Can Singapore Get to Net Zero by 2050?

BY **EDWIN TF KHEW,** Chairman, Sustainable Energy Association of Singapore

Solar energy, regional energy imports and hydrogen are at the heart of Singapore's net-zero strategy. The challenge lies not only in technology but in execution. How can boards and business leaders help bridge the gap between ambition and reality?

Singapore announced its aim to achieve net-zero carbon emissions by 2050. This target was formally submitted to the UN Framework Convention on Climate Change in November 2022. It marked a strengthening of Singapore's earlier position to "aspire to net zero by the second half of the century".

How realistic is this target, given resource constraints, such as limited land, a lack of natural renewable resources and high urban density? More importantly, what must be done to bridge the gap between aspiration and realisation – to reach net zero?

Strengthening energy security

Singapore's progress toward a cleaner energy future has been very much driven from the top, with a centralised and methodical approach. Given the high stakes involved in ensuring energy security and economic competitiveness, the state has played a firm hand in steering the national agenda. (See box, "Key Milestones in Singapore's Energy Transition").

This has meant combining strategic infrastructure investments with clear policy direction and close public-private collaboration. Together, these efforts have created an ecosystem in which government agencies, industry players, and research institutions work to accelerate the transition towards sustainability.

A coordinated national effort involving agencies, such as the Energy Market Authority (EMA), National Research Foundation, Sustainable Energy Association of Singapore (SEAS), and the Economic Development Board (EDB), has advanced energy efficiency across sectors. These agencies are geared toward building market readiness, industry capabilities and policy frameworks.

Sustainable energy development, involving renewable energy and energy efficiency, must be supported by a viable ecosystem. Launched in 2006, SEAS brings together more than 250 organisations in the renewable energy and carbon development sectors. Its members include environment consultants, financial institutions, multinational corporations, grid providers and energy storage companies.

Solar power – here comes the sun

From the outset, Singapore has prioritised solar as its most viable domestic renewable energy source. The Solar Energy Research Institute of Singapore (SERIS) was established in 2008 to lead in solar research and development, with a focus on technologies suited to tropical climates. For example, using lighter, thinner glass solar panels that do not need to withstand the

Key Milestones in Singapore's Energy Transition

Year	Milestone
2008	Solar Energy Research Institute of Singapore (SERIS) established
2014	SolarNova programme launched (HDB & EDB)
2021	Singapore Green Plan 2030 announced
2022	100MW of hydropower imported from Laos via ASEAN Power Grid
2022	National Hydrogen Strategy unveiled
2030	Target: 2GWp installed solar capacity
2050	Target: Net zero carbon emissions

weight of snowfall (unlike those for winter climates). Today, SERIS is amongst the top five solar research centres in the world.

The SolarNova programme, a whole-of-government initiative led by EDB and Housing Development Board (HDB), has driven large-scale rooftop and floating solar deployments. As of 2024, nine SolarNova tenders have been launched, and HDB is on track to achieve 540MWp of installed capacity by 2030.

However, solar energy deployment can account for only around 10 per cent of projected energy demand in Singapore. Renewable energy from rooftop solar panels and water bodies (reservoirs and nearshore areas) is not sufficient to meet Singapore's energy demands. Moreover, Singapore has little or no natural resources for other renewable energy sources, such as wind and hydro power.

The next phase in Singapore's energy journey is to replace its current natural gas-based electricity supply with renewable energy from the region. This involves developing, generating, and importing renewable or clean energy in countries outside Singapore, including hydro and wind power, as well as geothermal, biofuels, and nuclear energy.

Energy imports

To extend Singapore's energy strategy beyond its borders, SEAS and EMA are leading the charge in exploring projects in Malaysia, Indonesia, Vietnam, Laos and Cambodia. (See box, "Regional Collaboration in Action").

However, these cross-border initiatives are complex. They require substantial infrastructure investment (e.g., subsea cables, subsea bed leases, environmental impact assessment studies), regulatory alignment and collaboration across multiple governments (sometimes involving provincial and local jurisdictions).

Issues such as licensing, local content requirements and maritime approvals can delay project timelines. Nonetheless, such imports are projected to supply up to 40 per cent of Singapore's energy needs by 2050. These can involve solar consortia in Indonesia (particularly in Batam, Bintan and the Riau islands) and sometimes politically sensitive negotiations.

Data centres and manufacturing industries will expect to be part of the regional supply chain. For example, under an agreement known as the *Tingkat Kemampuan Dalam Negri* in Indonesia, the consortia of SEAS members must commit to working with local

Regional Collaboration in Action

Singapore's path to net zero depends on deep regional cooperation and energy interconnectivity. Examples of cross-border clean energy projects include:

Location	Project Highlights
Batam/Riau, Indonesia	Singapore consortia developing large-scale solar farms
Laos–Thailand–Malaysia–Singapore	ASEAN Grid pilot importing 100MW of hyropower
Cambodia, Sarawak, Vietnam, Australia	Emerging opportunities in solar, hydro and wind

suppliers and manufacturers. This requires solar project components to have 40 to 60 per cent local content.

At the state level, the Indonesian government, for instance, would expect Singapore to transfer its industry and research knowledge in exchange for tapping into its local resources. To that end, the Indonesian Solar Energy Research Centre was established through an agreement with SERIS.

In 2022, a landmark power import project began channelling 100MW of hydropower from Laos through the ASEAN Power Grid, serving as a testbed for future regional integration.

Public-private partnerships continue to underpin innovation. Institutions like SERIS and collaborations with ASEAN counterparts play a critical role in advancing technologies for solar, storage, hydrogen and energy efficiency. These foundational efforts now provide a platform for scaling.

Hydrogen – not just hot air

Singapore's energy needs must be sourced through a mix of imports and advanced technologies, particularly hydrogen. At least half of Singapore's power needs are projected to come from hydrogen, particularly in decarbonising industrial activities on Jurong Island.

Hydrogen can be used in power generation, transport and heavy industry. But the barriers are significant. Hydrogen is costly to produce, transport and store. It is highly flammable, requires specialised infrastructure, and has a low energy density. (See box, "Hydrogen at a Glance").

Singapore's hydrogen strategy acknowledges these issues, which is why it focuses on long-term development, pilot projects and collaboration with technology leaders worldwide.

To overcome the logistical hurdles of pure hydrogen, Singapore is exploring the use of hydrogen carriers, particularly ammonia and methanol. Each has trade-offs in safety, efficiency and cost. Their adoption will depend on use-case suitability and infrastructure readiness, and strategic decisions will be needed at both the policy and board levels.

Hydrogen at a Glance

- A hydrogen refuelling station costs approximately S$5 million and needs 0.56 hectares of land.
- Hydrogen has the widest explosion range of any fuel: 4 to 74 per cent concentration in air.
- Methanol (a hydrogen carrier), unlike hydrogen, is liquid at room temperature and can use existing petrol/diesel infrastructure. It is suitable for vehicles (including heavy transport and drones), power generators, marine fuel and even as a feedstock in the petrochemical sector.

- Ammonia (another hydrogen carrier) is easier to transport and store than hydrogen and is being pilot-tested for use in power plants. However, it is toxic and requires careful handling, especially under pressure or at low temperatures.

These practical constraints shape how hydrogen can be deployed across transport and industry as the green fuel of the future.

What Singapore needs to succeed

To close the gap between the current trajectory and the 2050 target, several enabling conditions must be strengthened.

1. **Sustained and scaled regional collaboration**
   Long-term bilateral and multilateral partnerships are essential for renewable energy imports. These arrangements must be resilient, commercially viable/bankable and backed by strong diplomatic and institutional support.

2. **Technology leadership and adoption**
   Singapore must continue to lead in clean energy research and development, especially in hydrogen technologies, grid resilience and energy storage. Accelerating commercialisation will be key.

3. **Robust regulatory and policy frameworks**
   Policy certainty and financial incentives will encourage private sector participation and de-risk long-term infrastructure investments. This includes carbon pricing, green financing and transparent permitting processes.

4. **Public-private research and development**
   Developing the right capabilities, from skilled labour to research and development infrastructure, will ensure that Singapore remains competitive and adaptable in a fast-changing energy landscape.

5. **Private sector support and leadership.**
   The transition to net zero cannot be led by the government alone. Businesses must embed sustainability into their core strategies and operations.

For company directors, the path to net zero is not just a compliance exercise. The energy transition will redefine supply chains, cost structures, resource allocation, business models and competitive advantage. In short, it is an existential issue. Boards must:

- Oversee long-term energy and climate risks within their enterprise risk frameworks.
- Evaluate investment decisions through a sustainability lens, including exposure to energy price volatility and carbon taxes.
- Guide their organisations to align with emerging regulatory expectations on sustainability disclosures and emissions reporting.
- Identify opportunities in low-carbon business models, green finance and energy innovation.

Singapore's net-zero ambition is both bold and necessary. It is achievable – but only if the enabling conditions are in place. Among these is the collective commitment of businesses to support the national vision. Boards must lead this charge. This will be critical to ensuring not just national success, but organisational resilience. ●