BRIEFING - June 2026

Port Electrification in Singapore

Identifying challenges and solutions to rapid port electrification and solutions for the region

Electrification Pathways for the Port of Singapore: Implications for the Global Maritime Industry. CSER, Shanghai Maritime University & T&E Asia Pacific (June 2026)

Summary

The Port of Singapore is the world's largest transshipment and bunkering hub. To maintain this leadership while meeting climate targets, the port is actively decarbonising its operations.

This briefing summarises the technical report by the Centre for Strategic Energy and Resources (CSER) on behalf of and in collaboration with T&E. We analyse the impacts of the current plan to electrify the Port of Singapore by 2050 against a Fully Electrified Port Scenario, with full electrification by 2035. In scope are the port cranes, automated guided vehicles (AGVs), and shoreside power for vessels.

Energy Demand Reduction of 430 GWh by 2030

Transitioning to a fully electrified port by 2035 would reduce total energy demand by 430 GWh compared to the reference case. However, this shift creates significant challenges for grid management. Without optimisation, peak hourly demand could hit 790 MWh by 2035, more than 3.5 times current levels, necessitating investment in battery storage and demand-side management.

Environmental and Economic Impact

Emissions Reductions: Full electrification could save up to 101 ktCO_2 annually by 2035. This also results in significant air quality improvements, including a projected cumulative reduction of 11.3 kt of NOx, 270 t of SOx, and 400 t of particulate matter.

Cost Efficiency: Cumulative energy costs are projected to be reduced by S$63 million annually by 2035. Furthermore, full electrification is estimated to save S$23 million in carbon taxes by 2035.

Investment Needs: Cumulative investments range from S$200 million (based on average annual power growth) to S$2,000 million (if peak load is unmanaged). While electrification requires significant upfront capital, incremental costs for port equipment can be recovered by 2030.

Policy recommendations:

Shoreside Power: A phased regulatory roadmap with supporting incentives would align all stakeholders

Grid Integration: A taskforce to align port planning with power system requirements could help ensure seamless coordination and delivery

Fiscal Policy: Strengthen carbon pricing and expand access to green finance to further help the economic case of electrification

Regional Leadership: Export standards to ASEAN and accelerate green corridors.

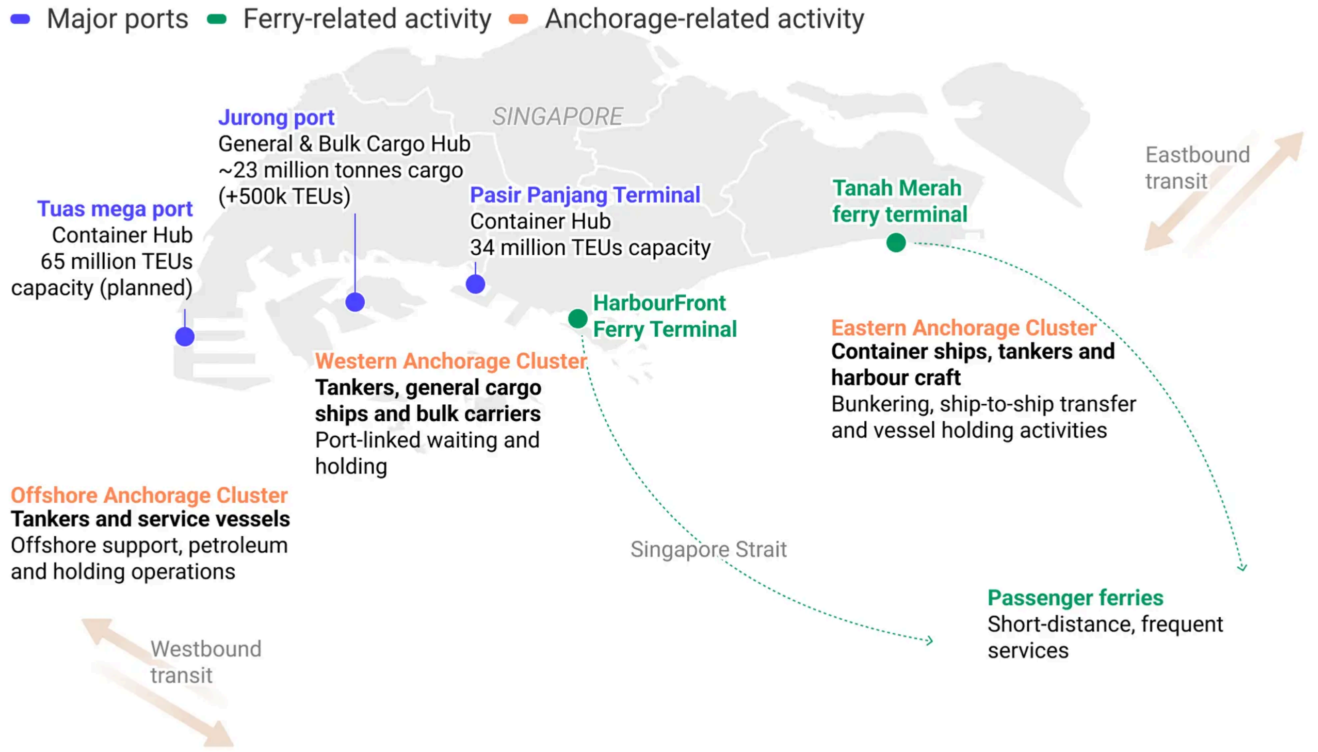
1. The port of Singapore in a green transition

1.1 The world's biggest transshipment and bunkering hub

The port of Singapore is one of the world's most important ports. It handles 20% of global container transshipment flows. Of the **44.7 million containers** that passed through the port in 2025, 90% were transshipped. Only Shanghai has a higher throughput. Singapore is by far the world's largest bunkering hub, trading **57 million tonnes of fuel**. The port's revenues of S$55 billion account for 7% of the country's GDP.

Shipping Activity in Singapore Waters

Illustrative operational patterns



Source: T&E analysis based on MPA chartlets, Singapore Statutes Online, and public port data. Note: Locations are indicative.

But Singapore has ambitions beyond its current positioning. By the 2040s, Singapore's five distinct container ports will be combined into Tuas port with annual throughput projected to reach 64 million twenty foot equivalent units (TEUs).

Below is a short summary of a technical report produced by the Centre for Strategic Energy and Resources (CSER) on behalf of and in collaboration with T&E. With it, we show the benefits and trade-offs of accelerating the electrification and, ultimately, decarbonisation of this port.

1.2 Current Regulatory Framework

The Republic of Singapore is actively pursuing policies to decarbonise its economy. As part of its nationally determined contributions (NDCs) it recently set a 2035 target equivalent of 36% to 43% below 2019 peak emissions. In 2019, it introduced a carbon tax covering 70% of the economy. The current price of emitting a tonne of CO_2 is S$45 and is expected to rise to S$50 to S$80 by 2030. In line with these targets, the Maritime Port Authority of Singapore (MPA) implemented targets to reduce port emissions and to electrify its activities.

The MPA targets include reducing port terminal emissions by 60% by 2030 compared to a 2005 baseline and to achieve net zero for the whole port by 2050. For in-port vessels such as harbour craft, there is a 15% emission reduction target by 2030 (vs 2021) and 50% by 2050.

Supporting policies to reach these targets include the MPA's "Green Ship Programme", whereby ships meeting environmental standards on new design efficiency or low-carbon fuel use receive up to 100% initial registration fee reduction and tonnage tax benefits. Ocean-going vessels using zero-emission fuels are eligible for up to 100% regulatory fee reduction when berthing in Singapore.

At the same time, the Port of Singapore Authority (PSA), the main container port terminal operator, has supplementary targets. One is the deployment of 700 electric prime movers by 2030 to phase out diesel. And in preparation for high charging power demand, PSA is piloting battery electric storage systems in conjunction with doubling roof-top solar generation to 9 GWh.

1.3 Comparing two electrification policy pathways

We compare two port electrification scenarios. The **Reference Scenario** describes a current policy trajectory, while the **Fully Electrified Port Scenario** assumes policy and measures are implemented to accelerate electrification to reach 100% by 2035, as shown in the table below. Here the electrification rate refers to the total energy demand of the **port's cranes**, **automated guided vehicles** (AGVs) and **shoreside power for container ships at berth**. It is assumed that this port equipment electrifies at the same rate. The full methodology of the analysis can be found in Section 3 of the report.

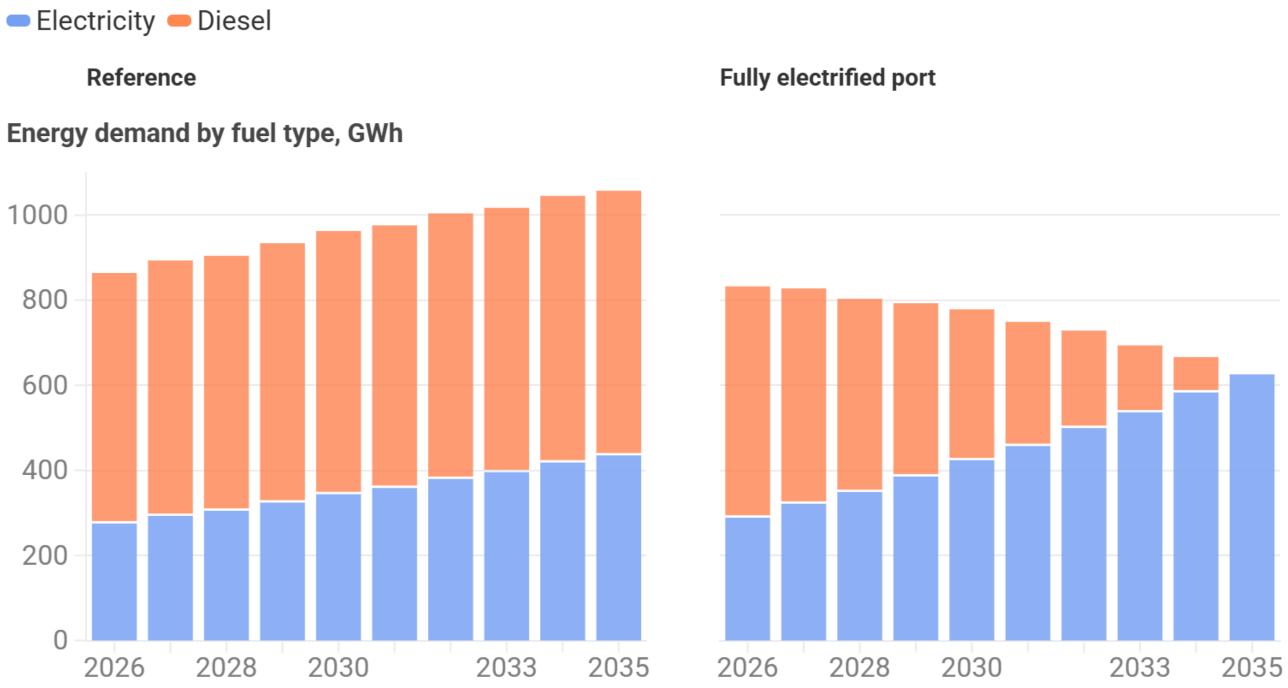
Electrification rate	2025	2030	2035
Reference Scenario	60%	65%	70%
Fully Electrified Port Scenario	60%	80%	100%

2. Potential energy demand reduction of 430 GWh by 2030

2.1 Faster electrification reduces total energy demand

A fully electrified port in 2035 would consume 430 GWh less energy by 2035 than in a reference case. This is equivalent to removing 7200 diesel powered heavy trucks off the road.

Diesel use in Port of Singapore flatlines under current policy



Source: CSER, SMU, T&E (2026)

We found that quay and yard cranes draw 80% of the electricity demand. Given this outsize electricity demand, the benefits of quickly electrifying cranes should be prioritised. While we only looked at containership berth demand for shore power, there could be emerging electricity demand from vessels themselves as battery electric technology continues to improve and deployment increases. Shore power could then be used to top up batteries in diesel electric hybrid ships or perhaps containerised batteries to be used in smaller and shorter distance pure electric vessels.

2.2 Managing peak electricity loads is critical

Accelerating the electrification of the port to 100% by 2035 has substantial impacts on peak electricity demand. With unoptimised and unmanaged charging demand and no further onsite battery storage for buffer, the peak hourly demand could reach 790 MWh by 2035, more than 3.5 times today's peak level and substantially above the Reference projection of 474 MWh.

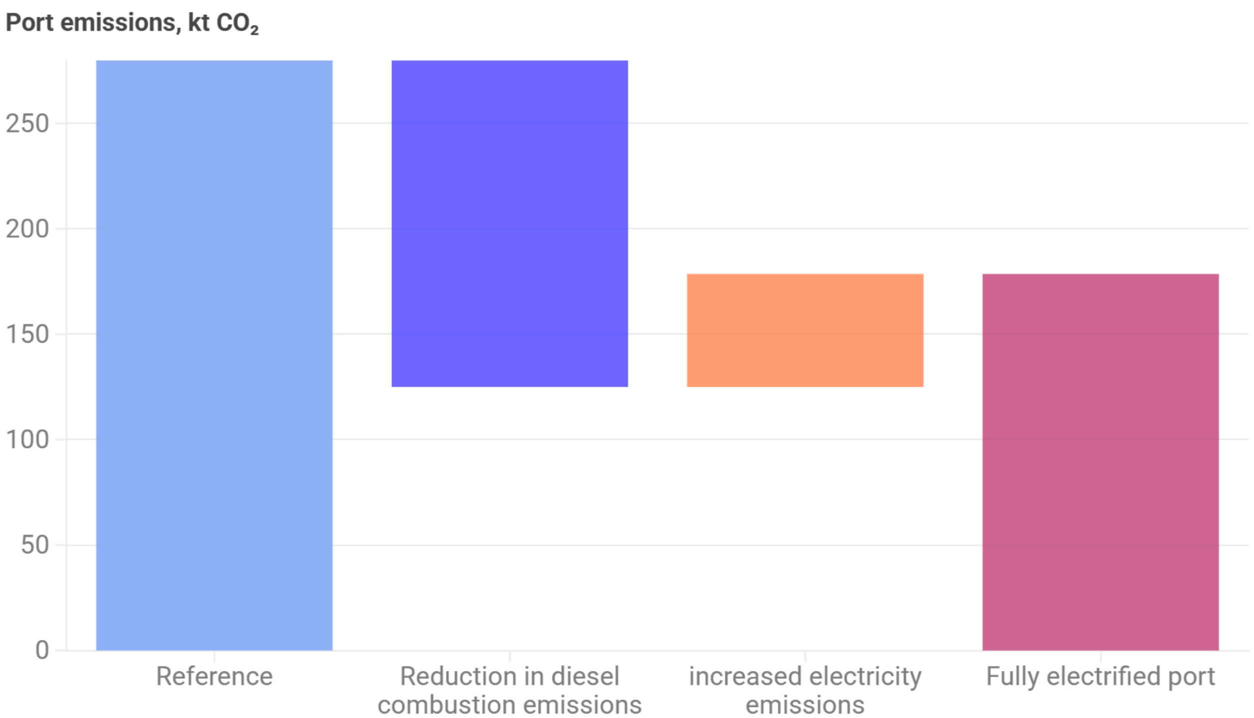
Peak demand growth was found to be disproportionately large relative to the 30 percentage point difference in electrification rate between scenarios. On the other hand, the increase in average power is quite stable and proportional to the electrification rate. This indicates that infrastructure investment planned solely on annual energy demand could severely understate actual investments required for peak power, a critical planning risk. As AGV charging and onshore power supply (OPS) adoption are primary drivers of peak power, price signals and other policies will play a big role in reducing peak load demand. However, analysis of those policies were beyond the scope of the report.

3. Environmental impacts and cost benefit of 2035 electrification

3.1 Annual CO_2 emissions reductions of 100 kt

The combined CO_2 emissions impact of reducing fuel use at the port were compared against the emissions of increasing the electricity demand. Given the Singapore Carbon Tax, which is levied on power generation, the grid emission factor will not likely remain at today's level. In the case that it falls to 0.265 kgCO_2/kWh by 2035, through the uptake of more solar power for example, fully electrifying the port would save 101 ktCO_2 per year by 2035. This is equivalent to the annual emissions of 52,200 four-room Housing & Development Board (HDB) flats, a common residential home in Singapore.

100 kt CO_2 annual savings from faster port electrification in 2035



Source: CSER, SMU, T&E (2026) • Electricity grid carbon intensity assumed to decrease to 0.265 kgCO_2/kWh

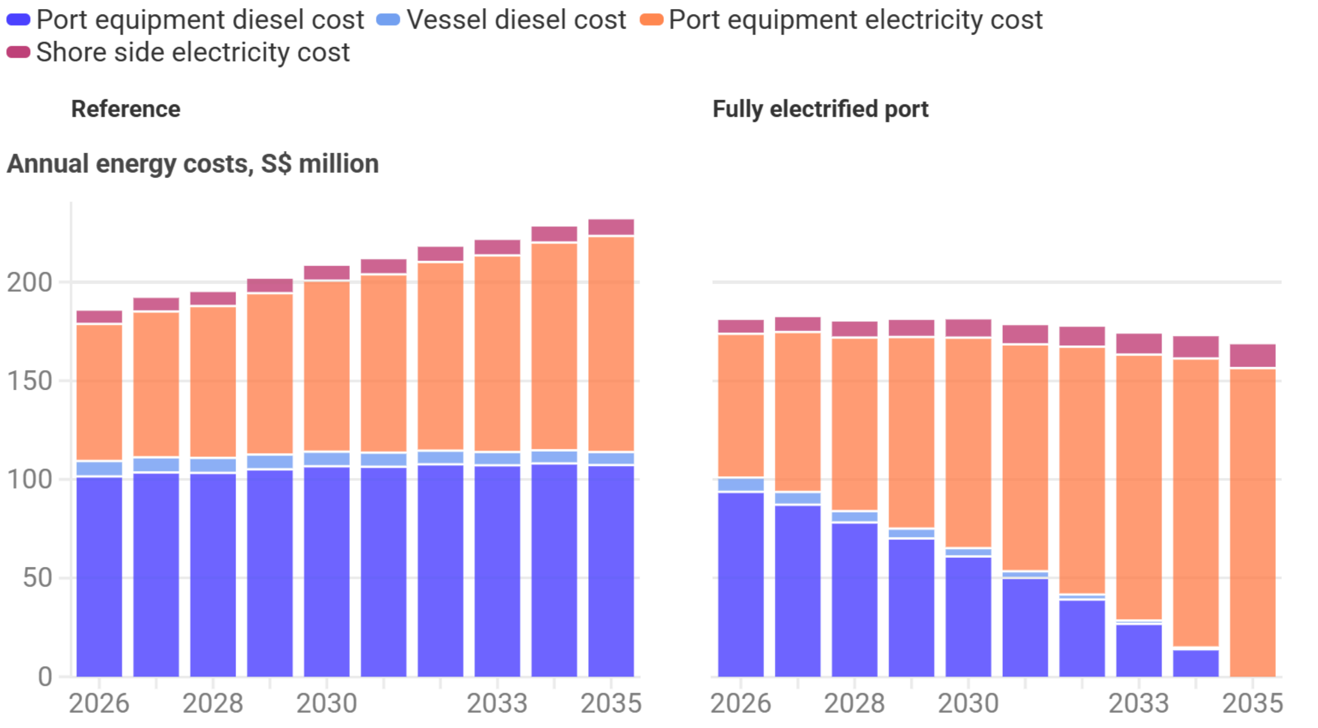
Even under a conservative assumption of a constant grid emission factor of 0.402 $kgCO_2/kWh$, there is a potential annual reduction of 68 $ktCO_2$ from port equipment by 2035, which is equivalent to the annual emissions of 37,800 four-room HDB flats. The vast majority of emissions savings would naturally occur from the port equipment (cranes and AGVs), from their higher energy demand.

The reduction of diesel combustion from hastening port electrification also yields benefits in terms of air quality. For air pollutants, NOx is projected to have a cumulative reduction of 11.3 kt, along with 270 t of SOx and 400 t of particulate matter (PM) by 2035.

3.2 Annual Energy costs reduced by S$63 million by 2035

The total cumulative cost savings for port electrification is calculated to reach S$320 million by 2035. This is thanks to the reduction in diesel consumption. While electricity consumption increases, the additional efficiency of electrical systems over combustion yields a net benefit.

Faster electrification reduces total energy costs by S$63 million



Source: CSER, SMU, T&E (2026)

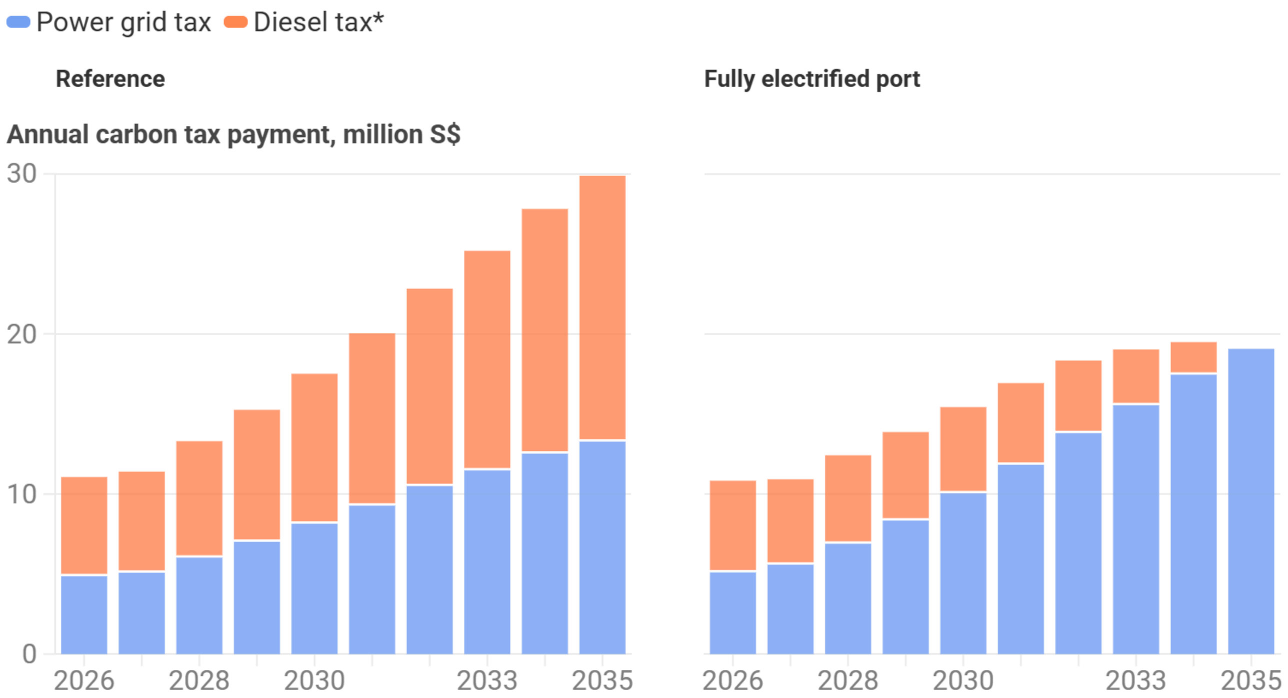
3.3 Carbon tax reductions of S$23 million in 2035

The Singapore Carbon Tax is likely to rise from S$45 per tonne of CO_2 to S$115 by 2035 as the government pursues its *Net-Zero by 2050* ambition. In this section we assume that diesel use by vessels at berth is subject to the Carbon Tax. This is not current policy, but is a very important element to making the business case for the more rapid electrification trajectory. It also may prompt a rethink in maritime energy taxation in the region.

Given our assumption on the inclusion of diesel fuel use in the port being covered by the Carbon tax, the speed of electrifying the port will impact the tax revenues we show. In the case where the grid emission factor decreases to 0.265 kgCO_2/kWh by 2035, the cumulative carbon tax payment would be S$131 million in the Reference scenario. Fully electrifying the port by 2035 would reduce this by $23 million. Likewise, the report discusses the importance of reducing the carbon intensity of the grid to avoid the tax burden being $11 million more in 2035.

Carbon tax payments reduced by S$40 million over coming decade

This is offset by a reduced diesel import bill



Source: CSER, SMU, T&E (2026) • Grid carbon intensity assumed to decrease over time
*Diesel is not currently included in the Singapore Carbon Tax.

3.4 Total investments between S$200 million to S$2 billion

We highlight the orders of magnitude difference in investment costs should peak demands not be effectively managed. Fully electrifying the port by 2035 using annual average increases in total power and energy would require cumulative investments of S$196 million, approximately double the S$97 million in the reference scenario. To put that into perspective, the investments are equivalent to 0.36% of the annual revenues. Despite lower electricity demand, shore-side power remains the largest investment expense, requiring $80 million in the accelerated case.

However, based on the projected peak loads without optimisation, the cumulative investments to 2035 would jump to S$2.6 billion, a more than 10-fold increase implied by planning for annual average increases. Port electrification can become an asset for grid stability. Ports are large, flexible energy consumers, so port operations can be optimised to act as a grid-responsive load. Charging of electric cranes, AGVs, and vessels can be scheduled during periods of low national demand or high renewable output. Port investments would offset those on the grid.

3.5 Payback requirements heavily dependant on peak power management

We modeled two approaches to estimating investment needs. Under the approach based on gradual annual energy demand growth, cumulative investment for full electrification is S$196 million over 2026 to 2035, with combined fuel cost and carbon tax savings meaning the incremental investment in port equipment is fully recovered by around 2030. Shore power under this approach has a payback period of 19 to 26 years from 2035 depending on the carbon tax assumptions. The second approach, based on peak power demand, produces far larger investment figures of S$1.2 billion to S$2.6 billion, with shore power payback extending to 342 to 445 years. It is important to note that these peak-demand figures represent an extreme scenario assuming no energy storage, demand-side management, smart pricing, or policy mandates to smooth peak loads. With such measures in place, we can conclude that payback is very likely to be shortened, and that electrification should be framed as a long-term strategic investment supported by regulatory mandates and financing mechanisms such as carbon pricing and green finance.

3.6 Fossil Fuel Price Volatility

The recent conflict in the Middle East and the subsequent closure of the Strait of Hormuz have severely disrupted the global oil trade. The resulting volatility in diesel and natural gas prices directly influences how this study's findings should be interpreted. The report assumes that both the diesel and electricity price remains at a long term average. For diesel, that was assumed to be S$2/l and for electricity, S$0.25/kWh.

Since the report was finalised, Singapore has since seen retail diesel prices exceed S$4/l, roughly 54% more than the 2025 average of S$2.60/l. As for the cost of electricity, it is closely linked to the price of natural gas. Almost all (96%) of Singapore's electricity production is derived from gas power plants, and 76% of the regulated tariff is the gas price. Liquified natural gas (LNG) spot prices almost doubled in April compared to the 2025 average. This implies that long term electricity prices will have increased by 73%.

Many businesses hold long-term fixed contracts that temporarily shield them from rising energy costs. As renewable adoption grows and reliance on gas shrinks, electricity price differentials tend to narrow, a trend already observed in markets like Spain. In contrast, this price cushioning is less structurally possible for diesel, which remains exposed to spot-market volatility and OPEC pricing interventions.

Although shore power shifts emissions accounting from ships to the national grid, this displacement should not be viewed as a failure of electrification. Instead, it highlights the urgent need for a transparent, cross-sector framework to fairly allocate these redistributed emissions. From a system-wide perspective, shore power significantly reduces net emissions by replacing inefficient onboard diesel generation with grid electricity. While this shift may superficially appear to inflate port-level emissions, it ultimately drives overall efficiency gains and enables deeper decarbonization as the grid becomes cleaner.

4. Conclusions and Policy Implications

Accelerating the electrification of the Port of Singapore is technically feasible, economically justifiable, and environmentally necessary. With throughput projected to grow 37% by 2035 and expected fuel price volatility, the investment case is compelling and the reduction in emissions and air pollution is significant. Leveraging its strategic maritime location, infrastructure, and regulatory leadership, Singapore is well placed to spearhead port electrification across the Asia-Pacific while establishing a scalable blueprint for global maritime decarbonisation. To support the transition toward full port electrification by 2035, several key policy levers encompassing both direct and indirect interventions can be utilised to accelerate development:

01 **Shoreside Power**: Mandate on-shore power supply adoption through a phased regulatory roadmap. Support through targeted and dedicated low utility tariffs, carbon surcharges, and green port fee concessions

02 **Grid Integration:** Establish a Port Electrification Grid Integration Taskforce, convening the MPA, Energy Market Authority (EMA), grid operators, and terminal operators to harmonise port and power system demand-side planning.

03 **Fiscal Policy:** Strengthen carbon pricing and fiscal incentives to underpin project bankability, including expanding access to green financing, accelerated depreciation, and energy-as-a-service models to reduce upfront capital barriers.

04 **Regional Leadership:** Export onshore power supply (OPS) technical standards across ASEAN, accelerating green shipping corridors, and positioning Tuas Port as a living laboratory for next-generation electrification technologies.

Further information

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