



SINGAPORE



COUNTRY OVERVIEW

In 2009, leading up to the UNFCCC Climate Change Conference, Singapore agreed to reduce greenhouse gas emissions by 16% below business-as-usual levels in 2020. Following the 2015 Paris Climate Agreement, Singapore has reiterated the intent to reduce emissions intensity by 36% from 2005 levels by 2030 and stabilise greenhouse gas emissions, with the aim of peaking around 2030.

In 2021, Singapore launched the Singapore Green Plan 2030 which sets out concrete and ambitious targets to advance the sustainable development agenda and make the city greener. Among the goals is greening 80% of the buildings, stopping registration of diesel cars by 2025 and installing more electric vehicle charging stations around the country, and decreasing the amount of landfill waste by 30% by 2030.

Singapore has very limited renewable energy options based on current technologies, and has to import almost all of its energy supply. Wind speed in Singapore is a lot lower than needed for successful generation of wind energy – 2m/s, as opposed to required 4.5m/s. The narrow tidal range and calm seas limit tidal power generation, and the lack of a fast-flowing river system meant that hydroelectric power is not viable either. The island's small size and high population density limit sustainably grown domestic biomass, or the large-scale deployment of solar power.

Nevertheless, Singapore has made an early transition from oil-powered generation to gas-powered generation over the last 50 years, and today more than 95% of Singapore's electricity is generated from natural gas, which although not renewable, is the cleanest burning fossil fuel. One of the pillars under the Singapore Green Plan 2030 is the Energy Reset, which will harness four "switches" to encourage cleaner power generation. This includes: (i) increasing the energy efficiency of natural gas power plants; (ii) accelerating solar energy deployment and energy storage systems to manage solar intermittency; (iii) exploring opportunities to use regional power grids; and (iv) examining emerging low-carbon solutions such as carbon capture, utilisation or storage (CCUS) technologies and hydrogen.
(Source: National Climate Change Secretariat / Energy Market Authority)



SECTOR OVERVIEW

Power generation

While there is limited potential for the deployment of renewable energy options domestically, Singapore seeks to maximise such deployment and does so through innovative solutions. To enable this, Singapore invests significantly in R&D activities. For example, the **Solar Energy Research Institute of Singapore (SERIS)**, has been pushing the boundaries of solar energy research to develop new and innovative solar applications, such as deploying solar photovoltaic cells on water spaces and on building facades, which would increase the solar deployment opportunities in land-scarce Singapore. The Energy Market Authority (EMA) and Keppel Offshore & Marine (Keppel O&M) have also jointly awarded a research grant to deploy a 7.5 MW/7.5MWh lithium-ion battery ESS on Keppel O&M's Floating Living Lab.

Singapore is also studying emerging **low-carbon technologies** such as hydrogen and CCUS, which have the potential to decarbonise the power and industry sectors significantly in the longer-term. For example, the Singapore Government has set aside S\$49 million (US\$36 million) for the Low-Carbon Energy Research (LCER) Funding Initiative (FI) to support R&D projects in low-carbon energy technologies such as hydrogen, and CCUS, and develop solutions that support Singapore's decarbonisation efforts.

One alternative solution is **hydrogen**, with the potential to shift Singapore's fuel mix towards low-carbon options for electricity generation, heavy transportation and industrial processes. It will be challenging for the country to produce green hydrogen at scale given the limited renewable energy resources, and Singapore will need to explore and secure various supply pathways for price-competitive low-carbon hydrogen. EMA is currently studying the infrastructure requirements to import, store and transport hydrogen for power generation. In addition, there is strong interest from industry players, with several consortiums studying the technical and economic feasibility to import and use low-carbon hydrogen.

EMA's study also found that **CCUS** can reduce the country's emissions from the industry and power sector and add to the adoption of low-carbon hydrogen. Singapore is investing in R&D to develop innovative solutions to overcome near-term technical and economic challenges and barriers

and reduce the costs of CCUS. Singapore is also looking partnerships to pilot and testbed new CCUS solutions which can be scaled up in due course.

Singapore is also looking to develop **regional power grids**, which will help in the development of renewable energy sources in the region, and provide greater resilience and stability for all parties involved. As part of the regional grid, Singapore is looking to import low-carbon electricity from the region. Singapore is commencing an electricity import trial with Malaysia, and participating in the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project.

Waste management

The National Environment Agency (NEA) is responsible for planning, developing and administering Singapore's solid (or general) and hazardous waste management systems, including licensing and regulatory functions to ensure that waste is properly collected, treated and disposed of. Singapore has its own waste disposal facilities, which includes four waste-to-energy incineration plants (Tuas Incineration Plant, Tuas South Incineration Plant, Senoko Waste-to-Energy Plant, and Keppel Seghers Tuas Waste-to-Energy Plant), and an off-shore Semakau Landfill which receives non-incinerable waste and incineration ash via the Tuas Marine Transfer Station.

Singapore has an integrated waste-to-resource management system. In land-scarce Singapore, waste-to-energy (WTE) incineration plants offer the best technical solution by reducing waste volume efficiently to conserve landfill space. The 3Rs (Reduce, Reuse, Recycle) also play a crucial role by preventing waste generation at its source and bringing along numerous benefits. With the Zero Waste Masterplan and Resource Sustainability Act introduced in 2019, Singapore is working to become a Zero Waste Nation by reducing consumption, as well as reusing and recycling all materials to give them a second lease of life. Focus is placed on three key waste streams – e-waste, food waste and packaging waste, including plastics.

NEA licenses **general waste** collectors (GWCs) in Singapore as well, operating primarily on commercial and industrial premises and the country has taken significant steps to tackle waste upstream. Several measures have been implemented to minimise waste and recycle waste at businesses, schools and households. The main challenges that Singapore faces in waste management include setting aside limited land for waste disposal, low recycling rates, and contamination of recyclables in recycling bins, which prevent them from being recycled. Noteworthy is also the plan for the first integrated water and solid waste treatment facility, enabling co-digestion of **food waste** slurry and used water sludge to improve energy recovery from waste.

The market for companies in Singapore, however, is fragmented, with local companies operating in all sub-sectors of the industry, and there are therefore opportunities for new market entrants in all fields.

Generating more than 60,000 tonnes of e-waste a year, Singapore's rate of **e-waste** generation is expected to grow in tandem with economic growth and the general rise in the use of electrical and electronic equipment (EEE) among businesses and consumers. NEA has been working closely with industry partners and communities to encourage e-waste recycling through National Voluntary Programmes (NVP) for e-waste recycling since 2015. Through the NVP, NEA and industry partners implemented various collection programmes and awareness raising campaigns. While voluntary e-waste recycling measures have yielded encouraging results, NEA recognises the limitations of a voluntary approach and need for a regulated system in the long run. A regulated e-waste management system, based on the Extended Producer Responsibility (EPR) approach, commenced in 2021. Under the EPR system, producers bear the responsibility for collecting and treating their products when they reach end-of-life. ALBA E-Waste Smart Recycling Pte Ltd has been appointed as the Producer Responsibility Scheme (PRS) Operator for a period of five years, from 2021 to 2026, to collect regulated consumer electrical and electronic waste across Singapore for proper treatment and recycling on behalf of producers.

Air quality improvement

As a member of BreatheLife, a global campaign to encourage countries, cities and citizens to prioritise tackling air pollution, Singapore has learnt a lot about the importance of air quality. Although the city is largely successful in eliminating traffic jams that are common across cities in Southeast Asia, during certain seasons, Singapore's air quality drops significantly due to the occasional haze. The ambient air quality in Singapore is continuously monitored through a network of air monitoring sensors across the country. One contributor to Singapore's good air quality is its accessible, well-utilised, efficient and sustainable public transport system, which, through the Land Transport Master Plan, is continuously becoming greener and cleaner in terms of technologies deployed. Under the Vehicular Emissions Scheme, vehicle buyers can get a rebate or pay a surcharge, depending on the emission levels of the vehicle bought. Technology companies can find business opportunities in this sector, mainly in monitoring and analysing of data on air quality, supplying filters to industrial exhaust systems, as well as supplying green transport technologies.

Water supply and treatment

Singapore has very limited freshwater resources, hence it is essential to regulate local water pollution. Access to water in Singapore is universal, affordable, efficient and of high quality. Over the years, Singapore has built a robust and diversified supply of water with the "Four National Taps". The Public Utilities Board's (PUB) efforts include ensuring that rainwater is collected across two-thirds of Singapore's land area, endless recycling of used water, and desalinating seawater. As Singapore ensures the sustainability of the water supply, it can be very attractive for businesses with innovative water collection, management and treatment technologies and expertise.



REGULATION

Consumers installing **solar PV** systems need to comply with necessary technical and market registration requirements calibrated based on the consumers' profile, size and type of their solar PV installations.¹ To facilitate solar deployment and ensure the regulations are fit-for-purpose, Singapore has proactively introduced regulatory enhancements such as streamlining the registration process for solar consumers to sell their excess solar electricity to the grid and reviewing metering requirements to reduce cost.

To support the deployment of solar, EMA has been investing in capabilities in areas such as solar forecasting and Energy Storage Systems (ESS) to manage the intermittency from solar generation. EMA launched the ACCelerating Energy Storage for Singapore (ACCESS) programme in 2018. The programme seeks to partner the industry and facilitate ESS adoption in Singapore by co-developing innovative ESS solutions, and promoting ESS use cases and business models. An example is the partnership between EMA and Keppel Offshore & Marine to pilot Singapore's first floating ESS in 2020.²

EMA is also working with government agencies, industry players and research community to establish standards to guide the safe deployment and maintenance of ESS in Singapore. In 2020, Singapore's first set of ESS technical guidelines and Technical Reference 77 (TR-77) was released.³

The management of **solid and hazardous** wastes is governed by the Environmental Public Health Act (EPHA), which covers Regulations for General Waste Collection, General Waste Disposal Facilities, and Toxic Industrial Waste. The act was amended in 2014 to implement the mandatory reporting of waste data and submission of waste reduction plans by any owner, or occupier, upon receipt of a written Notice. From 2024 onwards, it will become mandatory for the owners and operators of large commercial and industrial premises, where substantial amounts of food waste are generated, to segregate their food waste for treatment. These owners can choose the food waste treatment method that best suits their operations. NEA will also be developing a reporting framework to raise awareness among owners and operators of these industrial and commercial premises of the amounts of food waste they produce, so that they may pay greater attention to the potential for sustainable food waste management.

NEA, with the view to promote environmental sustainability and minimise the environmental impact of **e-waste**, has put in place upstream controls by restricting hazardous substances (RoHS) in EEE. The RoHS control measures restrict the allowable level of six hazardous substances (i.e., 4 heavy metals and 2 flame retardants) in certain types of household EEE. The initiative will reduce the presence of heavy metals in the incineration ash entering Singapore's Semakau landfill site. It will also increase the potential recyclability of incinerated ash, which is being explored as one of the strategies to extend the lifespan of the landfill site that is expected to reach capacity by 2035. In 2021, Singapore launched a national e-waste management system or the Extended Producer Responsibility (EPR) scheme for E-waste, which places the responsibility for the collection and proper treatment of regulated products on the producers, importers, brand owners and manufactures. Regulated products include such as ICT equipment, large appliances, light bulbs and tubes, batteries and solar panels.

Singapore prices potable **water** to reflect its long-run marginal cost, which refers to the cost to produce the next drop of water. There is a requirement to treat trade effluent to a specified standard before discharging it into the public sewers. To promote water conservation, Singapore runs a Water Efficient Building (WEB) (Basic) Certification Programme that promotes the benefits of implementing water efficiency measures on premises and in processes of businesses, industries, schools, and buildings.

There are plans to implement a beverage container return scheme in 2023, followed by an EPR scheme for managing packaging waste including plastics no later than 2025. There is also the Enterprise Sustainability Programme, supporting SMEs in taking up more sustainable business practices, and through the Research, Innovation and Enterprise 2025 plan, Singapore is encouraging local businesses and attracting foreign companies to develop sustainable technologies within CCUS, low-carbon hydrogen, energy efficient materials, and other solutions for circular economy.

¹ The requirements can be found at <https://licence1.business.gov.sg/feportal/web/frontier/home>

² https://www.ema.gov.sg/media_release.aspx?news_sid=20201026UiyBHcBySRr8

³ <https://www.ema.gov.sg/singapore-standards-technical-references.aspx>



MARKET ENTRY

Singapore's image of a green and sustainable city-state, a 'garden city', helps the cleantech sector to thrive. For foreign companies, especially SMEs or tech start-ups, it is not only the market opportunities in Singapore that might be alluring, but taking part in the R&D activities, innovation programmes and networking possibilities. Singaporean ventures have links to most of the ASEAN region and beyond. It is also a viable option for foreign entrepreneurs to establish their subsidiary company in Singapore and use that for further expansion.

As the green industry is now part of the Singaporean identity, government bodies are providing more support to cleantech companies. Enterprise Singapore (ESG) is the key agency responsible for assisting Singaporean SMEs in internationalisation, market development and export (as well as import), and is therefore a good way to start networking and finding contacts for foreign companies. The Economic Development Board (EDB) is the inbound investment agency in Singapore that is responsible for strategies that enhance Singapore's position as a global centre for business, innovation and talent. Besides facilitating investments, EDB works with companies by providing information, connection to partners and access to government incentives for their investments, as well as their transformation and growth initiatives. The various Trade Associations and Chambers such as the Singapore Business Federation and Singapore Chamber of Commerce and Industry, could be suitable partners to champion the interests of the Singapore business communities through its large membership, and contacts to key local and foreign business chambers.

Singapore has developed a 50+ hectare CleanTech Park, which serves as an R&D and test-bedding site for early adoption of sustainable technology and solutions. The park fosters a conducive, clustered environment that encourages cross-fertilisation of ideas and collaboration between industry and academia, and is a choice location for forward-looking corporations that embrace environmental sustainability.

Singapore also has a number of trade fairs and industry events, where contact can be made to relevant Singaporean companies as well as building knowledge of the market. Major events include:

- <https://www.siww.com.sg/>
- Singapore International Water Week is the leading global urban water management event.
- <https://www.asiacleanenergysummit.com/>
- Asia Clean Energy Summit is annually held in Singapore.
- <https://www.asiaclimateforum.com/>
- Asia Climate Forum on air pollution, meteorology, flood mitigation and prevention.
- <https://www.cleanenvirosymposium.gov.sg/>
- Clean Enviro Summit on waste, water and energy.



TRENDS AND RECOMMENDATIONS

Singapore follows the key trends in environmental protection, energy, and related sectors. In addition to the opportunities mentioned above, there are other cross-cutting as well as specific areas where SMEs can offer their technologies and expertise:

- **Sensors:** Monitoring is one of the fastest developing segments of the cleantech sector, mostly in air and water quality, therefore real-time data collection is sought after.
- **Automation:** Energy production or waste management are leading sectors of automation and robotics-based solutions.
- **Sustainability means efficiency:** All cleantech segments have to focus on increasing efficiency; the first levels of recycling was easy to reach, the more advanced ones will require a step ahead in efficiency.
- **Data driven solutions:** A lot of big data companies are targeting cleantech industry players to provide services.
- Developing **energy storage and balancing the national grid.**

Water:

- Digital solutions and smart technologies that increase efficiency, quicken planning and response, improve operations and service delivery, as well as water grids, water plants and sewers.
- Technologies for efficient seawater desalination.

Waste:

- Recycling technologies to reduce food waste, plastic waste and e-waste. Value extraction and creation from the above 3 key waste streams.
- Technologies to conserve the landfill.

Construction: technologies that increase the energy efficiency of buildings.

Overall, the Singapore market is highly competitive and advanced, setting high demands of suppliers. The country has a strong commitment however, to greening the island and operating as sustainably as possible, and has both the legislative capacity and the financing to be able to put this into effect. The market is therefore highly attractive to SMEs with leading technologies and services.



CLEANTECH SECTOR BRIEF