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New technologies driving decarbonisation: Collaboration and stewardship are vital

From airports to toll roads and seaports, the pathway to net zero relies on technological change – and the right policy settings to support investment.

By Aaron McGovern and Vivien Cheung

Aaron McGovern
Executive Director,
Infrastructure

Vivien Cheung
Vice President,
Infrastructure

New technologies that accelerate the journey towards net zero in transport infrastructure are vital. Transport accounts for over a fifth of global carbon emissions from end-use sectors.[1]

Decarbonising transportation assets within global infrastructure portfolios requires an understanding of current and emerging technologies, and their trade-offs. Most of all, decarbonisation requires cross-sector collaboration.

In **airports**, the adoption and deployment of sustainable aviation fuel (SAF) is the primary lever available to decarbonise the global aviation sector by 2050.

In **toll roads**, carbon emissions can be reduced by electric vehicle (EVs) penetration and the transition to autonomous vehicles (AVs) over time. This relies on new tolling systems and road-electrification technologies that will make journeys as seamless and safe as they are today, if not more, to encourage fleet transition.

In **seaports**, shoreside renewable energy can be provided to cargo ships, bulk containers and cruise liners while they are berthed (through a process of 'cold-ironing'), which reduces ports' carbon emissions and air pollution. With shipping companies exploring the potential of hydrogen, liquified natural gas (LNG) and green methanol powered fleets, it will also be important for ports to consider the technologies required for use of these alternate, low emission fuels.

Adoption of these and other emerging technologies in transport infrastructure is a critical step in the transition to 2050, but they can be complex, costly and introduce technology risk.

[1] According to 2022 IEA data, global emissions were 36.7 Gt CO2, of which 7.9 Gt is attributable to the transport sector. https://www.iea.org/reports/co2-emissions-in-2022

The key challenges

While the decarbonisation of aviation is likely to require a combination of multiple technologies including engine and aircraft advancements, electrification, and hydrogen, the majority of emissions reductions required for the aviation industry to meet its net zero by 2050 targets is expected to be achieved through SAF[1,2]. In part, this is due to the compatibility of SAF as a 'drop-in' fuel, allowing it to be blended 50:50 with traditional jet fuel and used in service today without significant alterations to existing aircraft engines and refuelling infrastructure. SAF is currently produced using costly and finite biogenic feedstocks, however, resulting in low availability and exposure to commodity markets which make SAF prices typically several times costlier than traditional jet fuel. Close collaboration between airport owners, airlines, governments and energy companies is therefore required to sustainably increase the scale and price competitiveness of SAF if aviation sector emissions are to be reduced in a timely manner.

For toll roads, it is widely accepted that EVs and AVs are the key to decarbonising road transport. Toll road owners must ensure their infrastructure can accommodate a critical mass of EVs and AVs (which is projected to be reached within 10-15 years).[2] This will require significant investment in extensive charging infrastructure and potentially other technologies that help charge EV batteries while they are driving along the toll roads. The rapid advancement of charging technologies has challenged the investment case of a large-scale roll-out of charging infrastructure in countries such as the US and Australia, where sparsely populated regions occasionally give way to significant metropolitan hubs. Convenience, cost-effectiveness and various policies, including subsidised rooftop PV solar installations, have supported the prevalence of private charging (at home and at the workplace), while the development of new battery technology is also expected to reduce the additional demand for charging stations. Consumer sentiment towards EVs will, however, will still rely on the knowledge that there is broad accessibility to reliable charging networks nationally.

Many toll roads have already rolled out rest-stop charging stations, however, developing easy to use and efficient charging infrastructure may also become a point of differentiation among toll roads as the adoption of EVs increases. Current global trials include overhead charging rails that can charge vehicles as they move through the corridor and contactless wireless-charging concrete highway pavement. For example, Dynamic Wireless Power Technology (DWPT) uses coils positioned under asphalt to transfer energy directly to electric cars and buses (see case study). If proven viable, DWPT could see toll road owners replace existing asphalt on roads or introduce it to new projects.

Similar challenges apply to port decarbonisation. Providing power to large vessels while they are docked requires investment in new port infrastructure and renewable energy supply. Implementing cold-ironing technology is particularly challenging for ports with smaller berths and a wide variety of vessels.

Operational trade-offs with decarbonisation are an important consideration. Airports have much to gain from greater use of renewable energy and through fuel supply models that facilitate and incentivise use of SAF. At the same time, as critical high-throughput assets, airports must continue to function efficiently and safely during this transition to decarbonisation.

Toll road and port owners need to weigh up the long-term benefits of investing in renewable technologies and growth in electric vehicles. A multi-billion-dollar investment in new charging technology and charging stations might not be feasible on a toll road if the uptake of EVs is too slow.

Policy settings are also key. For example, encouraging greater adoption of SAF to support the decarbonisation of the aviation industry will require the governments to provide policy settings and signals that encourage the use of domestically grown feedstock and stimulate investment in local refining capacity. Governments, too, must ensure they have the right policy settings to encourage investment in technology for toll roads and seaports.

On balance, IFM and other owners of transport infrastructure must weigh up multiple short and long-term considerations when investing in new technologies to decarbonise assets. They must seek to maintain their mandated target returns from transport investments in line with investor expectations, while ensuring these assets continue to serve society, amid population growth and changing community needs and expectations during climate change. They must also consider the risk of not decarbonising fast enough. Assets that do not decarbonise are likely to face a backlash from consumers who may favour lower-carbon transport options.

Collaboration and stewardship are vital. As a major investor in airports, seaports and toll roads, IFM collaborates with infrastructure asset operators, customers and tenants, governments and other stakeholders to help inform the development of appropriate policy settings that encourage investment and faster decarbonisation across all sectors.

[2] Have booming EV sales crossed the mass-adoption tipping point? (energymonitor.ai)

Policy settings

Collaboration requires a long-term commitment.

Globally, in areas such as SAF, governments overseas have adopted, or are close to adopting, two types of policy mechanisms to catalyse SAF demand and production. In Europe, we are seeing governments incentivise SAF on the demand side through mandated minimum usage, while the US has a stronger focus on production (supply side) incentives.

A clear transparent policy framework will be needed in Australia to support investments in emerging technologies.

In this regard, IFM welcomed the Australian Government's Aviation Green Paper. Released in September 2023, the Green Paper sought feedback on aviation matters, such as maximising the aviation sector's contribution to net zero, and emerging aviation technologies. The Green Paper will help inform the development of the Aviation White Paper, expected for release in mid-2024.

Outlined below are some of the key opportunities and challenges in new technologies to decarbonise airports, toll roads and ports.

Airports

Incentivising greater use of **Sustainable Aviation Fuels (SAFs)** that reduce carbon emissions from airplanes.

Installation of solar farms at airports to provide renewable energy to terminals and precinct tenants.

Investment in **Electric Vehicle chargers in airport car parks** to support expected EV uptake.

Designing terminals to support higher use of **ride-sharing and, later, autonomous vehicles**.

Investment in **digital technologies/analytics** that enhance airport efficiency and reduce energy usage.

Increased **electrification of ground vehicles and other machinery** at airports.

Greater use of **sustainable materials**, such as green cement, and wooden panels in terminals.

Landscape design at airports and within terminals that reduces energy usage, such as internal greenhouses and waterfalls.

Toll Roads

Incentives, such as lower toll charges or priority lanes, to **encourage drivers to switch to EVs on toll roads.**

Installation of **EV chargers** on toll roads.

Capturing energy generated on toll roads, through friction on roads or wind generated from moving vehicles.

Greater use of sustainable materials, such as green cement, asphalt and steel in toll-road construction.

Installation of **energy-efficient LED lighting** for road lights and signs.

Greater use of renewable energy at toll roads through use of solar panels.

Circularity initiatives, such as recycling water run-off on toll roads, or recycling waste materials.

Investment in **e-payment technologies and data analytics**.

Investment in intermodal hubs at toll roads that link modes of transport.

Seaports

Cold ironing technology that provides renewable energy to vessels while they are berthed.

Pricing and access incentives at ports that encourage ships to use lower-emission fuel.

Investment in EV technology for onshore port vehicles and machinery, and inshore vessels that guide ships.

Greater use of **lower-emission fuels for cargo handling equipment.**

Incentives for port stakeholders to **electrify trains and other heavy vehicles** that deliver goods to port by land.

Development of solar and/or wind farms at ports or offshore, to provide renewable energy to the port and nearby industry.

Investment in data analytics and technology to **reduce waiting times to enter ports and load/unload cargo.**

Investment in energy-efficient technologies, such as LED lighting, and sustainable materials at ports.

Airports and future aviation fuels

Although aviation accounted for only 2 per cent of global energy-related emissions in 2022, the sector's emissions are increasing faster than those from rail, road and shipping.[3] Demand for air travel continues to recover after the COVID-19 pandemic and longer term, population growth and an increase in the number of middle-class consumers in developing nations will support higher demand for air travel. All this points to rising aviation emissions this decade – and growing pressure on airports and airlines to invest in decarbonisation technologies.

Aviation has been described by the International Energy Agency as 'one of the most challenging sectors to decarbonise'.[4] Compared to road and maritime transport, the specific and volumetric energy density requirements for fuels suitable for use in aviation are far narrower. Currently, this limits applications for electric and hydrogen powered aviation. With stringent aviation authority testing requirements and long fleet renewal cycles[5], it is also unlikely that significant engine and airframe innovation will be seen in the near term. Given these constraints, increasing the availability and price competitiveness of SAF is likely to be the most viable path to decarbonising aviation for the foreseeable future.

SAF

Certified for use in commercial jet aircraft, SAF meets greenhouse gas and other sustainability criteria. Unlike traditional jet fuel made from fossil fuels, SAF can be made from a range of sustainable feedstocks including vegetable oils, sugar crops, waste oils, municipal wastes and agricultural waste.

In the US, the Sustainable Aviation Challenge has set a goal for airlines to use 11 billion litres of SAF – about 15 per cent of current fuel demand – by 2030.[6] The US Inflation Reduction Act of 2022 included a two-year tax credit for those that blend SAFs and a three-year tax credit for SAF producers.[7] The US also provided a US$297 million grant program for SAF projects, among other initiatives.

In 2021, the European Commission proposed a range of changes to encourage greater SAF uptake in aviation through its 'Fit for 55' plan (reducing greenhouse gases by 55 per cent by 2030). Through the ReFuelEU Aviation Initiative, draft regulation sets minimum obligations for fuel suppliers in the EU to increase the share of SAF in their jet-fuel mix over time.

The Australian Government's Aviation Green Paper describes SAF as 'one of the main levers' to reduce aviation emissions.[8] However, the government notes that SAF costs significantly more than traditional jet fuel to produce and that demand for it far exceeds supply.[9]

Lack of local refining capacity for SAF compounds the challenge. Australia produces significant volumes of sustainable feedstock suitable for use in the production of multiple biofuels, including SAF, however the majority of it is currently exported for use in biofuels production in Singapore and Europe. This restricts Australia's role in the growing global biofuels supply chain to raw feedstock provision.

With the right policy and investment signals, Australian feedstock producers would have a valuable local growth market to supply into – this would give investors of large scale domestic SAF refining capacity the confidence they need to invest. A robust domestic biofuels industry could safeguard Australia's long-term refining capability, harden

[3] International Energy Agency (2023), 'Aviation'
[4] ibid
[5] McKinsey & Company, (2023), 'Decarbonizing aviation: Executing on net zero goal.". 16 June 2023
[6] International Energy Agency, (2023), 'Biofuel'.
[7] US Government (2022), 'SAF Grand Challenge Roadmap'. September 2022.
[8] ibid
[9] Aviation Green Paper: Towards 2050 (2023)

Australian fuel supplies against global supply-chain disruptions, stimulate investment in decarbonisation and create skilled employment opportunities.

IFM has engaged global experts to support our understanding of how global airport operators are responding to Scope 3 emissions produced and controlled by airport tenants, airlines, ground-access vehicles and other airport stakeholders. We have also contributed to discussions on the policy frameworks to incentivise SAF production in a number of jurisdictions, including Australia.

We recognise that Australia is a long way behind the US and the European Union in terms of SAF targets and investment incentives.

In addition to SAF, airports are examining green hydrogen as an aircraft fuel source. Green hydrogen has a low volumetric energy density (relative to alternate low emission fuels such as SAF which poses challenges to its use in aviation. However, there is potential for it to become a more widespread aircraft fuel source over the long term, particularly for regional and short haul flights. In June 2023, Brisbane Airport and other aviation stakeholders launched the Hydrogen Flight Alliance, to enable Australia's first commercial emission-free, hydrogen-powered flight between Brisbane Airport and Gladstone Airport in 2026. IFM is a major investor in Brisbane Airport.

IFM-owned Australian airports also continue to invest in renewable energy supply, sustainable terminal design and EV chargers in car parks. By 2025, we expect the majority of Australian airports in our portfolio will run fully on renewable energy.

CASE STUDY: AIRPORTS

Working towards commercial emission-free hydrogen powered flights

Brisbane Airport is part of a new alliance that wants Australia to have a leading role in the aviation industry's transition to net zero by 2050.

Launched in June 2023, the Hydrogen Flight Alliance involves Brisbane Airport, Gladstone Airport Corporation, universities and industry partners. The goal is to enable Australia's first commercial, emission-free, hydrogen-powered flight.

Alliance partners are collaborating on a project that uses a 15-seater Stralis B1900D-HE aircraft, designed and built in Brisbane. The green-hydrogen-powered plane will fly between Brisbane Airport and Gladstone Airport in 2026 in a route operated by Skytrans Airlines.

Both cities have large green-hydrogen projects and Queensland wants to position itself as a significant international hydrogen trading partner by developing a larger hydrogen ecosystem.

Extending that ecosystem to the Queensland aviation sector could provide opportunities to develop hydrogen-powered aircraft that have low emissions and are quieter than aircraft powered by traditional jet fuels. It could also create a clean-energy innovation hub around hydrogen in aviation.

The Alliance says green hydrogen can contribute to the decarbonisation of air travel but acknowledges challenges around fuel availability at scale, cost and airport infrastructure required to service hydrogen-powered aircraft. Currently, hydrogen powered flight is not technologically or commercially mature and is unlikely to see applications beyond short-haul flight before 2035. In part, this is due to the energy density characteristics of hydrogen as an aviation fuel source that requires re-thinking of airframes and airside infrastructure.

Testing by the Alliance will provide real-time experience of operating and refuelling hydrogen-powered aircraft between Brisbane and Gladstone airports. If successful, the project could also support Queensland's goal for the 2032 Olympics and Paralympics to be climate-positive events.

Hydrogen-powered aircraft, in turn, could help airports in Queensland and other areas accelerate their decarbonisation strategy by incentivising aircraft that use sustainable energy. Much work needs to be done before experimental hydrogen-powered flights are a reality, but there is long-term potential.

Toll roads

In 2022, road transport contributed to almost a quarter of the EU's total carbon emissions.[10] In Australia, emissions from cars, trucks, buses and light commercial vehicles accounted for about 16 per cent of the country's total emissions in 2018.[11] Without intervention, the transport sector will be Australia's largest source of emissions by 2030, notes the Australian Government.[12]

Governments globally are investing heavily in rail infrastructure to support a modal shift away from road-based transport. While electrified rail will play an important role in decarbonising transport, particularly long-distance travel and freight, it cannot solve for the last mile (for example, the final leg between the train station and home, or for online retail deliveries to customers' doorsteps). As a result, we continue to see EVs as having a long-term role in providing flexible and on-demand mobility with a low carbon footprint.

Changes in government regulations, environmental policies, customer preferences and technological breakthroughs will drive the EV revolution. Many governments have created favourable environments for early EV adoption through financial incentives including subsidies and varying tax exemptions for new electric and hybrid vehicles purchases. In Australia, financial incentives for EVs are starting to be pared back (such as State-based stamp duty exemptions) as the price of EVs begin to reach parity with internal combustion engine vehicles (ICEVs).

Looking forward, policy makers are quickly turning towards regulation to speed up the transition. For example, 20 major cities globally have announced plans to ban ICEV by 2030[13] and many countries are announcing the same starting in 2040. In response, global automakers (including Volkswagen, Daimler, Volvo, Ford, GM, Honda and Toyota) have made significant investments and outlined aggressive strategies to electrify their fleets over the next decade.

Europe is far ahead of Australia on incentives to encourage green trucking on toll roads. In 2022, the European Parliament approved changes to road charges for heavy goods vehicles. Under the revised Eurovignette Directive, distance-based charges replaced time-based charges for trucks. Road charges for trucks and light commercial vehicles will vary according to their carbon emissions. The changes are expected to increase the use of green trucks on European toll roads – a trend expected to be followed for Australian toll roads in time.

Moreover, as the regulatory framework progresses around AVs and motorists gradually become more receptive to the safety and efficiency benefits that can be offered by automation, widespread adoption of AVs will have further implications for charging technology on toll-road infrastructure. Trucks are likely to be among the first AVs to use toll roads, and will require toll roads with the latest charging infrastructure to support long distance and long periods of travel. Benefits of autonomous EV trucks include the ability to transport long-distance freight through the night, freeing up capacity on the road during the day for commuters and delivering improved safety outcomes. For commuters, it is not hard to imagine a future world where AVs can play an equally compelling role for mass transit that is on a smaller scale but provides last mile advantages over rail.

Other decarbonisation initiatives on toll roads include fleet electrification, new toll collection and payment systems, including contactless systems, greater use of the connected technologies to capture toll road data, and increasing use of real-time route-optimisation technologies.

[10] European Union (2023), 'Road Transport: Reducing CO2 emissions from vehicles'.
[11] Climate Change Authority (2021), 'Transport" . Fact Sheet 6. February 2021.
[12] Australian Government, (2023) "Reducing Transport Emissions,". Department of Climate Change, Energy, The Environment and Water."
[13] Drake Star (2021), 'State of the Advanced Mobility Industry 2021'

CASE STUDY: TOLL ROADS

Building the world's first EV-charging highway

IFM has invested in the trial of Dynamic Wireless Power Technology (DWPT) in Italy through Aleatica, its fully owned transport infrastructure operator that focuses on the design and operation of highways in Europe and Latin America.

Aleatica is part of a collaboration that has developed 'Arena del Futuro', a 1050-metre-long circuit that uses DWPT to charge Electric Vehicles wirelessly. EVs are driven in wired lanes that have a system of coils installed under the asphalt to transfer energy directly to electric cars and buses as part of the trial.

The long-term potential is EVs being charged as they drive on a highway. Through a special receiver, EVs would receive energy from the road infrastructure directly to their electric motor – a revolutionary change for EVs.

If successful, this technology could extend the EV's range and conserve its battery. Tests have shown an EV can travel at normal speeds on the circuit without using its battery energy storage, and that the rate of energy transfer is comparable to that from fast-charging stations.

For some people, battery-range anxiety and concerns about available charging infrastructure are impediments to buying an EV. Knowing their EV is being charged as it's driven on a highway commute could ease their concerns.

DWPT could also aid the development of autonomous vehicles over time. At this stage, the batteries in trucks are too heavy for long-distance freight. However, as battery technology advances and significant investment and research goes into testing alternate low emissions fuel (such as hydrogen), the advent of self-driving trucks could, for example,improve truck productivity by reducing the number of stops required and enable self-driving trucks to travel longer distances in between refuelling or charging. Trucks may also be able to run overnight with an attendant, releasing capacity during the day for passenger vehicles and deliver safety outcomes.

Like other road-electrification projects, the Arena del Futuro Project is still at an early test stage. But the potential environmental and efficiency gains from charging EVs as they drive on electrified roads is significant – and another way technology could quicken the decarbonisation of toll roads.

ALEATICA

Seaports

International shipping accounted for 2 per cent of global energy-related carbon emissions in 2022.[14] Ships, on average, emit less carbon (per tonne and kilometre) than air transport, rail or trucks that move bulk cargo. However, the majority of international goods trade is moved by ships and most large vessels almost entirely use oil-based fuels.[15]

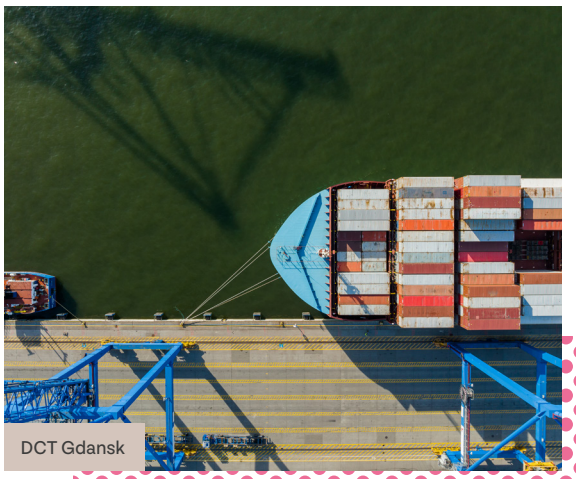
The International Maritime Organization (IMO), an agency of the United Nations, has adopted mandatory measures to reduce greenhouse gas emissions (GHG) from international shipping through the 2023 IMO Strategy on Reduction of GHG Emissions from Ships.

Key measures in the strategy, which member states of IMO adopted in 2023, include reducing carbon emissions across international shipping by 40 per cent by 2030 and increasing uptake of zero or near-zero GHG emission technologies, fuels or energy sources to at least 5-10 per cent of energy used by international shipping by 2030.[16]

In 2023, the European Union reached agreements on the inclusion of shipping in the EU Emissions Trading System and the FuelEU Maritime initiative. In the US, the Inflation Reduction Act in 2022 included direct support for port emissions reductions and provided clean hydrogen tax incentives.

In November 2022, the US Government announced funding of more than US$703 million to 41 projects, to improve port facilities. The US, UK and Canada have discussed facilitating Green Shipping Corridors, which includes ports.[17]

Similar to airports, ports have an important role in providing infrastructure and incentives to support the decarbonisation of fleet vessels. One way in which ports are using new technologies to decarbonise their operations is by providing renewable energy to vessels that call, such as container ships, bulk carriers and cruise liners. This practice, known as 'cold ironing', involves ports providing shoreside electrical power to ships while they are berthed, allowing them to turn off their main and auxiliary engines and avoid burning of fossil fuel. While it is often not feasible to provide for 100% of the energy needs of vessels through cold ironing, the practice can significantly reduce the Scope 3 emissions of ports.



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Another decarbonisation strategy at ports is reducing emissions from onshore equipment (cranes, vehicles and other machinery) and in-port vessels (ferries, tugs and pilot boats). In the near term, partial decarbonisation of these vehicles could be achieved through use of renewable diesel, and over the longer term, fleet replacement with electric and hydrogen-fuel cell variants, would further reduce carbon emissions at ports.

Finally, there is a significant decarbonisation opportunity for ports in facilitating the refuelling of vessels with alternate, low emissions fuels. Fleet order books for major shipping lines are increasingly trending towards ships powered by alternate fuels, including hydrogen, LNG and green methanol. With these different fuels, will come differing safety, environmental and technological requirements for portside refuelling infrastructure at ports where shippers choose to refuel. In view of this, IFM continues to monitor global trends in carbon reduction in international shipping and liaise with our portfolio ports in Australia, Europe and Canada.

[14] International Energy Agency (2023), 'International Shipping'.
[15] Ibid
[16] US Department of State (2022), 'US Announcement Under the Green Shipping Challenge at COP27', US Government. 7 November 2022.
[17] Ibid.
[17] International Energy Agency, 'International Shipping' (2023),

CASE STUDY: SEAPORTS

Seaports to harness the wind through supporting offshore wind development projects

In Australia, a proposed large-scale port facility at Port Kembla's Outer Harbour could help develop an offshore wind industry in the Illawarra region of New South Wales.

In February 2023, NSW Ports unveiled concept plans for a new facility at Port Kembla that could contribute to the State's transition to renewable energy.

NSW Ports holds long-term leases for Port Kembla in Wollongong and Port Botany in Sydney. Port Kembla is within NSW's Illawarra Renewable Energy Zone and adjacent to the Federal Government's proposed Illawarra offshore wind development zone. The Illawarra Renewable Energy Zone (REZ) covers 7,000 square kilometres, which includes the port, making it a prime location for large-scale renewable energy projects.

Port Kembla already handles the importation and transportation of onshore wind components and is expected to support the development of hydrogen and other critical minerals in NSW in the longer term.

Port Kembla's proposed Outer Harbour offshore wind farm port facility is part of an international trend of seaports investing in infrastructure to support wind farm projects in their region. These projects can increase the supply of renewable energy for nearby industry and also for ports, which need to source more renewable energy to power vessels while they are berthed, and transition more of their ground machinery and inner vessels to renewable energy sources.

As such, offshore wind-farm developments have a larger role in the ongoing decarbonisation of seaport infrastructure.

Port Kembla

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