

FROM AMBITION TO IMPACT





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Energy, carbon and cost savings arising from infrastructure improvement are interlinked. Digitalisation makes it possible to plan, track and optimise the benefits.

How hard would it be to improve energy efficiency by 1 per cent?

At UK 2022 year-end electricity prices, doing so would save a medium-sized container port upward of £2 million (\$2.47 million) year. A large port could save £5 million (\$6.18 million) or more.

There is a well-established correlation between energy, carbon and cost. For organisations seeking a new commercial edge, setting ambitious energy and carbon saving goals presents a substantial opportunity.

A pilot project at the Port of Singapore aims to cut energy use and carbon emissions by 2.5 per cent, equivalent to 1000 tonnes of CO₂e per year. The operator is now pushing for deeper efficiencies still, while preparing to replicate them across its international holdings and future terminal projects, including Singapore's Tuas Mega Port, which will be the world's single largest fully automated terminal when it opens in the 2040s.

The pilot has been carried out with Envision Digital, which has applied its 'automated intelligence of things' (AIoT) technology to a variety of transformative interventions. AIoT harvests data from port equipment – refrigerated 'reefer' units and buildings, generators, lighting, cranes, stackers and port vehicles. Analysis of that data tells a story about each asset's

workload, movements and dwell times, condition and efficiency. The data reveals energy use 'hot spots'. And by applying emissions factors to energy use, the system shows which port operations are most carbon intensive and where energy and carbon savings can be made.

AIoT involves command and control as well as data capture and analysis, which has enabled the Port of Singapore to automate and optimise asset movements and operations. Envision Digital's AIoT system employs cloud and edge computing, and seamlessly integrates with the Port of Singapore Authority's (PSA) systems.

The pilot project is being run on one of six terminals, the Pasir Panjang Terminal. Integrated energy management is being applied across its power grid to balance energy supply and demand, reduce peak consumption and optimise efficiency. It encompasses:

- 10 megawatts of roof-mounted solar photovoltaic generating capacity (PSA is aiming for 100 megawatts to meet 10 per cent of its total electricity need)
- 2 megawatt battery storage to capture surplus solar power and meet the port's peak energy demand
- Demand-side management, using the thermal inertia of buildings and reefer units to switch of cooling/ refrigeration for short periods and divert power to other uses
- Management of electric automated guided vehicles, cranes and lighting

Envision Digital's AIoT solutions are provided by a portfolio of powerful, artificially intelligent apps that run on its operating system, EnOS. Machine learning is used to observe and understand energy use patterns. This learning enables the terminal's energy demand to be predicted, supporting real time energy management, short-term scheduling and long-term planning of port assets, guiding PSA towards ever deeper energy and carbon savings.

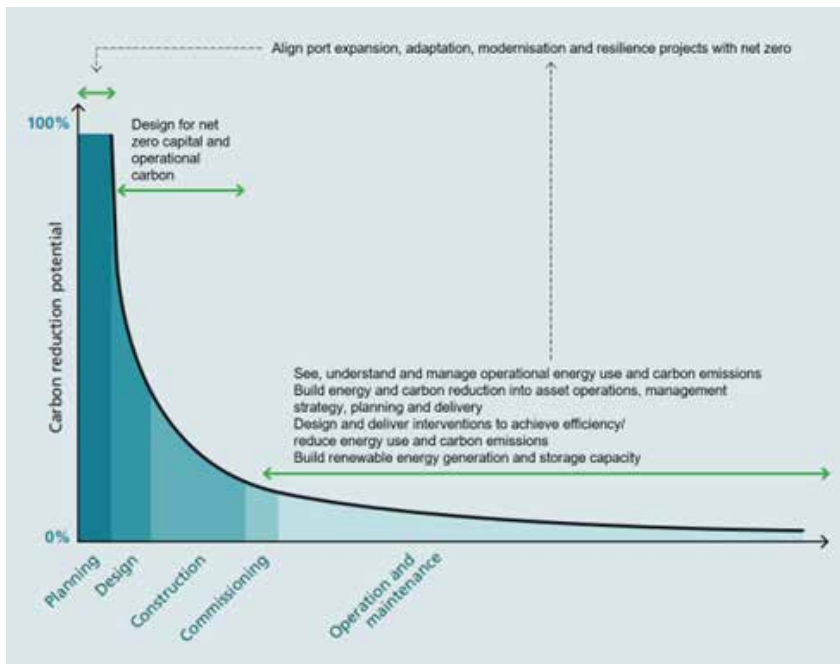
When the terminal's battery storage system is not in use managing operational demand, it can provide electricity to Singapore's power grid, generating revenue for PSA.

BETTER PERFORMING ASSETS

Alongside the energy and carbon saving, the pilot project is delivering a 20 per cent increase in asset availability through improved fault detection and diagnostics, linked with predictive maintenance. Assets are wirelessly connected; their onboard software is kept up to date through mass over-the-air upgrades.

The condition of plant and electrical systems is continuously monitored, with machine learning performing fault analysis and predicting when

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maintenance should be carried out.

Automated vehicle control orchestrates the scheduling and real-time management of the terminal's new and growing electric truck fleet. Their routes have been optimised; vehicles know where others are and can synchronise their movements to minimise braking, acceleration and wear, while maximising speed; they have 500 millisecond reaction times so outperform human operators for driver safety; and they can be automatically re-routed along the next most efficient path if they meet an obstruction.

Guidance systems have been introduced to make it easier and faster for trucks to position and sync with automatic cranes, reducing the amount of manual guidance from 20 per cent towards the target of 5 per cent.

From operational to capital savings

The energy and carbon saving gains achieved so far will pay back the investment required within three to eight years, depending on the nature of the intervention.

And the operational insights gathered can inform port expansion, modernisation and development, including non-traditional investments such as green energy and storage.

Substantial further cost and carbon efficiencies can be achieved in project planning and delivery: in sectors that have pioneered carbon reduction,

capital carbon has been cut by more than 60 per cent against emissions baseline measurements. Every 2 per cent reduction in capital carbon emissions delivers a 1 per cent capital cost saving. Pursuing carbon reduction has cut construction costs by 30 per cent.

Energy, carbon and cost savings can be achieved over the whole project lifecycle. The international specification for managing whole life carbon from buildings and infrastructure, PAS 2080, sets out a 'carbon reduction curve' showing that decisions made early in the project lifecycle have the greatest potential influence, but that substantial ongoing reductions can be achieved as projects are built and enter operation. Importantly, there is a 'feedback loop' from operation: operational insight generated from data can inform the planning, design and delivery of new capital works, and ensure they will deliver greatly improved efficiency in operation.

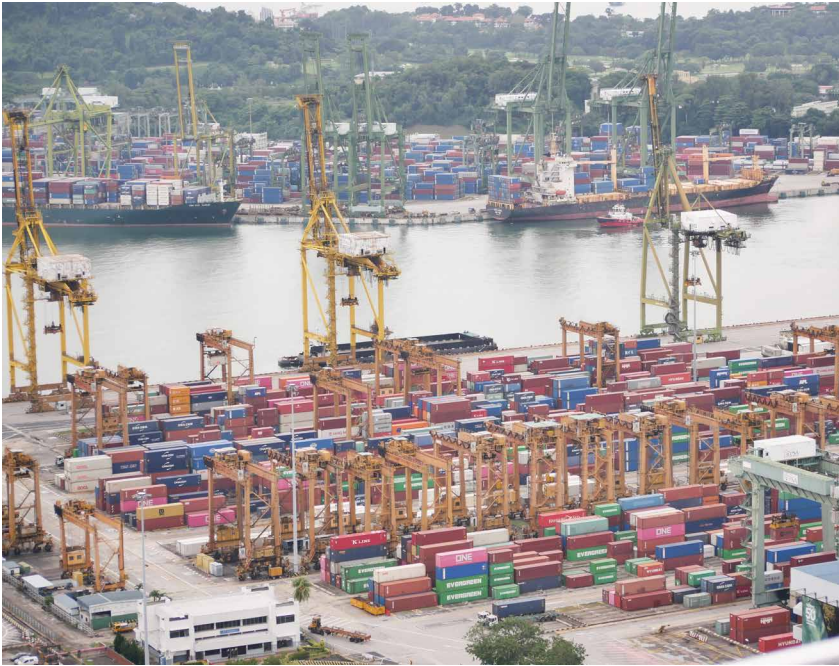
NET ZERO: A NEW BUSINESS DRIVER

The shipping sector accounts for 3 per cent of global CO₂ emissions, projected to rise to 4.5 per cent by 2050

if unchecked. The International Maritime Organization has mandated a 50 per cent reduction by 2050 and several countries including Japan, the UK and the USA have declared their goal of achieving net-zero shipping emissions. So-called 'green corridors' will help by creating an enabling ecosystem with targeted regulatory measures, financial incentives, and safety regulations – sharing net-zero benefits across global supply chains.

The run-up to the UN Climate Conference (COP27) in Egypt last November saw a flurry of announcements: the Port of Singapore Authority joined the Lloyd's Register Maritime Decarbonisation Hub 'Silk Alliance' green corridor project. The goal is to have 5 per cent of the world's shipping using zero carbon fuel by 2030. Singapore and Australia signed a 'green economic' agreement including 'initiatives to accelerate implementation and promotion of technologies to decarbonising shipping'.

And numerous zero carbon trade routes were unveiled by: Port of Dover in partnership with the ports of Calais and Dunkirk; the Maritime & Port Authority of Singapore (MPA) with Port of Long Beach, Port of Los Angeles and C40 Cities; MPA and the Port of Rotterdam; the Port Authorities of Hamburg and Halifax; the governments of the UK, US, Norway and the Netherlands.



While a large part of the maritime industry's overall carbon footprint is accounted for by ships, ports have a crucial part to play in the transition. They can become energy hubs, providing both shore-side electricity and infrastructure for storing and fuelling ships with future fuels. Quick wins can be achieved by improving the energy efficiency of buildings and on-dock processes, and developing on-site renewable generating capacity. Decarbonising operations has other stakeholder benefits – for example improved local air quality.

Investor pressure: Beyond being 'the right thing to do', investors are exerting pressure to decarbonise, right across the maritime logistics chain. From the manufacture of fast-moving consumer goods to shops in the high street, investors see climate change as one of the leading risks to capital and shareholder return. Increasingly they say they will divest from companies that fail to manage their exposure to climate risks: to robustly align their operations with science-based carbon reduction targets; and make themselves resilient against the physical impacts of climate change. In a challenging market for commercial property investors, green logistics is currently one of the few areas attracting interest.

Port operators failing to transition and adapt face disinvestment and difficulty

borrowing, which could ultimately result in stranded assets. Those that transition effectively will attract investment and secure loans to meet their business objectives.

Customer alignment: Customers are under the same investor pressure and are looking for low/zero carbon emissions alongside wider ESG performance in their supply and logistics chains. As they seek to bring their Scope 3 emissions into focus they increasingly do business only with operators that enhance their own end-to-end performance.

At the same time, they are seeking to reduce the cost of doing business.

Low carbon port operators that can create new green corridors and networks will gain competitive advantage over rivals with higher emissions.

Government agenda: Port operators also need to respond to governments, many of which have set and must achieve national net-zero goals. Nearly every national government worldwide signed the Paris Agreement in 2015 and many have committed to net-zero. A growing number have set policy backed by legislation and regulation to drive industry compliance.

Operators in breach face fines and reputational harm. Those going beyond compliance will gain operational 'headroom' and reputational benefit.

WHY WOULDN'T YOU?

Decarbonisation benefits owners and investors by preserving and growing the value of their assets, and retaining or strengthening their ability to compete under fast changing market conditions. Moreover, it helps:

- Secure key client relationships by meeting their needs, strengthening their right to win new business
- Gain energy independence, security and cost control
- Strengthen their social license to operate

START SMALL, MOVE FAST

As the Port of Singapore is showing, decarbonisation can be achieved with substantial commercial benefits. The operator has started by investing in and co-ordinating a number of clearly defined energy and carbon management sub-projects, under the overarching pilot project. Each investment is expected to deliver benefits within timescales of

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months, rather than years; those showing they will deliver success are then scaled up.

- Efficiency: Easy wins may have been achieved to date, but improved understanding of energy consumption and emissions sources will reveal further opportunities. The aggregation of gains achieved through operational fine tuning will add up to a significant total reduction, while planned capital maintenance or investment interventions can deliver substantial 'lump sum' reductions.
- Green energy: Adding renewable energy generation and energy storage alongside core operations can displace hydrocarbons in port operations, and can make a port more attractive as a location for freeport operations or adjacent industrial clusters. On site renewables may also complement green fuelling for ships and landside transport.

For many port operators, using digital technology in this way requires a deep domain understanding of both port operations and energy systems. For this reason the AIoT solution implemented in Singapore by Envision Digital is being offered in partnership with engineering consultancy Mott MacDonald. It starts with:

- Identifying what to instrument to generate useful data

- Gathering and using data to identify energy use and carbon hot spots
- Identifying and assessing carbon reduction and energy saving options
- Planning, designing and delivering cost-effective operational and capital interventions – emissions/energy use reduction and green energy production
- Monitoring performance
- Measuring and reporting residual emissions, to offset them

The key is to start small, move fast, upscale and win all the way.

ABOUT THE AUTHORS:

Craig Lucas works for Mott MacDonald as Director – Energy Transformation, with 30 years' experience, mostly in the energy industry, but also in rail and telecoms sectors. His experience ranges across sector management, regulation and policy, especially thinking about how new technology will transform the energy system, and the business models of the players in the sector.

Tim Naylor has over 25 years of experience in supporting digital transformation across multiple industries, markets and businesses. Most recently he has been focusing on renewable energies, smart cities, smart buildings, e-mobility technologies and decarbonisation. In 2015 he joined Envision Digital the global leading energy internet service provider.

ABOUT THE ORGANISATIONS:

Mott MacDonald is a £2bn global top-20 engineering, development and management consultancy, with a 150 year heritage. The company's purpose is to improve outcomes for society through excellence and innovation. It employs 18,000 people and works on projects worldwide. Its core strengths are in transport, energy and water. The company guides projects through their whole lifecycle – feasibility studies, business case development and environmental and social impact studies, preliminary and detailed design, construction, integration, operation and asset management. Its core engineering skillset is complemented with digital expertise driving efficiencies and value during project development and construction and in operation.

Envision Digital is a Singapore-headquartered artificial intelligence of things (AIoT) company with global reach. It applies digital technology employing machine learning to improve the performance of physical assets – delivering immediate and long-term value for users, owners and investors. EnOS™, Envision Digital's proprietary AIoT operating system, connects and manages more than 110M smart devices and 360GW of energy assets globally. The impact and promise of its technology earned Envision Group a place in Fortune's 2021 Change The World list. The company has 800 employees in China, Europe and the US.