businesses can adopt to reduce their Scope 2 emissions. The categorisation of solutions into time horizons is based on Singapore's unique challenges as an alternative-energy-disadvantaged and space-constrained nation.

The solutions in Horizon 1 (0-5 years) focuses on cost-competitive, technologically mature solutions that businesses can adopt today to reach near-term wins and reductions in Scope 2 emissions. Horizon 2 (>5 years) solutions include emerging technologies—that face technical, economic or regulatory barriers—that companies can plan for and invest in the mid-to-long term, after maximising Horizon 1 solutions.

Horizon 1 (0-5 years): Near-Term Solutions

Renewable Energy (RE) Generation

- Rooftop and ground-mounted PV systems
- Biomass
- Biomethane

Energy Storage Systems (ESS)

- Lithium-ion batteries

Green Energy Procurement

- Power Purchase Agreements (PPAs)
- Green retail contracts
- Renewable Energy Certificates (RECs)

Energy Efficiency

- Energy efficient appliances (e.g. Light Emitting Diode bulbs)
- Internet of Things (IoT) devices (e.g. thermostats, light sensors, passive infrared sensor)

Demand Optimisation

- EMA's Demand Response (DR) programme
- EMA's Interruptible Load (IL) programme

Description of Solutions

Companies should maximise RE deployment where possible, since it directly reduces purchased electricity and correspondingly, Scope 2 emissions. Rooftop and ground-mounted solar have relatively short payback periods, and companies can opt for solar/rooftop leasing models to minimise upfront capital costs. Sustainably produced biomass and biomethane leverage circular economy principles to turn agricultural, domestic, or industrial biowaste into useful energy.

ESS can smooth out the variability of RE by storing excess energy generated from renewables and discharging the stored energy during periods of system peak demand and/or periods when renewables are not generating energy (e.g. at nighttime for solar PV).

Companies can consider green retail contracts or PPAs with renewable energy providers and/or Electricity Importers which allow businesses to purchase RE/RECs over fixed durations, thus providing certainty on energy costs and access to RECs. Through these contracts, companies can obtain the associated RECs to certify that the electricity procured has been generated from RE sources.

Energy efficiency refers to the use of less energy to perform the same tasks. As a low-barrier solution, improving energy efficiency offers cost savings to companies through reduced energy consumption. The Government has also developed an Energy Efficiency Grant, which aims to support businesses in their sustainability journey by co-funding investment in energy-efficient equipment.

EMA's DR programme: DR participants are activated to reduce their electricity consumption during periods of high wholesale electricity prices. Participants who are activated and deliver 100% of what they had committed will receive a share of the total system savings arising from the reduction in wholesale electricity prices due to their electricity demand reduction. The average DR incentive payment in 2023 was \$2,770/MWh.

EMA's IL programme: IL participants are paid to be on standby. In return for payment, the participant is obligated to reduce their electricity demand when the system requires this reduction to improve system reliability. The average IL incentive payment in 2023 was \$16.51/MWh.

Horizon 2 (>5 years): Mid-to-Long Term Solutions

RE Generation

- Building-Integrated Photovoltaics (BIPV), Building Applied Photovoltaics (BAPV)
- Small wind turbines (e.g. vertical-axis wind turbines)

Low-Carbon Generation

- Low-carbon hydrogen
- Ammonia
- Novel fuel cell technologies + CCS

Energy Efficiency

- Cold Energy Utilisation from Regasification of Liquefied Natural Gas
- Advanced Building Materials (Energy harvesting/Phase change material)

Demand Optimisation

- Localised energy optimisation via Distributed Energy Resource Management Systems (DERMS), Virtual Power Plant (VPP), or Microgrids

Description of Solutions

BIPV where the solar PV systems are integrated directly into the building architecture (e.g. walls or windows) or BAPV where the solar PV systems are installed on an existing building's structure (e.g. on building facades) can be deployed to maximise solar potential.

Companies located around coastal areas or open water bodies can also deploy small wind turbines, which are compact in size, quieter in operation, and able to harness wind from any direction.

Low-carbon hydrogen and ammonia can help to decarbonise sectors which are hard to abate through renewable energy alone. Companies can also combine fuel cell technologies with CCS to produce power and reduce emissions into a valuable end-product.

Cold energy can be harnessed for various cooling and cryogenic applications such as in food storage, cooling of data centres, and manufacturing.

Phase Change Materials (PCM) offer potential for improving energy efficiency of industrial processes and insulation in buildings (e.g. when embedded in walls, ceilings, or roofs). This is because PCM contains substances that can store and release large amounts of thermal energy during phase transitions (typically between solid and liquid).

Localised energy optimisation via DERMS, VPPs, or microgrids refer to advanced energy systems that help to coordinate various distributed energy sources such as solar PVs, ESS, and demand-side IoT resources like smart thermostats and appliances. These advanced systems help to optimise energy generation, storage, and consumption which in turn enhance grid efficiency and reliability at the system-level.

Note: This is an executive summary of Section C. The finalised playbook will be launched later.



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