DECARBONISATION OF PORTS - THE FEASIBILITY OF SHORE POWER WORKSHOP 2023

AUGUST 14/15 2023
SUNSHINE COAST

BY: PIANC AUSTRALIA NEW ZEALAND

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WELCOME

We recognise the First Peoples of this nation and their ongoing connection to culture and country. We acknowledge First Nations Peoples as the Traditional Owners, Custodians and Lore Keepers of the world's oldest living culture and pay respects to their Elders past, present and emerging.

LUKE CAMPBELL

Chair PIANC ANZ

Luke is an accomplished Maritime Engineer with over 18 years of experience working on coastal and marine infrastructure. He is widely recognised as an expert in many specialist fields including port and recreational facilities. Luke has considerable experience managing multi-disciplinary teams on complex projects, with a particular interest in design for unorthodox engineering problems. Luke is a Director of WGA and oversees the Ports and Marine sector throughout Australia and New Zealand and is also the current chair of PIANC.

2023

AUGUST 14/15 2023
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DECARBONISATION OF PORTS - THE FEASIBILITY OF SHORE POWER WORKSHOP

OUR FACILITATORS:

Peter Engelen
Deputy Chair

Jackie Spiteri
Board Member/Co Secretary

Scott Keane
Board Member/MarCom Lead

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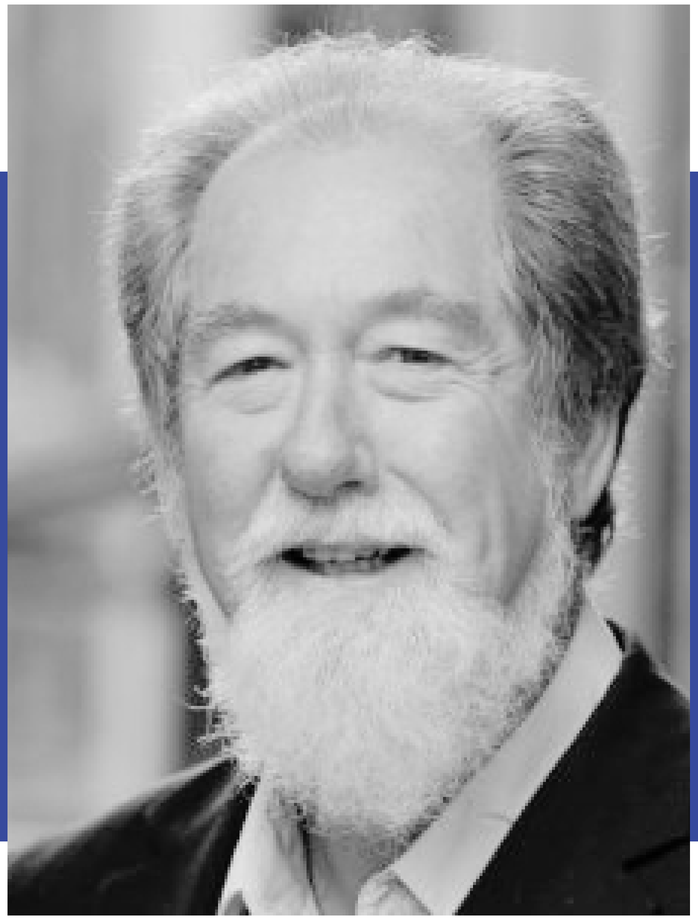
SPECIAL THANKS TO



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NCCOE Rep

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Regional Chapter Chair

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PIANC ANZ Comms

Paul Weston
Executive Officer

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INTRODUCTION & OBJECTIVES

Peter Engelen
NSW Ports | PIANC ANZ Deputy Chair

- Knowledge sharing and networking
- Decarbonisation challenge
- Revival of shorepower

IS SHORE POWER FEASIBLE??

MARCOM UPDATE

Scott Keane
PIANC ANZ Board Director |
MarCom Lead

SCOTT KEANE

Scott is the Industry director ports & maritime for Stantec and his experience spans Academia, executive management in public & private sectors, and consulting. He has 30 + years' experience and has been on the PIANC Board for 15 years and is our National Section representative on the Maritime Commission (MarCom).

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The World Association for Waterborne Transport Infrastructure

MarCom WG248 - GUIDELINES FOR ONSHORE POWER SUPPLY (OPS) FOR SHIPS

Presented by

Mr Scott Keane

at the occasion of the PIANC ANZ DECARBONISATION OF PORTS – EXPLORING THE FEASIBILITY OF SHORE POWER, 2023.

ONSHORE POWER SUPPLY

- Onshore Power Supply (OPS)
- Cold Ironing
- Shore side electricity (SSE)
- Shore connection
- Shore to ship power
- Alternative maritime power

THIRD PARTY REPORTS

- British Ports Association, 2015
- European Commission, 2006
- European Maritime Safety Agency (EMSA), 2022 (numerous)
- International Maritime Organisation / Global Maritime Energy Efficiency Partnerships. (2020)
- International Standards Organisation (ISO), 2019
- SSPA Sweden AB, 2022
- OCIMF, pending (and discussion during workshop)
- Qi, Wang, & Peng, 2020

(A comprehensive literature research has been compiled by Qi et. al. (2020) providing a systematic review of current research on shore power).

AD-HOC WORKING GROUP

- Dr. Lars Stemmler, Bremenports, Germany (moderator);
- Dirk Mahrholz, Head Electrician, Bremenports;
- Uwe Radke, Head of electrical engineering, Hamburg Port Authority, Germany;
- Geraud Hervé, OPS specialist, HAROPORTS, France;
- Lisa Sarodnik, Port of Kiel, Germany.

AD-HOC WORKING GROUP

- Technical aspects appear to be covered fairly sufficiently, but, in particular the SSPA-report (SSPA Sweden AB, 2022) needs an update.
- Organisational topics, such as organisational models for providing OPS, and related contractual arrangements/financing flows as well as risk allocations are insufficiently covered. Although analogies can be drawn from public-private interaction in other public infrastructure sectors, such as roads, the economics and legal structures of the energy market as the commercial basis for OPS warrant a particular focus.

AD-HOC WORKING GROUP

- The future of OPS caused some discussion amongst the members of the ad-hoc Working Group, as the increasing uptake of alternative fuels in shipping might prove OPS as a sole source of decarbonised electrical energy obsolete in future. As such, the report should also focus on possible roles of OPS within ports´ electrical grids as a facilitator for integration, energy storage, to name the most apparent ones
- Thoughts that for Europe – the relevant norm would cover any issue arising. In technical terms this might hold true, but in commercial and legal sense there are some gaps. However, judged by the discussions in Bremen/Bremerhaven, we are not yet there to provide a best practice example. Risk that a report might be outdated once published, so approach is perhaps practice guides

New WG248 TOR / Topics

What ships with what (future) power requirements?

- Requirement and scope of vessel size-type forecast, availability of OPS-ready vessels
- Requirements of different types of ships regarding energy consumption (peak requirements, voltage, current, position of plugs), including electric powered ships (as per IEC/ISO/IEEE 80005-1)

What power supply is available in the port?

- Typical measurements (peak supply, voltage, current)
- Constraints from local power grid (max. load, frequency).
- Available infrastructure connecting grid and port
- Consideration of other users/terminals etc. -> impact on port grid.
- Consideration of regulatory restrictions, such as limited supply of other users from OPS-stations

OPS and renewable sources of energy

- How do the sources of the onshore electrical energy affect the environmental benefits of the OPS project. Is OPS still “green” without renewable energy?
- Investigation of the feasibility of storage facilities (batteries, compressed or liquid air respectively CO2, electrolyser, wind turbines) for OPS

Available standards to be considered when planning for OPS

- IEC/ISO/IEEE 80005-1 as international standard for OPS (all other applicable national standards for electrical engineering to be considered as well)
- Considering if there are parts missing in the standards that instead should be covered in this report. (OPS standards exist, this is cooperative work under reference; further, if necessary, low voltage is currently not covered.

Technical aspects

Electrical engineering

- Presentation/coverage of different technical solutions available on the market related to OPS, including pros and cons.
- Mobile (land-side vs. sea-side) vs. fixed installations (capacity constraints vs. flexibility)
- Safety aspects, such as grounding, overload, lightning protection
- Costs (CAPEX, OPEX)

Civil engineering

- Necessary civil infrastructures in relevant port areas, esp. for dedicated OPS-equipped berths and buildings/containers/cable-trays etc.
- Potential interference with other quay-side equipment, such as ship-to-shore cranes, straddle carriers/AGVs etc.
- Costs (CAPEX, OPEX)

Implementation time horizons (port infrastructure, grid upgrades)

Market research and availability of suppliers

Operational aspects

- Operating procedures, OPS Compatibility Assessment procedures,
- Organisational concepts (public, private, public-private provision and operation of OPS; operational vs. maintenance aspects)
- Process integration (mooring/unmooring, crane operations, esp. rail-mounted)
- Integration into port security/business continuity planning
- Planning trade-offs: Berth planning (logistics vs. electrical requirements of terminal operators)
- Safety / accessibility of quay/sub-station (esp. automated terminals)
- Metering
- Required human capacity/staff requirements

Commercial aspects

- Procurement of required energy/contracting models/contracting parties
- Charging schemes
- Invoicing procedures
- The business model of OPS installations. Who will bear the cost? Can OPS be operated on a commercial basis? Best cooperation models?
- CAPEX/OPEX overview
- Public funding: EU, National or regional support schemes; e.g. EU Cohesion funds for reciprocal programs
- Risk analysis and risk mitigation strategies

Legal issues

- (Renewable) energy-law- and tax-law-related issues (national/international laws, incl. port/flag-state requirements)
- How to incentivise using OPS, such as by harbour dues discounts, integration into the Environmental Ship Index, IMO regulation (carbon emissions index)?
- Liability and insurance
- Permitting and plan approval procedures (construction, operation, environmental)

Case Studies

Case studies on different types of OPS projects (from feasibility to execution, depending on suitable cases, state-of-the-art and available information) .

- Technical best-practice
- Planning: typical planning timelines
- Procedural best-practice: A clear roadmap to the delivery of OPS installation in the port.
- Port co-operation: Possibilities to gain momentum by looking into a multiport project approach. Reciprocity [viz. Key advocacy point of European Onshore Power Supply Association] what are the benefits
- Lessons learned of existing operators

Future opportunities of OPS

- What future uses might OPS have/integration into wider environmental strategies (battery barge, inland shipping, last-mile going electric, ships as energy storage)
- Development of a port micro-grid?

Our ANZ National Section participation in the WG

- Call for members interested in participation recently closed and assessment and recommendation under way

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Thank you for your attention.

For more information visit us at

www.pianc.org

or join us on

ENVICOM UPDATE

Burton Suedel
US Army Corp | PIANC
EnviCom Chair

BURTON SUEDEL

Dr. Suedel is a research biologist at the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center, Environmental Laboratory in Vicksburg, Mississippi. He earned his bachelor's master's degrees in biology from the University of North Texas, and his Ph.D. in biological sciences from the University of Mississippi. Dr. Suedel has received international awards and recognition for applying Engineering With Nature® principles in practice. He is an active member of PIANC, where he serves as the Chair of the PIANC Environmental Commission (EnviCom). His PIANC activities include chairing PIANC EnviCom Working Group 143 on Conducting Initial Assessments of Environmental Effects of Navigation and Infrastructure Projects and Working Group 175 on Managing Environmental Risks of Waterborne Transport Infrastructure. He also served as the U.S. representative to PIANC Inland Navigation Commission Working Group 203 on Sustainable Inland Navigation and mentored EnviCom Working Group 214 on Sediment Beneficial Use

DECARBONISATION - ENVICOM UPDATE

PIANC's Environmental Commission (EnviCom) mission to provide practical, science-based guidance to shape and inform future environmental practice in the development and operation of sustainable navigation infrastructure is well positioned to develop Working Groups that address decarbonization of ports and harbors worldwide. The UN Sustainability Goals (SDGs) can be used as a measuring stick to identify how decarbonization and shore power can play a role in making ports and harbors more sustainable in the future. In the United States, an unprecedented level of policy directives related to adapting to and mitigating the effects of climate change are paving the way for decarbonization of ports and harbors to contribute to a more equitable and sustainable navigation infrastructure future.

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EnviCom and USA Updates: Decarbonization

Presented by

Burton Suedel

14 August 2023

EnviCom Overview

PIANC Environmental Commission

- Demonstrates PIANC's commitment to environmental and sustainability development principles
- Addresses navigation sustainability and environmental risk issues that crosscut PIANC areas & partners
  - Develop and provide environmental guidance for sustainable waterborne transport infrastructure
  - Network/communicate with international organizations and associations including Countries in Transition
  - 30 members from 11 nations and 7 partner organizations
  - Active Working Groups (e.g., Beneficial Sediment Use, Underwater Sound)
  - ToRs in progress: Blue Carbon (with PTGCC)

EnviCom: Mission

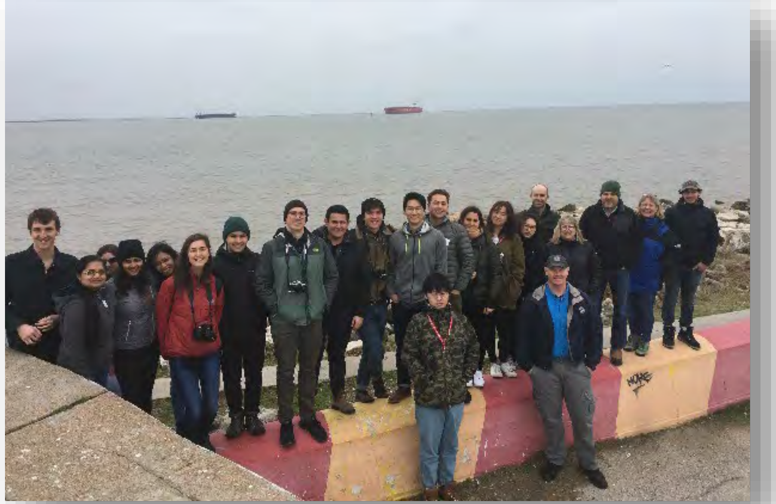
Provide practical, science-based guidance to shape and inform future environmental practice in the development and operation of sustainable navigation infrastructure

Goals

1. Develop best practice guidance to create environmental value through sustainable, resilient navigation infrastructure
2. Integrate best environmental practice into navigation planning, engineering and operations
3. Use strategic communications to expand PIANC's reach, engagement, partnering, and impact

Major Work Themes

- Enhancing the economic, environmental, and social benefits of infrastructure through sound environmental practice
- Support proactive climate change posture
- Support application of risk-informed decision making to environmental management
- Promote Working with Nature philosophy



Decarbonization and Shore Power:
Association with UN Sustainable Development Goals

- 3: Good Health and Well-being
- 6: Clean Water and Sanitation
- 8: Decent Work and Economic Growth ←
- 9: Industry, Innovation and Infrastructure ←
- 11: Sustainable Cities and Communities ←
- 13: Climate Action ←
- 14: Life below Water
- 15: Life on Land
- 17: Partnership for the Goals ←

WG188 – Carbon Management for Port and Navigation Infrastructure (2019)

Report Objectives

1. Review and report technical literature on carbon footprint of navigation infrastructure and supporting activities
2. Provide guidance on applying life cycle analysis and related assessment tools and techniques
3. Investigate opportunities for reducing atmospheric GHGs through operational practices, Working with Nature, land use management, blue carbon projects, environmental management
4. Life cycle framework
5. Case Studies

WG188 – Carbon Management for Port and Navigation Infrastructure (2019)

Case Study: Horseshoe Bend Island, Louisiana

- Strategic placement of dredged sediment mid-river of between 0.5 to 1.8 mcy sediment every 1-3 years contributed development of 35 ha island
- Engineering with Nature (EWN) principles and practices benefits: carbon management, navigation, environmental, economic
- The USACE developed carbon management and other metrics to capture benefits from reducing atmospheric GHGs and carbon sequestration
- Estimated 5,220 kg of carbon sequestered per year (assuming stability)
- Estimated 186 million metric tonnes of carbon dioxide equivalent (MTCO2e;) realised each year
- Estimated reduced fuel savings over 10 years (1.27 M gal diesel) translates into 12,98 MTCO2e emissions reduction from reduced dredging operations

Last dredged: 2014

915,000 cy Apr-May 2019

Photo: June 2019

PIANC Strategic Initiatives

Nature-based Solutions and Working with Nature

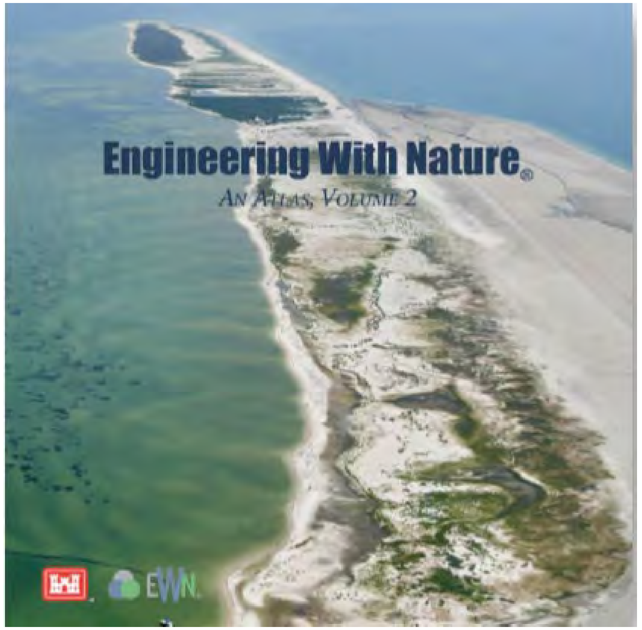
- Promote Working with Nature philosophy
- WwN Position Paper published in 2008; updated in 2011
- PIANC website (https://www.pianc.org/working-with-nature)
- WG 176 - Guide for Applying Working With Nature to Navigation Infrastructure (2018)
- Permanent Task Group on Climate Change
- Engineering With Nature (USACE)
- Building with Nature (EcoShape)
- Renewed sustainability focus with UN Sustainable Development Goals (SDGs) as guide

Engineering With Nature® Atlases

Volume 1
56 Projects
27 USACE

Volume 2
62 Projects
23 USACE

Volume 3
December
2023



"The mission of US Army Corps of Engineers is to deliver vital public and military engineering services; partnering in peace and war to strengthen our nation's security, energize the economy and reduce risks from disasters. Engineering With Nature supports this mission which is why it will always be an important initiative for the Corps."

LTG Scott A. Spellman, 55th Chief of Engineers, Commanding General, USACE

Decarbonization and the Role of Shore Power: NBS a White House Priority

BRIEFING ROOM

Executive Order on Strengthening the Nation's Forests, Communities, and Local Economies

APRIL 22, 2022 · PRESIDENTIAL ACTIONS

BRIEFING ROOM

Executive Order on Tackling the Climate Crisis at Home and Abroad

JANUARY 27, 2021 · PRESIDENTIAL ACTIONS

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

WHITE HOUSE ROUNDTABLE – "KNOWLEDGE IN NATURE: HOW NATURE CAN HELP GROW A BETTER FUTURE"

OPPORTUNITIES TO ACCELERATE NATURE-BASED SOLUTIONS: A ROADMAP FOR CLIMATE PROGRESS, THRIVING NATURE, EQUITY, & PROSPERITY

A REPORT TO THE NATIONAL CLIMATE TASK FORCE

NOVEMBER 2022

THE WHITE HOUSE
WASHINGTON

- EO 14072, Sec. 4. Deploying Nature-Based Solutions to Tackle Climate Change and Enhance Resilience:
  - "To further amplify the power of nature, including its ability to absorb climate pollution and increase resilience in all communities, today's Executive Order calls for the following:"

1. Report on Nature-Based Solutions
2. Guidance on Valuing Nature
3. First U.S. National Nature Assessment

US Policy Directives and Supports

President Biden’s Investing in America Agenda

- $17B Bipartisan Infrastructure Law to improve US ports and waterways
- $4B Inflation Reduction Act focus on electrifying port equipment & heavy-duty vehicles; investment in electrification & other low-carbon technologies
- DOT Federal Highway Admin. Improvements to port efficiencies and reducing GHG emissions
- Justice40 Initiative to ensure that 40% of overall federal investment clean energy benefits flow to disadvantaged communities

MAY 05, 2023

FACT SHEET: Biden-Harris Administration Announces Key Infrastructure Funding to Electrify Ports

BRIEFING ROOM › STATEMENTS AND RELEASES

US Policy Directives and Supports

Port Electrification Projects

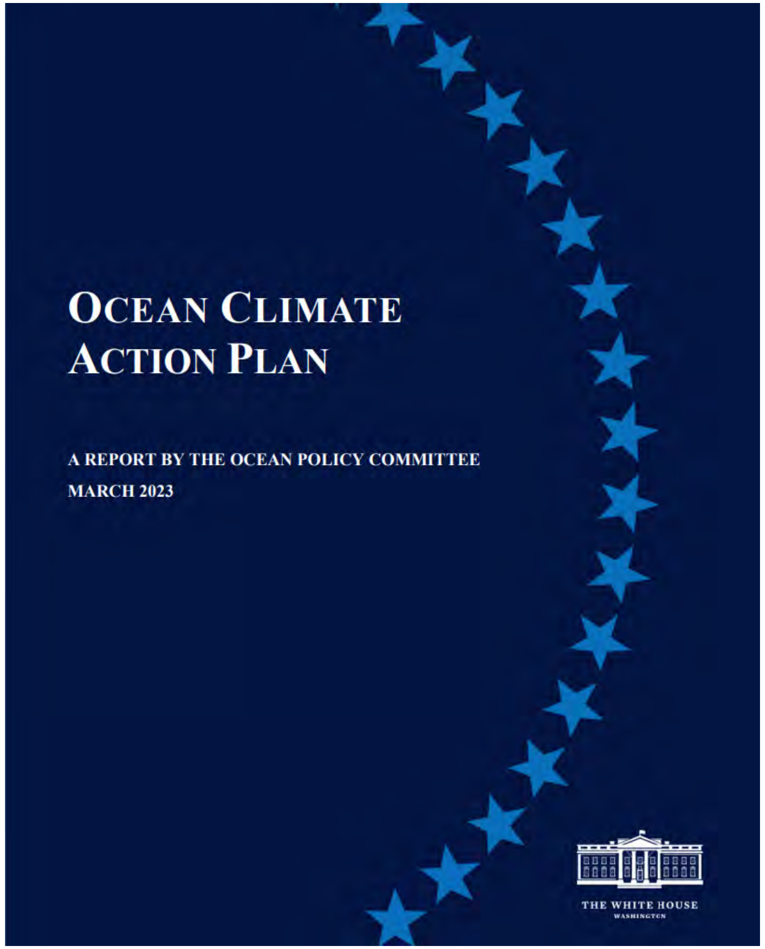
- Middle Harbor Terminal Zero Emission Conversion Project, Long Beach
- JAXPORT EXPRESS Project, Jacksonville, FL
- Terminal 6 Infrastructure Improvements Project, Portland
- Kapalama Container Terminal Project, Honolulu
- Port Miami (US DOT Ports Electrification Program) NetZero: Cargo Mobility Optimization and Resiliency Project

Photo: Hawaii Dept. of Transportation

US Policy Directives and Supports

Ocean Climate Action Plan Outlines Big Goals for US Maritime Industry

- "…electrification, optimization, and more energy-efficient port operations can greatly reduce or, in combination, may eliminate shoreside GHG emissions."
- "Green the Nation's ports by upgrading, modernizing, and decarbonizing port infrastructure and operations by accelerating transportation electrification and enhancing port information infrastructure."
- Explore transitions to a climate-ready fishing fleet:
  - Conduct scoping to understand the requirements associated with electrification of U.S. domestic vessels, including shore-side infrastructure…and supporting funding programs…"



Shore Power Technology Assessment at US Ports

US EPA 2022 Update – Key Findings

- Shore power can effectively reduce ship pollutant emissions at berth; benefits vary by port and vessel type
- Application of shore power in the United States is expanding to more places and vessel types
- Barriers to shore power include infrastructure and electricity costs
- Lessons learned include:
  - Need for system designs to be flexible
  - System design should account for future demand
  - Public funding sources critical

https://www.epa.gov/ports-initiative/shore-power-technology-assessment-us-ports

Take Home Points

- Unprecedented US focus on climate change impacts and means to adapt and mitigate them
- US ports and harbors can be part of a decarbonization solution
- Electrification and shore power identified as solutions
- Path to sustainability will be equitable and include environmental justice initiatives

Dredging in the Port of Oakland, CA

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NAVIGARE NECESSE
STATUS REPORT
Kenny Walker
Royal Haskoning DHV

KENNY WALKER

Kenny Walker is a highly experienced environmental consultant with over 20 years' experience in the engineering and environmental sector with a focus in energy and infrastructure and the transition towards emission reduction and decarbonisation. He has worked around the world including Australia, the UK, Ireland, the Netherlands, Norway, the Middle East, West Africa, and the USA working across a number of industry sectors including energy (renewables, oil and gas and mining) and maritime infrastructure. His roles include both acting as project manager as well as providing technical lead in environment management, sustainability and compliance.

Kenny has developed expertise in the environmental aspects of port and coastal infrastructure, focused on initial feasibility assessments through to full environmental impact assessment for development and operation. His experience includes delivery of the impact assessment and approval for the world's first offshore tidal power array in Scotland, alongside review and development of approvals for ports all around Australia. He has also been technical lead for land feasibility assessments for a range of developments in Africa and the Middle East alongside developments in Australia. Recently he presented at "All Energy" renewables conference in Melbourne on the transition and development of fossil fuel-based economy to renewables and a few months ago presented at the Greenports Oceania congress on the sustainability of the supply chain for the transition to renewables in Australia.

INTERNATIONAL LANDSCAPE ANALYSIS ONSHORE POWER SUPPLY

Onshore power supply, also known as shore power or cold ironing, a technology that allows ships to connect to the local power grid while at port, reducing emissions, noise, and fuel consumption. This presentation provides an outline of what shore power is, different current operational types of onshore power and how it is being used. It then explores the international landscape of onshore power supply, examining key regions, adoption rates, regulatory frameworks, challenges, and future considerations such as international standardisation. The study highlights the current state of onshore power supply in Europe, North America, and Asia, and identifies the technological advancements, policy developments, and stakeholder collaboration needed to accelerate its adoption globally. Additionally, it explores briefly future considerations, including environmental sustainability, technological innovations, economic viability, regulatory frameworks, and international collaboration.

International Landscape Analysis Onshore Power Supply

Technology – Development – Renewable Energy

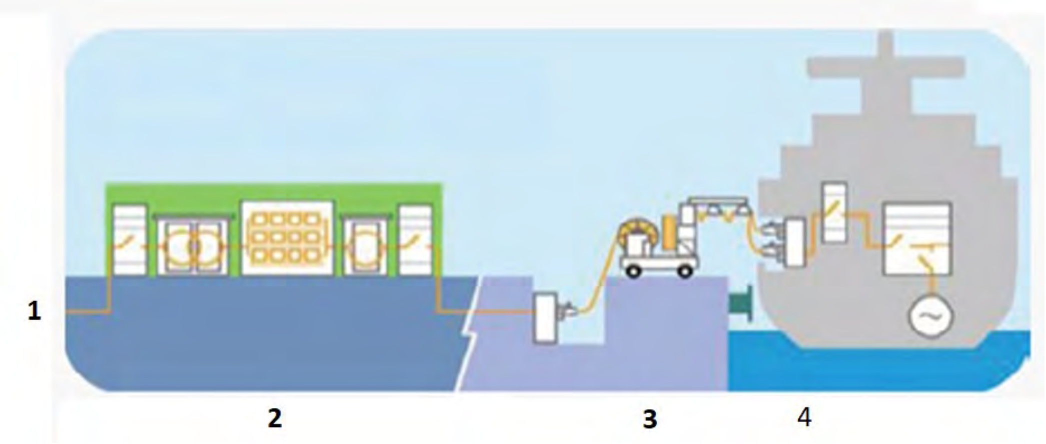
Project related
Kenny Walker
14 August 2023

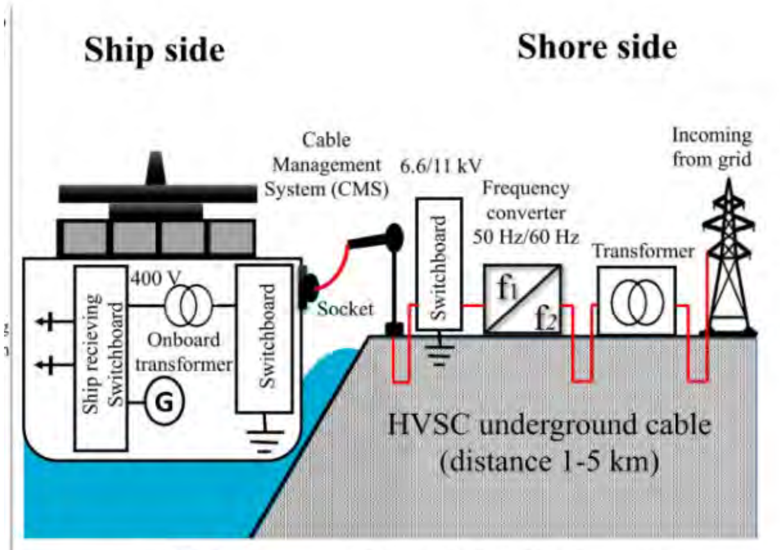
Summary of presentation

- What is Shore Power?
- Why is it used(and legislative context)?
- Types and vessel requirements
- Technology
- Economics of Shore Power
- Global Status
- Examples (NL)
- Social/Environmental Benefits
- Renewables(for use in a shorepower context)- Pros and cons
- Discussion and summary

What is Shore power: Connect ship to landside power grid

1. Grid connection – Incoming power supply
2. Converter station – Adaptation voltage / frequency from grid to ship
3. Connection point or Cable Management system – Connection at the right spot
4. Ships' on-board connection point





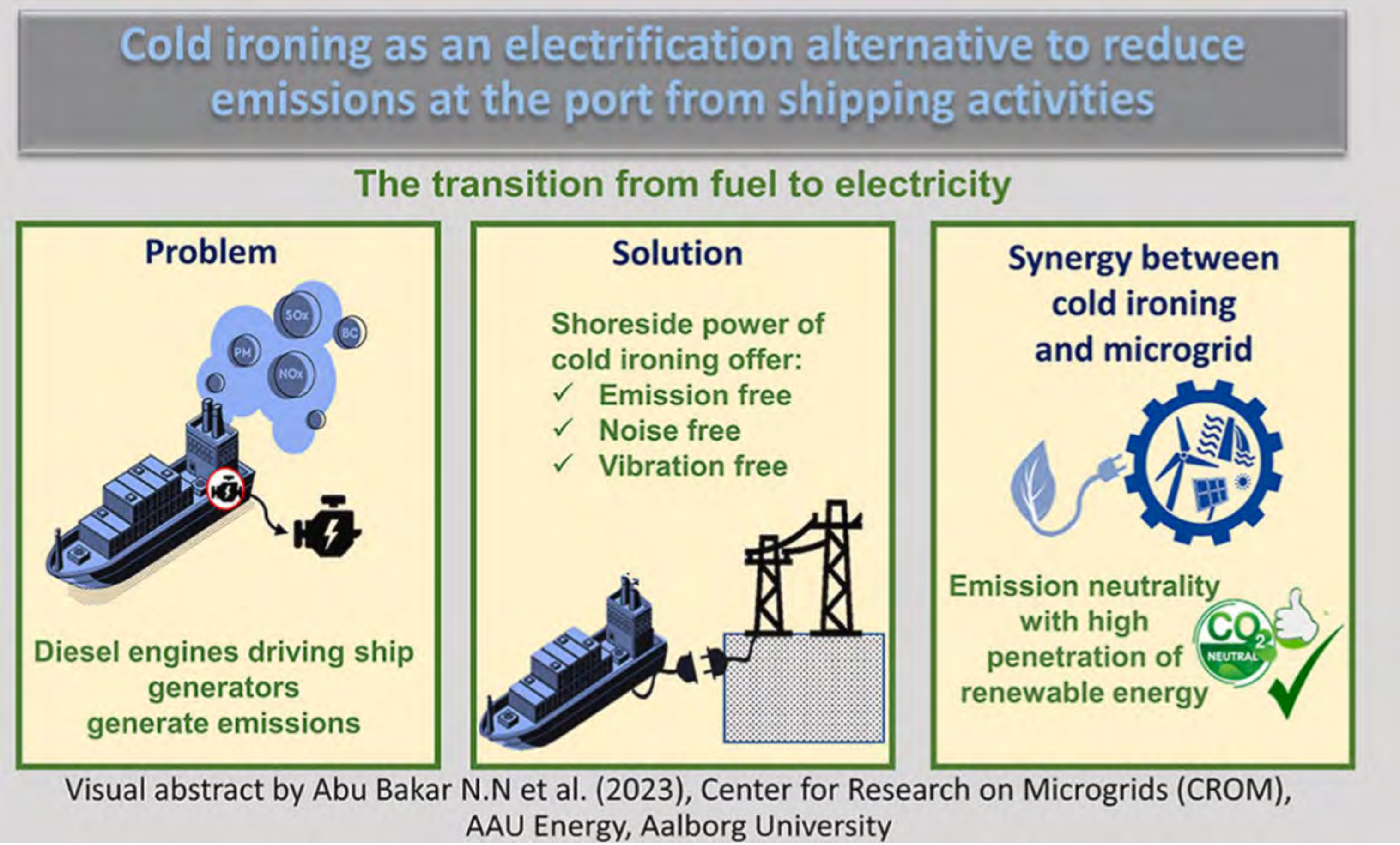
(c) Main component of the typical cold ironing system

Why Shore Power?

- Environment:
  - Reduction of harmful emissions (SO_2 / NO_x / Dust particles)
  - Climate CO_2 emission reduction (Use renewable power on board of ships)
  - Working conditions on-board / In the port (Noise / Vibrations)
  - Living conditions close to the port (Low frequent noise / Vibrations)

- Local rules and legislation (For example USA, EU)(Green deal issued by EU)
- Commercial benefits: Green exposure for the port / shipping line

- Operational:
  - Electrical power cheaper than diesel power
  - Low load of diesel generator: Maintenance issues


Cold ironing as an electrification alternative to reduce emissions at the port from shipping activities
The transition from fuel to electricity
Problem
SOx
BC
PM
NOx
Diesel engines driving ship generators generate emissions
Solution
Shoreside power of cold ironing offer:
✓ Emission free
✓ Noise free
✓ Vibration free
Synergy between cold ironing and microgrid
Emission neutrality with high penetration of renewable energy
CO2
NEUTRAL
Visual abstract by Abu Bakar N.N et al. (2023), Center for Research on Microgrids (CROM), AAU Energy, Aalborg University

Role of Royal HaskoningDHV in shore power

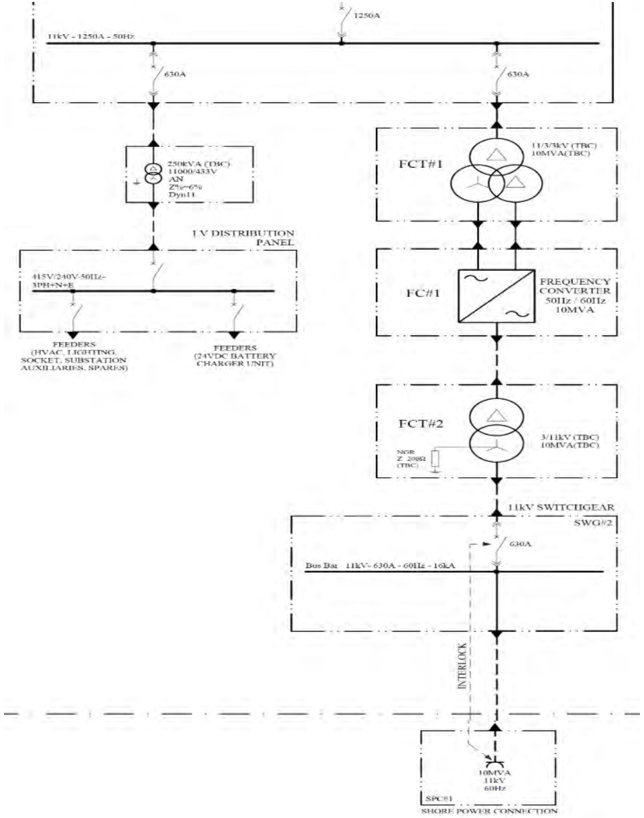
- Feasibility studies:
  - Shore power options
  - Power supply: Grid / Renewables
  - Economic feasibility

- Design & Contracting:
  - Concept design
  - Tender documents – Design & Build
  - Contract

- Construction:
  - Site supervision
  - Testing & Commissioning

Shore power requirements per ship type

- Wide variety of systems:
  - Yachts (Marinas): 230V / 1kW (50Hz)
  - Barges: 400V / 5kW (50Hz)
  - Bulk / General cargo ships: 400V / 100kW (50 or 60Hz)
  - Fish trawlers: 400V / 250kW (50 or 60Hz)
  - Ferries: 6,6kV / 2MW (60Hz)
  - Container ships: 6,6kV / 5MW (60Hz)
  - Cruise ships: 11kV / 16MW (60Hz)



Royal HaskoningDHV

Technology of shore power

- Electrical equipment room on quay wall (Port of IJmuiden, 1MVA)

Technology of shore power

- Ship connection (400V, 400A) in pit on quay wall

Royal HaskoningDHV

Technology of shore power

- Converter station for Cruise ship (12MVA)

Technology of shore power

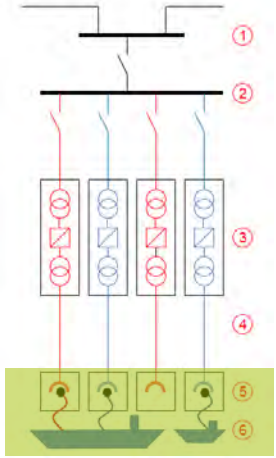
- Shore power connection on-board of Cruise ship with 3200 passengers / 16MVA

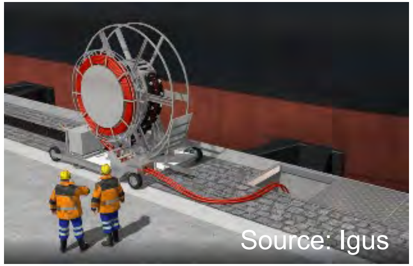
Technology of shore power

- Shore power panel for barges (400V, 6 x 63A) in Port of Rotterdam

Connection of a Container ship

- Following options considered
  1. Option Fixed double-sided dual socket boxes with dummy plugs per max. 50m
  2. Cable chain (Horizontal = Stemmann / Vertical = IGUS)
  3. Cable reel with 1 double-sided socket box per 125m





Connection of a Cruise ship

11kV / 12MVA – Hamburg Altona

Electrical system

- Payment system
  - Manual read-out of kWh meters
  - Remote kWh measurement / SCADA system
  - Full automated measurement and billing system

- Safety and reliability
  - Earth fault protection
  - Galvanic insulation
  - Reset of failures
  - Operations – avoid mistakes with voltage and frequency

Royal HaskoningDHV

Economy of shore power: Investment and operations

- CAPEX (order of magnitude, per connection point and/or per ship):
  - Small yacht in marina: EUR 1k – 5k
  - Barge (Rotterdam standard): EUR 10k – 25k
  - Fish trawler / General cargo: EUR 200k – 500k
  - Container ship: EUR 2M – 5M
  - Cruise ship: EUR 5M – 12M

- OPEX (order of magnitude 5-15% of initial investment):
  - Handling: Connection and disconnection, metering, invoicing
  - Maintenance and repair
  - Depreciation
  - Interest

Economy of shore power: Business model

- Business perspective:
  - Sales margin of electricity
  - Shore power needs to be cost-competitive
  - Pricing of shore power:
    - Depending on fuel price
    - Attractive pricing - Prohibit generator use
    - Include SP in port fee

- Socio-Economic perspective:
  - Environmental benefits
  - Benefits for people in/ near the port
  - Benefits quantified in money

Royal HaskoningDHV

Economy of shore power: Business model

- Investors:
  - Port authorities
  - Terminals
  - Service providers – Shore power as a service

- Operations & Maintenance

- How to make Business case feasible:
  - Include indirect revenues (Additional residential areas close to the port)
  - High requirements on fuel quality for in-port use
  - Prohibit the use of on-board generators (Port of Rotterdam)
  - Apply for subsidy (EU)

Actual status of Shore Power implementation

- USA and Canada:
  - Several systems operational for Cruise and Container ships
  - Los Angeles / Vancouver / San Francisco/Seattle
- Europe:
  - Ferries and Cruise: Several systems operational
  - Germany / Netherlands / Norway / Sweden / UK
  - Smaller ships: Barges and fish trawlers – Wide spread of connection points
- Asia:
  - Cruise and Container ships: Several systems planned
  - China, Korea, Singapore, India

Royal HaskoningDHV

Actual status of Shore Power implementation

- Australia and New Zealand:
  - First plans being developed
- Africa and Latin-America
  - Rising awareness
  - Civil provisions sometimes taken into account
  - No implementation plans yet

Shore power in The Netherlands: Actual status

- Barges: Appr. 800 connections all over NL – Appr. 500 in Port of Rotterdam
- River Cruise: Appr. 20 connections mainly in Rotterdam and Amsterdam
- Fishery ships: Appr. 15 connections in Scheveningen and IJmuiden
- Ferry: 1 Shore power system at Stena Line Hoek van Holland
- Offshore service ships: 2 connections at Heerema Rotterdam
- Sea cruise: Cruise Terminal Rotterdam: Under construction





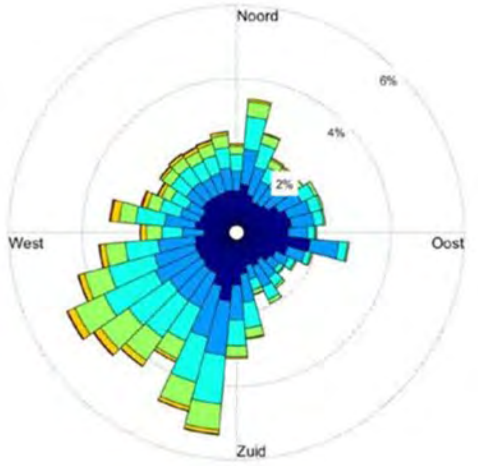
Royal HaskoningDHV

Environmental effect of shore power

- Emissions of diesel generators:
  - CO_2 : Direct related to fuel consumption – Appr. 800 g CO_2 per kWh
  - SO_2 : Depending on Sulphur content of fuel
  - NO_x / Dust particles: Depending on emission category of diesel generator

- Emissions of grid power:
  - Depends on energy mix per country:
    AUS appr. 680g / kWh / NZ APPR. 110g/kWh
  - No emissions if 100% is self-generated

- Location of emission:
  - For NO_x emissions the presence of sensitive nature is relevant
  - For Dust particles the presence of residential areas is relevant



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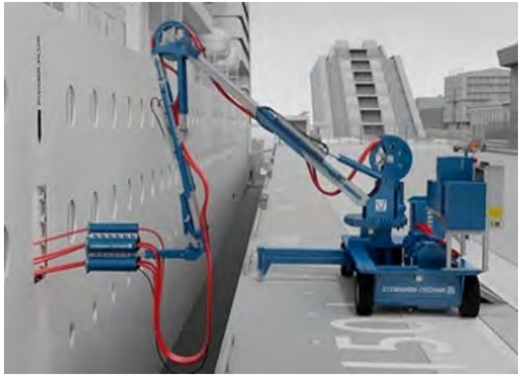
Standardisation of Shore power systems: IEC80005

- General standard for all shore power systems(high voltage)
- Specific: Cruise ships - 11kV / 60Hz / Cables land side
- Specific: Container ships – 6,6kV / 60Hz / Cables ship side



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Informal standards for Shore power systems

- Informal standards (NL / Western Europe)
  - Yachts (230V / 50Hz / 3kW)
  - Barges (400V / 50Hz / 25kW)
  - River cruise (400V / 50Hz / 50-250kW)
  - Fishery ships (400V / 50 – 60Hz / 250kW)

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Design of shore power system

- Connection technology: Costs – Flexibility
- E-power supply
- Locations of electrical equipment rooms
- Cable routes
- Integration in quay wall design / structure

Wind farm Maasvlakte Netherlands 120MW

- 120 MW
- 22 Turbines
- Connected to Port internal 66kV
- Main consumer: Shore power for container terminals

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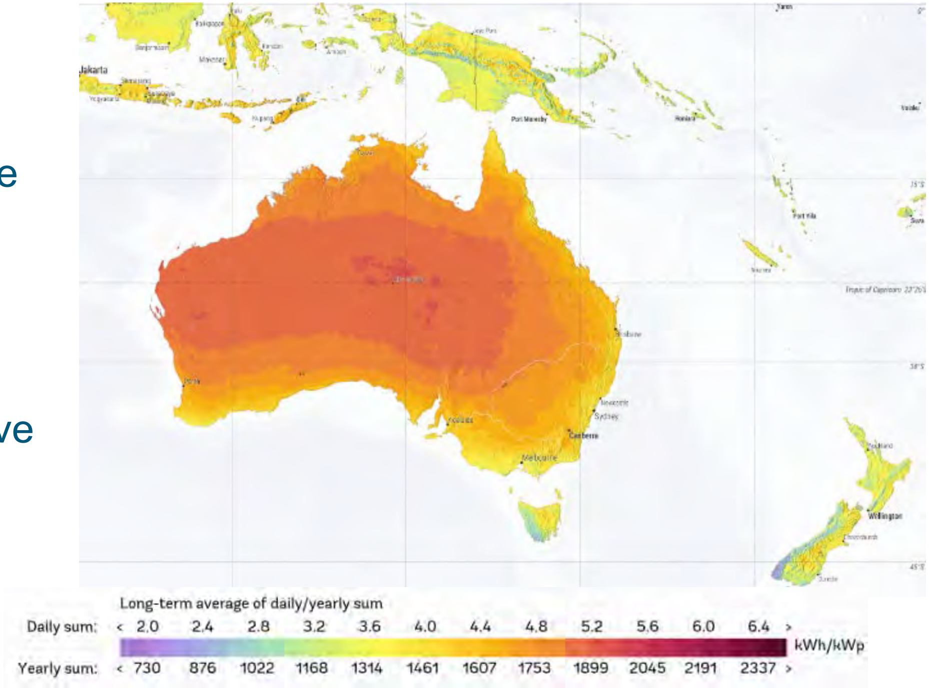
Pro's and Con's of renewable generation

- No fuel costs – Low MWh price
- Yearly output is reasonably predictable
- Long term fixed energy price
- Scalable (solar)
- Actual output is unpredictable / limited predictable
- Limited scalable (wind)
- Spatial impact (mainly solar, wind less)
- Local noise disturbance (wind)
- Depending on rare resources (such as cobalt)
- Recycling unclear
- Electricity storage not yet efficient

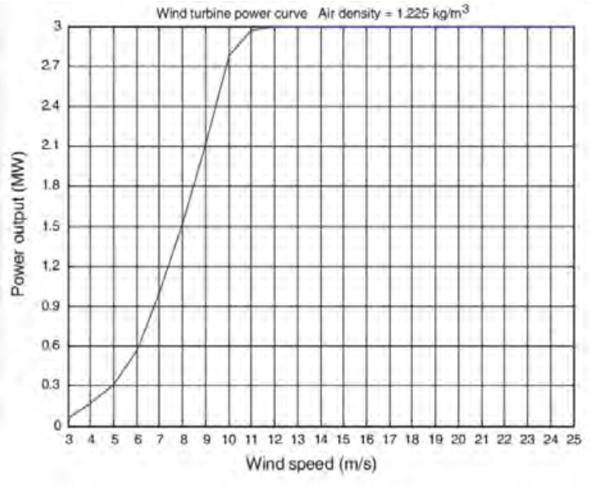
Renewable power feasibility: Solar

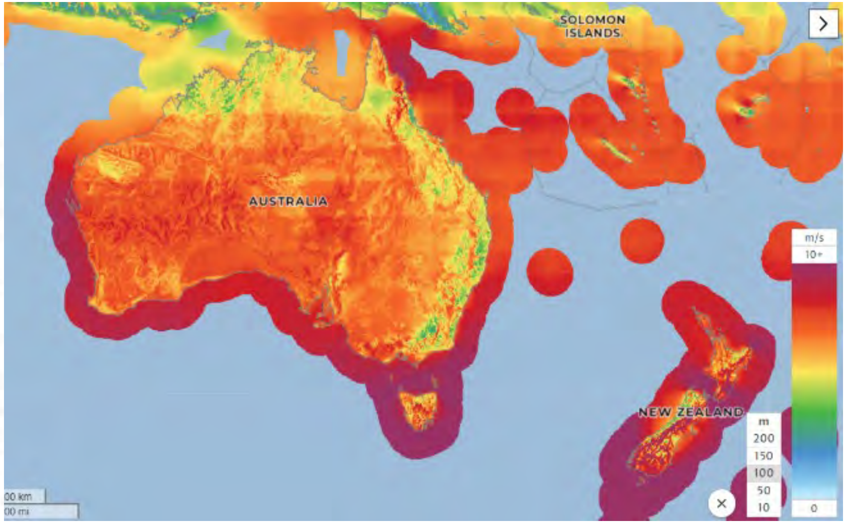
- **Solar power:**
  - Solar intensity and hours sunshine define solar efficiency
  - Free space – Rooftops / Obsolete land = Attractive
  - Use port area = Commercially unattractive
  - Pollution / dust can be a problem



Renewable power feasibility: Wind

- **Wind turbine characteristic**
  - Average wind speed has high impact
  - Economic feasibility starts around 8 m/s





Vestas V112 3MW

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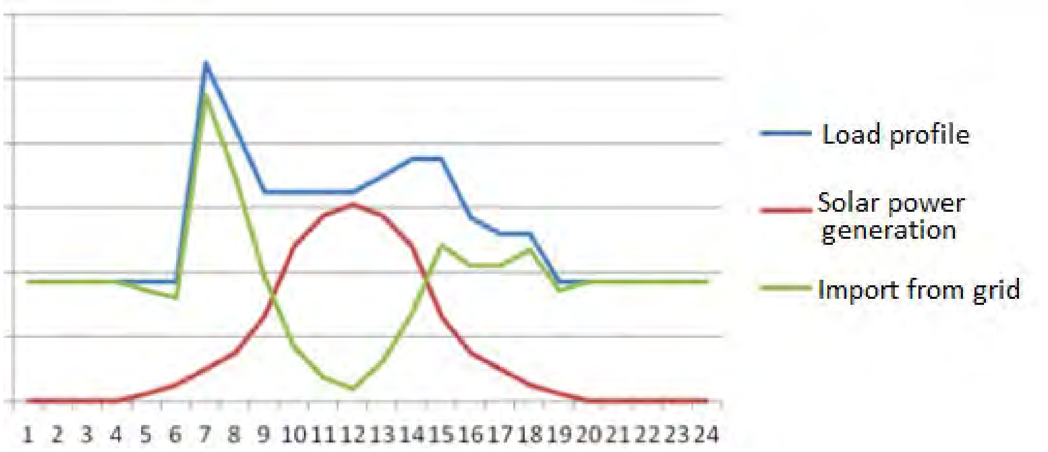
Renewable power generation - Challenges

- Balancing generation <-> consumption
  - Renewable power not / limited predictable
  - Storage
  - Feedback into the grid

- Installation
  - Space (Rooftops, open site)
  - Orientation
  - Support structure
  - Electrical connection



Balancing renewable generated power

- Generation < Consumption at any time:
  - Maximum revenues
  - No interference of grid operator
- Generation < Consumption over 24 hours:
  - Storage required for periods with generation > consumption
  - Grid feedback and later withdrawal
- Generation > Consumption over 24 hours:
  - Grid feedback
  - Conversion into renewable energy carrier (Hydrogen / Ammonia / Methanol)

Renewable power cost price (indicative only)

Wind @ 6m/s average:	106 EUR / MWh
Wind @ 8m/s average:	42 EUR / MWh
Wind @ 10m/s average:	26 EUR / MWh
Solar @ 1350kWh/kWp:	74 EUR / MWh
Solar @ 2350kWh/kWp:	44 EUR / MWh

Based on: Wind turbines 2-3MW on land / project scale 10MW / MV grid connection nearby / land or rooftop available for free / standard solar panels 400Wp

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Decision criteria for renewable power source

- Scale:
  - Wind: Minimum 2MW / Solar Minimum 1kW
- Space:
  - Wind: 20 x 20m for 3MW / Solar: 100 x 100m for 1 MW
- Noise & Shadow:
  - Wind can cause disturbance up to 500m
  - Solar: Some disturbance by reflection; very limited
- Cost price: MWh price based on local conditions
- Consumption profile: Day-night cycles? Seasonal effects?

Summary of Shore Power

- PROS
- Emissions reduction
- Climate benefit
- Noise reduction
- Compliance in some constituencies
- Operational Efficiency

- CONS
- High infrastructure costs
- Standardisation and compatibility
- Energy source
- Power Generation capacity
- Operational Constraints
- Technological limits
- Maintenance

Green Ports Strategy(Shore power is part of the process)

Below is a selection of some of the topics we frequently include in emerging Green Ports Strategies:

- Green Port Health Check
- Port Operational Efficiency (including port estate, marine and hinterland traffic)
- GHG Emissions/Air Quality
- Energy efficiency
- Biosecurity and biodiversity
- Solid waste management
- Water management (freshwater)
- Light and noise pollution management
- Climate change adaptation and mitigation
- Marine water quality management
- Emergency Environment Protection/Disaster preparedness
- Compliance with international/national legislation
- Green Ports Certification

Thank you from Royal HaskoningDHV

- Dutch independent Engineering and Environmental Consultancy
- Worldwide local presence – Including Australia (New Zealand to open 2023)
- Worlds 2nd largest consultancy in maritime sector: > 6000 colleagues
- Since 1881
- Our services: Consultancy – Design engineering – On-site services
- 1st Shore power project delivered in 2006(Port of Rotterdam Maashaven)
- > 1000 Shore Power connections built within scope of RHDHV projects

Royal HaskoningDHV
Enhancing Society Together

ENERGY, ELECTRIFICATION AND INSURANCE

- *Peter Court*
  DNV
- *Ben Waters*
  Presync
- *Halani Lloyd*
  Thomas Miller

PETER COURT

A master mariner, Peter has over 25 years' experience across the commercial maritime industry both overseas and in Australia. He has sea-going experience in bulk, container, RORO, LNG, icebreaking, and offshore oil and gas operations. He moved ashore in 2011 to join Woodside as Manager of Marine Operations. He later joined Port Phillip Sea Pilots, gaining an unrestricted licence in Melbourne, Geelong, and Corner Inlet, before becoming Chairman and MD of that organisation. Peter's most recent work has been advocacy for the Maritime industry to the highest levels of the federal government. Peter joined DNV in July 2023. In his presentation he discusses the progress towards shore power internationally, and the need for broad collaboration amongst stakeholders to develop solutions in Australia.

WHEN TRUST MATTERS

Shore Power

Cleaner ports, healthier communities

Peter Court

Peter Court, Introduction

- 25 years experience across industry
- Master mariner
- Manager Marine Operations Woodside
- Pilot, MD and Chairman Port Phillip Sea Pilots
- Maritime industry advocate

A global assurance and risk management company

159	~13,000	~100,000	100+	5%+
years	employees	customers	countries	of revenue in R&D

Ship and offshore classification and advisory

Energy advisory, certification, verification, inspection and monitoring

Software, cyber security, platforms and digital solutions

Management system certification, supply chain and product assurance

Enabling our customers and their stakeholders to manage risk and complexity with confidence

Certify, verify and test

against standards, specifications and regulatory requirements

Qualify and assure

new technologies, systems, data, platforms, supply- and value chains

Give expert advice

on safety, technology and commercial risk, and operational performance

Co-create and share

new rules, standards, software and recommended practices

Lets discuss:

- Shore Power, what we know
- Shore Power, electrification developments around the world
- Implications for Australia, time to get thinking

Lets discuss:

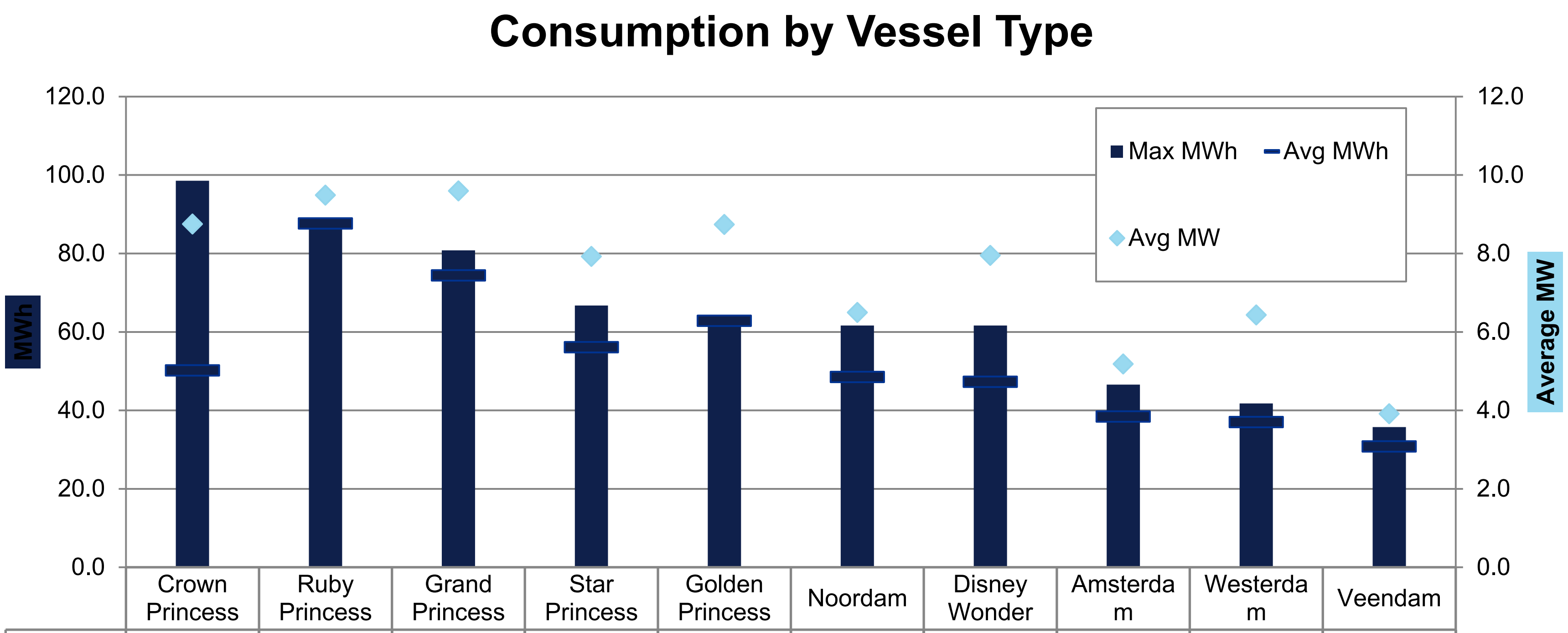
- Shore Power, what we know
- Shore Power, electrification developments around the world
- Implications for Australia, time to collaborate

Shore power, what we know

Case Study

- One cruise ship in port creates as much diesel exhaust as 34,400 prime movers
- Power from the grid reduces CO2 emissions by 36%, NOx emissions by 30%, and Diesel Particulate Matter (DPM) by 65% (USA example)
- Shore power technology is now mature, used in roughly half the major ports in the USA
- 36 – 100 MWh per call consumed by a ship using shore power
- Studies have found that shore power is cost-effective investment when the benefits of avoided respiratory illness is accounted for in ports that are near urban areas.

Examples of consumption in port for cruise vessels



	Crown Princess	Ruby Princess	Grand Princess	Star Princess	Golden Princess	Noordam	Disney Wonder	Amsterdam	Westerdam	Veendam
Max MWh	98.5	89.1	80.8	66.7	62.8	61.6	61.6	46.6	41.8	35.7
Avg MWh	50.2	87.6	74.4	56.1	62.8	48.5	47.2	38.4	37.0	30.8
Avg MW	8.8	9.5	9.6	7.9	8.7	6.5	8.0	5.2	6.4	3.9

Lets discuss:

- Shore Power, what we know
- Shore Power, electrification developments around the world
- Implications for Australia, time to collaborate

DNV

Shore power developments

- Electrification is increasingly understood as an effective means to reduce fuel usage and emissions
- Examples of battery electric commercial watercraft we are starting to see:
  - Ferries
  - Pilot vessels
  - Lines boats
  - Tugs and port equipment
- Improvements in energy storage technology will enable some degree of hybridisation for most ships and enable use of renewable power such as wind and sun
- Significant reductions of CO_2, NO_X and SO_X, depending on how electricity is generated
- The advent of battery electric ships.

Shore power is about more than just ships

- Norway electric car ferries. Major ports that have a large ferry capacity will need shore power capability

Electric vessels of all descriptions are gaining traction

- Ireland - Artemis foiling workboat "Pioneer of Belfast" 60' range at 25kts
- Pilot launch and 100 person ferry application being developed

Tugs and container handling equipment

‘Sparky’ New Zealand

London Gateway: 8 fully electric straddle cars

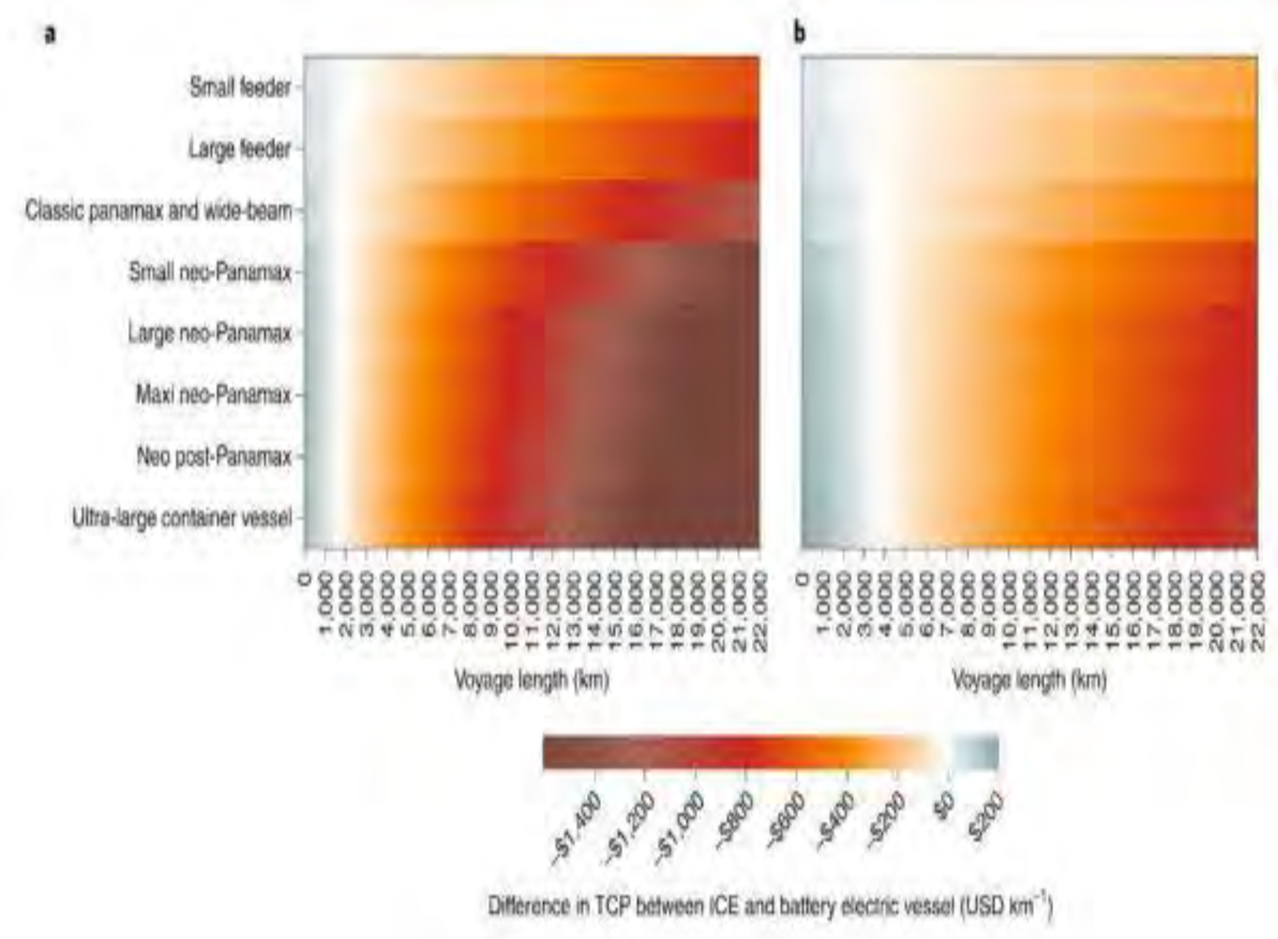
Electric ships are on the horizon

- Norway - Yarra Birkland. Electrification and autonomy/remoteness go hand in hand

Battery Electric Ships, what are the current restrictions?

- University of California, Berkeley, and Lawrence Berkeley National Laboratory

- Using technology available today, nearly all ships with routes shorter than 3,000 kms are economically viable



Lets discuss:

- Shore Power, what we know
- Shore Power, electrification developments around the world
- Implications for Australia, time to collaborate

Implications for Australia, time to collaborate

- Multiple applications requiring shore power in and around our major ports are maturing as we speak
- Ports, local and state govts, utilities, communities and stakeholders will need to collaborate to deliver appropriate shore power
- DNV has significant experience in the areas required to deliver great shore power outcomes for ports and the communities they reside in

Finally, my personal experience with “shore power”

BEN WATERS

Ben Waters is a thought leader in sustainability and cleantech; an engineer who can link practical hands-on technical expertise with commercial opportunity via a deep understanding of innovation and commercialisation. From his work in the RAAF to leadership of GE's Ecomagination initiative, Ben has the experience and relationships to ensure broad and deep analysis of likely future scenarios.

Ben is a recognised industry leader on procuring grid renewable electricity. Ben chaired WWF's Renewable Energy Buyers' Forum from 2015 until the advent of the Business Renewables Centre Australia, is a foundation member of the BRC's Advisory Panel and co-author of BRC Australia's Retail Renewable Energy PPA Guide. Ben leads Presync’s work with its Ports Customers and has facilitated renewable PPAs for Port of Newcastle, NSW Ports, and Port Authority of NSW. Presync’s Energy Strategy for Port Authority of NSW includes a detailed analysis of the impact of shore power on electricity consumption.

RENEWABLE ELECTRICITY FOR SHORE POWER

Provision of shore power by ports will improve local air quality as well as reduce carbon emissions by avoiding the combustion of liquid fuels by docked ships, but will dramatically increase the port's electricity consumption. Depending on the source of the electricity, emissions can be reduce to zero. The challenge for the port is to match the irregular demand with a mix of local and grid renewables. Realistically the heavy lifting is likely to come from grid renewable power. Ben will explain business-as-usual electricity procurement and compare it to long-term procurement of 100% renewable electricity via a retailer, which offers long-term cost stability as well as cost reductions.

Renewable Electricity for Ports and Shore Power

PIANC Shore Power Workshop

4 August 2023

Background

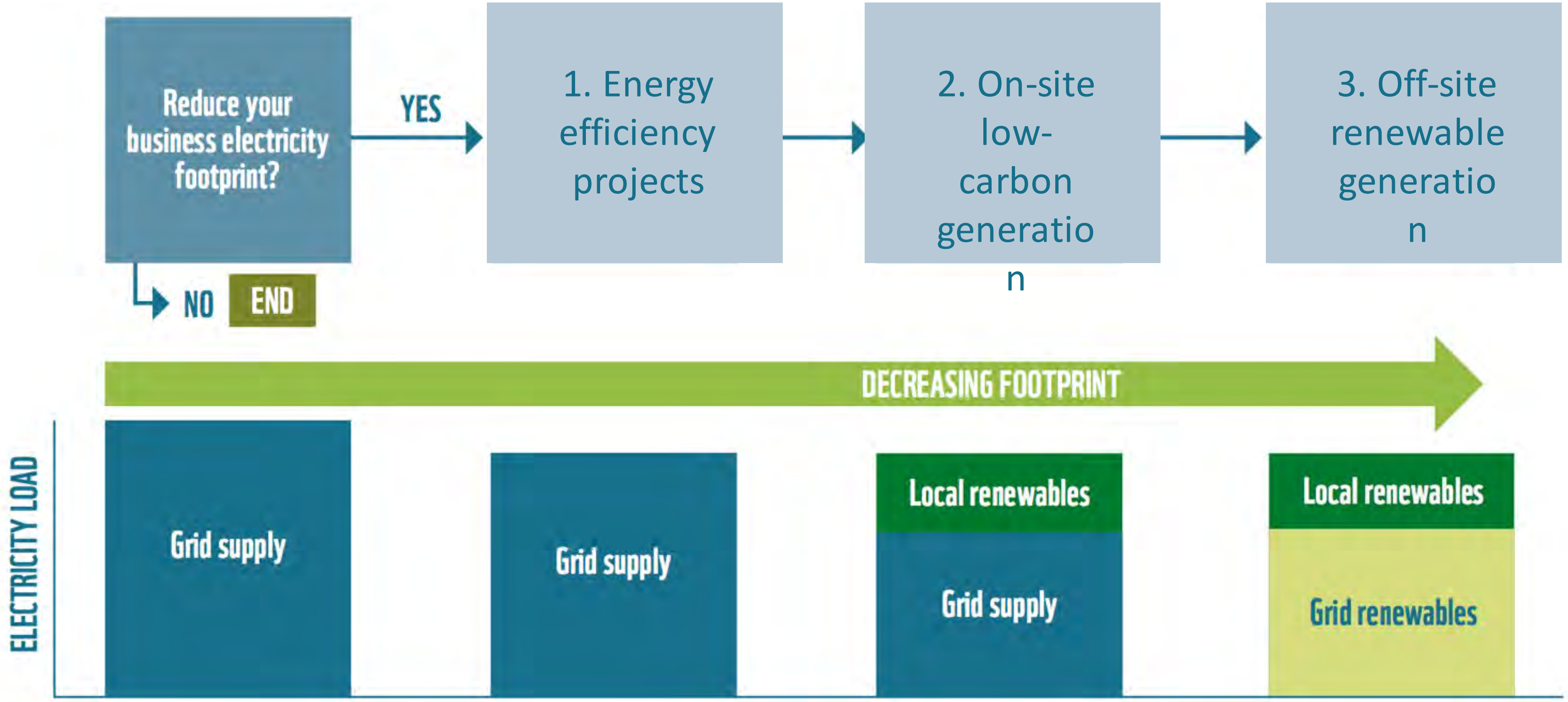
- Presync is a boutique sustainability consultancy active since 2014
- We do strategy work and facilitate (efficiency, on-site solar, battery, electrification etc) projects, as well as facilitating retail grid renewable supply agreements
- We have worked with ports, councils and other businesses on energy strategy, renewable project implementation, and grid renewable supply
- 40+ grid retail renewable PPAs facilitated to date
  - Including 3 for ports

*We act as a consultant to you and **not a broker**…*

Presync never accepts any form of commission or other payment from electricity retailers or equipment suppliers, to remain independent and able to act in your best interests.

Presync

Our approach to reducing energy cost and emissions



Reduce demand…

Displace demand with local renewables…

Replace remaining demand with off-site renewables

While increasingly electrifying other loads…

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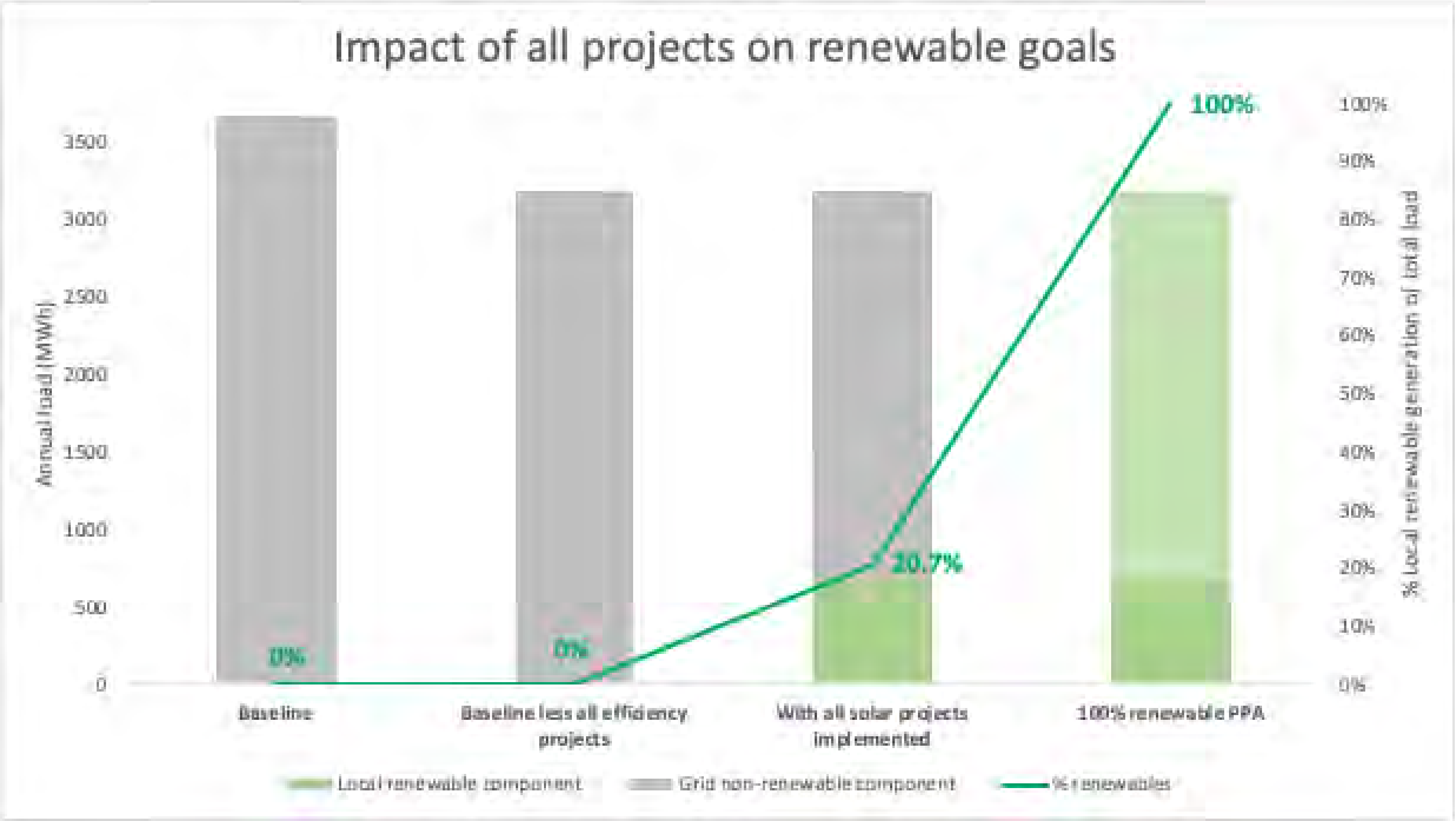
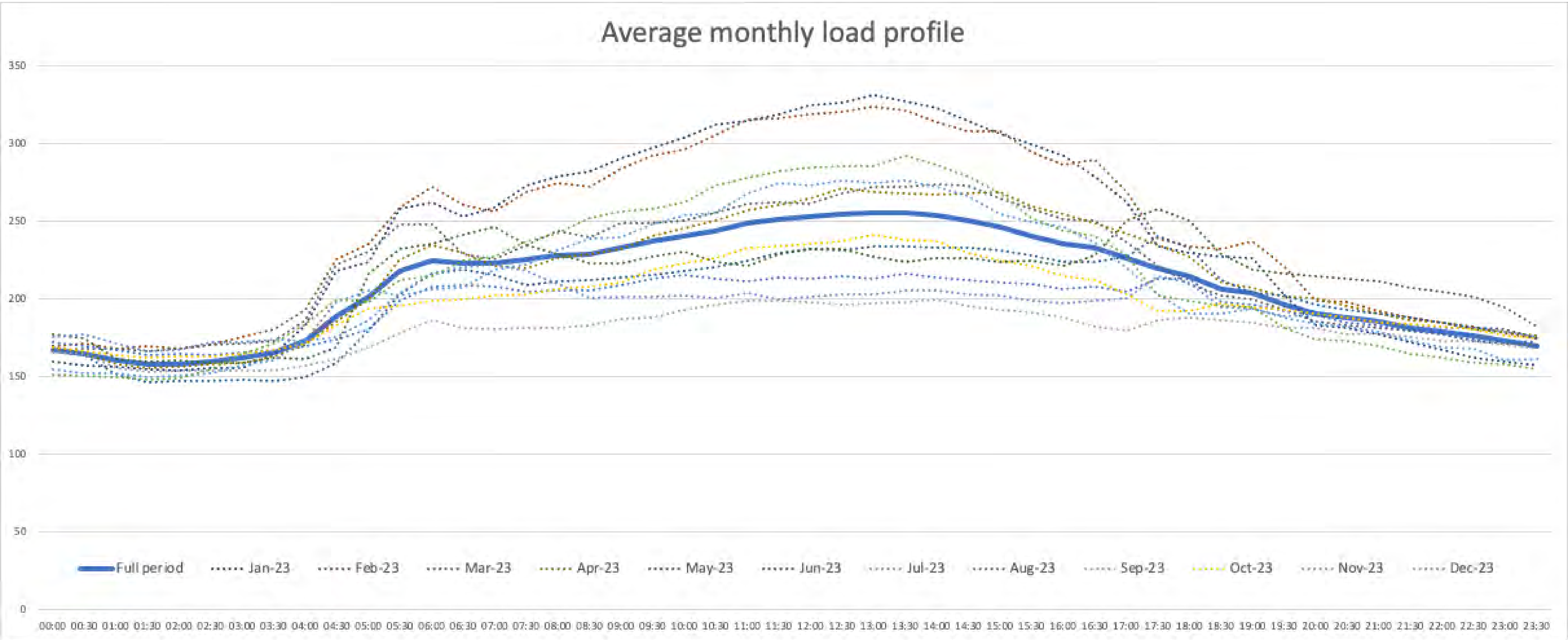
The journey to 100% renewable - example



Presync

Understanding electricity consumption - example



Before shore power: 3,675MWh

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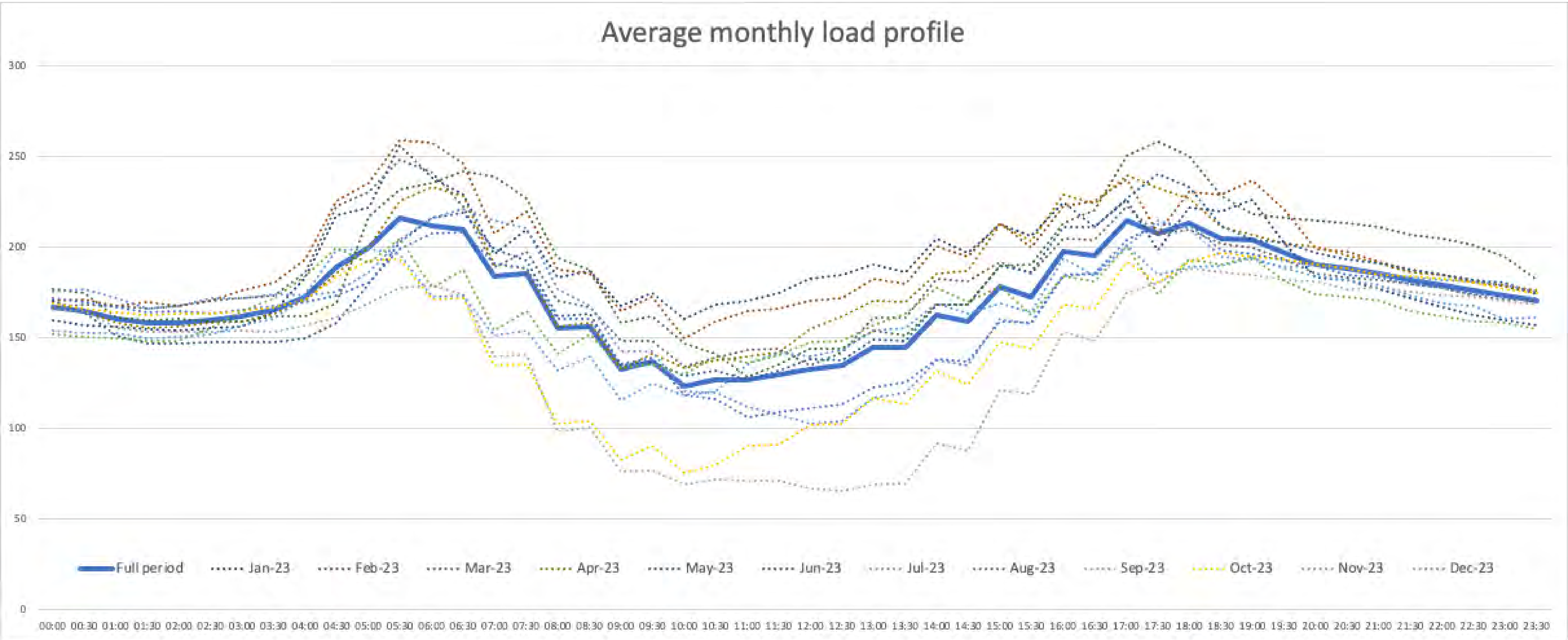
Understanding electricity consumption - example

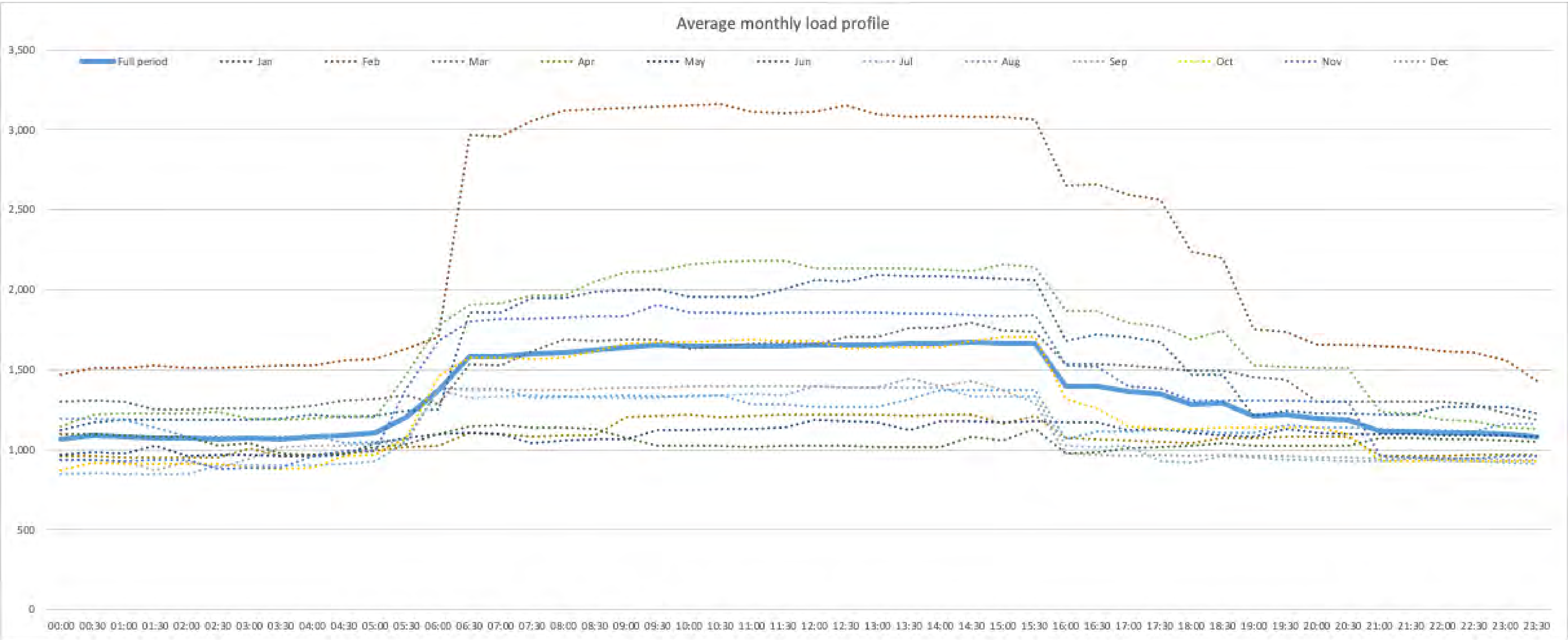


Forecast after all solar and efficiency projects: 3,014 MWh

21% reduction

Presync

Understanding electricity consumption - example



Forecast after shore power: 23,675MWh

Shore power dominates electricity use for this customer – 6.5x increase in consumption

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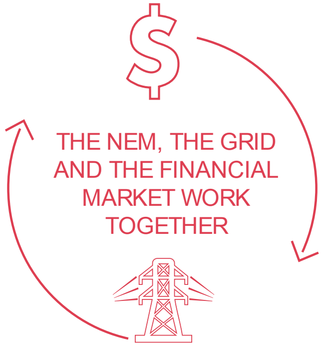
Understanding the electricity market

How the NEM works

The NEM is a wholesale electricity market in which generators sell electricity and retailers buy it to on-sell to consumers. There are over 100 generators and retailers participating in the market, so it's highly competitive and therefore an efficient way of maintaining relatively competitive electricity prices in the wholesale market.



Fluctuating prices

All electricity sales are traded through the NEM. It is a wholesale market and prices fluctuate in response to supply and demand at any point in time.

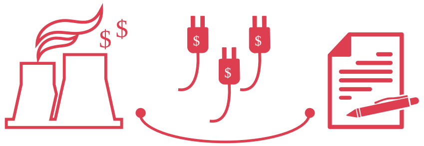
NEM market price

The price of electricity in the NEM is based on:

1. Offers by generators to supply electricity to the market at particular volumes and prices at set times.
2. Demand at any given time.

Financial market price

To manage price volatility, retailers and generators often enter into hedging contracts to fix the price for future electricity sales.



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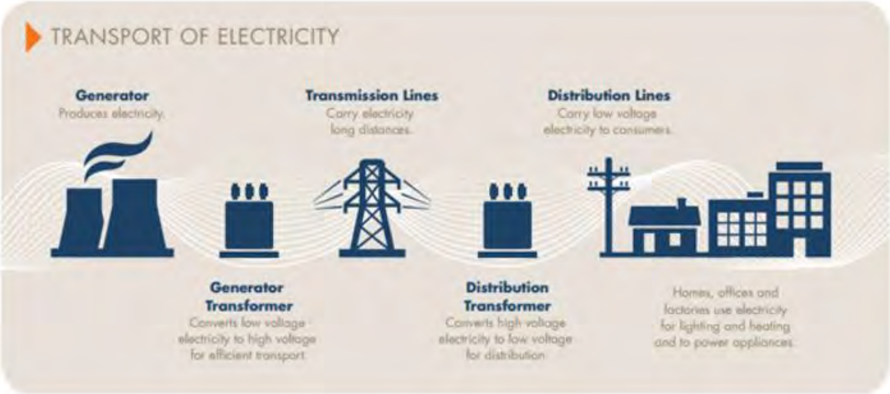

NATIONAL ELECTRICITY MARKET

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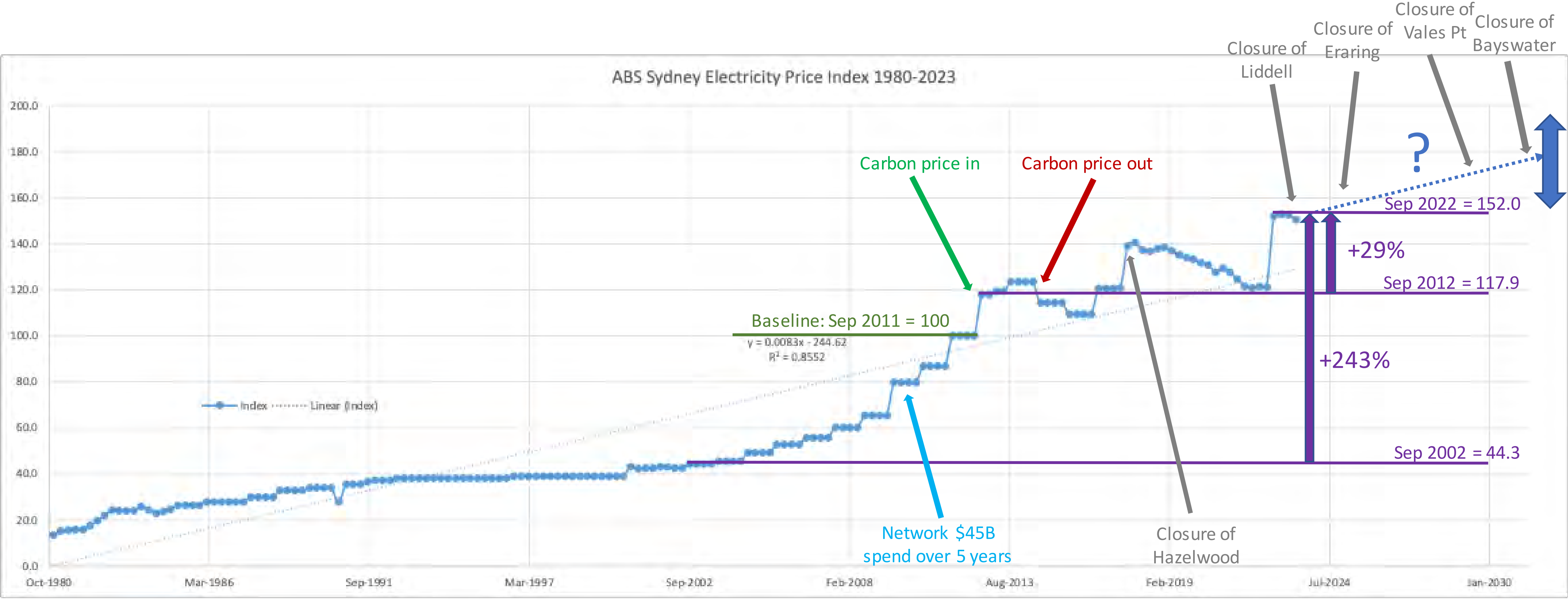
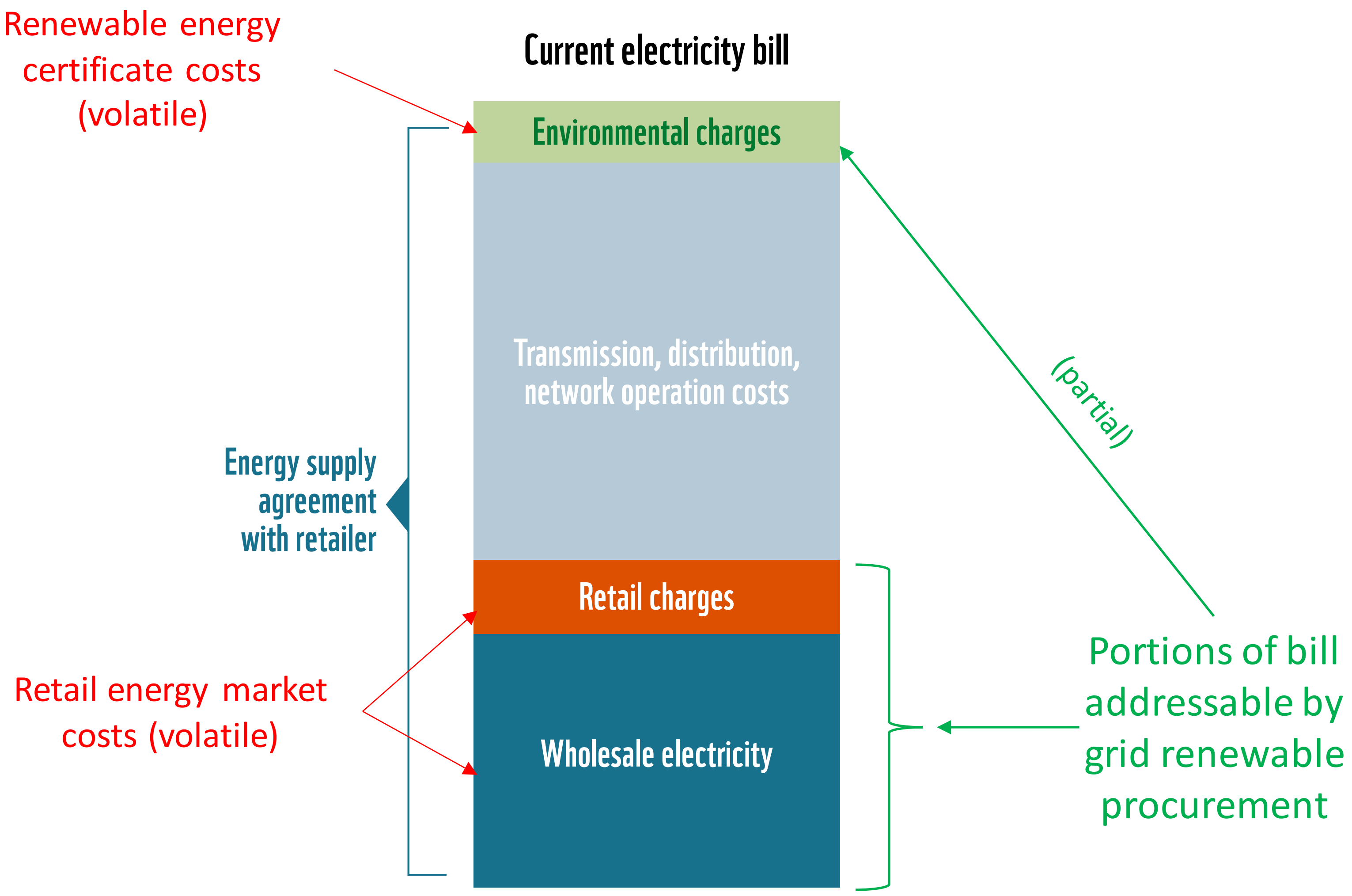
NSW electricity price history



Electricity prices have tripled in the past two decades…
the changes in the coming decade are far greater than in the past two…
Normal electricity procurement has not been low risk, and is unlikely to be low risk

Presync

Elements of electricity pricing



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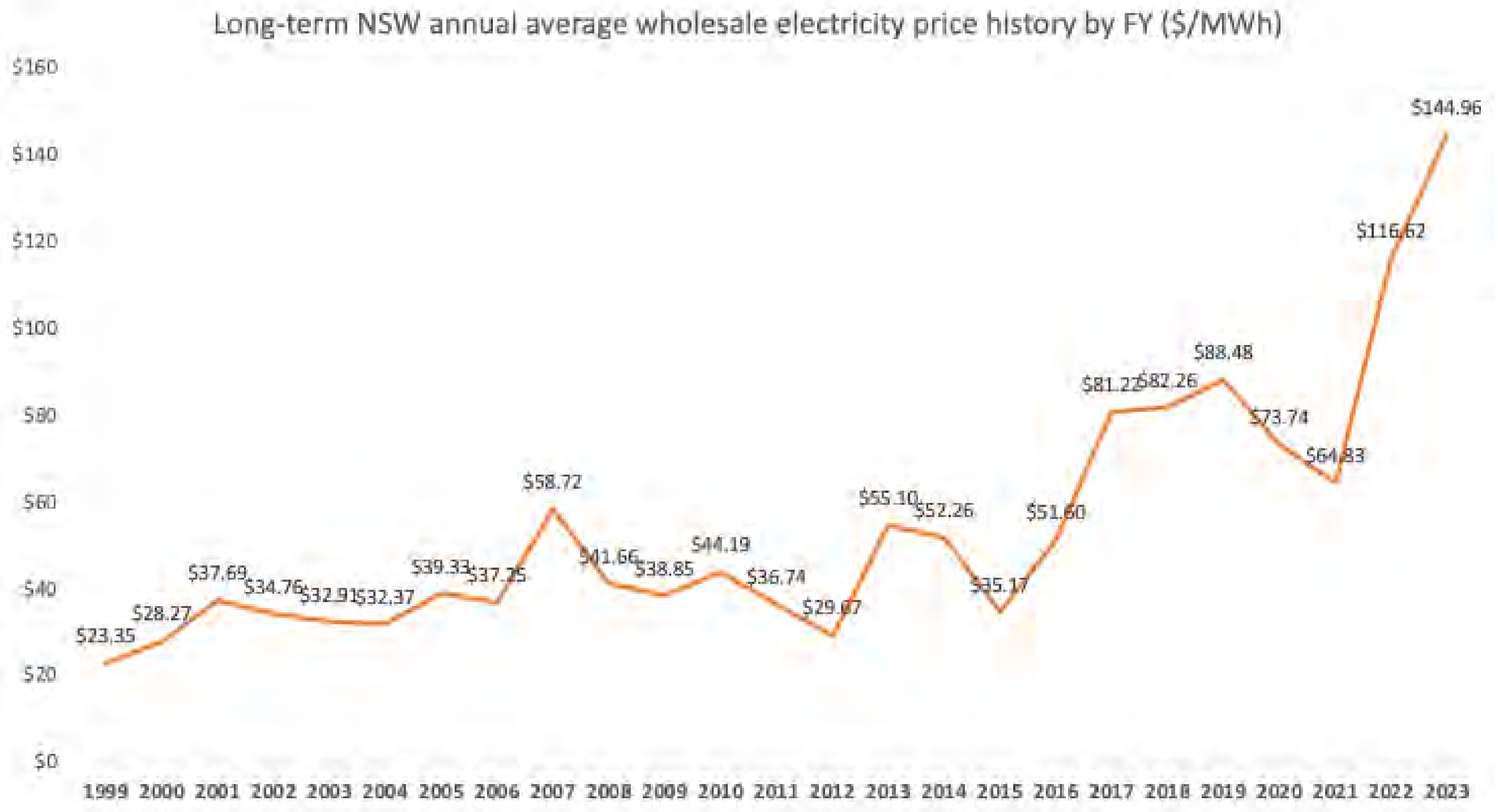
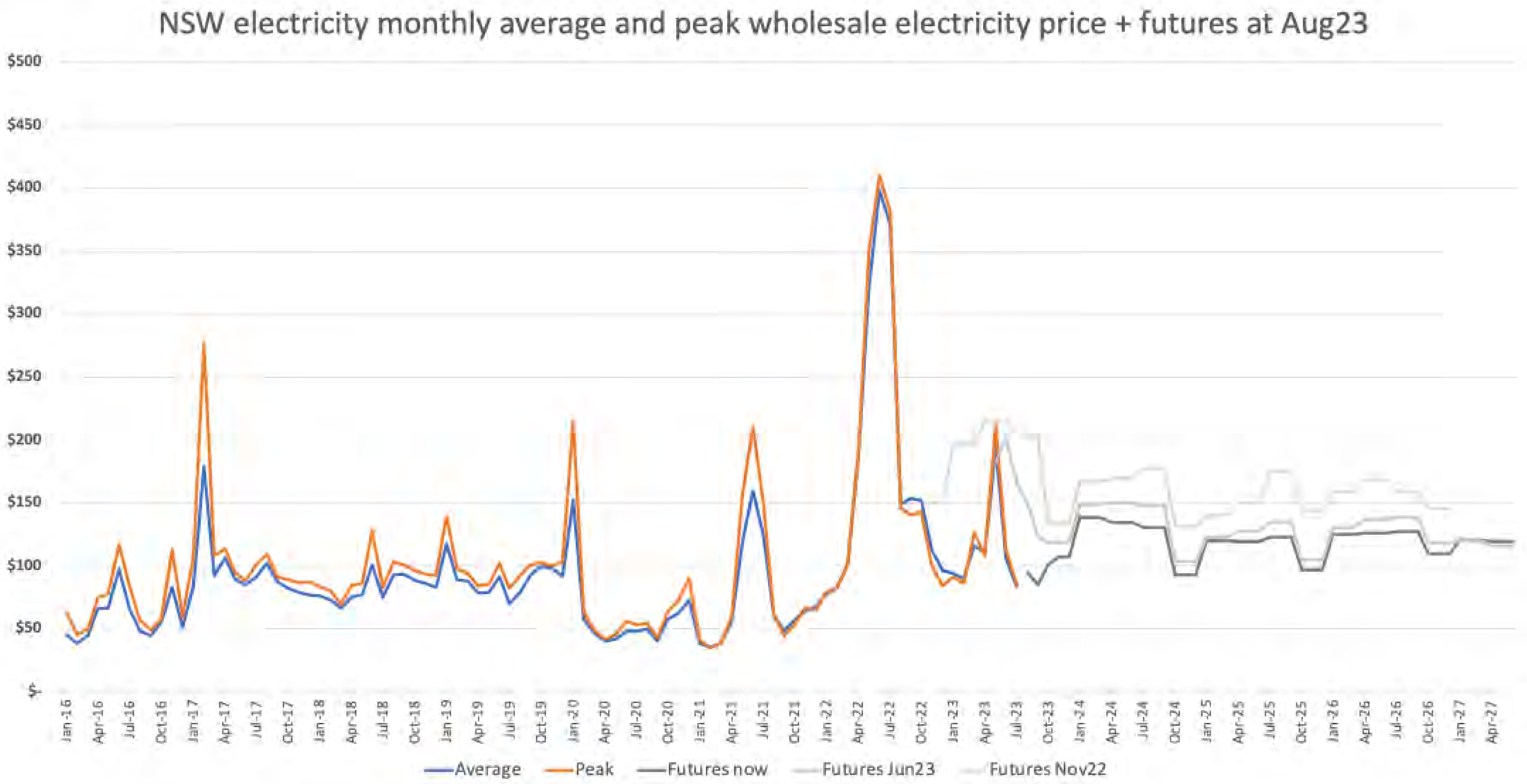
NSW electricity wholesale market history



NSW electricity wholesale market history



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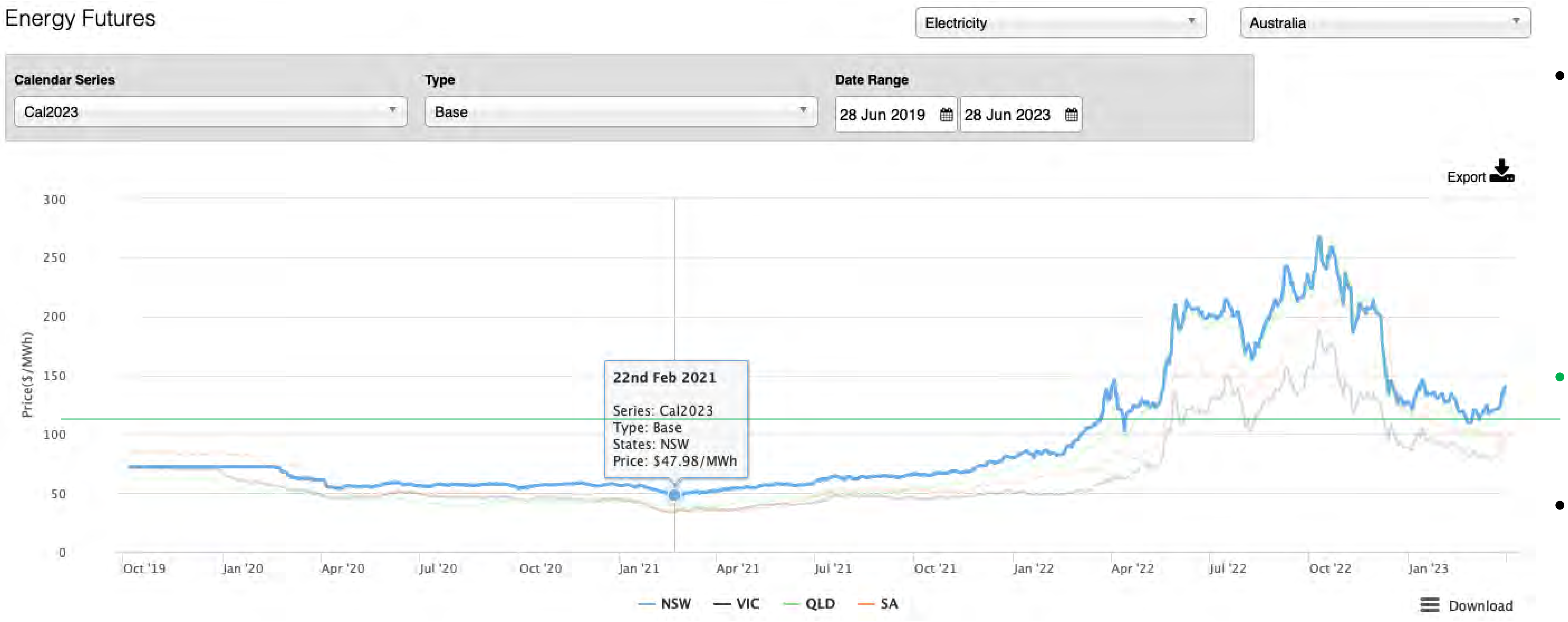
“Normal” electricity purchasing: a roller-coaster



- This year’s electricity, which traded as low as $48 in Feb 2021, was $267 on 10Oct22, and back to $140 in Mar23
- Actual price YTD: **$114**
- 2024-2026 prices around $115 to $125 presently *(but volatile…)*

Drivers of recent volatility:

- Underlying high international gas/oil and coal prices driving up costs for gas and coal power stations
- A war in Ukraine greatly exacerbating these prices and driving market fears of prolonged future instability
- Recent market announcements of early shutdowns of old coal power stations (largely driven by their inability to compete with cheap renewables), particularly Origin’s Eraring plant - the largest in NSW
- Unreliability of old coal power stations

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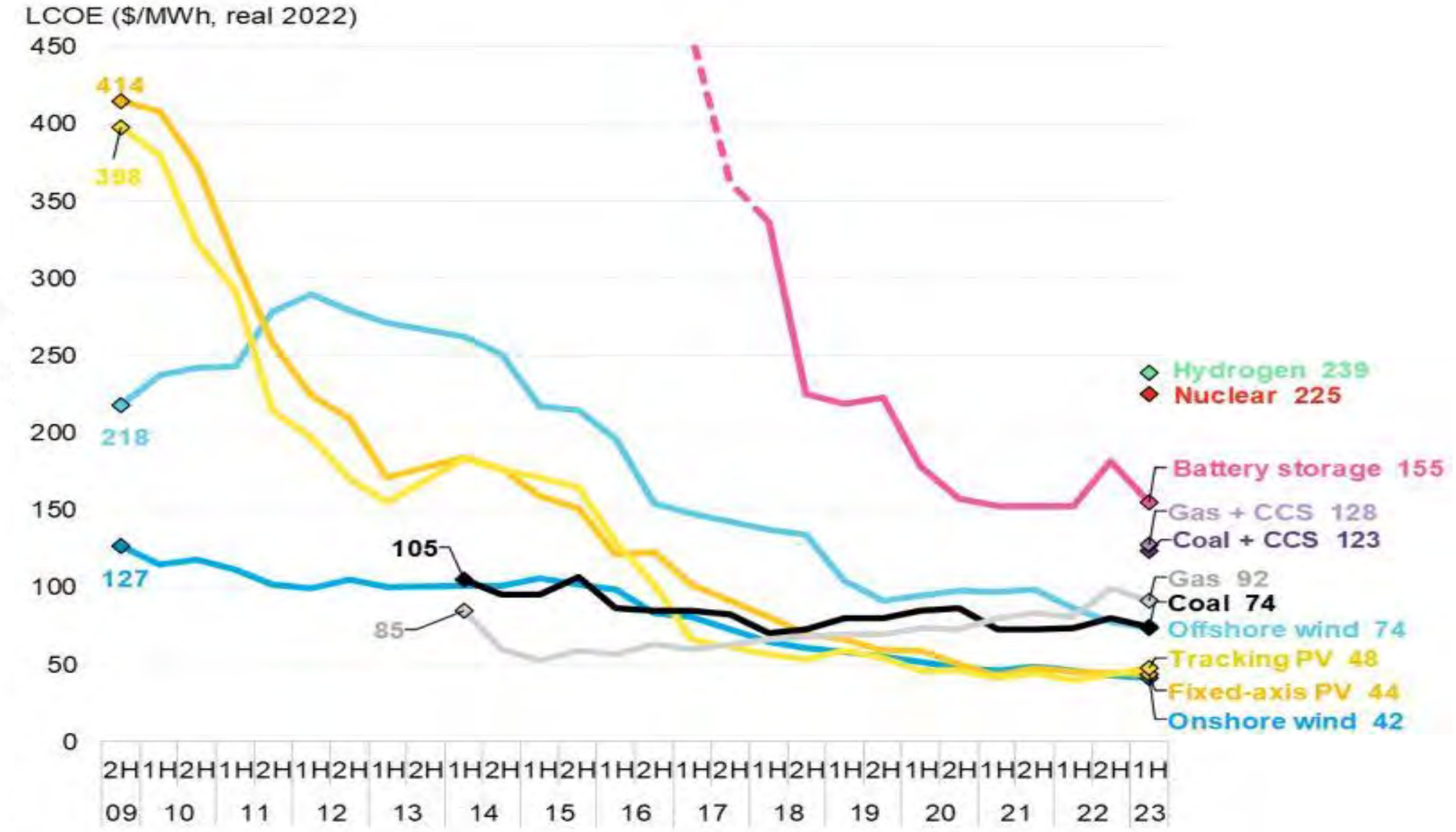
Renewables are the cheapest new generation source



Source: BloombergNEF 1H 2023 LCOE Update of 08Jun23

Electricity Supply Contract types

	Standard retail deal	Progressive purchasing	Greenpower or separate LGC purchase	Renewables-linked retail deal
Term	1-3 years	2-3 years, rolling extensions	Ad hoc	7-10 years
Renewable project link	No	No	No	Yes
Price	Fixed	Progressively firmed by buyer by quarter	Varies with LGC market, has been very high	Fixed for matched energy, firming can be fixed, progressively firmed or linked to spot price
Flexibility to vary load	No	No	No	Yes
Budget Risks	Electricity price re-contracting risk every 2-3 years	Exposed to wholesale market fluctuations	Electricity price re-contracting risk every 2-3 years	May include spot price exposure on 10-20% unmatched load

Retail renewables-linked covers a broad spectrum from fully-fixed to spot-exposed with ceiling protection. Important to choose a structure that suits your risk appetite.

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Spectrum of commercial models for renewable PPA

Wholesale

Purchase of LGCs from, and firming electricity price paid to, a project

- **Counterparty:** Renewable project
- **Load size needed:** >~50GWh
- **Purchase electricity?** No
- **Accounting treatment:** derivative accounting usually required

Examples:
- CBA
- BlueScope
- Sydney Metro
- Sydney Desal Plant

Retail

Purchase of electricity and often LGCs from renewables via a retailer

- **Counterparty:** Electricity retailer
- **Load size needed:** >0.5GWh
- **Purchase electricity?** Yes
- **Accounting treatment:** Usually none, electricity purchase as usual. LGC purchase/resale may be considered a derivative.

Examples:
- Sydney Opera House
- City of Sydney
- City of Newcastle
- SCEGGS Darlinghurst
- SSROC1

LGC only

Purchase of LGCs from a project

- **Counterparty:** Renewable project
- **Load size needed:** usually large
- **Purchase electricity?** No
- **Accounting treatment:** May require intangible asset accounting.

Examples:
- NSW Government/Neoen
- Vic Government/numerous
- Yarra Trams

Self-owned

Direct investment in a renewable project, often in local area

- **Counterparty**: EPC contractor, consultants, electricity retailer to purchase output and manage
- **Accounting treatment:** Asset on balance sheet.

Examples:
- City of Newcastle
- Sunshine Coast Council
- University of Queensland

Retail PPAs usually preferred by councils and small-medium buyers:
- Applicable to load size
- Avoid financial derivative accounting
- Quicker, cheaper transaction

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Presync retail renewable PPA experience

Group Buys

Operational or executed

2018
- Ascham School

2019
- CITY OF SYDNEY
- City of Newcastle
- SCEGGS DARLINGHURST

2020
- TWEED SHIRE COUNCIL
- northern beaches council
- PORT of NEWCASTLE
- Canva

2021
- LAKE MACQUARIE CITY
- Central Coast Council
- maitland city council
- CESSNOCK CITY COUNCIL
- UPPER HUNTER SHIRE COUNCIL
- muswellbrook shire council

2022
- Cairns REGIONAL COUNCIL
- CENTRAL NSW JOINT ORGANISATION (Group of 11 councils)
- REROC RIVERINA EASTERN REGIONAL ORGANISATION OF COUNCILS (Group of 5 councils)
- KIAMA MUNICIPAL COUNCIL
- Shellharbour CITY COUNCIL
- Shoalhaven City Council
- HERBERT SMITH FREEHILLS
- PORT AUTHORITY OF NEW SOUTH WALES
- NSW Ports
- INTERNATIONAL GRAMMAR SCHOOL
- SHORE
- Newcastle Airport

2023
- DUBBO REGIONAL COUNCIL
- COUNSEL'S CHAMBERS LIMITED

Procurement/ Early Stages
- BYRON SHIRE COUNCIL
- UTS
- HUNTER WATER
- NSW GOVERNMENT, Coates, Fulton Hogan, WesTrac CAT, AMPCONTROL (Hunter Region Business Group)
- BaptistCare

Presync

Includes customer confidential information – not to be forwarded

Possible structures for retail grid renewable purchase

Key considerations:

- Term >=5 years usually, price better at 10 years
- Offtake price will be known for full term
- But unmatched energy adds risk for retailer
- Some spot market exposure can reduce price
- Can purchase Renewable Energy Certificates (LGCs) as well as power
- LGCs voluntarily surrendered for "renewable electricity"
- Projects can be filtered on location, environmental and social license factors to provide desired co-benefits

Presync

Why a PPA?

	Normal electricity procurement	**Renewable PPA**
Goal 1: *Reduce and stabilise electricity cost*	A roller coaster • Volatile • Price fixed for up to 3 years only • Then anything can happen • No ability to plan costs long term	Long-term stability • Price demonstrably below BAU • Price fixed for 7-10 years • No fuel cost risk • Assists long-term financial planning
Goal 2: *Reduce emissions over time*	Add GreenPower (LGC certificates) • Price linked to spot market & volatile • From projects anywhere in Australia • Including old projects built last decade	Lock in long-term LGC supply • Price fixed for 7 years • From specific projects in NSW • New projects
Goal 3: *Assist a fair transition by creating new economic opportunities in the regions*	No value • Buy from centralised generation • Supports 1950s grid architecture	Support local jobs • Supports decentralisation of power • Directly support local projects • Local jobs & community support

Presync

Presync retail PPA experience

Group Buys

In operation or executed

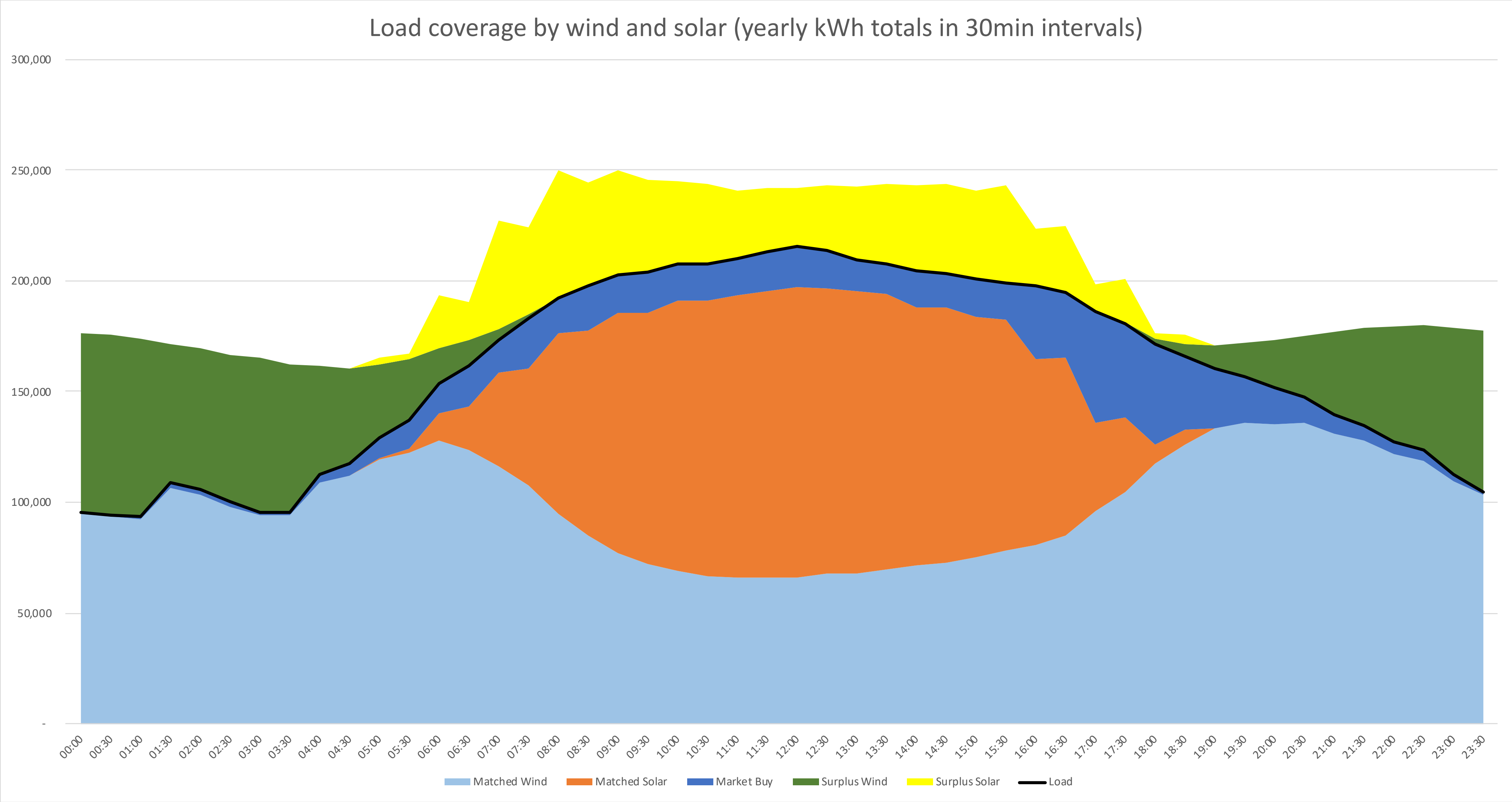
Presync Customer	Load Size (GWh)	PPA start date/term	Model	Renewables used
Sydney Opera House	16	Jan19 / 7(10) years	Spot price w ceiling	Wind and solar
Ascham School	1.4	Jan19 / 10 years	Spot price w ceiling	Wind and solar
SCEGGS Darlinghurst	0.8	Nov19 / 10 years	Initially firmed, spot price w ceiling	Wind and solar
City of Sydney	30	Jan20 / 10 years	Spot price w ceiling	Wind solar, community PV
City of Newcastle	12	Jan20 / 10 years	Spot price no ceiling	Wind + own solar farm
Tweed Shire Council	14	Oct20 / 10 years	Spot price w ceiling + demand management	Wind and solar
Port of Newcastle	6	Nov20 / 5 years	Fully firmed	Wind/portfolio
Northern Beaches Council	15	Jan21 / 7+3years	Fully firmed for 5yrs	Wind/portfolio
Canva	2.5	Mar21/10 years	Firm 3yrs, then firm/spot	Solar/future wind
Hunter Councils Group (x6)	100	Jan22/10 years	Fully firmed	Solar/wind portfolio (local)
Port Authority of NSW	3.7	Jul22/8.5 years	Spot price w ceiling	Wind and solar
NSW Ports	0.3	Jul22/8.5 years	Spot price w ceiling	Wind and solar
HSF	1.3	Jul22/8.5 years	Spot price w ceiling	Wind and solar
Central NSW Councils Group	39	Jan23/8 years	Fully firmed	Wind (local)/portfolio
Cairns Regional Council	25	Jul24/10 years	Fully firmed	Local wind
Illawarra Councils Group	36	Jan23/8 years	Spot price w ceiling	Wind/solar portfolio incl local
Dubbo Regional Council	13.5	Jul23/7.5 years	Fully firmed	Wind (local)/portfolio

Total executed: **~300GWh**

Includes customer confidential information – not to be forwarded

Presync

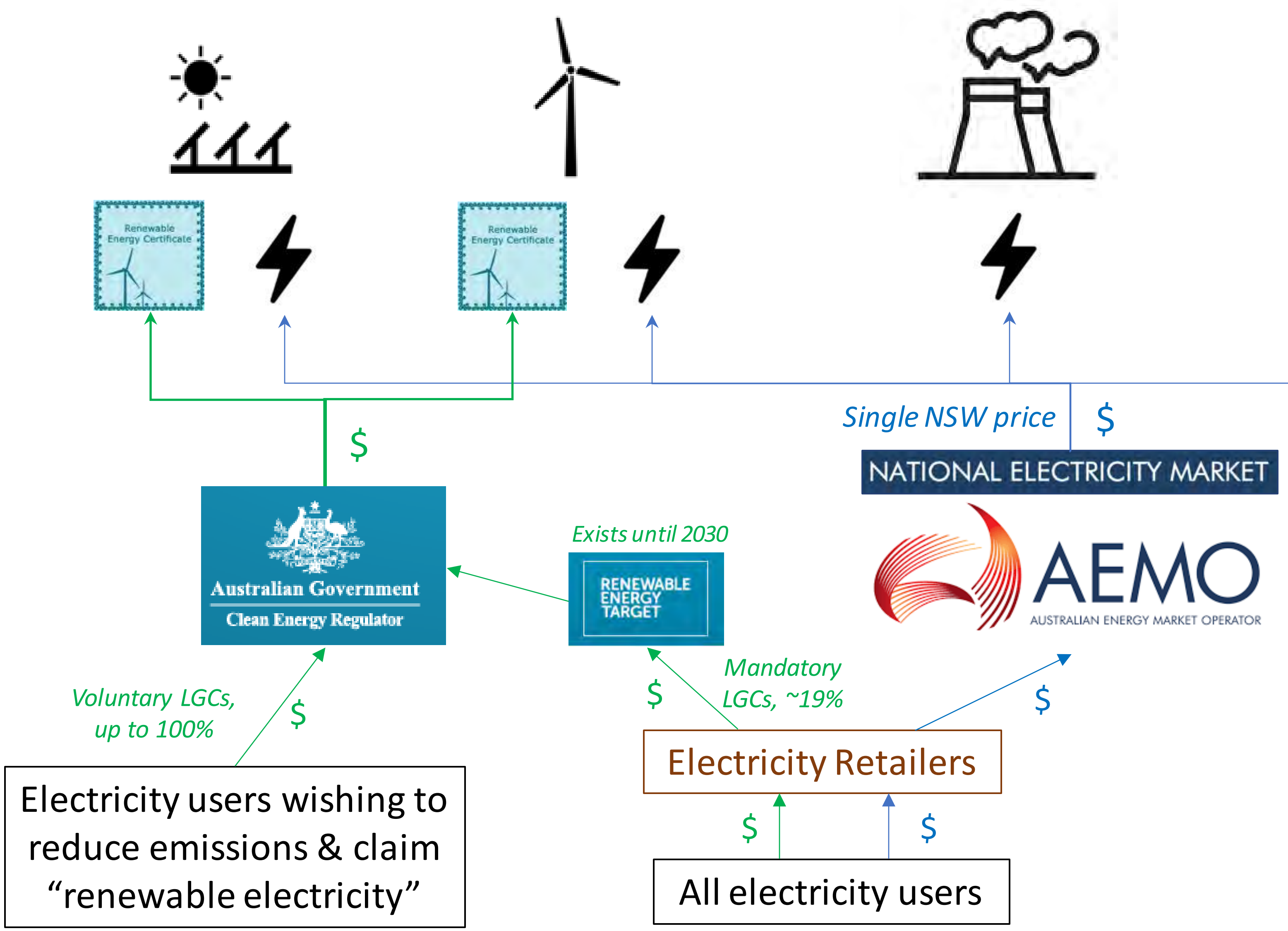
Example: 85% load matching with 65% wind, 35% solar



With renewable purchase slightly above load.
If more on-site solar installed you need less grid solar; but you will always need the wind.

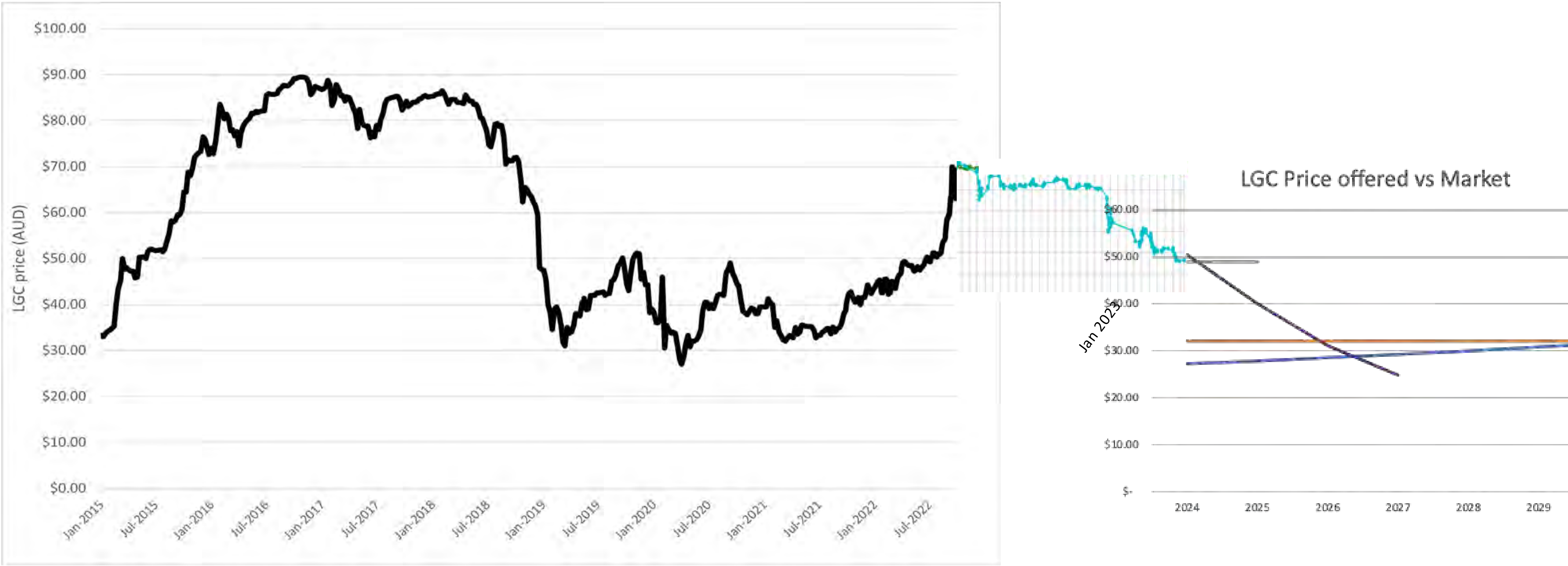
Presync

Electricity vs "Renewable" Electricity



Presync

LGC price history



The market continually expects future LGC prices to reduce;
they have been doing the opposite, buoyed by voluntary demand.
There can be significant savings in locking in long-term LGC supply.

Presync

Summary: renewable PPAs for ports/shore power

- Ports electricity costs are already, or will soon be, substantially higher than previously
  - And BAU energy market will continue to be volatile for the next ~decade
- A retail renewable PPA offers lower prices and more price stability than “normal” electricity procurement
  - Requires longer-term contracting
- A PPA also makes it easier/cheaper to achieve 100% renewable electricity
  - At an extra cost for renewable electricity certificates
- Long-term procurement minimises both electricity and certificate prices
- Shore power replaces ship fuel combustion and can reduce both local and greenhouse gas emissions
  - However the power required may swamp existing port consumption
- More local solar and batteries can help level out the load and avoid high prices
- Possible to incorporate shore power into your retail renewable PPA
  - But understand the impact on your consumption before starting procurement process

Thank you

Presync

HALANI LLOYD

Halani Lloyd is an English and Australian qualified lawyer. She worked in maritime law firms for 15 years in Sydney, London and Hong Kong before joining the TT Club in Sydney in 2020 as a Senior Claims Executive.

SHORE POWER – A LIABILITY INSURER'S PERSPECTIVE.

The presentation will explain liability insurance as against other insurances available to ports and ships, and TT Club's background, before looking at claims examples that the Club has seen to date, arising from the provision of shore power overseas. I will then consider, more broadly, what risks (from a liability perspective) might arise for ports from the provision of shore power, and which will need to be considered in contractual documentation between ports and their customers.

Shore Power – A Liability Insurer's Perspective

14 August 2023 | Halani Lloyd

TT CLUB
IS MANAGED
BY **THOMAS**
MILLER

TT

Our Background

Governed by the industry for the industry

TT Club and its network offices

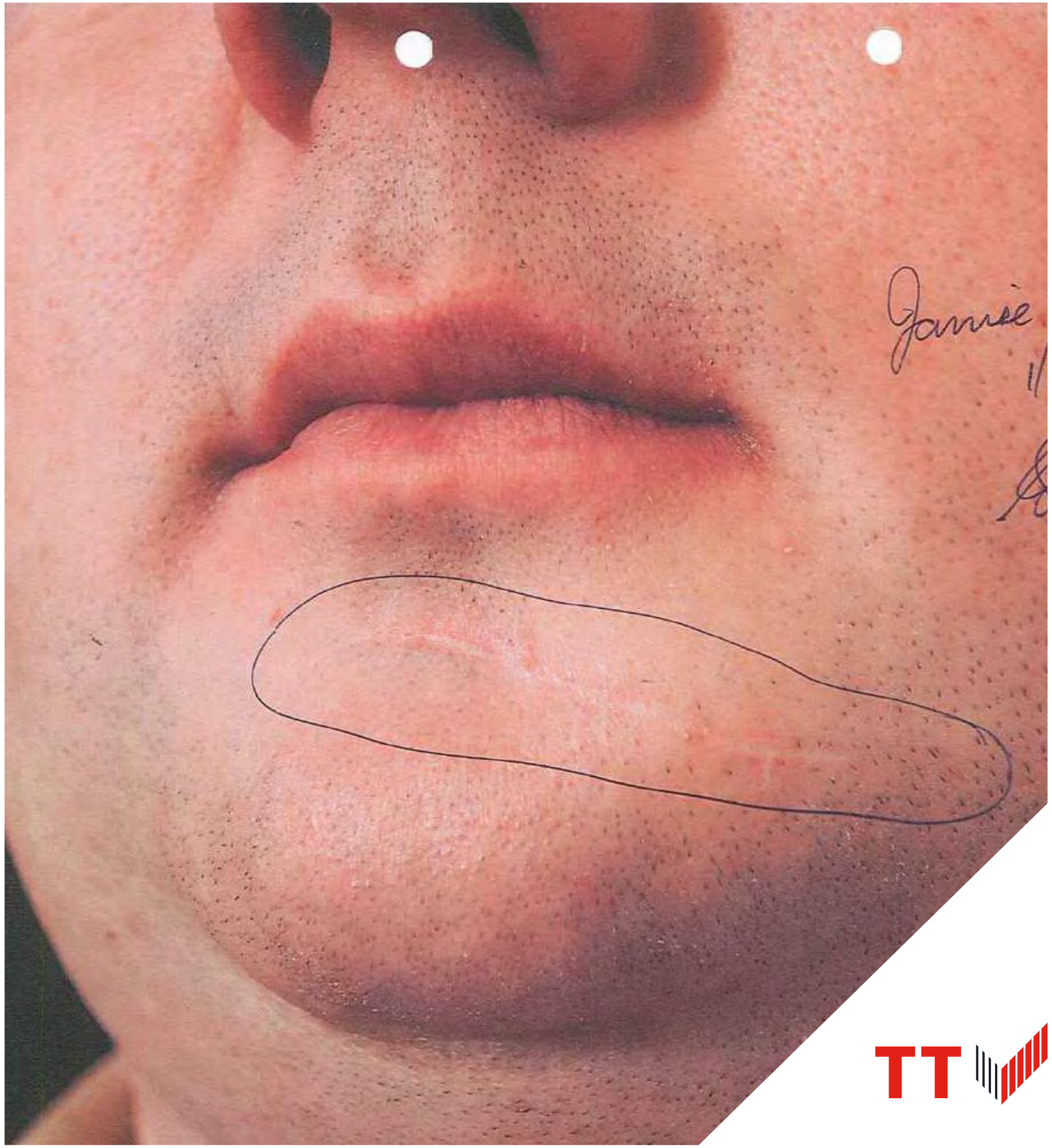
Key

- Regional Headquarters
  - Hong Kong
  - London
  - New Jersey
- Regional Offices
  - San Fransciso
  - Shanghai
  - Sydney
- Network Partners
  - Antwerp
  - Auckland
  - Barcelona
  - Buenos Aires
  - Dubai
  - Durban
  - Genoa
  - Hamburg
  - Moscow
  - Mumbai
  - Newcastle
  - Qingdao
  - Seoul
  - Tokyo

Liability Insurance for Port Authorities

Covering a port's liabilities for:

- Loss/damage to cargo and a customer's ships
- Errors and omissions causing financial loss to your customer under contract
- Pollution
- Injuries to and death of third parties
- Loss/damage to third party property



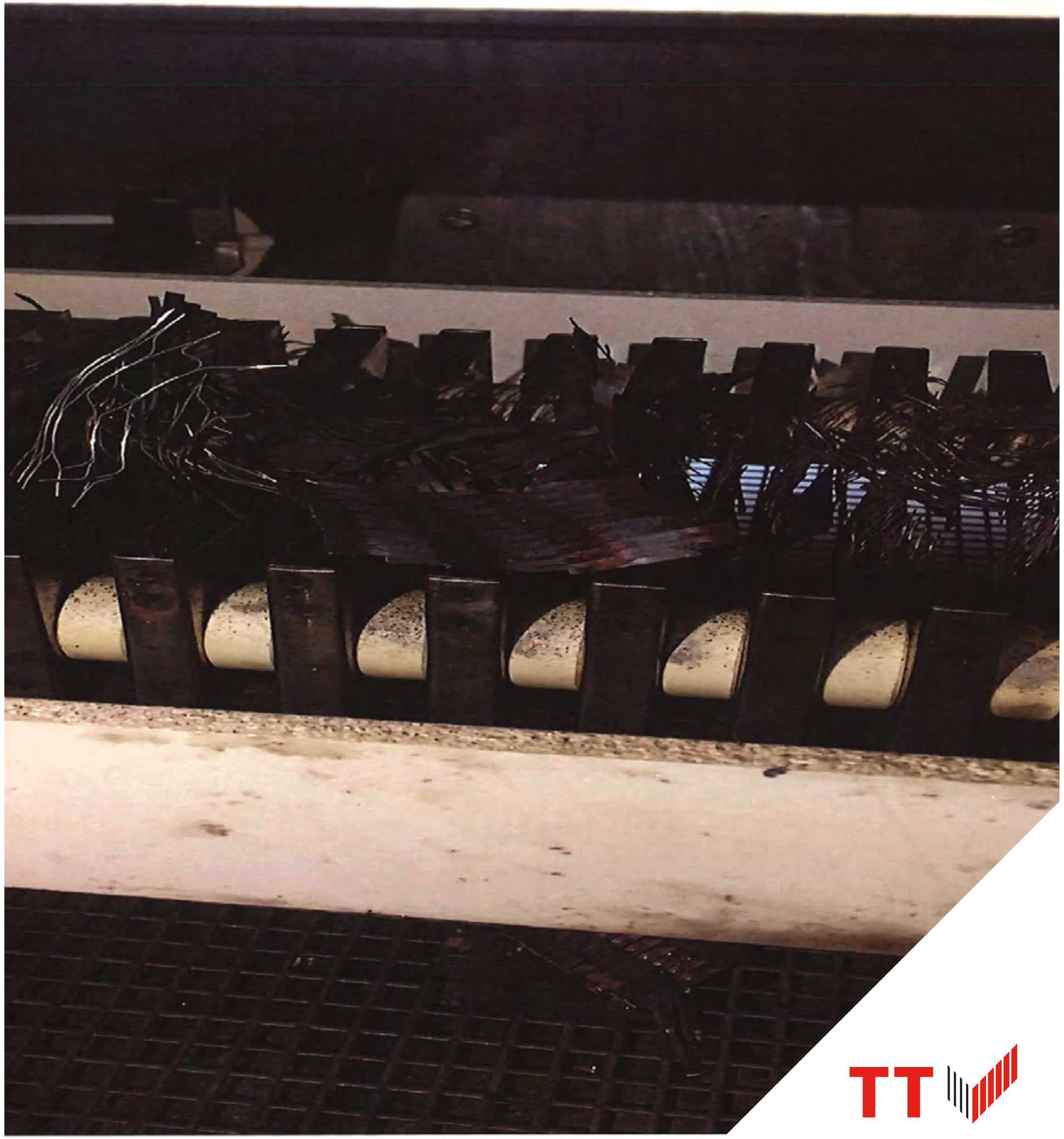
Claims Examples

Example 1 – European Port (2018)

- Medium port, significant ro-pax traffic
- Transformer failure – OPS out of order for 3 months. Temporary repairs succeeded after two failed attempts (connected to grid). OPS fully operational only 3 months later.

Example 1 – European Port (2018)

- Cost to Member:
  - Repairs
  - Increased cost of working
  - Loss of income



Example 2 – US Port, 2016

- Containership connected to OPS
- Explosion at shore side connection terminal box unit
- Repair costs (property cover)

Liability Risks

Examples of Potential Claims

Claims by Customers:

- Damage to cargo
- Delay and demurrage

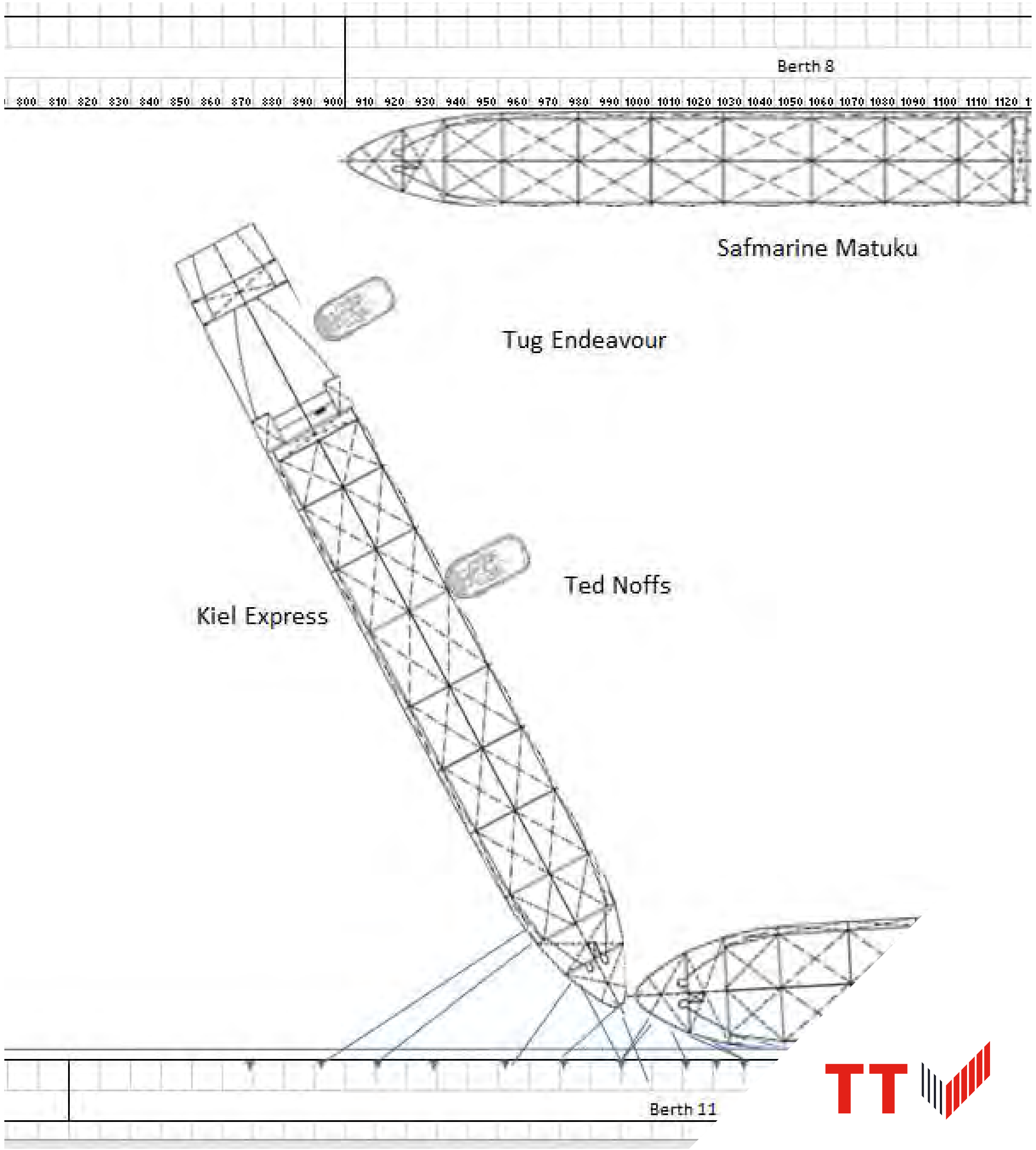
Claims by Third Parties:

- Neighbours – pollution? Injury?
- Climate change related litigation
- Safety risks – employees, public liability

Fines

Examples of Potential Claims

Damage done by ships



Thank you

ttclub.com

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BY **THOMAS**
MILLER

SHIPPING LINES: CONTAINERS

- *Yashika Yadav, Ocean Procurement*
- *Riikka Elina Mikkola, A.P. Moller Maersk (Denmark)*

RIKKA ELINA

After working over ten years with the UN in Africa, Middle East and Asia, and serving as an advisor to the Ministry of Foreign Affairs for Finland, Riikka joined A.P. Moller - Maersk as a Senior ESG Enablement Manager with focus on the social and governance agenda. Working with human rights and social impact at the world's leading integrated transport and logistics company, allows her combine her background and experience in working on inclusion, human rights and SDGs with her passion for sustainability to enable the business and promote sustainability throughout Maersk's global supply chain. Riikka has a Masters on International Development Economics from Sciences-Po Paris and on Business Administration with focus on international strategy and sustainability from Hanken School of Economics.

YASHIKA YADAV

Just over nine years of experience spread across Analytics, Supply chain management, and Procurement with Accenture and Maersk. Joined Maersk in 2016, since then has worked in several roles across business in different geographies (India, UAE, and now CPH) her most recent one being ESG Manager for Ocean Procurement. In her current assignment, the focus is on strategically integrating the sustainability agenda within Procurement strategy and ways of working and driving sustainability outcomes together with our value chain partners.

THE PERSPECTIVE OF SHIPPING LINES – CONTAINERS

We believe in an integrated world. One planet. Connected all the way. A world where an exchange of goods can create an exchange of culture, innovation, and trust. At Maersk, we do more than move the food, clothes, medicines, and goods we all rely on. We integrate the world. Not just to improve quality of life and raise global prosperity. But also, to make it sustainable for future generations.

Our ESG strategy is centered around three core commitments. These encompass areas our Executive Leadership Team has determined as strategic priorities within the environment, social and governance dimensions. Supporting KPIs and targets represent issues where Maersk can create the most significant impact due to our position, size and reach. This also makes them critical to the success of our business strategy.

Sustainability at A.P. Moller-Maersk

Our ESG strategy and commitments

14th Aug 2023

MAERSK

Integrating the world

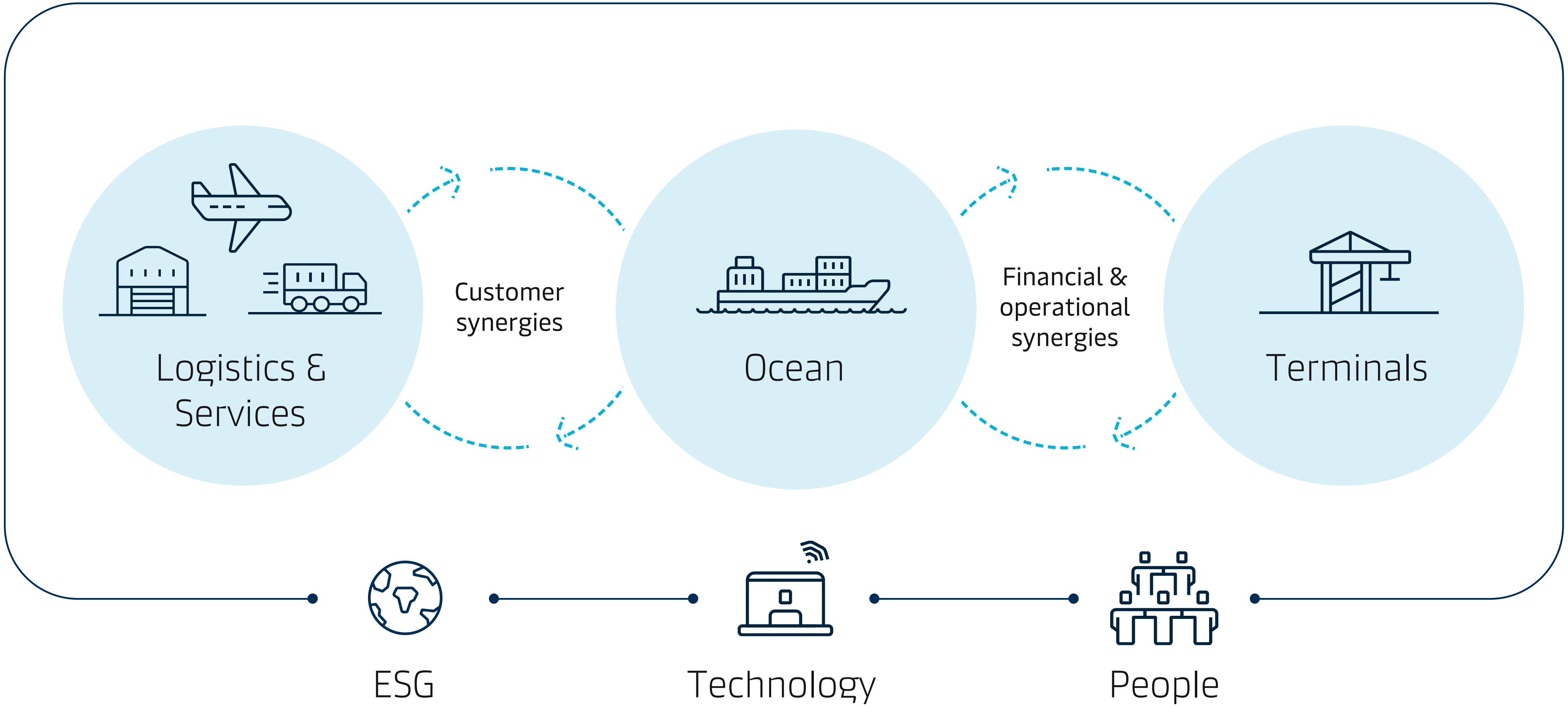
Facilitate and impact

Customers worldwide, large and small	100,000+
Containers moved in the world by the Ocean fleet	~16%
Countries on all continents where we call on 500+ ports	130+
Net zero GHG emissions across our business	2040
Green methanol-enabled vessels on order	19

MAERSK

ESG is integrated

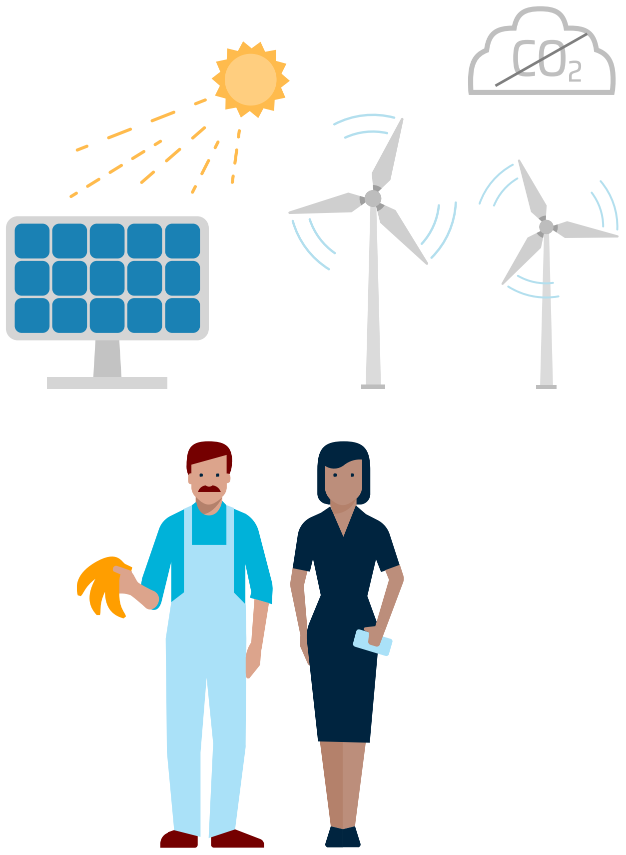
into our business and an enabler of strategic value creation



Customer needs we typically see in sustainable logistics

Strong sustainability partner

- An expert in sustainability that guides you towards the right initiatives
- Partner to decarbonize your supply chain, and drive sustainability initiatives beyond decarbonisation



Credible sustainability solutions with real impact

Solutions should…

- be credible and 3rd party verified
- Aligned with industry standards
- offer real and immediate reductions of GHG emissions
- do not disrupt operations and are easy to contract

MAERSK

Roadmap to deliver net zero by 2040

We have **accelerated our decarbonisation target by a full decade** as there is no time to wait! We are taking a lead in decarbonising the logistics industry through **partnerships with customers and suppliers,** as well as **bold investments**.

2018
Net zero ambition launched

2019
Maersk ECO Delivery launched – world's first green ocean solution

2020
- First pilots on green inland transportation

2021
Emissions Dashboard tool launched

2022
- First 16 electric vehicles in operation in North America

2023
World's first container ship sailing on green methanol

2024-27
24 additional vessels sailing on green methanol

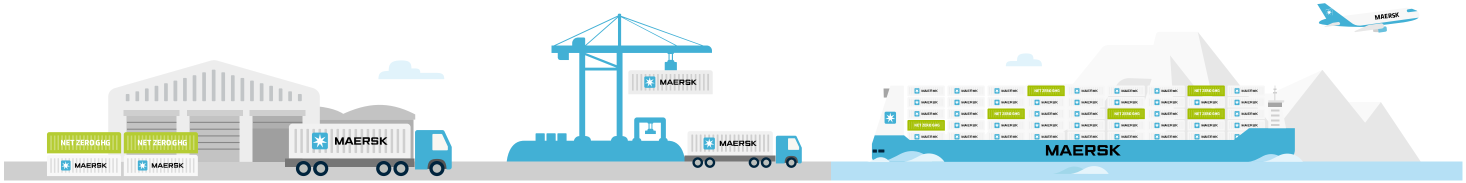
2030
- Aligned with a SBTi 1.5° pathway
- **Industry-leading green solutions across supply chain:**

- **Ocean:** At least 25% cargo transport with green fuels and ~50% reduction in emissions intensity (2020 baseline)
- **Air:** At least 30% cargo transport with sustainable aviation fuels
- **Landside transportation:** Min. 20% of moves of cargo on low/zero emissions technology
- **Logistics facilities:** Min. 90% green operations (Scope 1 & 2)
- **Terminals:** ~70% absolute reduction of Scope 1 & 2 emissions

Key Levers

- Efficiency improvements
- Transitioning to green fuels
- Electrification

2040
Net zero across our business and 100% green solutions offered to customers



*Note: Green is defined as fuels or energy that have low or very low GHG emissions over their life cycle compared to fossil fuels. 'Low' refers to fuels with 65-80% and 'Very low' refers to fuels with 80-95% life cycle GHG reductions compared to fossil fuels.

MAERSK

We have a responsibility to provide a safe and secure work environment

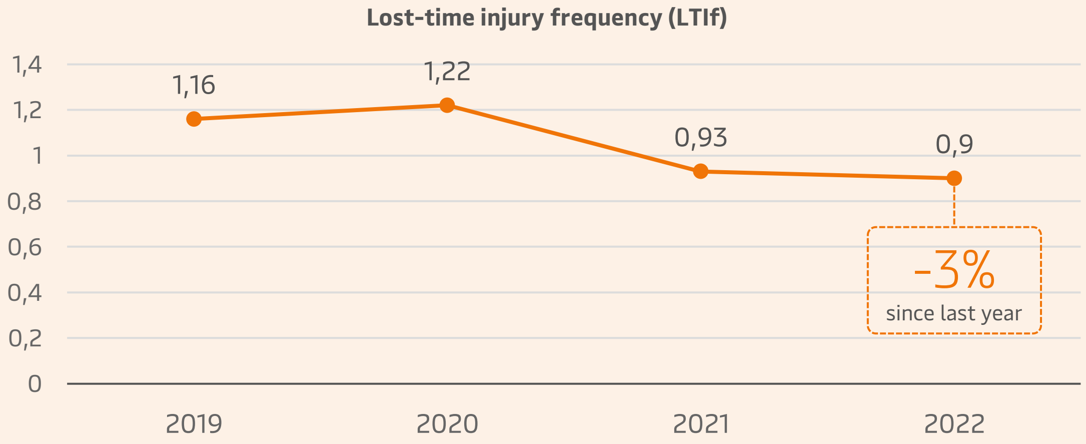
Our commitment

We ensure everyone gets home safe by preventing fatal and life-altering incidents.

Our 2023 targets

- 100% High Potential Incidents trigger frontline Learning Teams
- Global Leadership (Top 1,200) upskilled in Maersk Safety & Security Principles

Driving down the injury frequency rate



In 2022, we improved our lost-time injury frequency rate from 0.93 to 0.90. The lost time injury frequency rate expresses the number of lost-time injuries per million exposure hours of our employees.

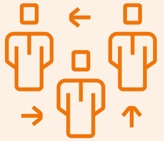
MAERSK

Classification: Internal

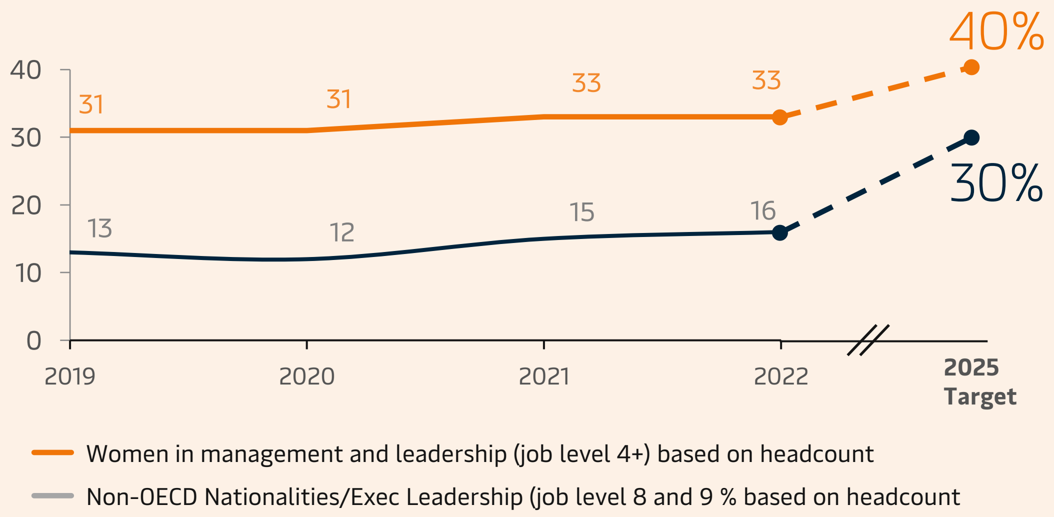
We are becoming a diverse, equitable and inclusive workplace

Our commitment
Leverage diversity of backgrounds and experiences to create a more equitable, and inclusive workplace at Maersk, where our employees feel able to bring their whole selves to work and contribute to their fullest.

Our 2025 targets
- >40% of women in management and leadership (job level 4+)
- >30% diverse nationality (non-OECD) of executives (job level 8 and 9)



We understand diversity as ‘who is in the room'; inclusion as 'how we create a sense of belonging for every person in the room'; and equity as exploring ‘who is trying to get into the room, but cannot’.



The way we treat our employees, and their representatives is fundamental to the way we want to do business.

Our commitment

We are committed to respecting fundamental labour rights and constructive employee relations. Our commitment is based on core ILO conventions and internationally accepted frameworks from the UN and OECD, as well as compliance with applicable local legislation where we operate.

Our 2023 targets

- 100% of employees with Maersk trained in employee relations and labour rights

How we work with employee relations and labour rights

Commit – our central governance system, manages our commitments

Employee Relations Council – sets the direction and monitors progress

Training – we provide all employees with labour rights training

Highlights in 2022

83%

More than four out of five Maersk employees had received training in employee labour rights by the end of 2022

Our targets

100%

Of employees within Maersk trained in employee relations and labour rights by 2023

MAERSK

Aligning our business practices with the UN Guiding Principles

Our commitment
Respect human rights, in line with the UN Guiding Principles on Business and Human Rights, and as a member of the UN Global Compact. Our commitment is explained in our Human Rights Policy.

Our targets
- Capacity building on human rights, including targeted trainings for human rights issue owners
- Continued integration of human rights into key due diligence processes

Strengthening internal capabilities, building risk-based due diligence processes, engaging with rightsholders and ensuring a just green transition are all core priorities in the way we work with human rights at Maersk.

Maersk's prioritised salient human rights issues

- Health and safety in the supply chain
- Working conditions in the supply chain
- Just transition
- Violence and harassment at work
- Access to remedy

MAERSK

Shore Power: Legislation and Market ramp up

Future regulatory landscape

- California 2023: 100% vessel calls to connect
- China 2023: Shanghai deploying California-style OPS regulations
- EU 2030: vessels required to use onshore power in major EU ports as of 2030. From 2035, cover all EU ports if these have onshore power supply. Exemptions exist for ships using zero-emission technology.

Some EU Ports targeting earlier adoption of shore power(2028 in Rotterdam, Antwerp; 2025 in Hamburg)

➡ *Basis current info on implementation dates on the connection requirements, it seems that by 2030 all vessel that operate in US/China/EU – or are intended to be globally deployable must have shore power.*

MAERSK

Thank you

INTERNATIONAL CASE STUDY: HAMBURG PORT AUTHORITY

Hanno Bromeis,
Hamburg Port Authority (Germany)

HANNO BROMEIS

Hanno joined Hamburg Port Authority in 2020 to assume responsibility for HPA's shorepower activities. As Director of Shorepower he was overseeing the go-to-market strategy and its execution ranging from the planning and construction, to launch and operation of the various facilities, HPA is setting up in order to meet Fit-55 requirements as well as the City / Port's own targets. In 2023 he became the Head of HPAs newly formed Port Energy Solutions Division, broadening the scope to enable the energy transition of the Port of Hamburg.

He has a background in strategy consulting focussing on go-to-market and growth strategies with a broad industry experience ranging from tourism & transportation, logistics, mining, energy and others lately focussing more on the issues of sustainability and renewables. He holds a business degree from University of Cologne and London School of Economics and lives with his family in the beautiful city of Hamburg.

INTERNATIONAL CASE STUDY

2016 the port of Hamburg was the first port in Europe to introduce shore power for cruise vessles. Practical experiences were gained that allowed Hamburg to launch Europe's first shore power offering for container vessels in 2023 at three of its major terminals. The presentation will focus on the pathway chosen, the practical experiences gained and the lessons learned for the further projects to come to meet Fit-55 compliance and beyond.

HAMBURG PORT AUTHORITY

EXPERIENCE WITH ONSHORE POWER

Hamburg Port Authority

Hamburg Port Authority – Experience with onshore power

PIANC ANZ OPS Workshop 14th August 2023

Hanno Bromeis / 14th August 2023

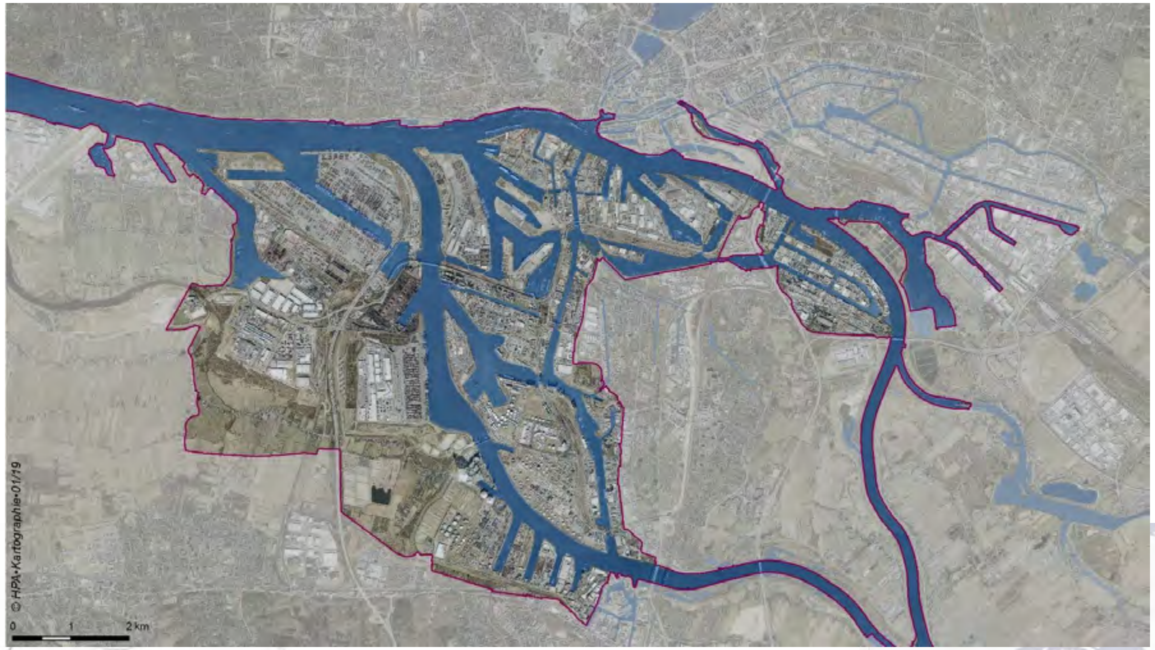
The port of Hamburg

01

The Port of Hamburg

Hamburg Port Authority

A port in the middle of the city

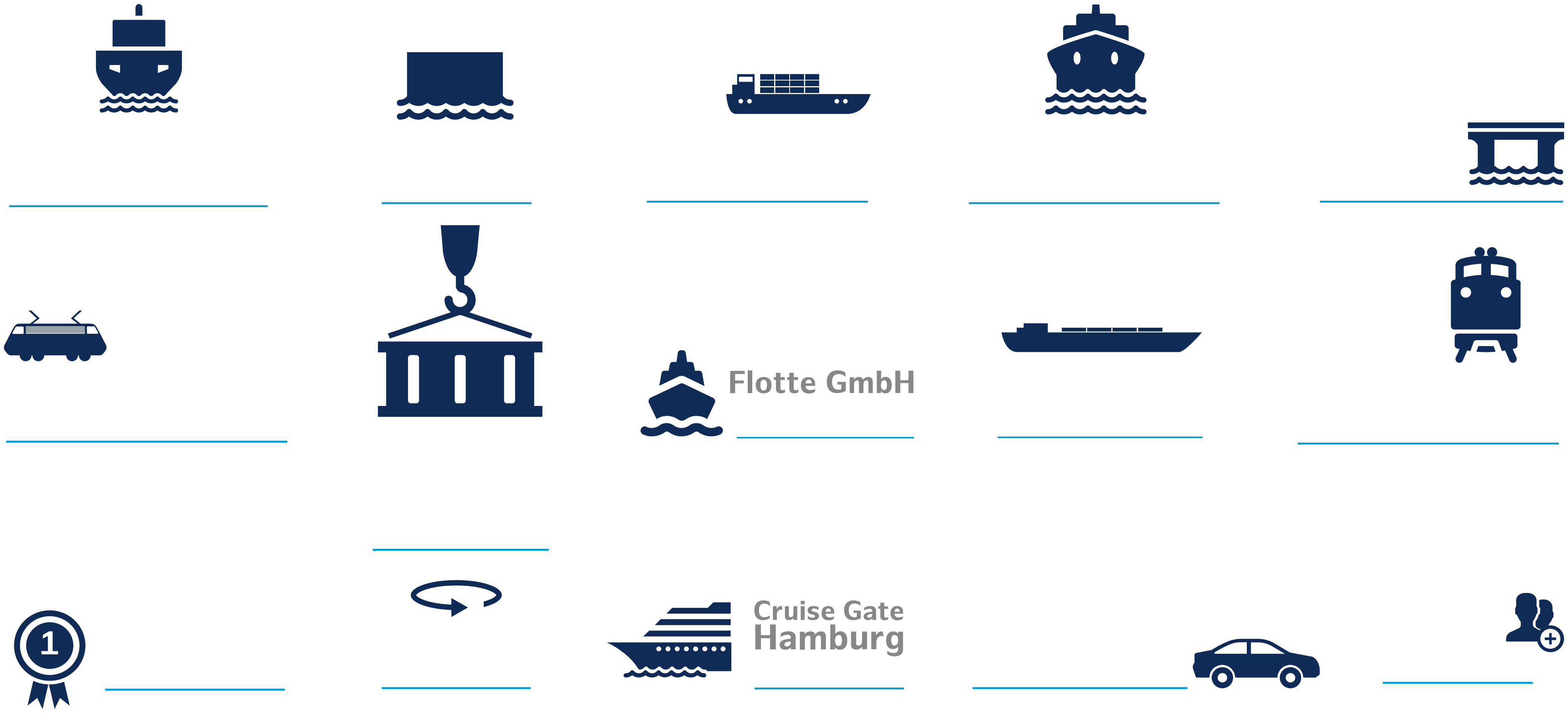


Major North-West European Port

73 nm away from the North Sea

The Port of Hamburg

Hamburg Port Authority



Last updated in 2021

Onshore power in the port of Hamburg

02

Bildnachweise

The start of onshore power in the Port of Hamburg

- Cruise Center Altona
  in operation since 2017
- Delivery: 12 MVA 60 HZ / 50 HZ
  11/6.6 kV 10/5 kV
- IEC/ISO/IEEE 80005-1 standard
- First user: AIDAsol
- Motivation: Clean Air Action Plan of the Free and Hanseatic City of Hamburg

Onshore Power in the Port of Hamburg – Next Steps

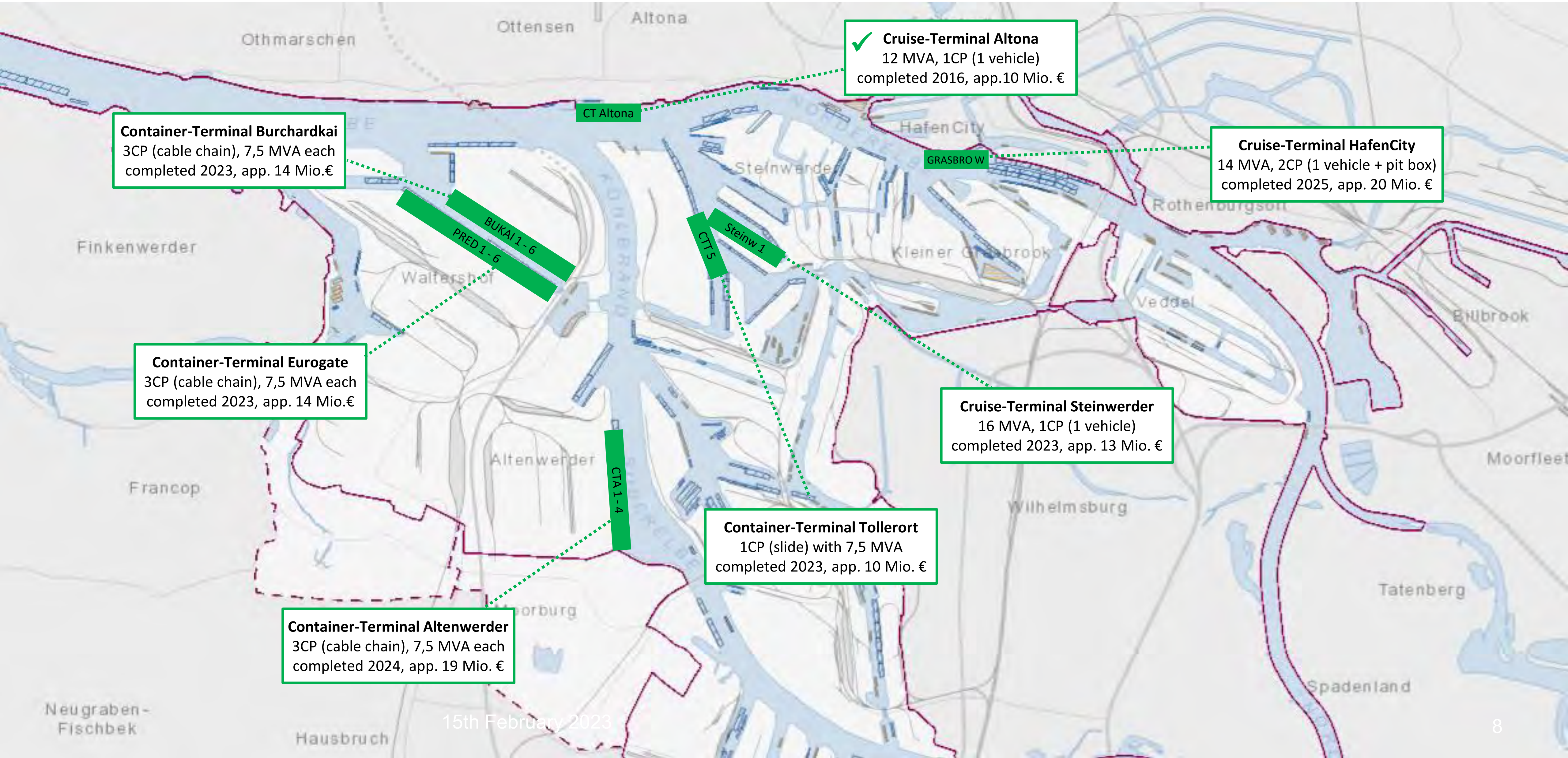
Roll-out of onshore power for cruise and container vessels:

- 3 additional berth for cruise
- 10 new berth for container
- Comissioning 2023-25

Motivation:

- Clean Air Action Plan of the Free and Hanseatic City of Hamburg
- Upcoming EU Regulation Alternative Fuel Infrastructure Regulation
- Request from cruise ship-owners

Major projects of current program



Example for technical solution Container terminal CTT

Key facts CTT shore power facility:

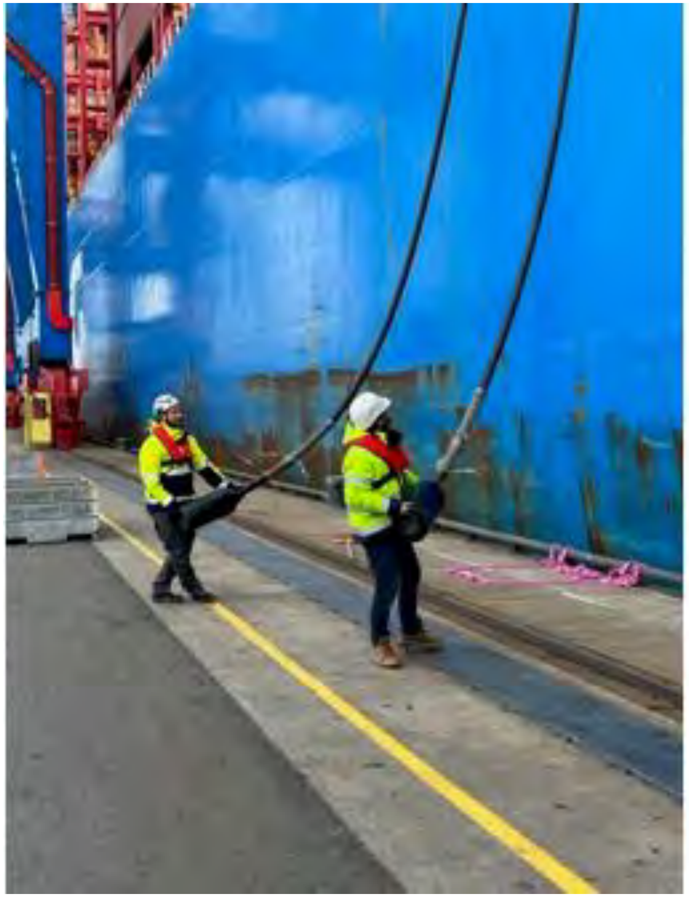
- 1 connection system, service range of 100m.
- Cable drum with pulling system
- Maximum supply of 7,5 MVA to per vessel
- Power sourced from the public grid via SNH transformer station Drehbrücke, converter located on bordering Ross Terminal

Indication of service areas

Connection System (pulling system with cable drum on platform next to quay)

Connection system CTT

Connecting the vessel CTT

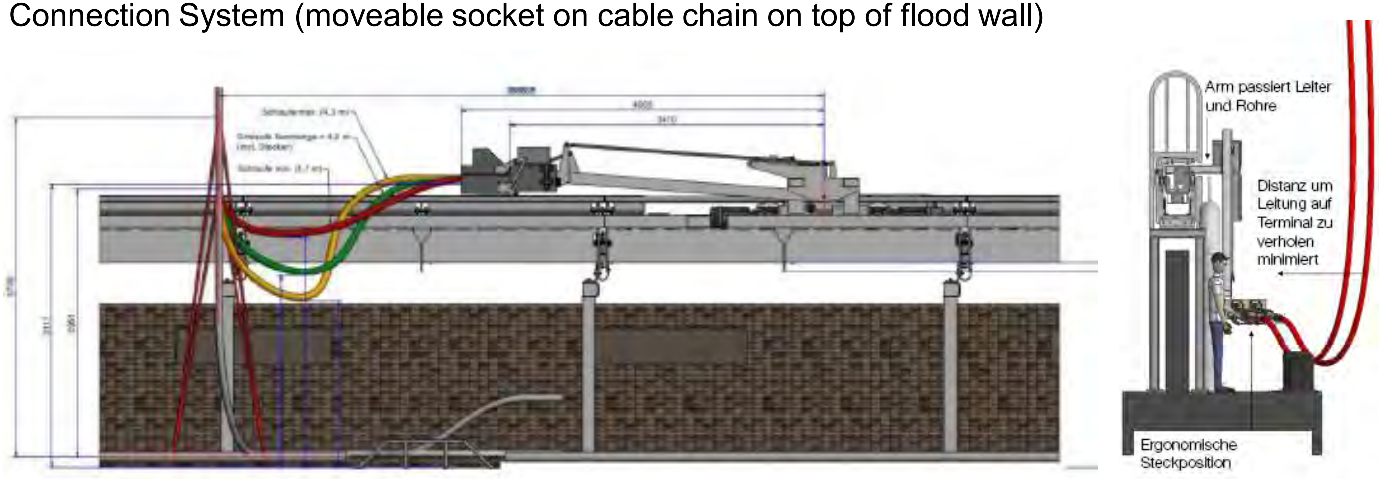


Example for technical solution Container terminal CTH

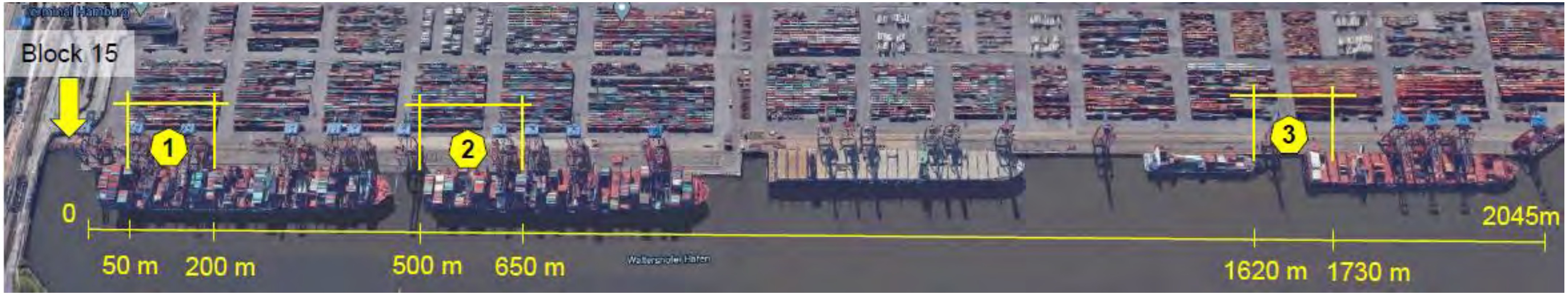
Key facts CTH shore power facility:

- 3 connection systems with a service range of 2x150m and 1x100m.
- Movement along a cable chain build on top of flood wall.
- Maximum supply of 7,5 MVA to per vessel
- Power sourced from the public grid via SNH transformer station Dradenau, converter located next to terminal on Block 15

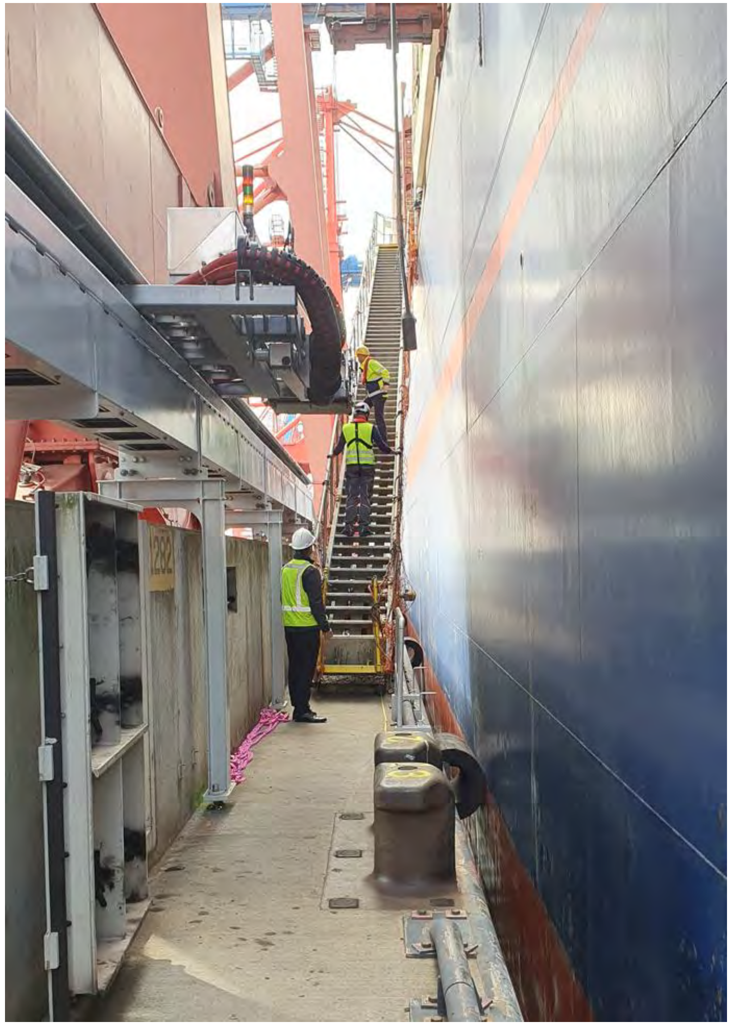
Connection System (moveable socket on cable chain on top of flood wall)

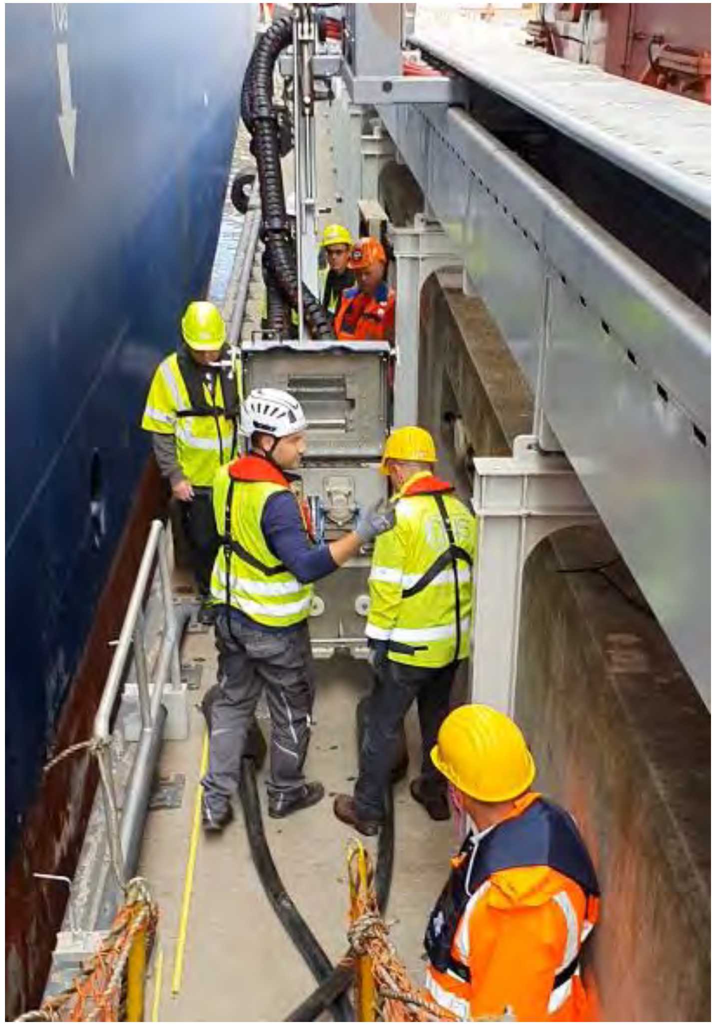


Indication of service areas

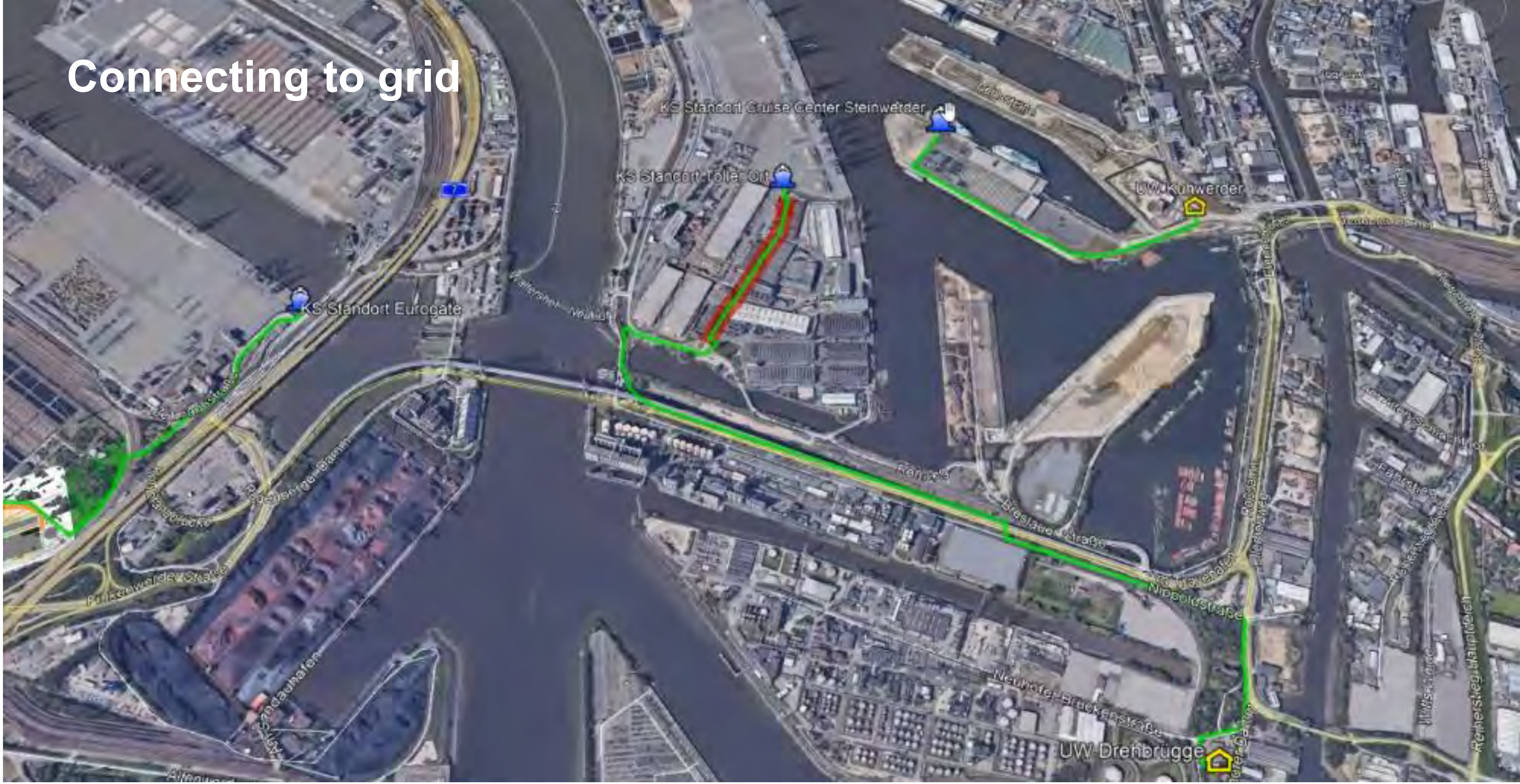


Anschlusssystem CTH

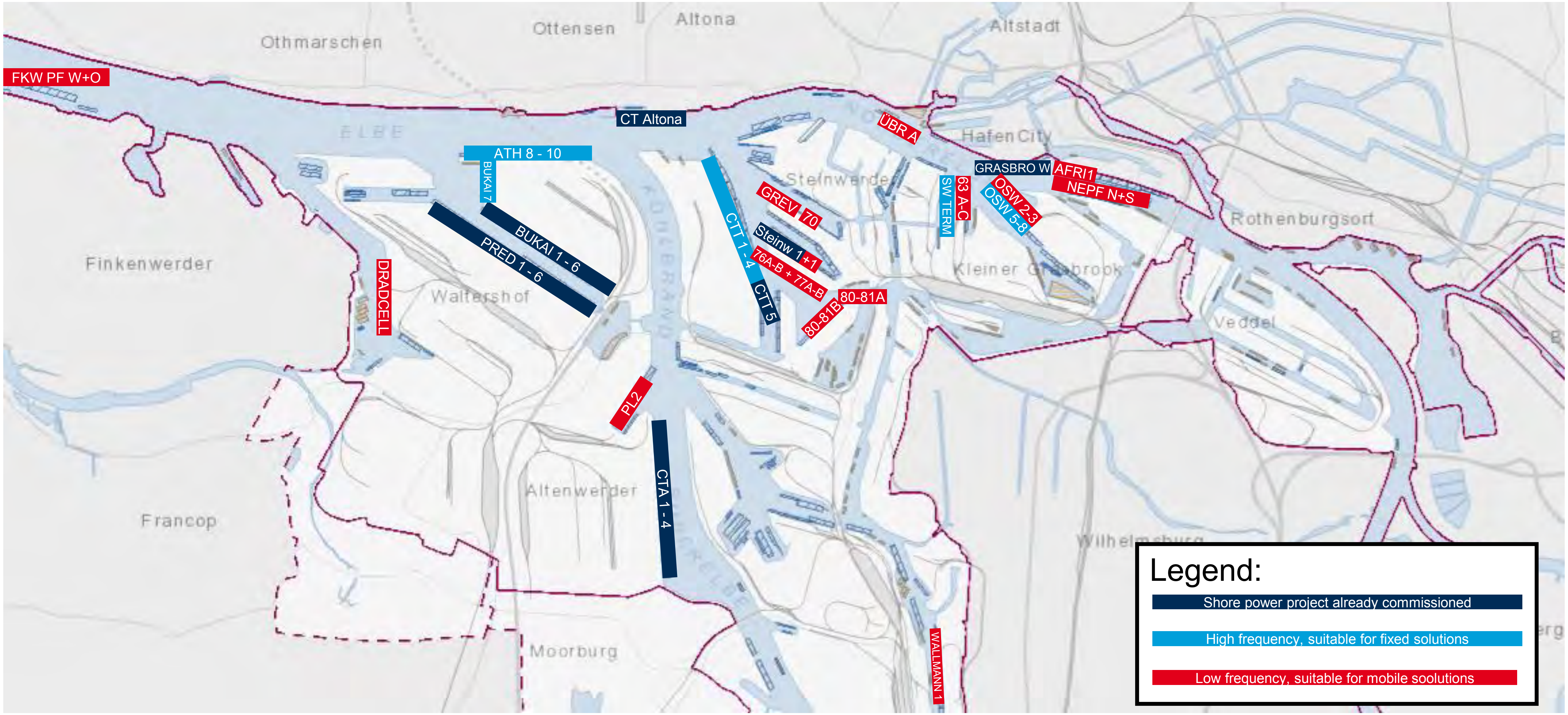




Connecting to grid



Further solutions in discussion to meet Fit-55 compliance



Onshore power
What we learned

03

Bildnachweise

The basics

- Make reasonable and realistic assumptions
- Know the ships calling your port
  - Influence on technical design
  - Influence on business case
- Different segment require different solution and have different attitudes
- You will not start with 100 % connection of ships
  - Not all ships are equipped with OPS
  - Not all ships are willing to take OPS
- Ramp-up phase when introducing OPS – learning curves at both sides

The technical challenges

Hamburg Port Authority

- Green electricity expected
- Availability of enough electricity
- Connection to the grid
- Rightsizing the transformers
- THE technical challenge: the connection point
  - Make it flexible (Lesson learned from port of LA)
  - There is no space at container terminals
  - All Terminals are different (at least in Hamburg)
- Brownfield challenges can be massive

Business Case

- OPS is (usually) more expansive than onboard electricity production
- => Someone has to pay!
  - Ship-owner – but how to motivate?
  - Port – but why offering a loosing business?
  - State – is it a market failure?
- Does regulation helps?
- Keep a level-playing field
- Micro level: rightsizing tech and manpower

Legal framework

- Is your legal framework fit for OPS?
- Are you allowed to sell electricity?
- Which taxes are on electricity?
- Can OPS be treated as deferable grid load?

- Importance of early and frequent interaction and planning between the port, regulatory agencies, and utilities
- Cooperate with your competitors

Herzlichen Dank!

Hanno Bromeis
Director Shore Power

Hamburg Port Authority

shorepower@hpa.hamburg.de


PIANC · A.D.1885 · AIPCN
NAVIGARE NECESSE
SHIPPING LINES: OIL & GAS
Jeff Bayham
Oil Companies International Marine Forum (United States)

JEFF BAYHAM

Jeff is a Senior Principal Marine Engineer and professional licensed civil/structural engineer with ExxonMobil based in Houston Texas.

Jeff has been in the ports and marine terminal industry for 25 years. His core responsibility is to ensure we drive toward flawless operations with regards to safety and protecting the environment and develop the next generation of talent in our organization. We have 36 marine and marine terminal engineers that support these efforts.

During his career he has had the opportunity to serve in a number of roles covering marine terminal engineering design and both technical and operational leadership positions both in and outside of the marine industry. In addition, Jeff represents Oil Companies International Marine Forum (OCIMF) as the Structures Expert Group Chair, the OCIMF industry representative on PIANC MARCOM, and currently serves as the Chair for the upcoming publication on Shore Power Workgroup.

SHORE POWER FOR OIL AND GAS VESSELS

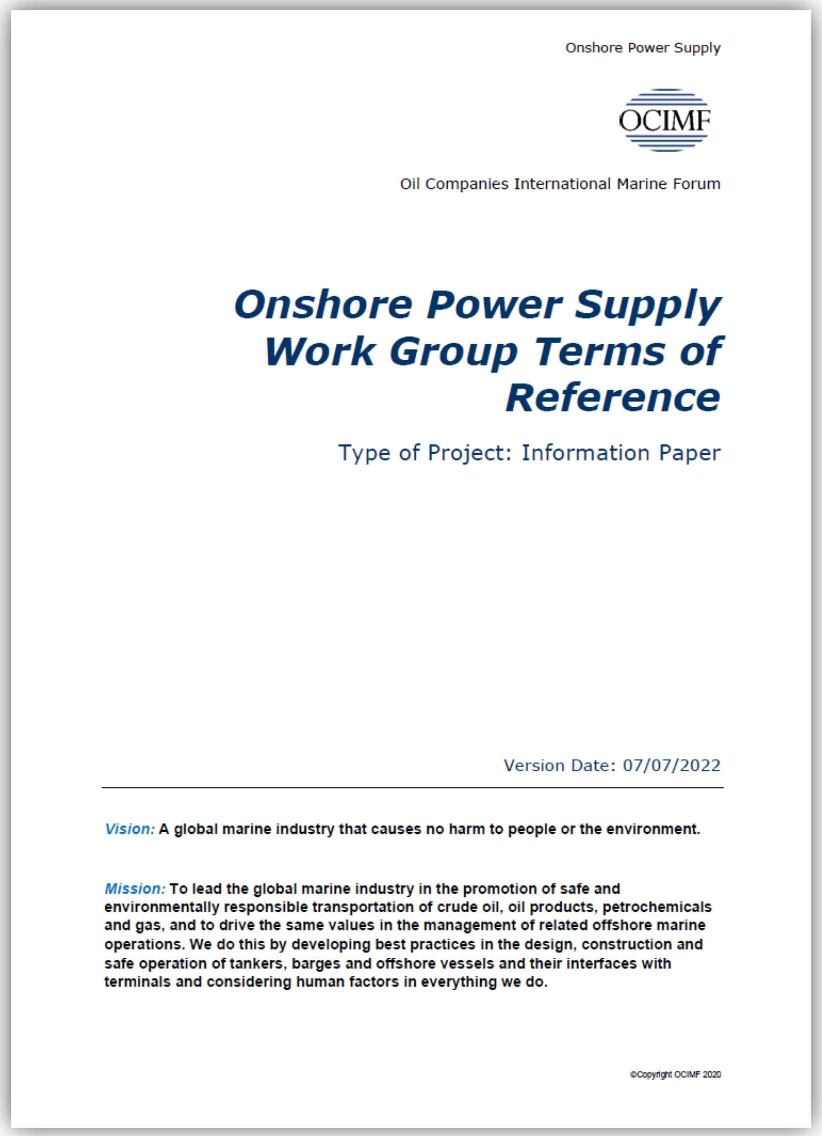
In an effort to drive toward reduced air emissions of oil tankers while in port, OCIMF and its industry partners are developing an industry standard on a means to safely provide high voltage electrical power to oil and product tankers that are moored at port considering the electrical classification zones that are typically provided at such facilities. This will enable the tanker to run completely on shore power once moored alongside. The upcoming publication will ensure a set of unified design and operational recommendations aligned with industry stakeholders that will be followed by tanker and shore facilities including the location of electrical connections, voltage/power requirements, connection and cable types, and all appropriate human factor and safety standards to enable shore power without increasing the risk of ignition in the hazardous zones on the tanker and on the berth.

Onshore Power Supply WG

Chair: Jeff Bayham (ExxonMobil)
Vice-chair: Robert Bridges (TotalEnergies)
Secretary: Filipe Santana

11 July 2023

Terms of Reference


Onshore Power Supply

OCIMF

Oil Companies International Marine Forum

Onshore Power Supply Work Group Terms of Reference

Type of Project: Information Paper

Version Date: 07/07/2022

Vision: A global marine industry that causes no harm to people or the environment.

Mission: To lead the global marine industry in the promotion of safe and environmentally responsible transportation of crude oil, oil products, petrochemicals and gas, and to drive the same values in the management of related offshore marine operations. We do this by developing best practices in the design, construction and safe operation of tankers, barges and offshore vessels and their interfaces with terminals and considering human factors in everything we do.

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Objective

- To detail standardised practices guidance for the global application of **onshore power supply (OPS)** alongside the berth **for tankers, the terminal, and their interface**.

- To complement existing industry guidance, which includes:
  - EMSA Shore-Side Electricity Guidance to Port Authorities and Administrations.
  - IMO Draft Interim Guidelines on Safe Operation of Onshore Power Supply (OPS) service in Port for Ships Engaged on International Voyages.
  - IEC/IEEE 80005-1:2019.

Scope

- The focus is on the **tanker segment** (oil, oil products, and chemical).
- Barges and gas carriers are out of scope.

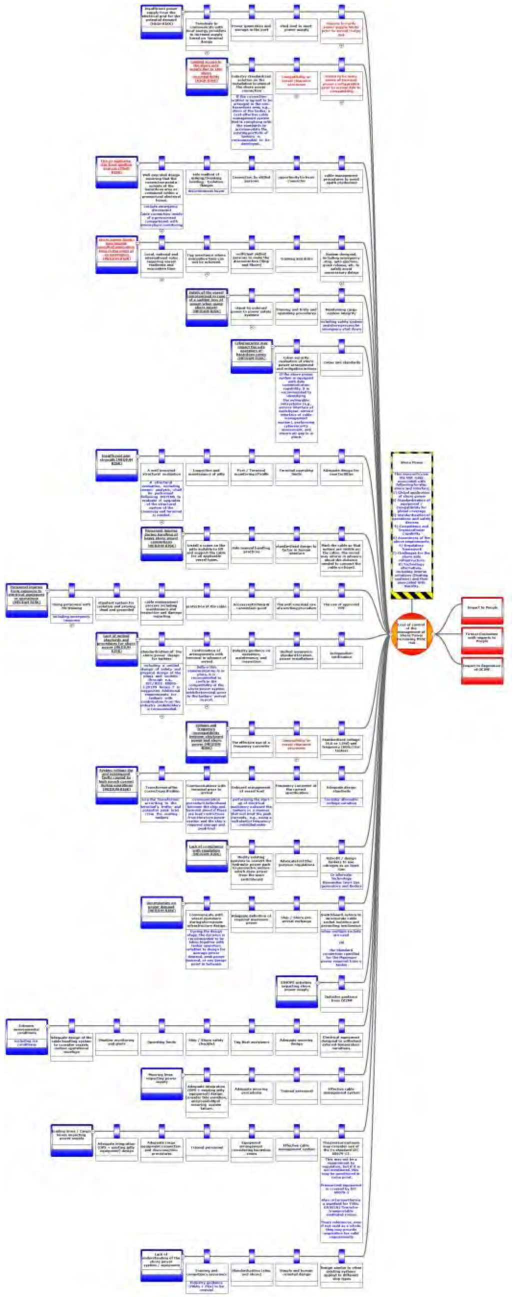
Working Group

#	Name	Company/Body
1	Antti Kettunen	NESTE
2	Arild Røed	IEC
3	Arvid Longva	Equinor
4	Brian R. McElhaney	Marathon Petroleum
5	Claes Möller	Tarntank
6	Eric Harrier	Conocophillips
7	Filipe Santana (S)	OCIMF
8	Franklin Schurum	Marathon Petroleum
9	Gil-Yong Han	INTERTANKO
10	Henk van der Biezen	ExxonMobil
11	Iwona Anaszewicz	BP
12	Jacob Schmidt	Marathon Petroleum
13	James (Jim) Erickson	Moffat & Nichol
14	Jeff Bayham (C)	ExxonMobil
15	Jeremy Richardson	Shell
16	Joost Bos	Port of Rotterdam
17	Jörgen Wrennfors	Port of Gothenburg
18	Kai Cheong Wong	INTERTANKO
19	Paul Martella	Chevron
20	Peter Steinhoff	Chevron
21	Ramesan E	IACS
22	Robert Bridges (VC)	TotalEnergies
23	Sean Crowley	Stolt Tankers
24	Siddharth Barua	IACS
25	Stephen D. Ernst	Marathon Petroleum
26	Thomas Hartmann	DNV
27	Thomas Hoven	Siemens-Energy/IEC

Risk Mapping

Threats to be covered:

- Insufficient power supply from the electrical grid for the potential demand.
- Limited access to the shore side supply due ship shore incompatibility.
- Fire or explosion risk from ignition sources.
- Shore power design may impede specified evacuation time in the event of an emergency.
- Safety of the vessel compromised in case of a sudden loss of power when using shore power.
- Cybersecurity may impact the safe operation if hazardous cargo.
- Insufficient pier strength.
- Personnel injuries from exposure to electrical equipment or operations.
- Lack of unified standards and procedures for shore power.
- Voltage and frequency incompatibility between shipboard power and shore power.
- System voltage dip and subsequent faults caused by high inrush current during operations.
- Lack of compliance with regulation.
- Uncertainties on power demand.
- SIMOPS activities impacting shore power supply.
- Extreme environmental conditions.
- Loading arms / cargo hoses impacting power supply.
- Lack of understanding of the shore power system / equipment.



Initial Key Design Decisions

Position of the **shore power connection** on board:

Mid-ship vs stern

Standard **maximum power** available for shore power, **number of cables** and **connections**.

Voltage

(6.6 vs 11 kV).

Position of the shore power connection on board

- There are **pros and cons associated with either position**.
- The group assessed a list of potential safety concerns.
- Items to be further investigated:
  - The **cable properties** are unsuitable for the hazardous area (no impervious shielding).
  - If the CMS is installed in a hazardous zone, the **cable handling systems' maturity** is insufficient for the proposed scope.
- The group decided **not to recommend a single shore power connection position**. Instead, the OPS WG agreed to **develop guidance for both options**.

Voltage, Maximum Power, Number of Cables, and Connections

- OPS WG developed a survey questionnaire to gather actual power requirements onboard tankers, including accommodation and cargo systems, while in port.
- The survey applied to all types of tankers of all different sizes except gas carriers.
- 550 tankers replied to the survey, mostly INTERTANKO members.
- After analysing and comparing all options, a **voltage of 6.6 kV** is to be provided by the terminal.
- As per the IEC/IEEE 80005-1:2019, the terminal shall provide the power at a frequency acceptable to the tanker. Most tankers operate on **60 Hz**.
- **The number of cables and sockets will be design-specific**, i.e., the terminal and the tanker will define this number based on their needs.
- Additional engineering barriers, such as circuit breaks per cable/connection and interlocks, will be recommended to prevent the threat of live connection ends.

OCIMF will release an interim report with the power survey details and insights on maximum power required, voltage, number of cables, and connections.

Timeline

Interim report – **Q4/2023**

Final guide – **Q3/2024**

Please let me know if you have any questions.

Thank you

SHIPPING LINES: CRUISE

James Larsson
Carnival Australia

JAMES LARSON

James is a recent starter at Carnival Australia after many years working for federal and state government, and prior to that as a consultant working with the likes of Uber, QBE and IAG and as a strategic adviser to the then board and CEO of the Gold Coast 2018 Commonwealth Games. But he's no stranger to the industry having worked previously with Carnival as a consultant.

Shore power – a key component to cruise decarbonisation

PIANC Australasian Coast & Ports 2023 Pre-conference workshop

Decarbonisation of Ports – The Feasibility of Shore Power

Tuesday 15 August 2023

Acknowledgement of Country

Presenters

James Larsson

CAU Director Government and Stakeholder Relations

Agenda

- Introduction
- Our sustainability goals and aspirations
- Shore power ready
- How can we achieve decarbonisation together?

Introduction

Carnival Australia

Carnival Australia

- 2023 marks the 90th Anniversary of P&O Cruises Australia
- Total of 7 leading cruise lines
- 3 cruise lines based in Australia year-round
- 7 out of 10 Australians who have cruised sailed on CAU brands

Our fleet in Australia

- Five home-ported ships
  - Pacific Adventure (Sydney)
  - Pacific Encounter (Brisbane)
  - Pacific Explorer (Melbourne, Adelaide, Fremantle, Sydney, Brisbane, Cairns)
  - Coral Princess (Brisbane, Sydney, Fremantle)
  - Carnival Splendor (Sydney)

2024 port visits

- Sydney: 187
- Brisbane: 121
- Melbourne: 76
- Cairns: 62
- Hobart: 48
- Adelaide: 33
- Darwin: 19
- Fremantle: 19
- Port Lincoln: 16
- Broome: 14
- Eden: 11
- Burnie: 10
- Geraldton: 8
- Albany: 7
- Newcastle: 4
- Townsville: 3

Our sustainability goals and aspirations

Sustainable from ship to shore

Sustainability focus areas

- Climate Action
- Good Health & Well-being
- Circular Economy
- Biodiversity & Conservation
- Sustainable Tourism
- Diversity, Equity & Inclusion

CARNIVAL CORPORATION & PLC
Sustainability

SUSTAINABILITY

2030 GOALS AND 2050 ASPIRATIONS

Climate Action

2030 Goals

Achieve 20% carbon **intensity reduction** relative to our 2019 baseline measured in both grams of CO_2e per ALB-km and kilograms of CO_2e per ALBD.

✓ **Achieved 50% reduction in absolute particulate matter air emissions** relative to our 2015 baseline.

Increase fleet shore power connection capability to **60%** of the fleet.

Expand **liquefied natural gas** (LNG) program.

Optimize the reach and performance of our Advanced **Air Quality Systems (AAQS)** program.

Expand battery, fuel cell and biofuel capabilities.

Reduce scope 3 (indirect) emissions associated with food procurement and waste management.

Identify carbon offset options only when energy efficiency options have been exhausted.

2050 Aspirations

Achieve net **carbon-neutral ship operations.**

Achieve **100% fleet shore power.**

Circular Economy

2030 Goals

✓ **Achieved 50% single-use plastic item reduction** in 2021.

✓ **Achieved 30% food waste reduction** per person in 2022.

NEW: Established interim goal to achieve **40% unit food waste reduction** by 2025

Achieve **50% food waste reduction** per person by 2030.

Increase **Advanced Waste Water Treatment System coverage to > 75%** of our fleet capacity.

Send a larger percentage of waste to waste-to-energy facilities where practical.

Partner with primary vendors to reduce upstream packaging volumes.

2050 Aspirations

Build ships without the need to discharge to the ocean or air.

Send 100% of **waste to waste-to-energy facilities.**

Partner with primary vendors to ensure near **100% reuse of packaging materials.**

Sustainable Tourism

2030 Goals

Establish **partnerships with destinations focused** on sustainable economic development, preservation of local traditions and capacity management.

Continue to support disaster resilience, relief and recovery efforts.

Build stronger community relationships in our employment bases and destinations via **employee volunteering programs.**

Achieve **100% cage-free eggs** by the end of 2025.

Achieve **100% responsible chicken sourcing** by end of 2025.

Achieve **100% gestation crate-free pork** by end of 2025.

2050 Aspirations

Be recognized as the **leader in global sustainable tourism.**

Good Health & Well-Being

2030 Goals

Committed to continued **job creation.**

Establish measurable **Company Culture** metrics in 2022 and set annual improvement targets.

Implement **global well-being standards** by 2023.

Reduce the number of guest and **crew work-related injuries.**

2050 Aspirations

Be a leader in **employee well-being measures.**

Reduce the number of guest and crew work-related **injuries.**

Biodiversity & Conservation

2030 Goals

Support biodiversity & conservation initiatives through select NGO partnerships.

Conduct audits and monitor animal encounter excursions regularly.

2050 Aspirations

Have deep NGO partnerships embedded in the business and supporting strategy execution.

Supply 100% of seafood needs through **sustainable fishery programs.**

Diversity, Equity & Inclusion

2030 Goals

Ensure our overall shoreside employee base reflects the diversity of the world.

Expand shipboard and shoreside diversity, equity and inclusion across all ranks and departments.

2050 Aspirations

Make diversity, equity and inclusion in management a "given," not a measurement.

Our progress on climate action

Carnival Corporation and PLC (global business)
Source: 2022 Sustainability Report

2030 GOAL	FY2022 PROGRESS	STATUS
Achieve 20% carbon intensity reduction relative to our 2019 baseline measured in both grams of CO_2e per ALB-km and kilograms of CO_2e per ALBD	Achieved 2% carbon intensity reduction on an ALB-km basis and 4% on an ALBD basis For ships in guest operations, achieved 11% carbon intensity reduction on an ALB-km basis and 13% on an ALBD basis	On Track
Reduce absolute particulate matter air emissions by 50% relative to our 2015 baseline	ACHIEVED	Achieved
Increase fleet shore power connection capability to 60% of the fleet	57% of the fleet has shore power connection capability, up from 46% in 2021	On Track
Expand liquefied natural gas (LNG) program	7 LNG ships in operation across the fleet (as of November 30, 2022)	On Track
Optimize the reach and performance of our Advanced Air Quality System (AAQS) program	93% of the fleet has an Advanced Air Quality System (AAQS) installed[1]	On Track
Expand battery, fuel cell and biofuel capabilities	Piloted the use of biofuels as a replacement for fossil fuel on two ships Installed a lithium-ion battery storage systems and fuel cells powered by hydrogen derived from methanol	Ongoing
Reduce Scope 3 (indirect) emissions associated with food procurement and waste management	Completed an inventory of our Scope 3 emissions; following the Greenhouse Gas Protocol, we estimate that our Scope 3 emissions represent approximately half of our total emissions	Ongoing
Identify carbon offset options only when energy efficiency options have been exhausted	Continuing to monitor the carbon offset market and options, as well as exploring carbon capture and storage opportunities	Ongoing

On Track · Ongoing · Achieved

[1]Excluding LNG ships

On Track: Quantifiable/numerical goals that are showing a positive trend towards achieving the goal. *Ongoing:* Qualitative/non-numerical goals which are currently in progress.

Shore power ready

Fleet enabled

We are ready

- Carnival Australia's fleet is shore power ready
- Most visiting fleet is shore power ready
- We've been working with ports around the world to get ready

How can we achieve decarbonisation together?

Willing partners for shore power

What we need

- Infrastructure
- Adequate supply
- Reasonable cost

- First shore power enabled port is slated to be Sydney's White Bay (2024)

Challenges

- Understand economies of scale
- Cost of infrastructure
- Who pays?

We can do it together

- Ports: adequate dock and uplands space
- Government: will assist with emissions targets
- Utilities: technology and time at reasonable price
- Operators: decarbonisation at reasonable cost


Thank you
Carnival
CUNARD
Holland America Line
P&O CRUISES
PRINCESS
SEABOURN

SHORE POWER AUSTRALIA: CRUISE

- *Catherine Blaine & Fauzan Zulkhepli, Port Authority of New South Wales*
- *Craig Wilson, Port of Brisbane*

CATHERINE BLAINE

Catherine is the Chair of the NSW Chapter of PIANC ANZ, and the General Manager of Projects at Port Authority of NSW.
Catherine has worked in the private and government sectors of the port and maritime industry for over 20 years, specialising in port and maritime infrastructure development. Catherine has completed large scale projects in most major ports on the east coast of Australia.
Catherine is a qualified civil and environmental engineer, with a passion for sustainable development, and enjoys finding ways to implement sustainable design and initiatives into port infrastructure and its operation.

FAUZAN ZULKHEPLI

Fauzan is the Senior Project Manager – Shore Power at Port Authority of NSW.

Fauzan has worked in the dynamic world of upstream and downstream oil and gas industry for over 15 years, specialising in major multimillion-dollar infrastructure development and spearheading implementation of sustainability initiatives for multinational energy conglomerates. Fauzan has completed large scale mission critical projects in most major cities in Australia and other regional hubs in Asia Pacific.

Fauzan is a qualified electrical and instrumentation engineer, and has a passion for sustainable development, and expediting Australia's transition to renewable energy inline with the government's net zero target.

BAYS PORT SYDNEY SHORE POWER PROJECT, PIONEERING SHORE POWER IN AUSTRALIA

In a world first for a dry-bulk precinct and a first in the Southern Hemisphere for a cruise terminal, Port Authority of NSW is in the process of installing and supplying Shore Power in the Bays Port precinct. Port Authority intends to invest $60 million for the development of a landside electricity supply for cruise and bulk ships, powered by renewable energy.

The introduction of shore power facilities of this scale and nature in Sydney is anticipated to be a driver and catalyst for the increased uptake of similar facilities around in Australia, leading to the support of the shipping industry in significantly reducing carbon emissions.

The presentation will provide an overview of the journey to achieve project approval, an update on project progress, and an insight into other complex facets of the project including benefits analysis, power supply and ensuring design consistency across ports to facilitate user uptake.

PORT AUTHORITY OF NEW SOUTH WALES

BAYS PORT, SYDNEY - SHORE POWER PROJECT

PIONEERING SHORE POWER IN AUSTRALIA

PIANC ANZ WORKSHOP: DECARBONISATION OF PORTS – THE FEASIBILITY OF SHORE POWER
Maroochydore, 14-15 August 2023

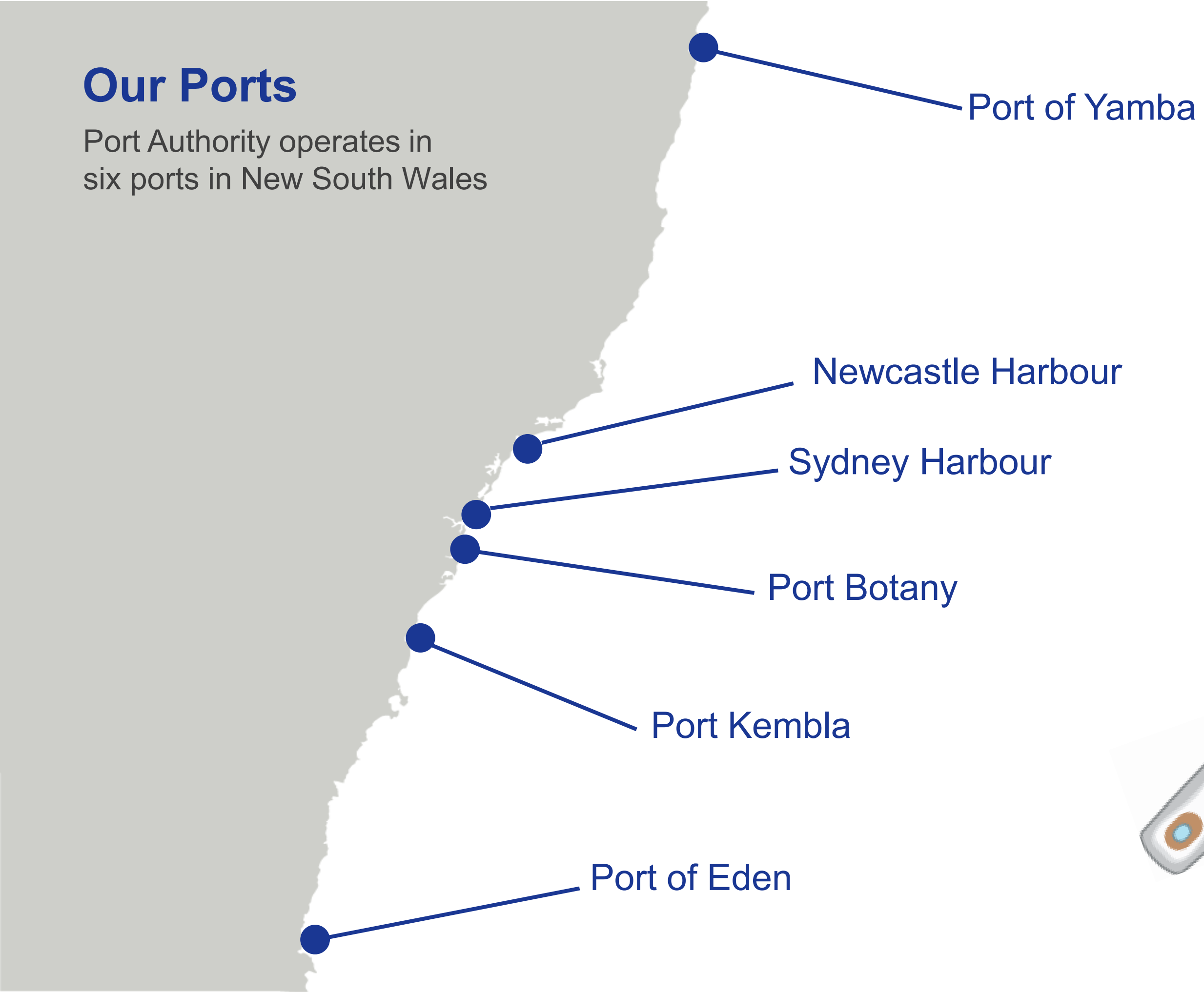
PORT AUTHORITY OF NEW SOUTH WALES

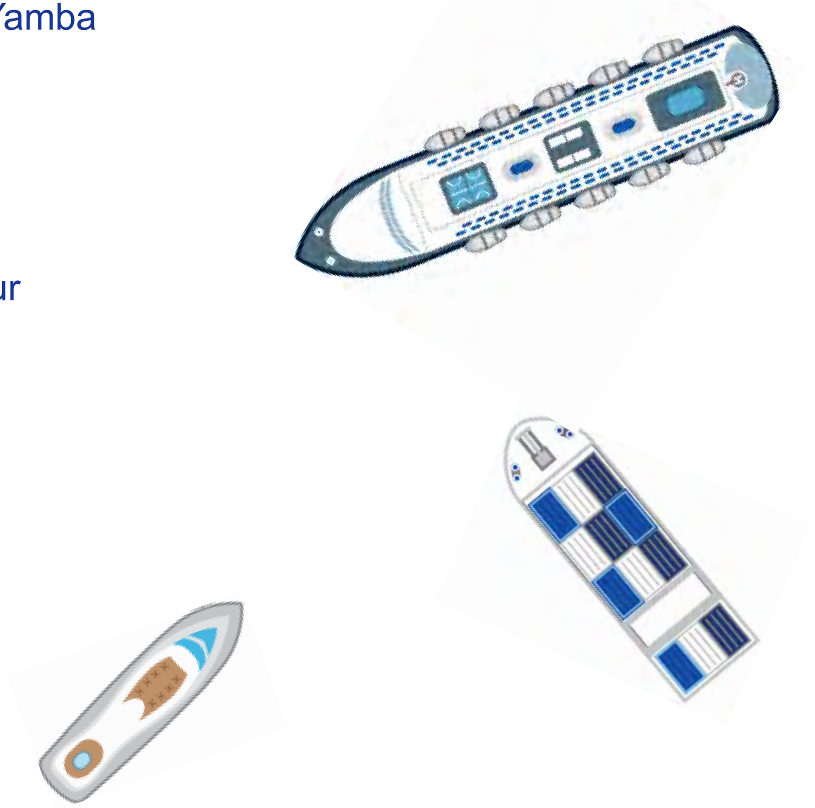
- Cruise terminals
- Hydrographic survey
- Marine pilotage
- Dangerous goods
- Safe navigation
- Cruise development
- Marine assets
- Emergency response
- Vessel traffic services
- Harbour master directions
- Port security
- Port management

PORT AUTHORITY OF NEW SOUTH WALES

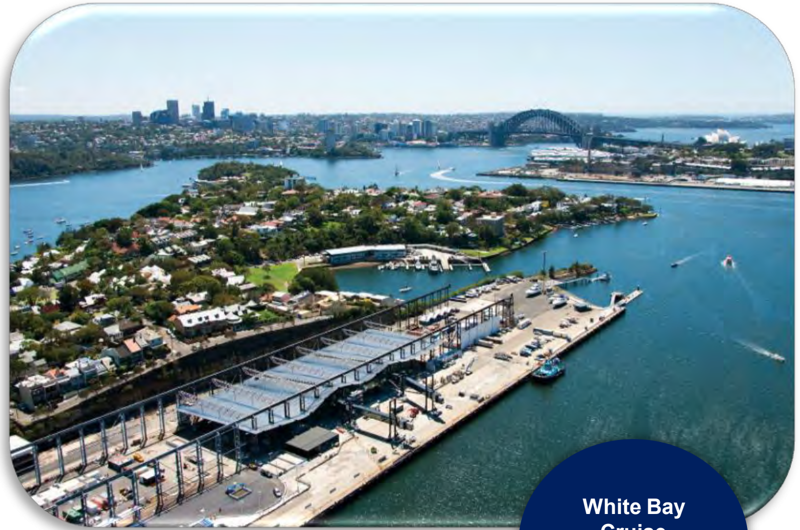
Our Ports

Port Authority operates in
six ports in New South Wales

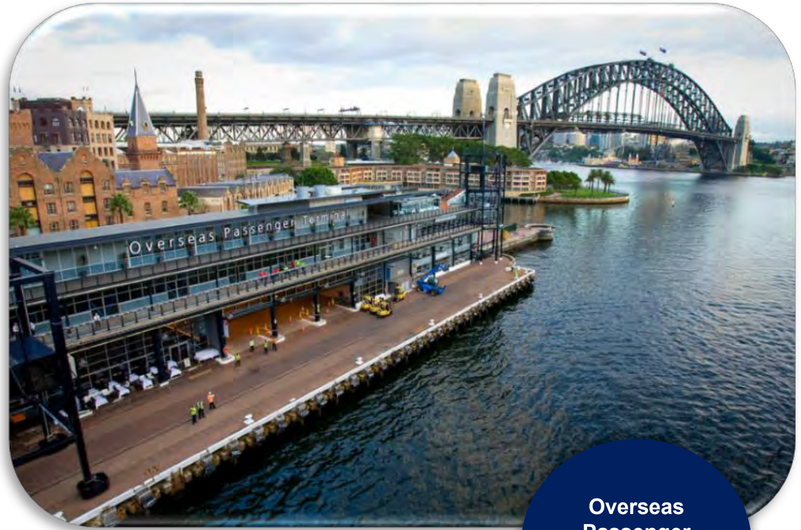




PORT AUTHORITY OF NEW SOUTH WALES



White Bay Cruise Terminal, Sydney



Overseas Passenger Terminal, Sydney

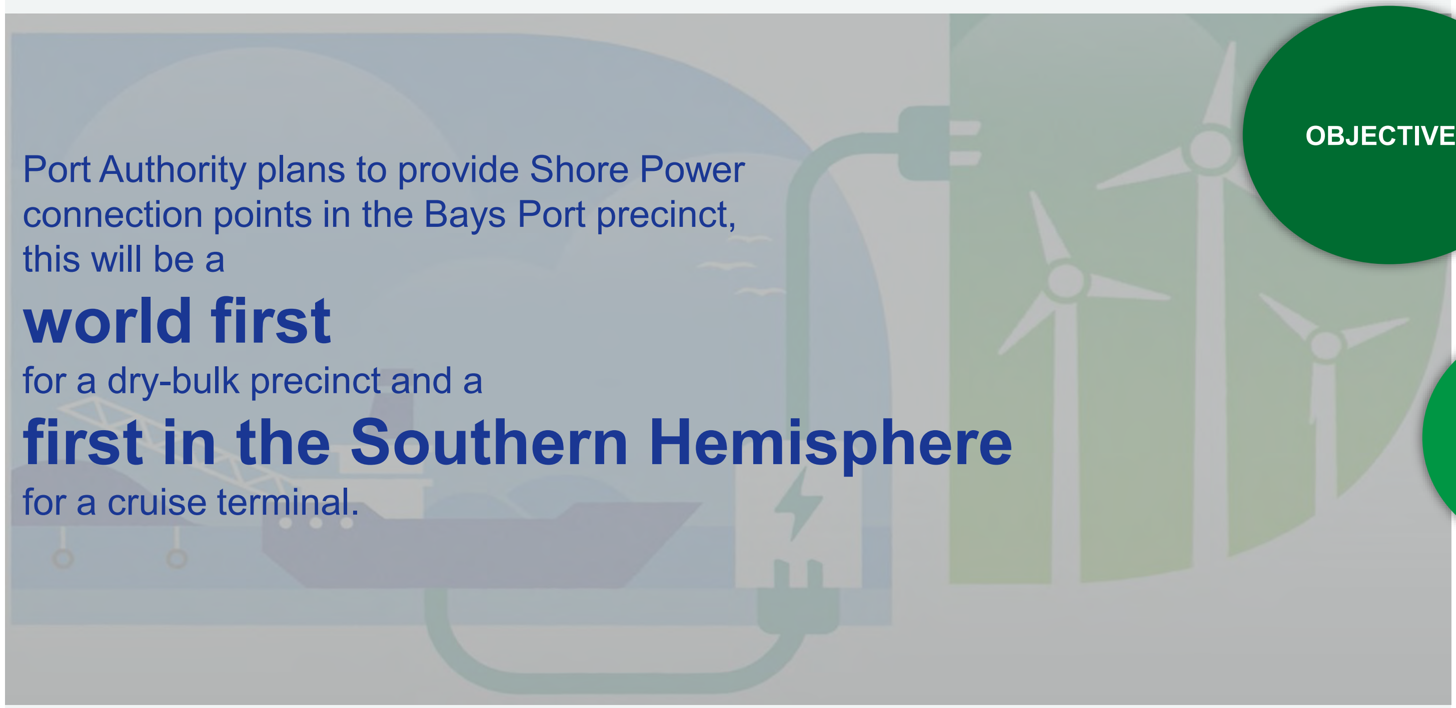
Eden Cruise Wharf, Eden

PORT AUTHORITY OF NEW SOUTH WALES

Glebe Island Bulk Berths, Sydney

Glebe Island Bulk Berths, Sydney

1 PROJECT OBJECTIVES



Port Authority plans to provide Shore Power connection points in the Bays Port precinct, this will be a

world first

for a dry-bulk precinct and a

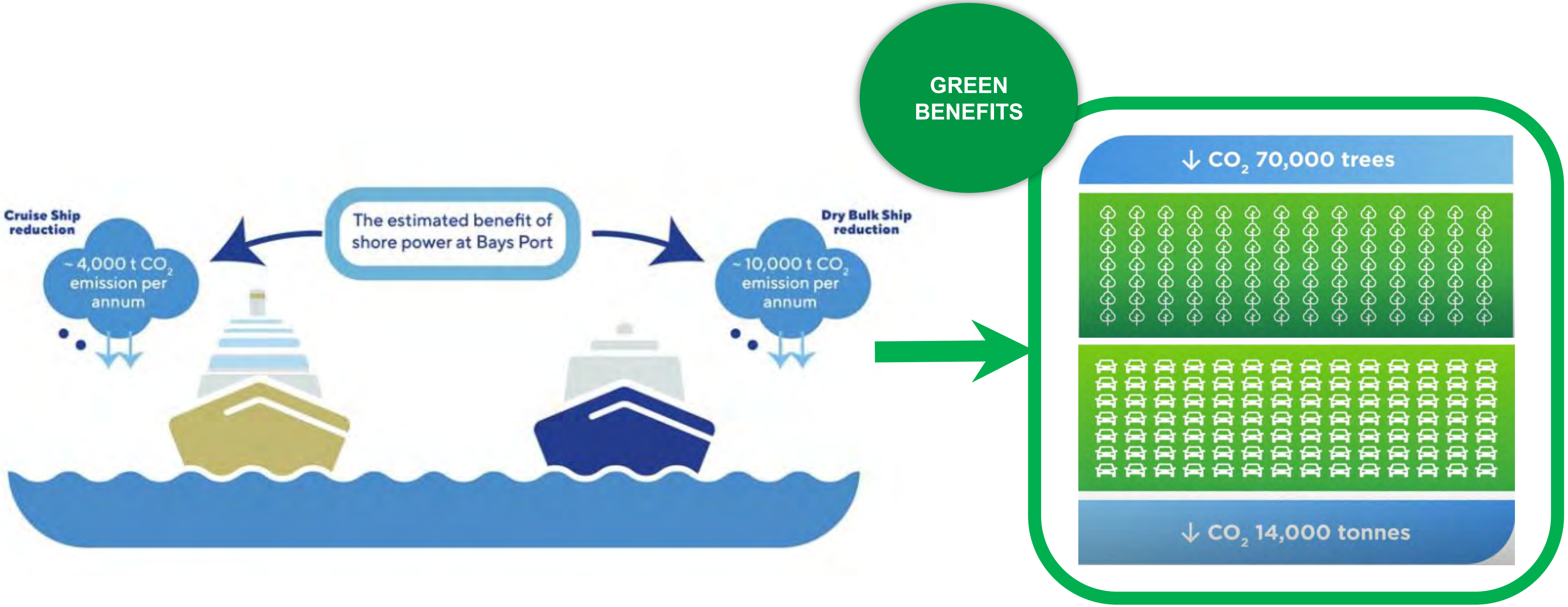
first in the Southern Hemisphere

for a cruise terminal.

OBJECTIVES

- Demonstrate industry commitment
- Support NSW Government, Port Authority & industry Net Zero target
- Deliver a **world-class infrastructure** upgrade
- Reduce noise and local air emission
- **Sustainable port operation** – leader in sustainability, license to operate

1 PROJECT OBJECTIVES



2 PROJECT JOURNEY

2022
March
Minister's announcement, signed MoU with key tenants/operators.

2022
June – December
Ausgrid, port and industry conversations.
Appointed design consultants.

2023
January – July
Complete concept design, EOI & RFT process.

Next steps:
Commence detailed design, fabrication and construction.

2024
December
GO LIVE – White Bay Cruise Terminal & Glebe Island 8!

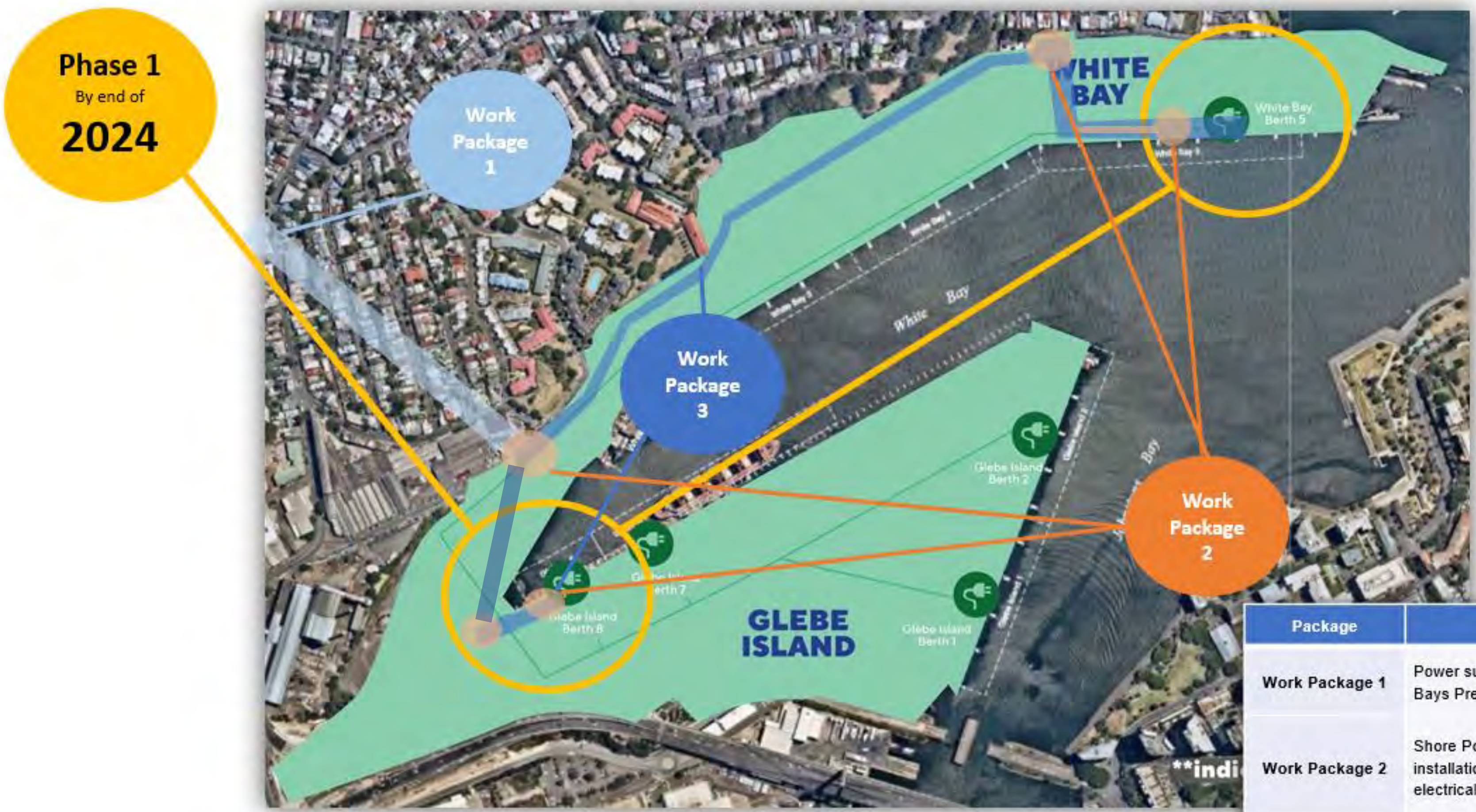

The Sydney Morning Herald

Carnival Australia senior vice-president Peter Little, left, Transport Minister David Elliott and Port Authority chief executive Philip Holliday at the White Bay Cruise Terminal on Monday. EDWINA PICKLES


PORT AUTHORITY
SHORE POWER
LETTER OF INTENT

3 PROJECT OVERVIEW

PROJECT OVERVIEW – PHASE 1 WORK & CONSTRUCTION STAGES



Package	Scope
Work Package 1	Power supply from Ausgrid substation to Bays Precinct
Work Package 2	Shore Power equipment supply & installation for WBCT and GI8 (inc. electrical design of internal network)
Work Package 3	Internal network civil works

PROJECT OVERVIEW – PHASE 2 WORK & CONSTRUCTION STAGES

Phase 2
By end of
2030

PROJECT OVERVIEW – SCOPE

WBCT - White Bay Cruise Terminal
15MVA, 50/60Hz, 6.6/11kV

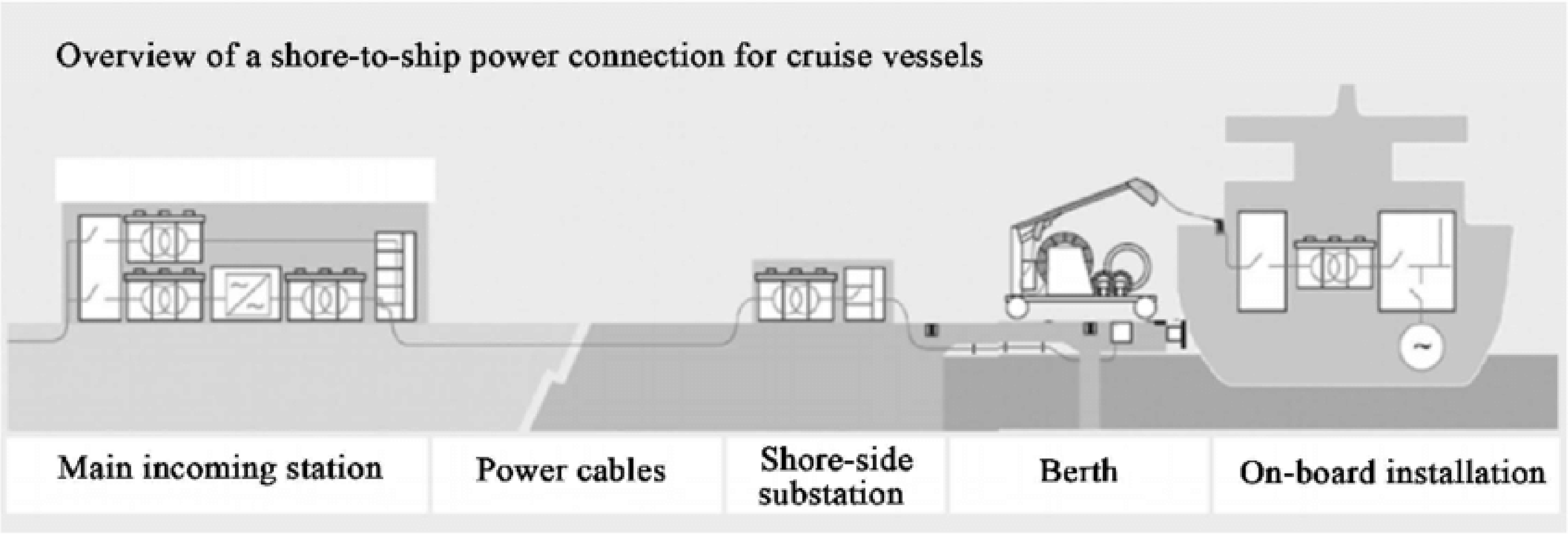
GI2 – Glebe Island 2
4.4MVA, 50/60Hz, 6.6/11kV

GI1 – Glebe Island 1
0.1MVA, 50/60Hz, 415V

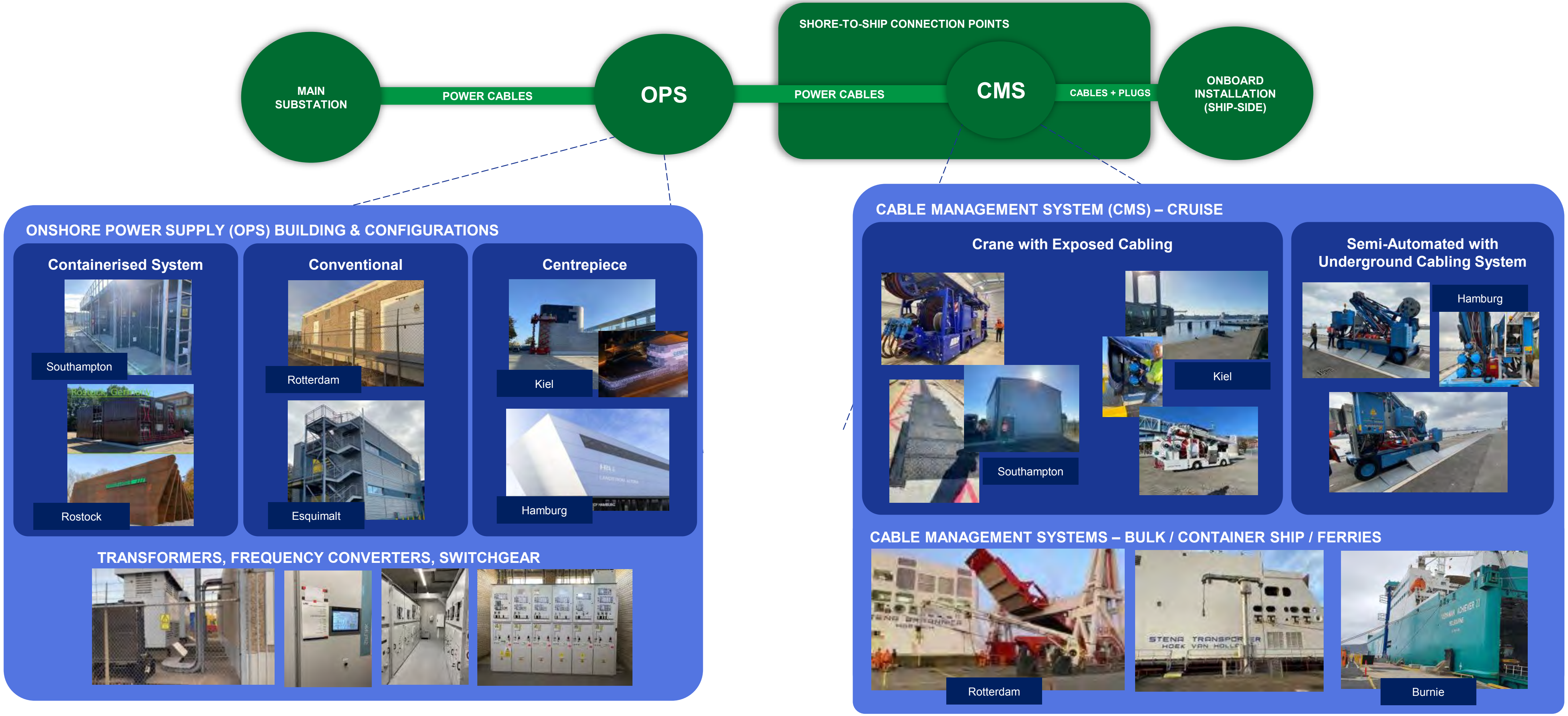
GI7 – Glebe Island 7
1.3MVA, 50/60Hz, 415V

GI8 – Glebe Island 8
4.4MVA, 50/60Hz, 6.6/11kV

3 PROJECT OVERVIEW – SHORE POWER COMPONENTS



3 PROJECT OVERVIEW – SHORE POWER COMPONENTS



3 PROJECT OVERVIEW – DESIGN & OPERATIONAL CONSIDERATIONS

Equipment Design
Substation / Onshore Power Supply (OPS) System

- **Temperature and noise control**
- Shore-side VS ship-side
- Switching gear to "**prove dead**"
- **Monitoring interface screen's** location
- Potential risks in connecting **wharf power socket in series**
- Modular and **expandable**
- Conversion location

Cable Management System (CMS)

- **Size of mobile unit/s**
- **Above ground wharf connection** points isolate areas of the wharf
- **Remote VS local** CMS operation panel
- Connection **plugs weight**
- **Point of failure** – Fibre optics and connection plugs/cables
- **Standardisation** of solution
- Connection time

Energy Sourcing

- **Energy consumption forecast**
- Electricity **source**
- Energy pricing

Operation / Safety

- **Switching location** (i.e., proximity to wharf)
- **Operation protocol** – clear connection procedures, electrical safety & switching rules
- **Personnel required** – cable connection, pits
- **System automation**

Maintenance

- **Planned maintenance** services
- Trained local personnel VS sub-contracting

PROJECT OVERVIEW – SHORE POWER JOURNEY WITH PORT AND MARITIME INDUSTRY

COMPLETED ENGAGEMENTS:

- 12 October 2022, **MIAL Maritime Decarbonisation Summit, Sydney** – CEO presentation on Shore Power
- 14 – 16 February 2023, **GreenPort Oceania Congress, Newcastle** – CEO presentation on Shore Power
- 03 May 2023, **Ports Australia, Logistics Working Group, Port Botany** – Project Team presentation on Shore Power project journey
- 17 – 18 May 2023, **Ports Australia, Engineering and Asset Management Working Group, Fremantle** – Project Team presentation on Shore Power technical details
- 12 – 13 July 2023, **Asia Cruise Forum, South Korea** – CEO presentation on sustainability initiatives including Shore Power and port noise management

FUTURE ENGAGEMENTS:

- September 2023, **Ports Australia Business Operations Conference** – Project Team presentation on Shore Power inception and journey
- October 2023, **International Electrotechnical Commission (IEC/IEEE) Shore Power Standards Annual Committee Meeting, Seoul, South Korea** – Project Team invitation to represent Oceania / Asia Pacific at International Shore Power Committee for Technical Standards Formation
- October 2023, **IMO OPS Workshop, Mumbai** – Starcrest (Shore Power emissions consultant) presentation about Bays Port Shore Power Project and showcasing the precinct as a case study

4 NEXT STEPS

- **2023**
  January – February
  Complete concept design & EOI process.
- **2023**
  April – July
  RFT for Shore Power equipment design, fabrication and installation (Work Package 2).
- Complete detailed design. Asia Pacific rep in International Standard (IEC/IEEE) committee.
- Construction, testing and certification.
- **2024**
  December
  GO LIVE – White Bay Cruise Terminal & Glebe Island 8!

Q&A SESSION

CRAIG WILSON

Craig is a sustainability and environmental management professional with over 20 years of experience in the maritime transport industry having worked at the Ports of Townsville, Port Hedland and now Brisbane. Craig holds a Bachelor Degree in Applied Science and a Masters Degree in Environmental and Business Management.

Throughout his career Craig has been exposed to a wide cross section of environmental management and sustainability challenges including the development of key corporate environmental and sustainability strategies.

Craig is passionate about the environment and has used his position to develop award winning innovative solutions to environmental management and sustainability problems that not only deliver better environmental outcomes but also better financial and social outcomes.

OPS FEASIBILITY STUDY OUTCOMES PORT OF BRISBANE

Port of Brisbane Pty Ltd (PBPL) is the manager of the Port of Brisbane under a 99 year lease from the Queensland State Government. PBPL has a strong sustainability focus with sustainability embedded in Business Strategy through our four pillars; People, Planet, Prosperity and Partnerships. Our Sustainability Program is aligned with the UN Sustainable Development Goals and is focused on delivering ambitious 2030 targets.

Emissions reductions is a key focus for PBPL. We have achieved significant reductions in our Scope 1 and 2 emissions and expect to be net zero this financial year. We are now focusing our efforts on Scope 3 emissions.

Emissions from commercial shipping make up 55% of our Scope 3 emissions with nearly a quarter of our total Scope 3 emissions from ships alongside a berth. Shore power is viewed as a potential option for reducing our Scope 3 emissions.

The Brisbane International Cruise Terminal (BICT) is a logical focus for shore power being shore power ready and with a strong interest in shore power from the cruise industry. PBPL is undertaking a feasibility study to investigate the risks and opportunities of installing shore power at the BICT including investigating the potential for local renewable energy generation.

Shore Power Feasibility at the Port of Brisbane

Craig Wilson
Head of Sustainability

Tuesday 15 August 2023

PORT of BRISBANE
Here for the future

Acknowledgement of Country

Port of Brisbane Pty Ltd acknowledges the Traditional Owners of the lands and waters on which the Port of Brisbane operates – the Quandamooka, Turrbal and Yuggera peoples – and pay our respects to their Elders past, present and emerging. We acknowledge any First Nations people in attendance today.

Artwork: Journey through the bay to the river, 2020.
Created by Delvene Cockatoo-Collins.

Agenda

Our business and operations

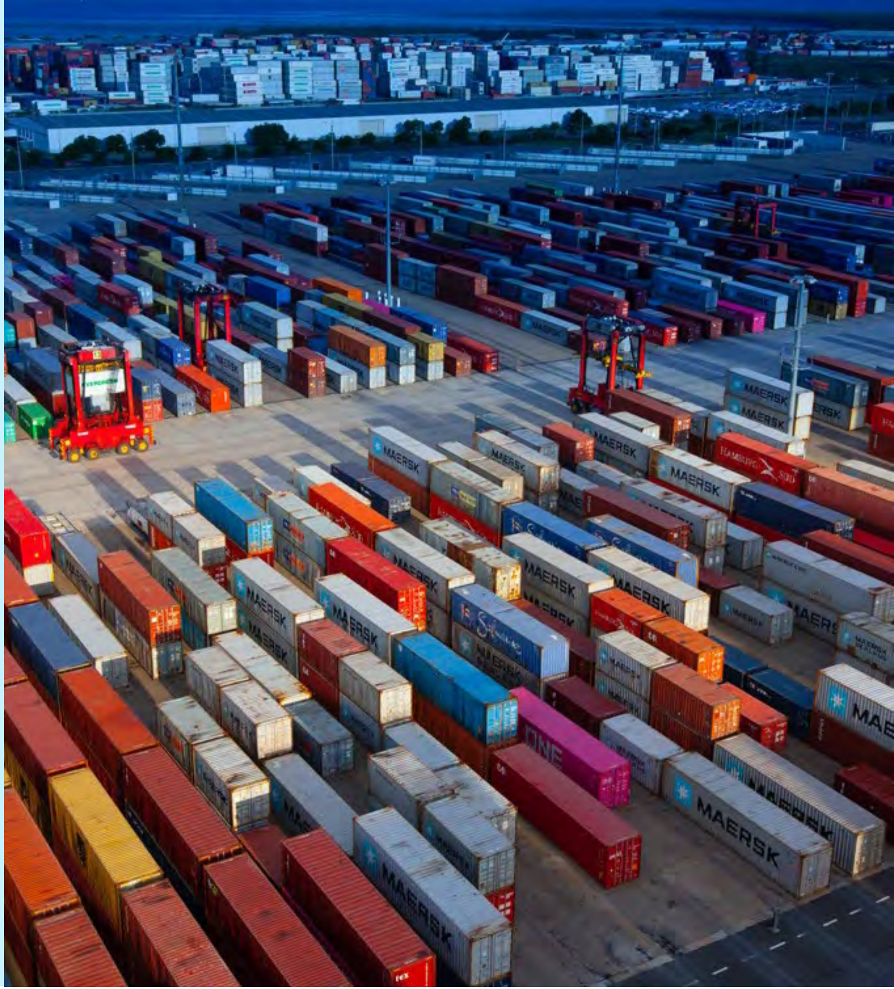
Sustainability and energy transition

The drivers for shore power

Shore power at the Port of Brisbane

Shore power feasibility – risks and opportunities

Summary



Port of Brisbane Pty Ltd

A world-class port

- Queensland's largest multi-cargo port
- Approx. $1 billion invested in capital works since 2010
- One of only three Australian ports to handle 8,500+ TEU container vessels
- Leading environmental innovation
- State-of-the-art hydrographic surveying technology
- Manage one of SEQ's largest industrial property portfolios
- Robust health and safety management systems

Ownership structure

- Privatised since 2010 under 99-year leases from the Queensland Government
- Owned by four of the world's most experienced infrastructure investors:
  - Caisse de dépôt et placement du Québec
  - QIC
  - ADIA
  - IFM Investors

2022/23 trade overview

A record
1.56m
containers

33.5m
tonnes of **cargo throughput**

Approx.
95%
of Queensland's **containerised trade** and 90% of its motor vehicle imports

19%
of Australia's **east coast port container** throughput

Approx.
$55b
in **international trade** annually

Approx.
50%
of Queensland's **agriculture exports**

Sustainability

Sustainability Program

Our Sustainability Program, which is at the core of our business strategy, is aligned with the United Nations’ Sustainable Development Goals (UN SDGs). Fourteen of the 17 UN SDGs are relevant to our business.

Sustainability Achievements

In 2022 and for the third year running, Port of Brisbane achieved a 5-star GRESB rating for infrastructure assets (Global Real Estate Sustainability Benchmark) and was the second highest ranked port company in the Other Port: maintenance and operation category. Our overall score was 94/100.

Sustainability Report

Our annual Sustainability Report provides an overview of how we are progressing against our sustainability agenda and is available on our website.

Sustainability Program

- Our Sustainability Strategy (April 2019) was developed following the significant global transition to consider environmental, social and governance factors in business performance.
- The Strategy sought to enable responsible growth, by adopting a ‘whole of business approach’ which adds value to our business by delivering balanced financial, social and environmental outcomes at the Port of Brisbane.
- The Strategy is focused on our 4P’s framework which each have a goal to be achieved by 2030:
  - Planet: achieve net positive environmental benefit
  - People: create an engaged, diverse and responsive culture
  - Prosperity: deliver efficient and sustainable economic growth
  - Partnerships: enable responsible growth
- Since its inception, the Sustainability Strategy has been incorporated into the Business Strategy and now reflects a program to ensure transition and achievement of the 2030 goals.
- These goals are being delivered through the Sustainability Program and through focus areas which align to our business operations and the UN SDGs

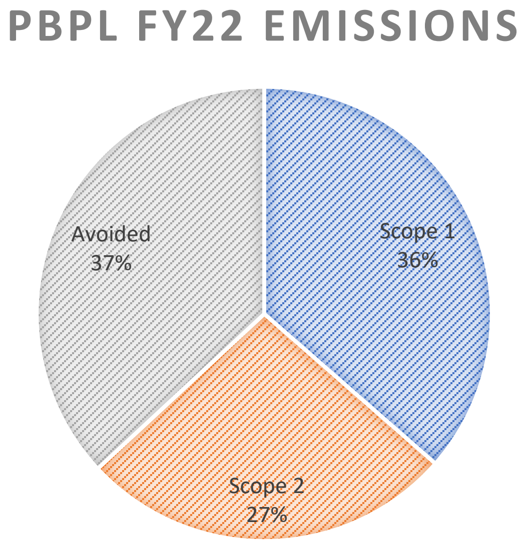
Energy Transition

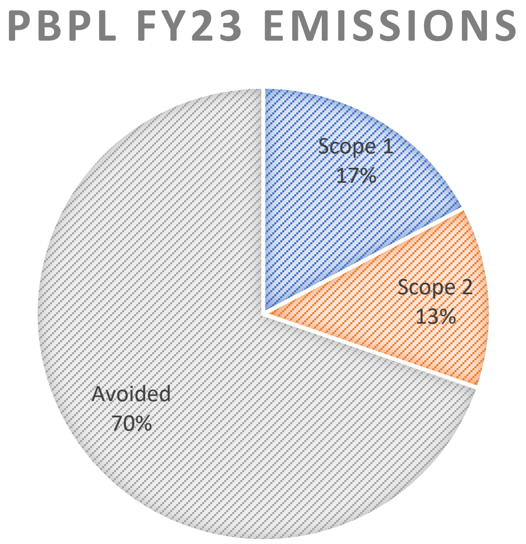
PBPL has an ambitious emissions target of net zero by 2030

Initiative	Progress
Scope 1 and 2 emissions	Clear reductions achieved with various initiatives implemented
Renewable PPA	100% renewable PPA in place (Momentum Energy – Jan 2023) / long term planning ongoing
Generation capacity	VEN operational / 1.3MW of solar installed / 600kW on tenanted assets ~25% of total electricity consumption provided by onsite generation
Scope 3 emissions	Identification complete / initial measurement undertaken and reported / influence across key port users commencing
Assets/Buildings/EEM	5 star green star builds completed / lighting conversions/ energy efficiency
Fuel sources	Bio-fuel trail successfully completed / AMPOL carbon neutral fuel in use (bulk and fleet)
Carbon value	Blue carbon assessment completed across port controlled lands / Biodiversity enhancement and rehabilitation program developed
Sustainable financing	Sustainability linked loan secured / 3 meaningful measures incorporated (emissions/biodiversity/people) / action plan in place to deliver

Energy Transition

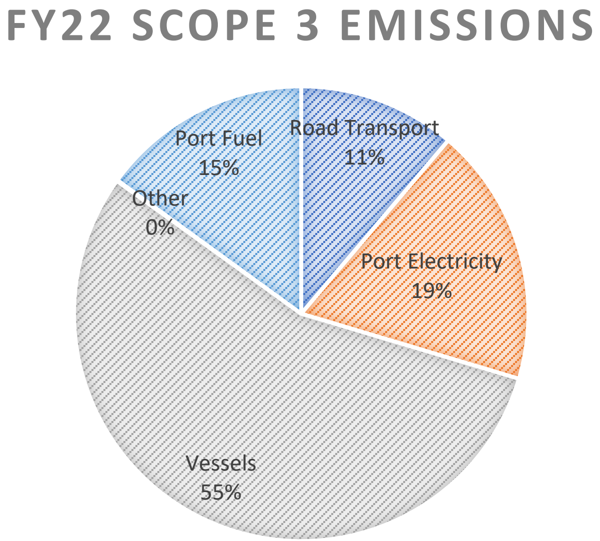
We have made significant progress on reducing our Scope 1 and 2 emissions.





Scope 3 Emissions

We reported our Scope 3 Emissions for the first time in FY22. 97% of our emissions are Scope 3.



- Our focus is shifting from Scope 1 and 2 emissions to recording, reporting and influencing Scope 3 emissions.
- Over half of our Scope 3 emissions originate from shipping activities. The remainder are made up of road transport and port fuel and electricity use.
- Other includes emissions from construction, waste and staff commute and business travel.

The focus on shipping

Emissions from shipping make up 55% of our Scope 3 emissions.

- Shipping is an obvious target for Scope 3 emissions reduction (55% of total Scope 3 emissions)
- Shipping emissions are estimated using the RightShip Maritime Emissions Portal. Emissions are calculated across four modes of operation – anchorage, transit, maneuvering and alongside
- 41% of all shipping emissions occur whilst vessels are alongside making up just under a quarter of our total Scope 3 emissions.

Why shore power?

Nearly a quarter of Port of Brisbane Scope 3 emissions are from vessels alongside a wharf.

- Shore power is seen as a potential solution to reducing shipping emissions whilst alongside (switching from burning fuel to electrification)
- Given nearly a quarter of our Scope 3 emissions are from vessels alongside a wharf, it is a clear target for Scope 3 emissions reduction.
- Other ports also focusing on shore power (Port Authority of NSW, Port of Melbourne). Consistency of delivery across Australian Ports may expedite take-up.
- Port of Brisbane does not have other significant drivers such as air quality.

Shore Power at the Port of Brisbane

Historically we have not seen much benefit or demand for shore power; this is changing.

- We have historically included provision for shore power within wharf infrastructure (e.g. electrical conduits and pits)
- Previous investigations identified limited emissions reductions benefit from shore power due to grid carbonization. There were localised air quality benefits.
- Some interest from shipping lines for shore power however limited.

Shore power feasibility

We have identified the opportunity for the installation of shore power at our new cruise facility.

- Review of shipping appetite for shore power has identified that the cruise industry appears to be most advanced in Australia (largely as a result of pressures in Sydney)
- Cruise vessels have the largest electricity demand of vessels whilst alongside (and largest emissions profile)
- The new Brisbane International Cruise Terminal (BICT) is shore power capable with electrical conduits and pits built into infrastructure
- Some risks around the adequacy of the local electricity network infrastructure

Shore power feasibility study

PBPL have contracted Arup to undertake a detailed study into the feasibility of shore power at BICT.

Local Energy Network Analysis	BICT Precinct Instructure Analysis	Cruise Industry Analysis	Concept Design Options Development	Business Case Development
a. Capacity of the electricity network b. Capacity of the zone substation and bulk supply network c. Network upgrades and connection options required to support shore power d. Network operator appetite to support a large network connection for shore power	a. Analysis of local electrical network and civil infrastructure b. Wharf infrastructure capability for shore power	a. Analysis of vessels visiting BICT b. Determine range of energy demand across vessel fleet c. Analysis of current shore power readiness of vessels d. Analysis of shore power requirements and how this will influence design e. Appetite within the industry to both use shore power and retrofit vessels if required	a. Undertake high level concept design of required infrastructure, including locality and recommended network connection/upgrade	a. Provide estimate of costs of infrastructure b. Identify likely cost recovery mechanisms from shipping

Energy supply

The key driver for installing shore power is emissions reductions

- Emissions reductions is the key driver for shore power.
- An additional element of the feasibility study is to investigate opportunities for the use of locally generated renewable energy.
- This may include local solar generation in combination with storage or other potential sources such as waste to energy.
- Use of local sources of renewable energy generation would also minimize the impact on the local energy network.

Summary

- PBPL has a strong sustainability focus with sustainability embedded in our Business Strategy and a Sustainability Program focused on delivering ambitious 2030 targets.
- Emissions reductions is a key focus for PBPL. We have achieved significant reductions in our Scope 1 and 2 emissions and are now focusing our efforts on Scope 3 emissions.
- Shipping emissions make up over 50% of our Scope 3 emissions. Nearly a quarter of our Scope 3 emissions are from ships alongside.
- Shore power is viewed as a potential option for reducing Scope 3 emissions. It will also provide local air quality benefits.
- The Brisbane International Cruise Terminal is a logical focus for shore power. The facility is shore power ready and there is a strong interest in shore power from the cruise industry.
- Our feasibility study will investigate the risks and opportunities of installing shore power at the BICT.
- Local renewable generation is seen as a key part of any shore power offering.

Thank you

PORT of BRISBANE
Here for the future

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SHORE POWER AUSTRALIA: CONTAINERS

- *Steve Wallace,*
  Port of Melbourne
- *Peter Engelen,*
  NSW Ports

STEVE WALLACE

Prior to joining the port in 2007 I had 20 years in the electricity industry in various roles including network planning, network reliability, network pricing and capital program management.

I have been at the Port of Melbourne for 16 years starting as the Investment Program Manager overseeing the development and monitoring of the delivery of the capital works program. In 2014 moved into the asset management space. In 2017 I was seconded to the ISO certification project with my focus being on ISO55000 Asset Management resulting in PoM being certified in 2019.

My current role is the Asset Planning Manager responsible for the strategic asset management function for PoM. I lead a team of nine responsible for the:-

- Management and development of the Strategic Asset Management Plan, Asset Management Plans and detailed engineering strategies in accordance with the requirements of the Port Concession Deed
- Management & maintenance of all elements of the asset management system to ensure continued certification to ISO 55000
- Development of the annual and 5 yearly capex remediation program
- Development and delivery of the annual condition assessment and monitoring program
- Administration & development of the asset management IT system

PORT OF MELBOURNE FEASIBILITY ASSESSMENT OF SHORE POWER

As part of the sustainability strategy, Port of Melbourne (PoM) is exploring options to reduce the scope 1, 2 & 3 emissions of the port and its users. With the forecast trade growth and extensive redevelopment activities outlined in the Port Development Strategy it is an opportune time to investigate the options and implications of the provision of facilities for shore power to assist industry in reducing PoM's scope 3 emissions.

PoM have engaged Arup to perform a high level assessment of the technical and commercial implications of installing shore power at selected locations taking into account such things as required electrical load, electricity network capacity and augmentation options (both PoM network and external Citipower network), high level estimates for the augmentation options as well as the cost of electricity and the identification of cost benefits from Government incentives and sustainability initiatives. The presentation will describe the investigations so far and the constraints and issues identified.

Port of Melbourne – Feasibility Assessment of Shore Power

Steve Wallace

Asset Planning Manager, Port of Melbourne

Port of Melbourne

Presentation overview

- Port of Melbourne context
  - Ownership environment
  - Regulatory environment
  - Physical layout – Current & Future
  - Sustainability
- Feasibility assessment
  - Context of the study
  - Scope
  - Considerations

Ownership environment

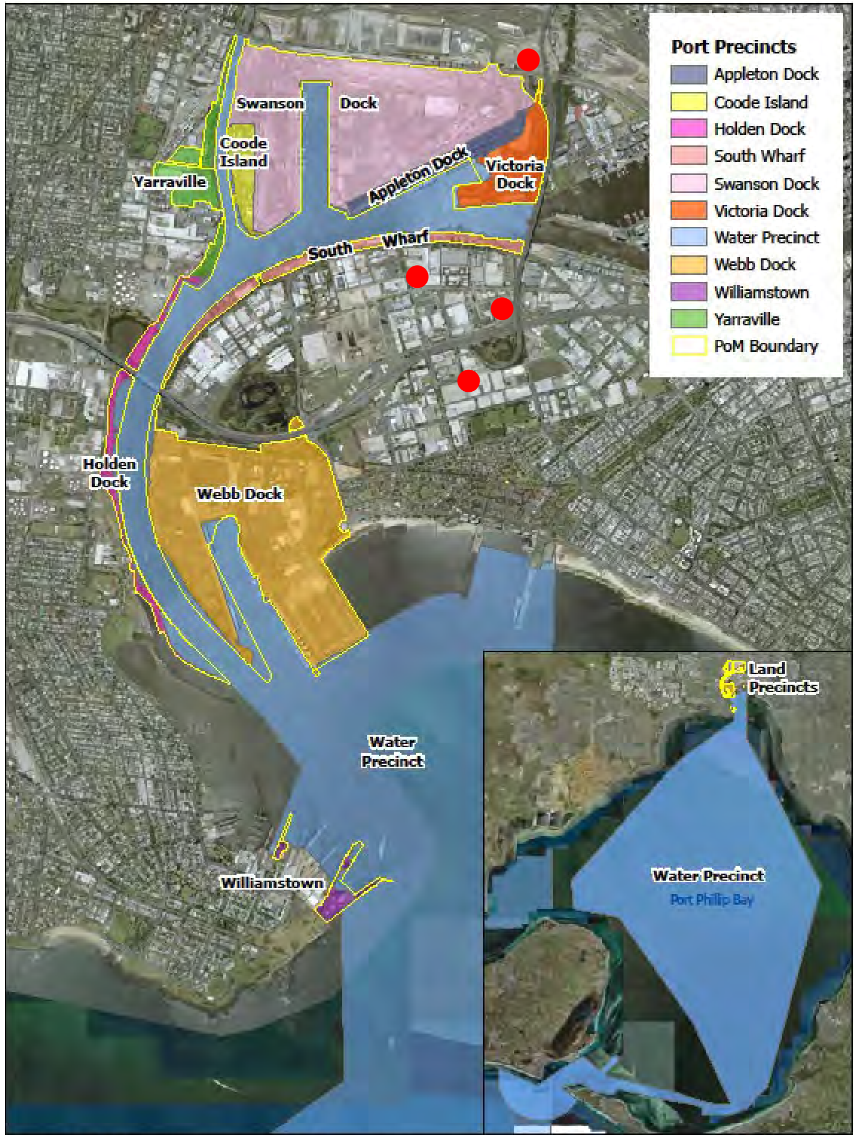
- 50 year lease sold to Lonsdale consortium
- Commenced 1 November 2016
- Lonsdale consortium consists of
  - QIC
  - Futurefund
  - Global Infrastructure Partners
  - OMERS
- Lease overseen by Port Lessor (Vic govt)
- Harbour Master, vessel traffic services & cruise shipping facility remained with the state (Ports Victoria)

Regulatory Environment

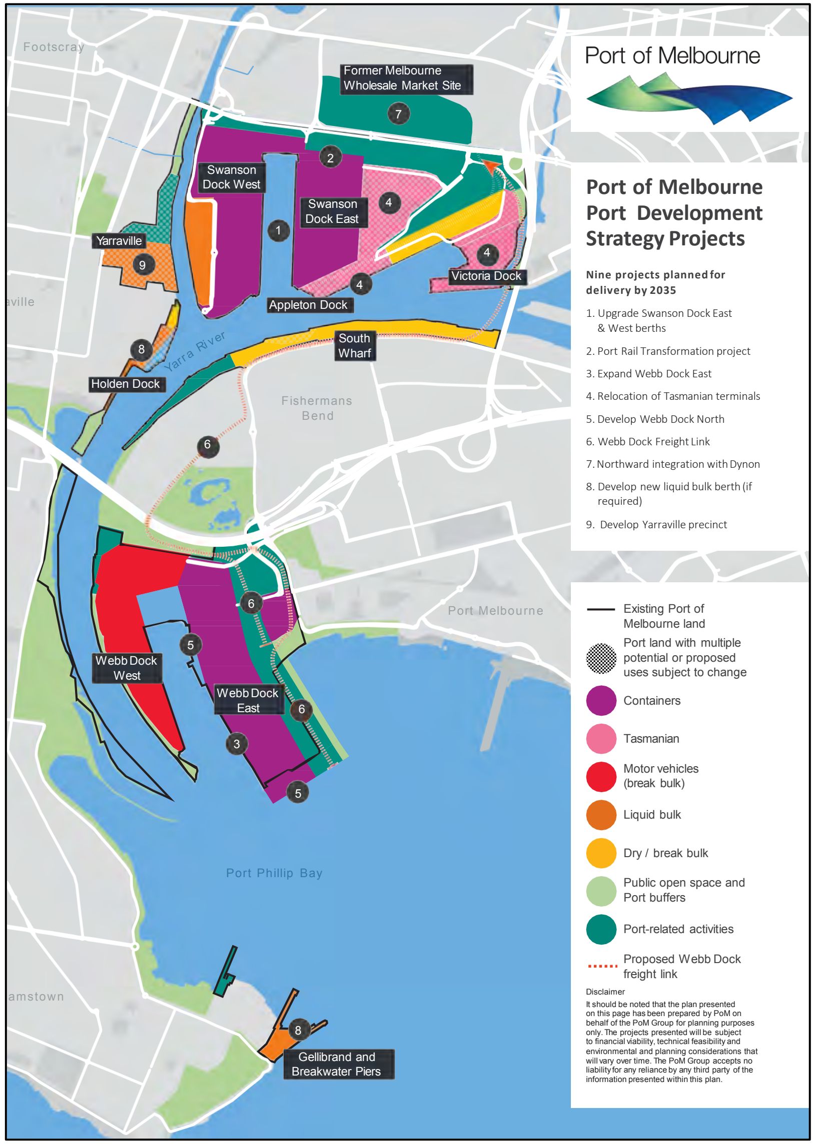
- Price regulated by the Essential Services Commission
  - Five year regulatory period
  - Prudent & efficient investment
- Port Concession Deed
  - Obligations regarding maintenance & repair
  - Remaining service lives
  - ISO55000 certification
    - AMPs
    - Asset register
    - Asset renewal expenditure program
  - Provision of asset information to Port Lessor

Physical Layout – Current & Future

Current

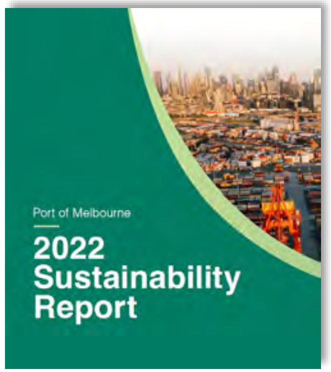


Future



POM sustainability context

POM has a Sustainability Strategy to manage a range of economic, social and environmental impacts. We publish an annual Sustainability Report and have a 5-star GRESB Infrastructure rating measuring our policies, risk management and performance.



Climate Change and GHG emissions are significant issues for POM and its stakeholders across government, port users and local Melbourne residents.

In FY23 POM set a **Net Zero target by 2030** for its own Scope 1 and 2 emissions.

But at a larger port-wide level beyond POM’s business, Scope 3 emissions are approximately 100 times greater and include vessel movements, land-side tenant operations, construction, road and rail transport. Vessels are POM’s largest Scope 3 emissions source.

Shore power is one major opportunity for POM’s infrastructure to reduce this impact, as vessel owners and operators also look for technology and fuel solutions.

Context of the feasibility study

- “pre” feasibility
- Understand the issues
- Understand the “order of” costs
- Understand the benefits
- Identify stakeholders
- Enable an informed decision on how to progress
- No commitment

Feasibility Assessment - Scope

Understand the technical & commercial implications of the provision of shore power in the context of sustainability and future port development

For the three existing container terminals, future container terminal, Tasmanian trade, cement facilities engaged Arup to:-

- Develop an incremental electrical load forecast
- Assess current electricity network capacity (internal & external network provider)
- Develop network augmentation options & staging
- Develop high level costing of options; capex & opex
- Assess options for purchase of green power
- Consider implications of different ownership models
- Consider cost of emissions for all options
- Investigate possible cost benefits from government incentives

Load forecasts

- Container vessels
  - Ship size/fleet forecasts
  - Base load of ship
  - Load per reefer
  - Reefers per ship
  - Load per ship
  - Number of ships at dock
  - Diversity of ships at dock
- Tasmanian trade
- Cement trade
- Citipower network forecasts
  - Only 5 year available
  - Organic growth
  - Large developments

Network Capacity

- Load vs capacity
  - N-1 considerations
  - Reliability considerations
- Internal PoM network
  - HV underground cables
  - HV switchgear
- External Citipower network
  - Current HV network capacity
  - Current zone substation & subtransmission network capacity
  - Current Citipower plans

Ship to shore connection

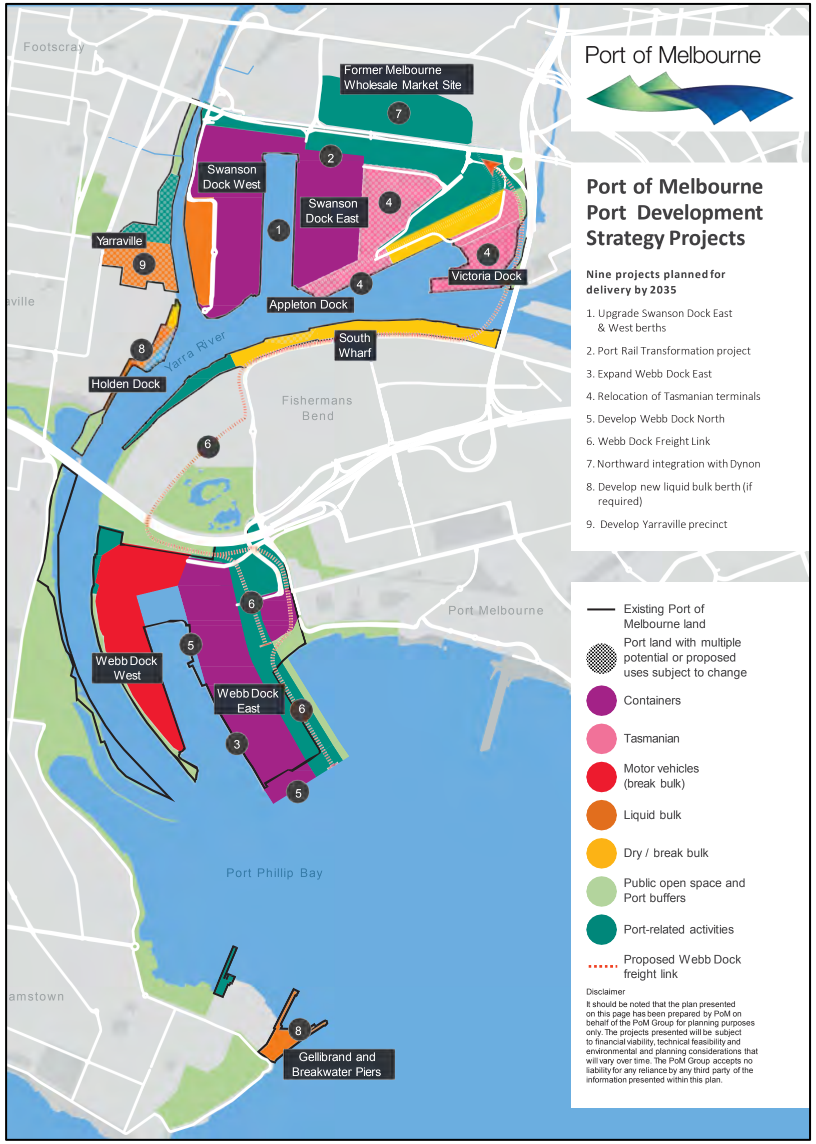
- Location of connection
- Impact on operations
- Ship orientation
- Frequency
- Voltage
- Connection equipment

Internal network augmentation Brownfield sites

- Brownfield sites
  - Swanson Dock – East & West
  - Webb Dock East
  - South Wharf
- Capacity of existing network
- Location of equipment
  - New HV lines & routes
  - New substations & switchgear
  - Frequency conversion equipment
  - Other utility services
- Minimise disruption to tenant operations during construction
- Minimise disruption to tenant operations during operations & maintenance

Internal network augmentation Greenfield sites

- Greenfield sites
  - Webb Dock North
  - Appleton/Victoria
  - "Swanson Dock West"
- Consider in concept & detailed designs
- Location of equipment
  - HV lines & routes
  - Substations & switchgear
  - Frequency conversion equipment
- Minimise disruption to tenant operations during operations & maintenance



External network augmentation

- Possible Citipower network augmentation
  - Zone substation
    - Additional transformer(s)
    - New zone substation(s)
    - Ownership/point of supply
    - Available footprint
  - Subtransmission
    - Line routes
  - HV feeders
    - Line routes
- Alternative sources

Costs & benefits

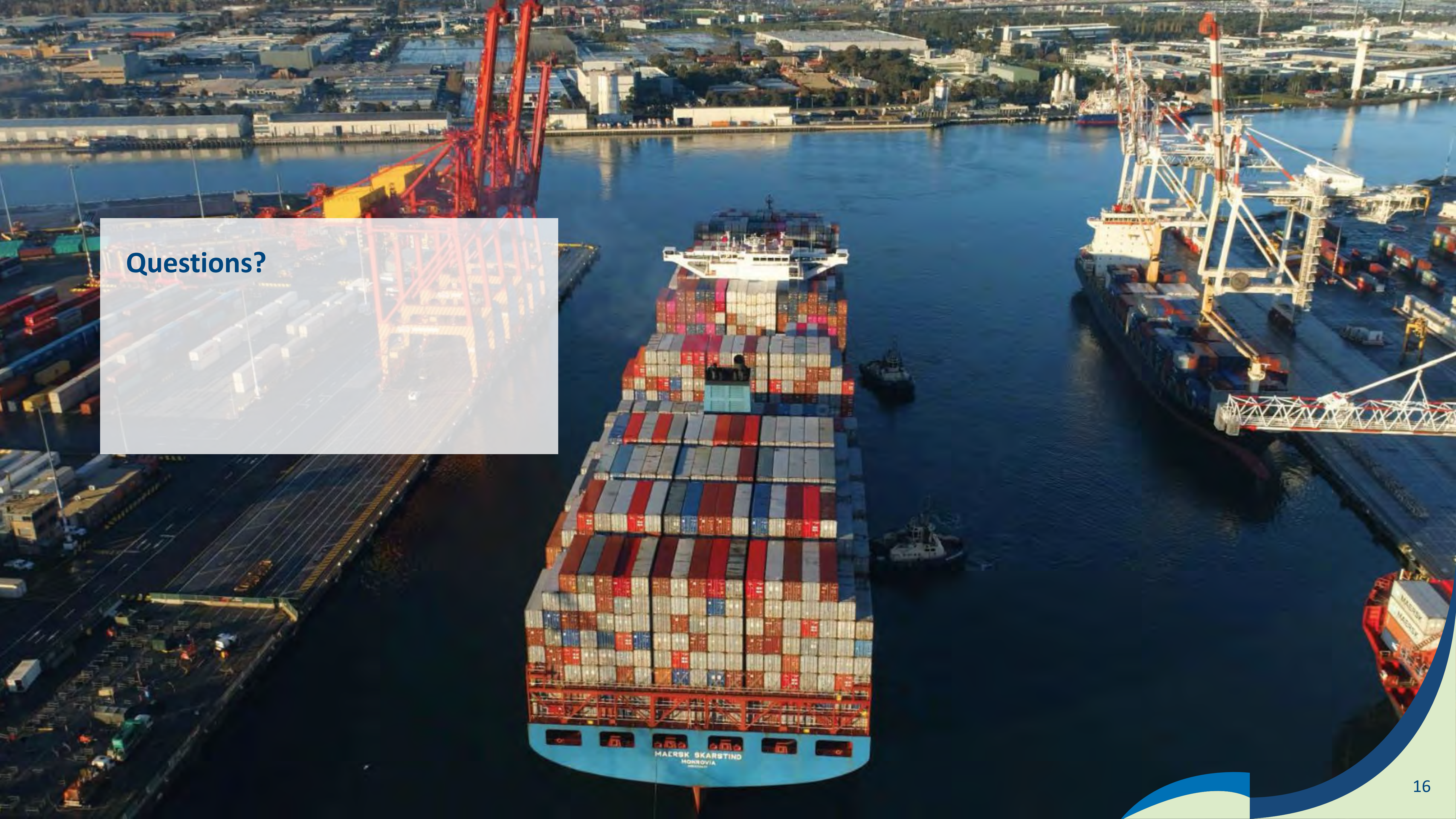
Costs

- Internal augmentation
- External augmentation
  - Customer contribution considerations
    - Advancing existing plans
    - Load curve
    - Contribution calculation
    - Capex/opex?
    - Regulatory pricing considerations
    - Cost of electricity
- Understand cost of emissions for all options

Benefits

- Purchasing green power
- Government subsidies

Questions?



Thank you

Steve Wallace
Asset Planning Manager

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steve.wallace@portofmelbourne.com

Port of Melbourne

PETER ENGELEN

Peter is General Manager Infrastructure at NSW Ports and oversees the strategic planning, development and maintenance of NSW Ports' infrastructure assets at Port Botany, Port Kembla and the Cooks River and Enfield Intermodal Logistics Centres. Peter has 26 years experience in the planning, design and delivery of port development projects. Peter is passionate about delivering on decarbonisation initiatives.

Peter is deputy chair of PIANC Australia New Zealand.

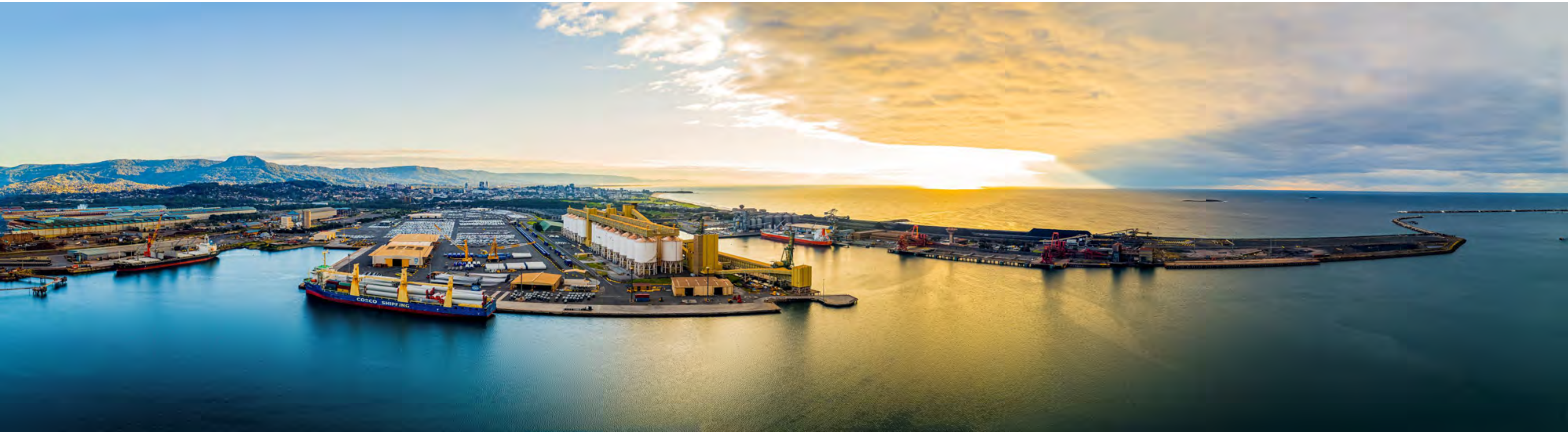
CONSIDERATIONS FOR SHORE POWER PILOT AT PORT BOTANY

NSW Ports is mapping the carbon emissions at the port precincts of Port Botany and Port Kembla, and is investigating the role of shore power as part of a decarbonisation roadmap. The presentation will discuss the findings of an industry working group set up in FY23 into the feasibility of onshore power supply at a container berth at Port Botany.

NSW Ports

Onshore Power Supply Pilot study

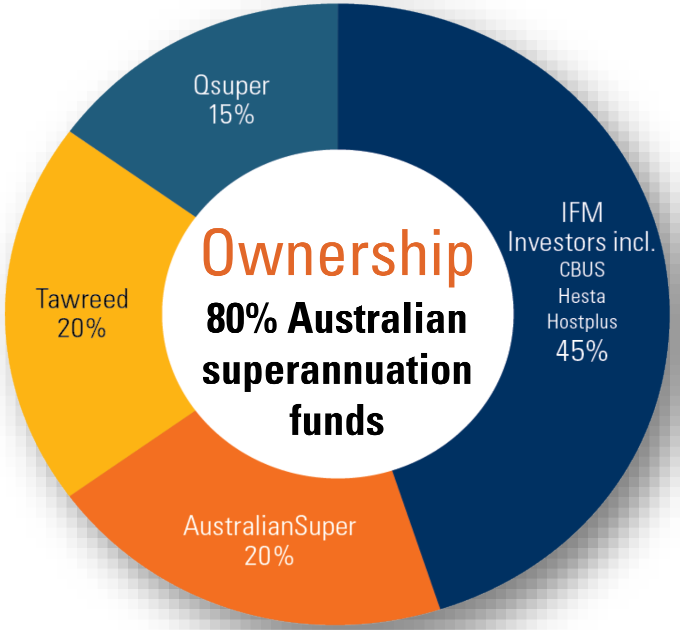
Agenda



NSW Ports
Strategic context
Port emissions
Working group
Shore power analysis
Next steps

About NSW Ports

Who we are



Australian superannuation fund owners represent over 6 million Australians

Port Botany: NSW's critical trade gateway

- **1500 vessel per year**
- **Significant capacity for growth**
  - 2.8 million TEUs current throughput
  - Capacity >7m TEUs
- **Deep water shipping channel**
- **Large vessel capability** – 15,000 TEU ships
- **Three independent container terminals** with 12 berths (DP World Australia, Patrick Terminals and Hutchison Ports)
- Only port in Australia with **on-dock freight rail at each container terminal**
- Proximity to population of Greater Sydney and empty containers for regional exporters
- Location leverages connectivity to road / rail infrastructure investments

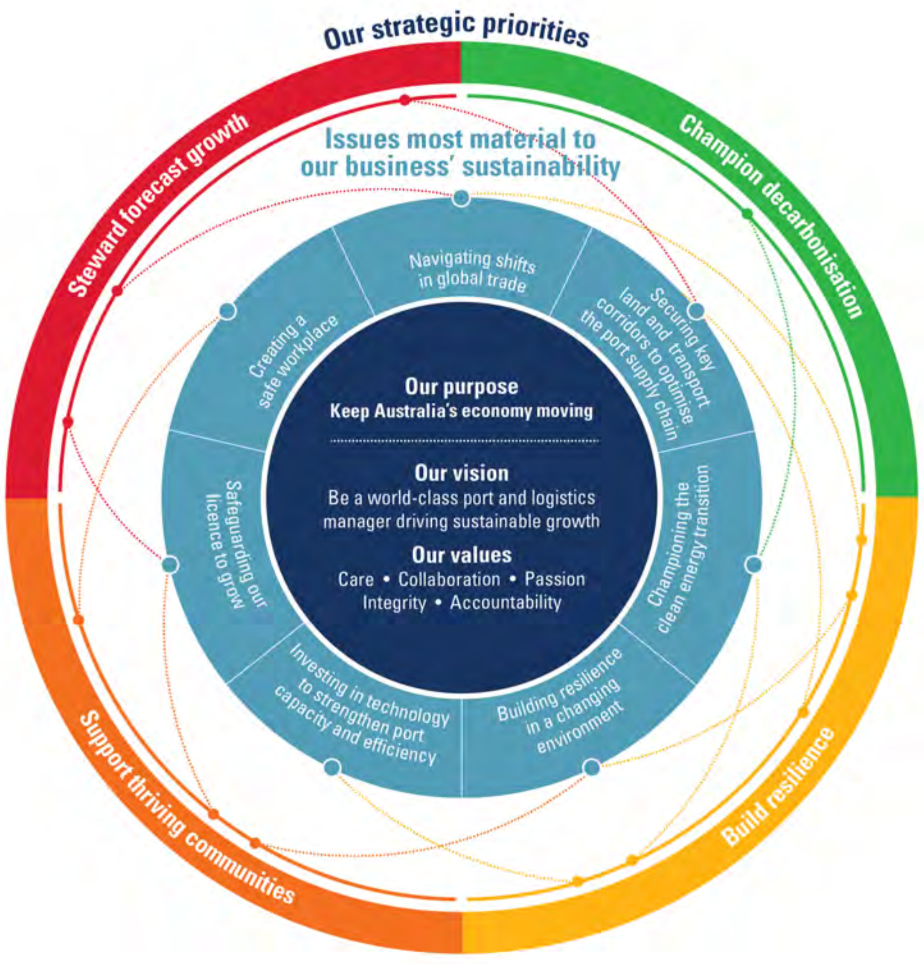
Port Kembla: NSW's port of growth

- **900 vessel per year**
- **18 berths handle diverse cargo** – motor vehicles, agricultural, mineral, liquid and construction cargo
- **Largest export grain terminal** on Australia's east coast
- Services the State's southern and western coalfields
- **Deep water shipping channel and berths**
- **Road and rail network** connected to Sydney and regional NSW
- Home to **100% of NSW's motor vehicle imports**
- **Next closest port to Sydney** (after Port Botany) - close to growing populations of south-west Sydney (67km), western Sydney (90km) and Illawarra
- **NSW's next container terminal** once Port Botany nears capacity

Onshore Power Supply

Strategic context and emission reduction

Strategic context

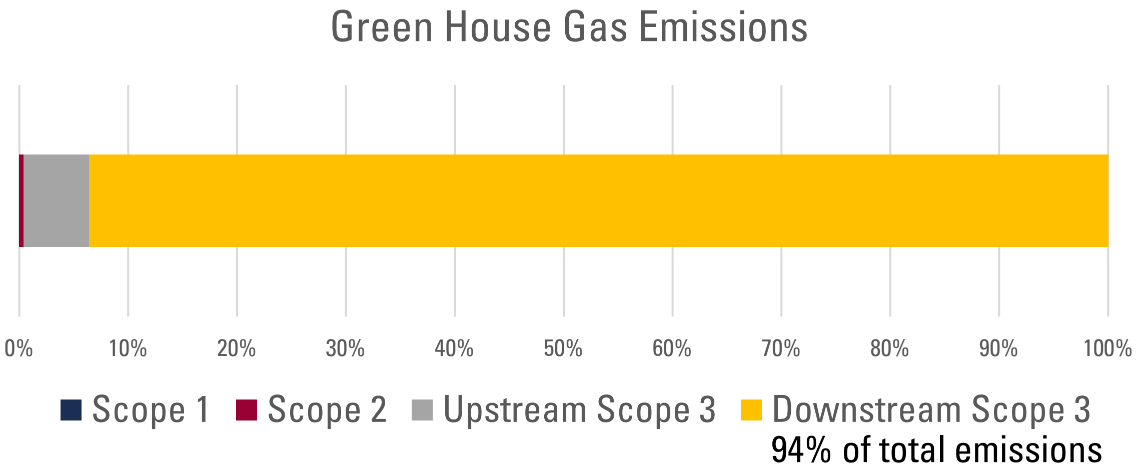


Reduce Green House Gas emissions

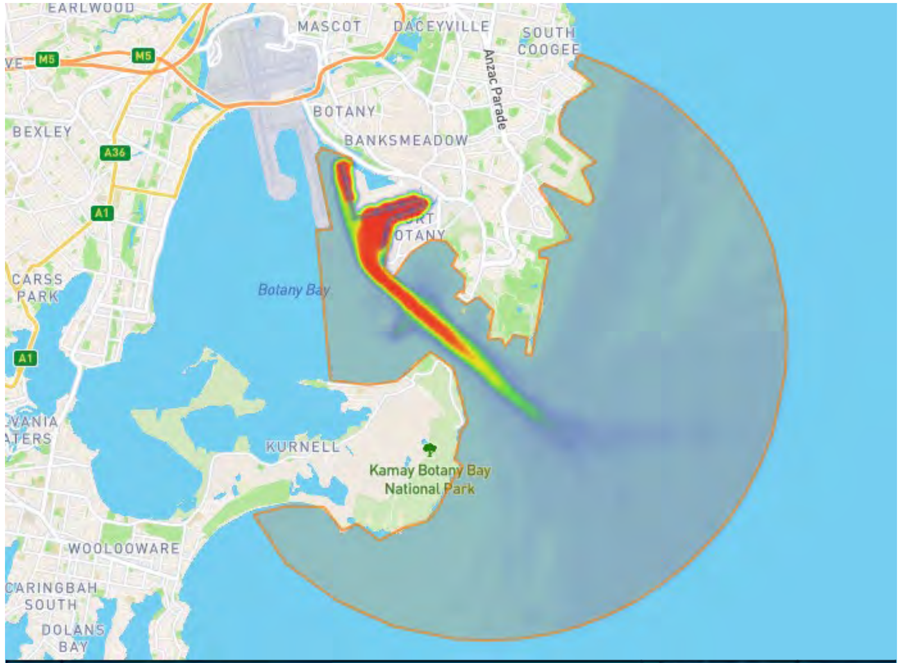
Reduce noise impact

Improve local air quality

Scope 123 emissions

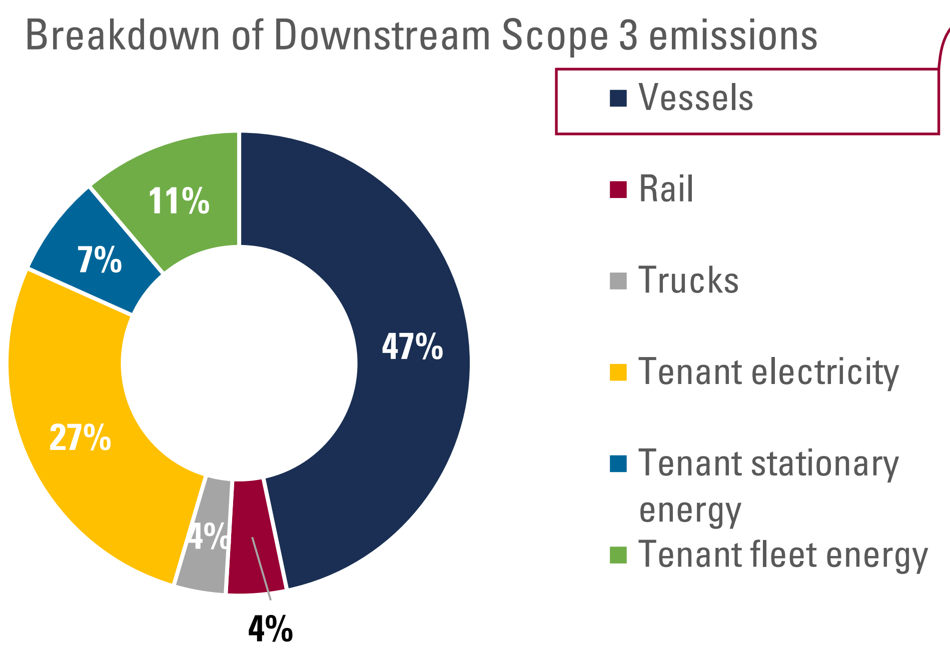


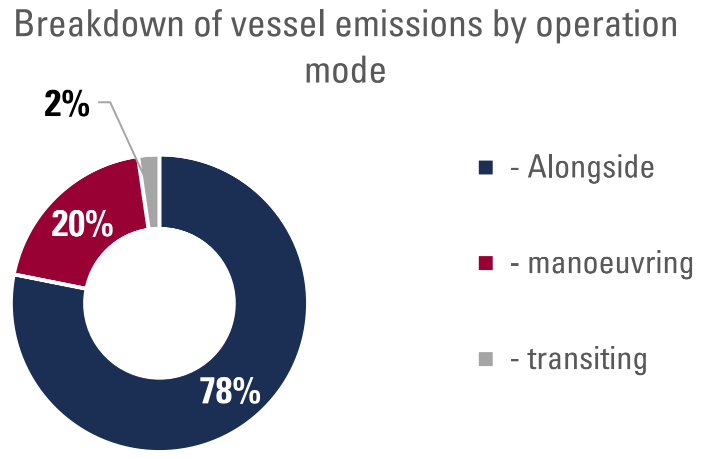
FY22 scope 3 emissions was 343,544 tCO2e: 99.6% of total emissions.



	GHG Protocol Category	FY22 Emissions (tCO_2-e)	%
Upstream Activities	1. Purchased goods and services	6,707	2%
	2. Capital goods	13,637	4%
	3. Fuel and energy related activities	149	0%
	4. Upstream transportation and distribution	n/a	n/a
	5. Waste generated in operations	51	0%
	6. Business travel	7	0%
	7. Employee commuting	82	0%
	8. Upstream leased assets	n/a	n/a
Downstream activities	9. Downstream transportation and distribution	n/a	n/a
	10. Processing of sold products	n/a	n/a
	11. Use of sold products and services (vessels, trucks & trains)	176,037	51%
	12. End-of-life treatment of sold products	n/a	n/a
	13. Downstream leased assets (tenant fuel and electricity)	145,494	43%
	14. Franchises	0	0%
	15. Investments	0	0%

Emissions from vessels alongside

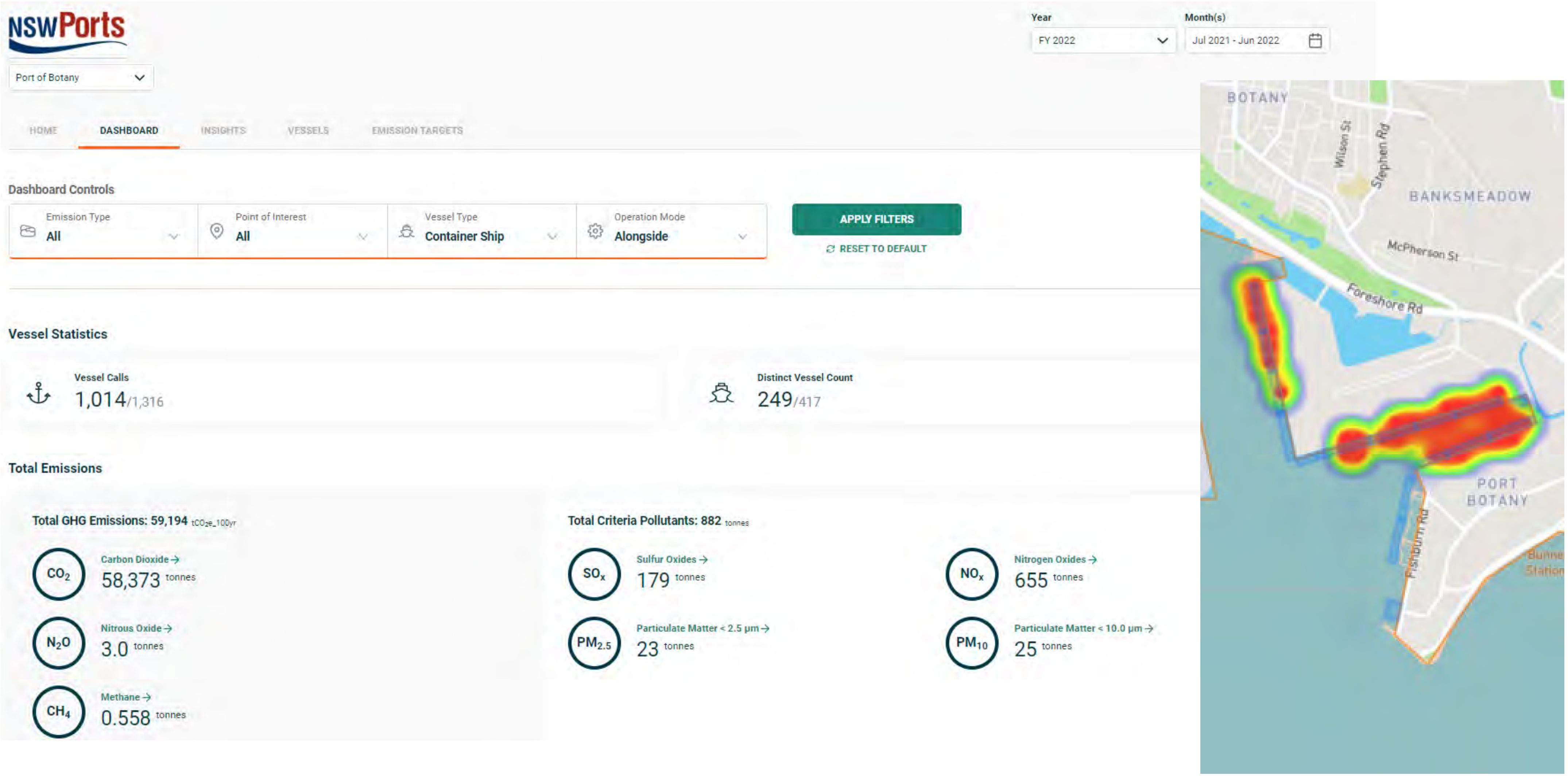




Vessel emissions alongside = 35% of total GHG emissions

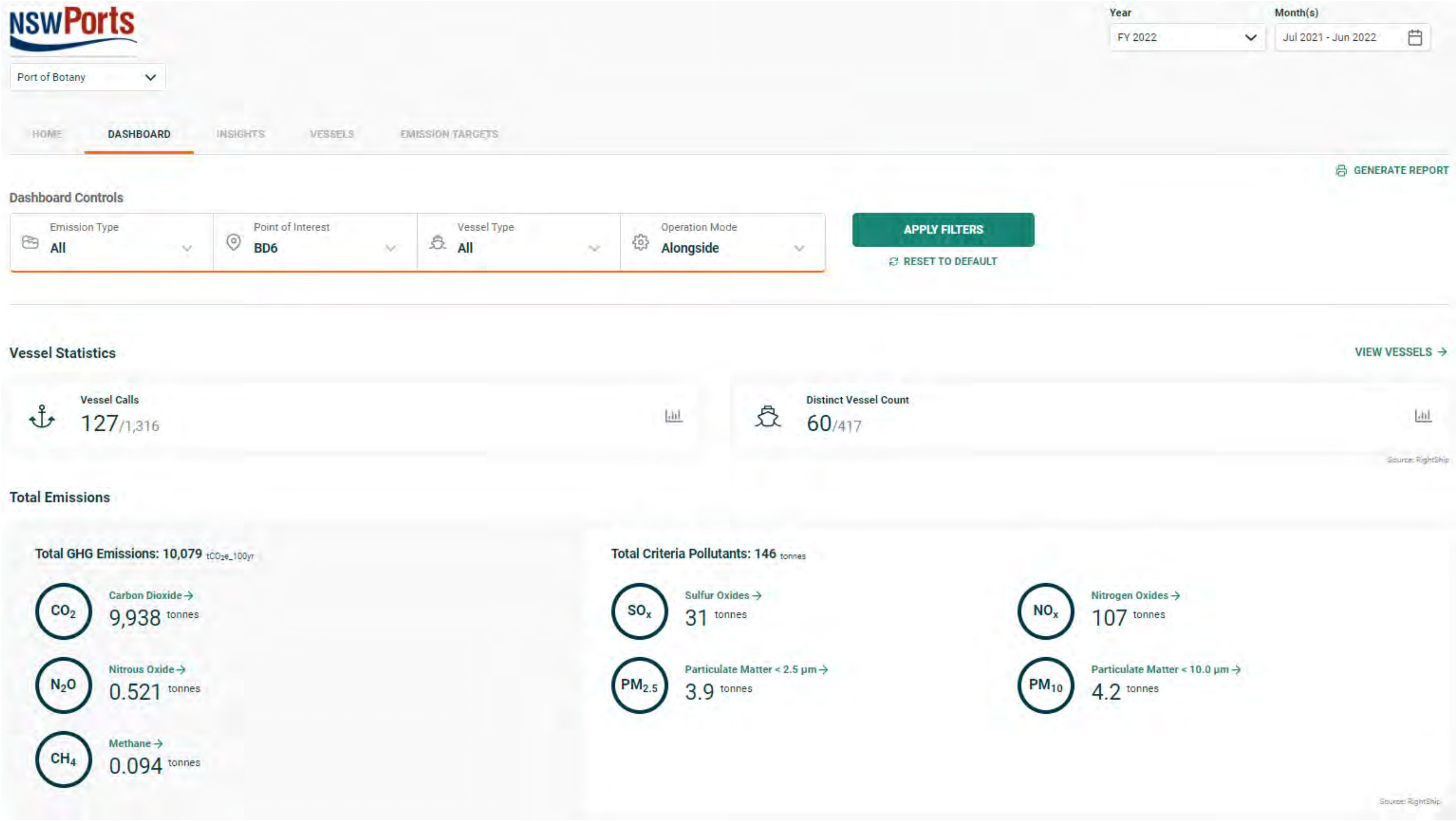
Onshore power supply is the single biggest tool to reduce emissions at the port

Vessel emissions monitoring

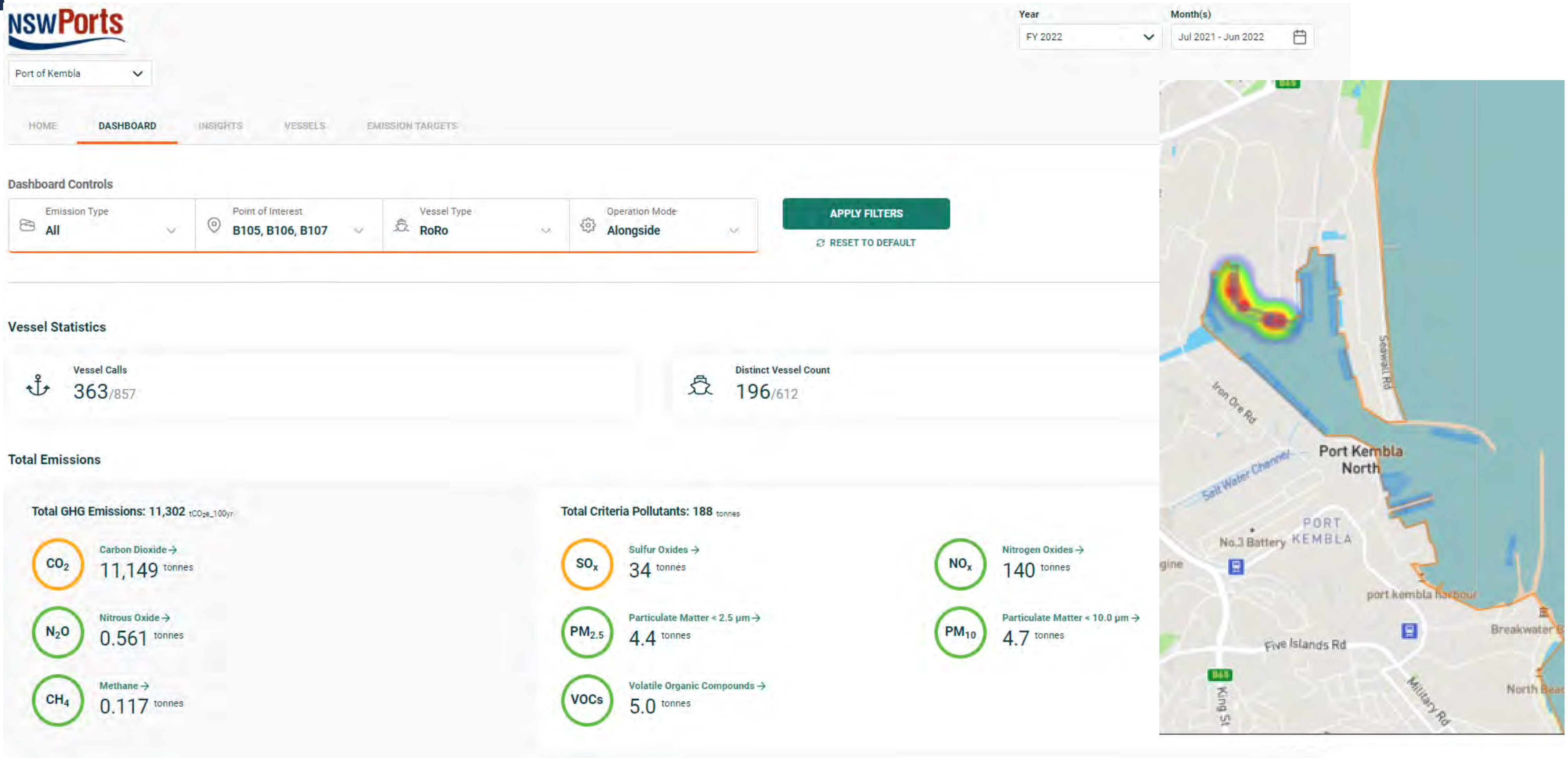


https://rightship.com/solutions/ports-terminals/maritime-emissions-portal

Vessel emissions monitoring



Vessel emissions monitoring



Working Group OPS Pilot

Working Group OPS Pilot

Parties: NSW Ports
Hitachi Energy
Cavotec
Real Assets Advisory and Finance

Stakeholders:
Ports (Port of Los Angeles, Port of Vancouver, Port of Rotterdam)
Shipping Lines (MSC, CMA CGM, Maersk, PIL)
Utilities (Ausgrid, Energy Australia, PLUS ES)
Stevedores (Patrick, DP World)

Scope: Stakeholder engagement, data collection, develop high-level feasibility concept of infrastructure and operational/commercial models. No obligation to proceed to implementation. FY23.

Port Botany

NMS
HD-1
HD 1
HD-2
HD 2
SICTL
HD-3
HD 3
HD-4
HD 4
BD-5
BD 5
BD 6
BD-6
BD 7
BD-7
BD-8
BD 8
PATRICK
Patrick
BD 9
BD-9
BD-10
BD-11
BD-12
DP WORLD
DPW
BLB1
Ampol
Ausgrid
Svitzer
PANSW
TfNSW
DP
DPW
Tzaneros
T&F
Zed
Dpt Home Affairs
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Quantem
Vopak B5 Bitumen
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Elgas
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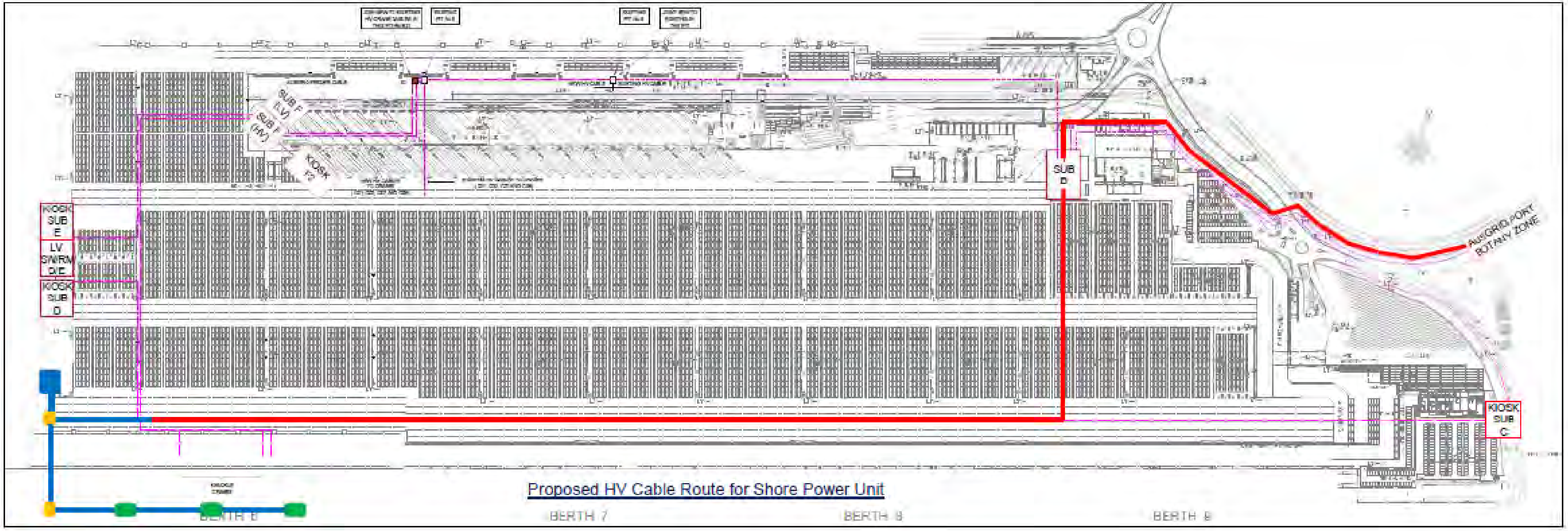
200m

Concept design OPS Pilot at BD6



Legend:

Blue line	New 2 x 100 mm dia. UG PVC conduits to be connected to existing HV cable pit (approx. 160 m)	Green	New 6.6 kV cable turning pit
Red line	Proposed HV cable route using existing HV conduits within Patrick Terminal	Yellow	New HV cable turning pit
		Blue square	New Shore Power11/6.6 kV substation

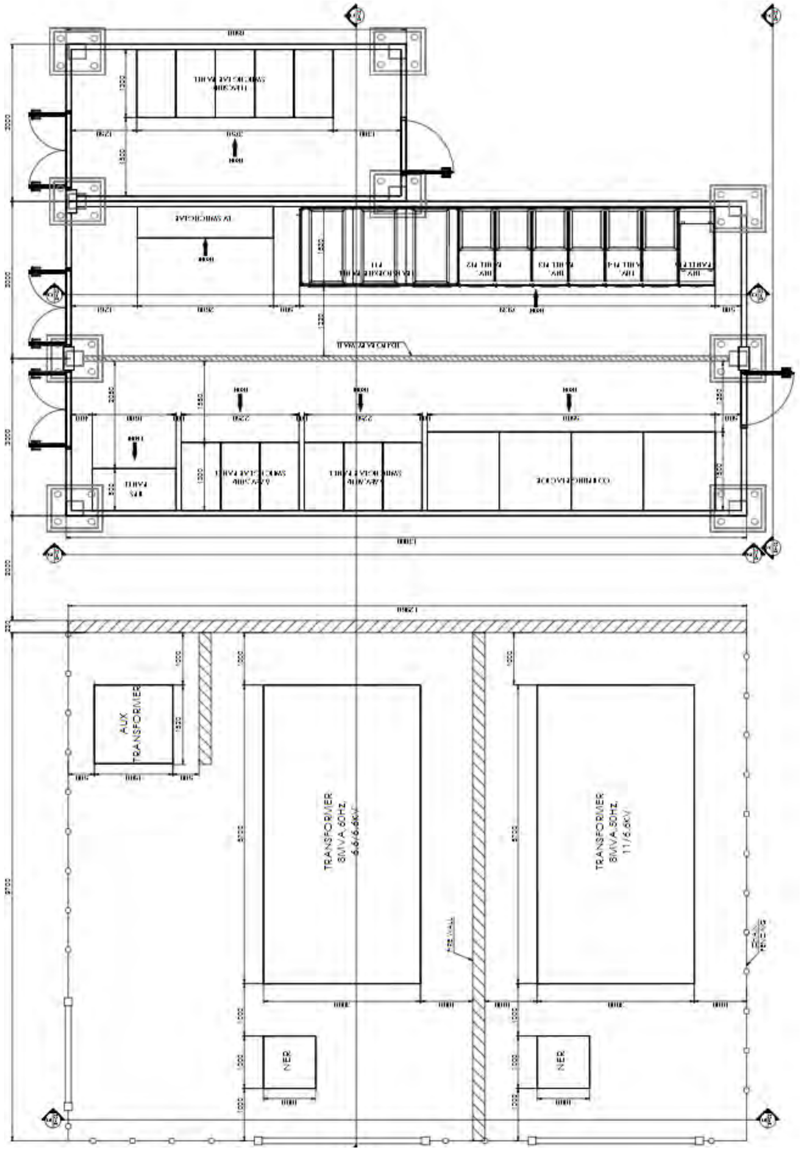
Notes:

(1) The proposed HV cable route shown is approximate only and shall be confirmed on site.

(2) The construction of the new 160 m (approx.) for the HV UG conduits shall be approved by Patrick.

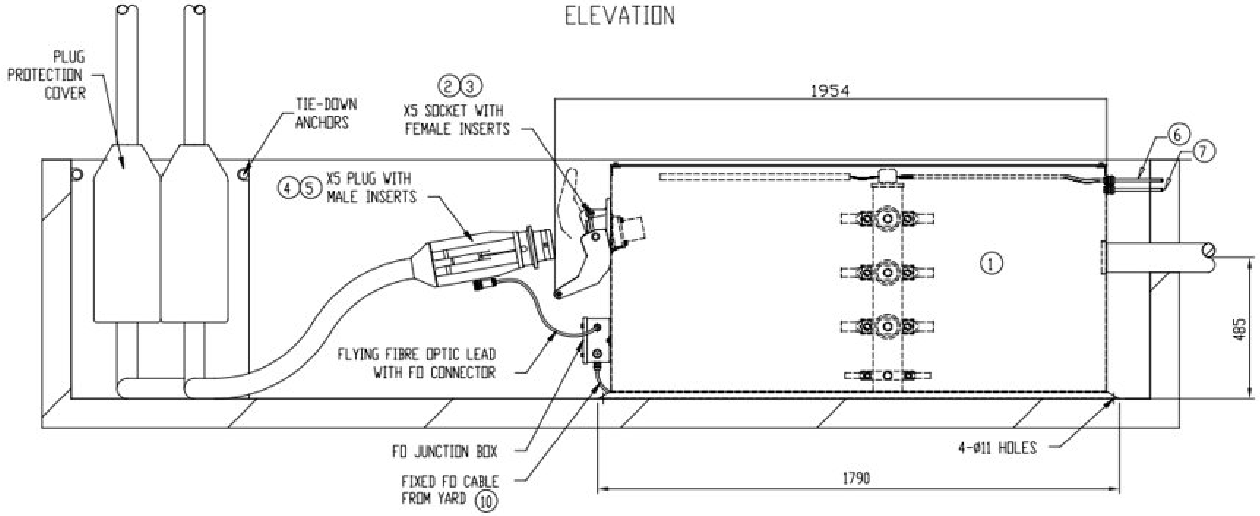
(3) The proposed HV cable pits shown are approximate only and shall be confirmed on site.

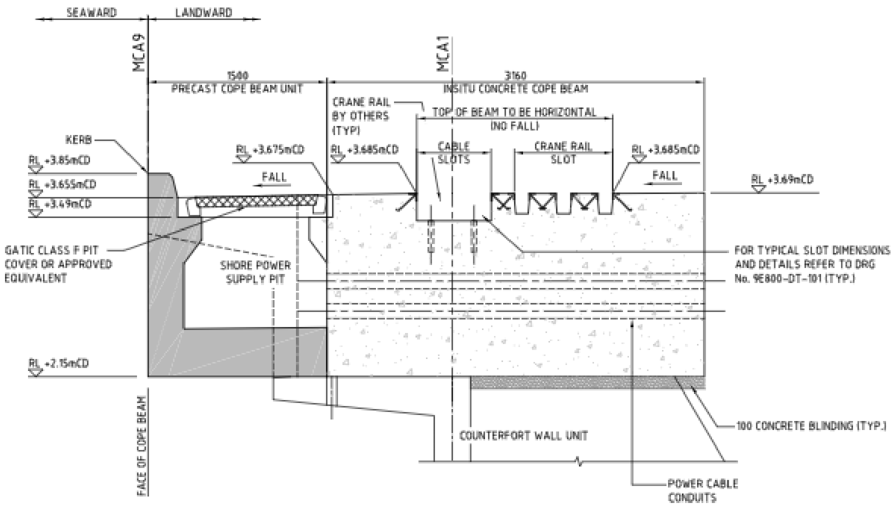
Local substation: transformers and converters



Hitachi concept design local substation at BD6
7.5MVA 60 Hz
7.5MVA 50 Hz
11/6.6kV
Switch rooms
25 year design life

Shore power pits





TYPICAL SHORE POWER SUPPLY SECTION

SECTION 4
1 : 20

What the stakeholders said:

Ports said:

- Port of Los Angeles: California Air Resources Board requires that all container vessels use OPS (or technology to minimise emissions) by 2023.
- Vancouver: Mixed success with OPS due revised vessel berthing practices.
- Port of Hamburg: Delivering OPS for container berths from 2023. Government subsidies.
- Port of Rotterdam: Directive 2014/94/UE requires OPS is installed at all container ports by 2030. Rotterdam implementing OPS for container berths 2023, with target to have all berths on OPS by 2028. Port fees were increased to offset costs. Government subsidies.

Shipping lines said:

- Retrofitting program in place with aim to have 50% of existing fleet converted to OPS in next 5 years.
- 100% of new vessels are being equipped with OPS.
- If OPS is cost competitive with fuel, we will use it. If regulated, we have to use it.
- Alternative fuels are unlikely to replace OPS in the foreseeable future due to the high cost and limited availability of alternative fuels.

What the stakeholders said:

Utilities said:

- On initial inquiry Ausgrid confirmed 4.5 MVA can be made available from existing zone substation at Penrhyn Road. Availability for larger loads for multiple berths and additional port electrification needs to be investigated.
- Very interested to either build, own, operate, maintain OPS and / or supply renewable electricity on the basis of minimal level off take-off.
- Billing directly to shipping lines is not preferred, would like NSW Ports or agent to be intermediate.

Stevedores said:

- Supportive of initiative, but not a priority at the moment.
- Have technical expertise on site to operate high voltage, but are not currently interested to provide OPS service.
- Shore power pits exist at BD6 and HD1-4, but no ducting. Spare existing ducting can be made available.

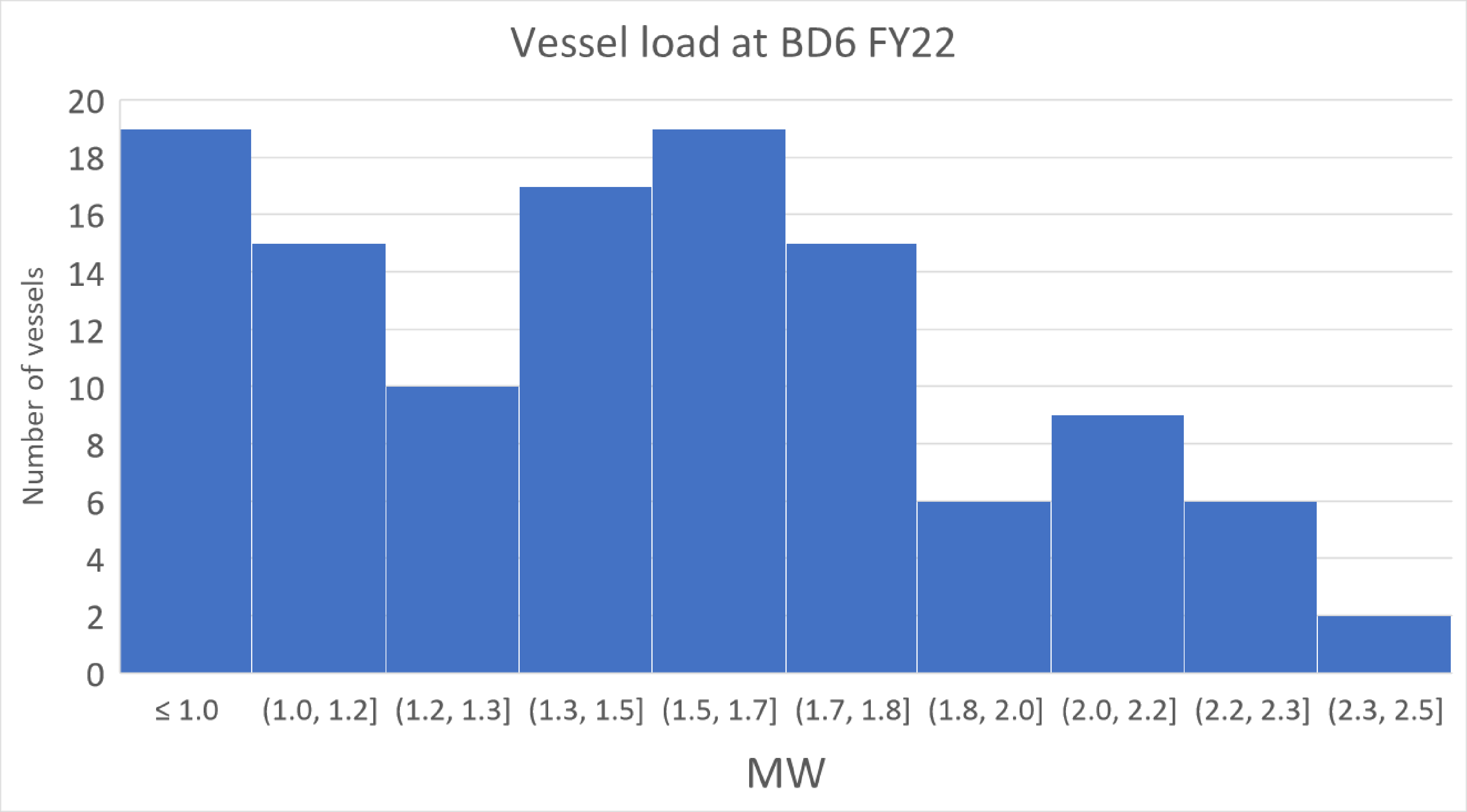
OPS demand at BD6

Verified reefer data with Patrick to estimate number of live reefers on board
Reefer load = 5 kW/reefer x volume (100% live reefers on board and 20% live reefers exchanged)

Vessel data Brotherson Dock 6 - FY22	Number of vessels per year = 118 vessels
	Average vessel call duration = 65 hours
	Total hours per year utilised = 7,750 hours (= 88% of year)
	Number of different vessels = 66 vessels
	Number of vessels OPS ready 2023 = 41 vessels confirmed (35% of vessels), could be more
Vessel power demand Brotherson Dock 6 - Forecast	Average vessel load at BD6 Port Botany = 1.5 MW
	Estimate of annual energy consumption of 41 vessels in 2025 = 5,400 MWh per annum
	Assumed uptake increase to 90% in 2035. Estimate annual energy consumption in 2035 = 12,000 MWh per annum

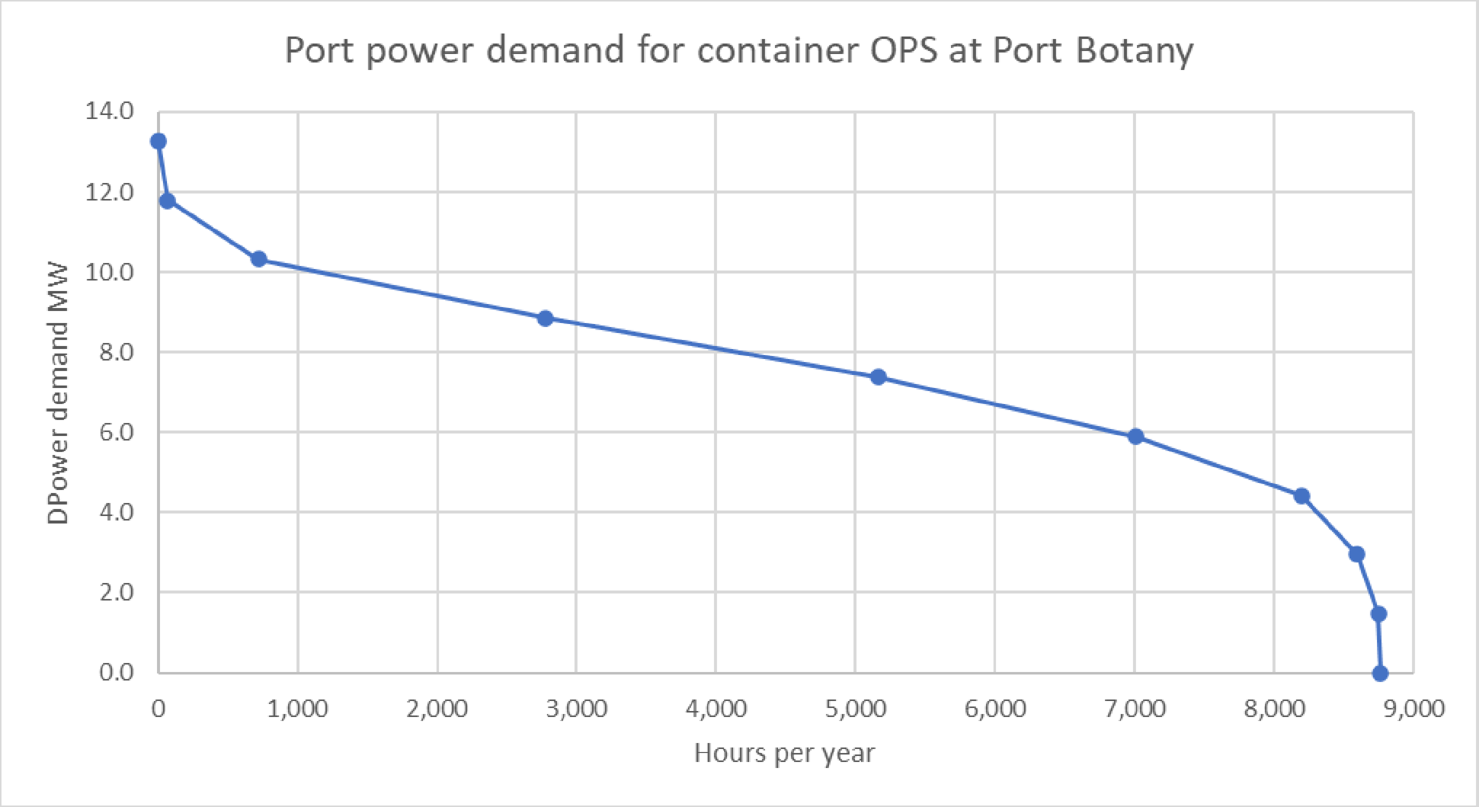
	Vessel Per Year	Hours Per Year
MSC	40	2,849
CMA CGM	29	2,291
MAERSK	23	1,340
HAPAG LL(	6	334
OOCL	6	301
ONE	4	199
PIL	2	99
TS LINES	2	73
HMM	2	110
EVERGREE	2	104
SWIRE	1	21
COSCO	1	30
TOTAL	118	7,750

OPS demand at BD6



Port power demand (current)

Alongside	Count of Hours	Share of Hours in Period
0 Vessels	0	0.0%
1 Vessel	14	0.2%
2 Vessels	152	1.7%
3 Vessels	400	4.6%
4 Vessels	1,182	13.5%
5 Vessels	1,848	21.1%
6 Vessels	2,384	27.2%
7 Vessels	2,062	23.5%
8 Vessels	648	7.4%
9 Vessels	70	0.8%
Total	**8,760**	**100.0%**



Onshore Power Supply

Next steps

Operational and business models

Grid capacity and availability of renewables

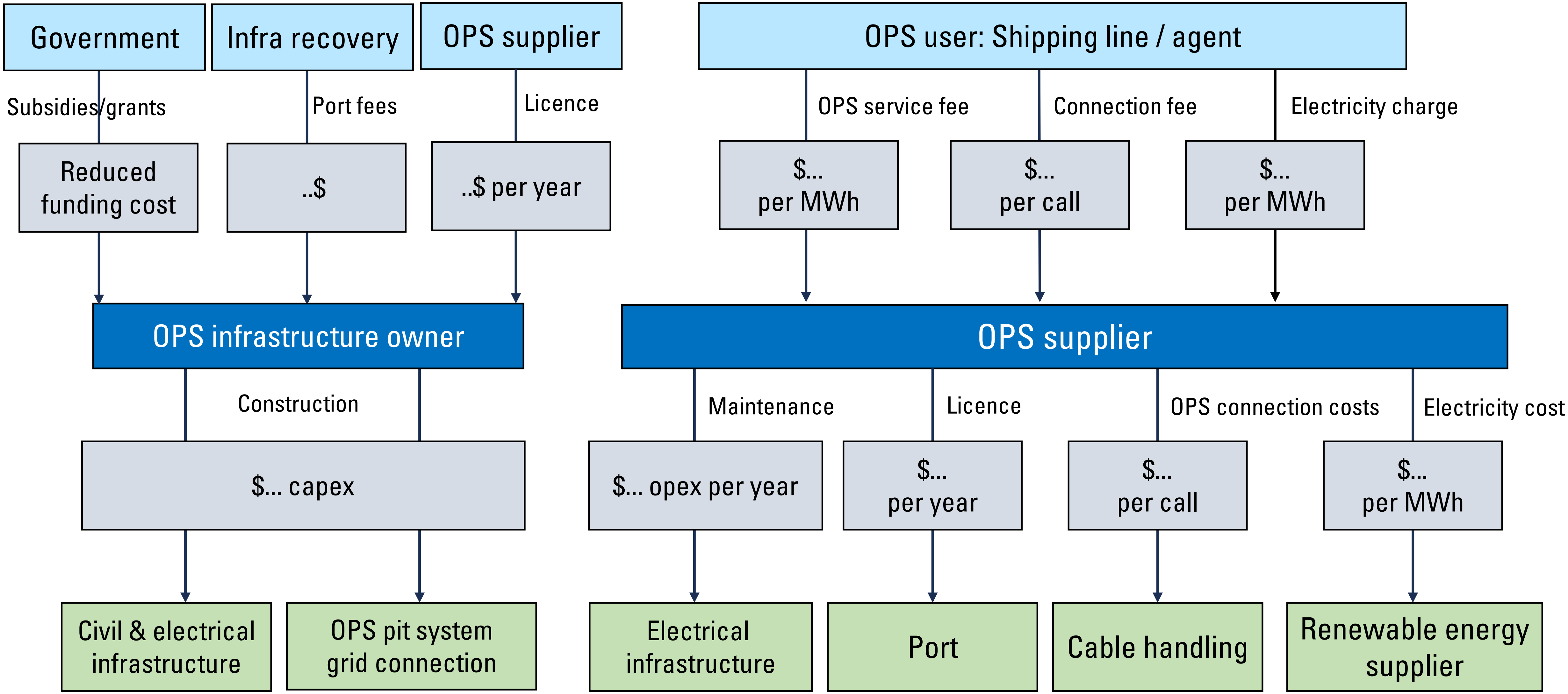
Operational impacts – plug in time, safety and labour requirements

Revenue and cost recovery models for consideration:

- Infrastructure (capex) and operations (opex)
- Grants
- User pays
- Polluter pays
- Every vessel pays

Roles and responsibilities

Example model



NSW Ports

Thank you

RISK & FINANCE

- *Jackie Spiteri*
  Sustainable ESG
- *Julia Hinwood*
  Clean Energy Financing Corporation

JACKIE SPITERI

Jackie is an experienced Environmental, Social, Governance (ESG) professional with a history of working in the maritime and infrastructure sector bringing a wealth of knowledge on sustainable development and operations.

With over 15 years' experience in environment, planning and sustainability management, Jackie is has most recently been focused on strategy development and business transformation. With a gift for creating collaborative partnerships, alongside a strong ability to recognise and cultivate the potential in others, Jackie has a proven track record of accelerating organisational sustainability through strategy development, implementation, communication, and education.

During her career Jackie has been responsible for the development of a number of Sustainability Financing Frameworks in the export/import infrastructure sector, enabling over $750million of sustainability linked debt to be realised through a series of innovative sustainability financing transactions.

CLIMATE RISK ANALYSIS

This presentation examines the intersection of climate risk analysis, shore power adoption and reporting and disclosure.

As the maritime industry navigates the challenges of climate change, the integration of shore power emerges as a potential solution to mitigate emissions from commercial vessels at ports, however it is not without its own risk and challenges.

By analysing climate risks, exploring the benefits of shore power implementation, and aligning actions with relevant United Nations Sustainable Development Goals (SDGs), this presentation underscores the holistic approach required for sustainable port operations.

Additionally, it delves into the significance for TCFD reporting, which enhances transparency by assessing climate-related financial risks and opportunities.

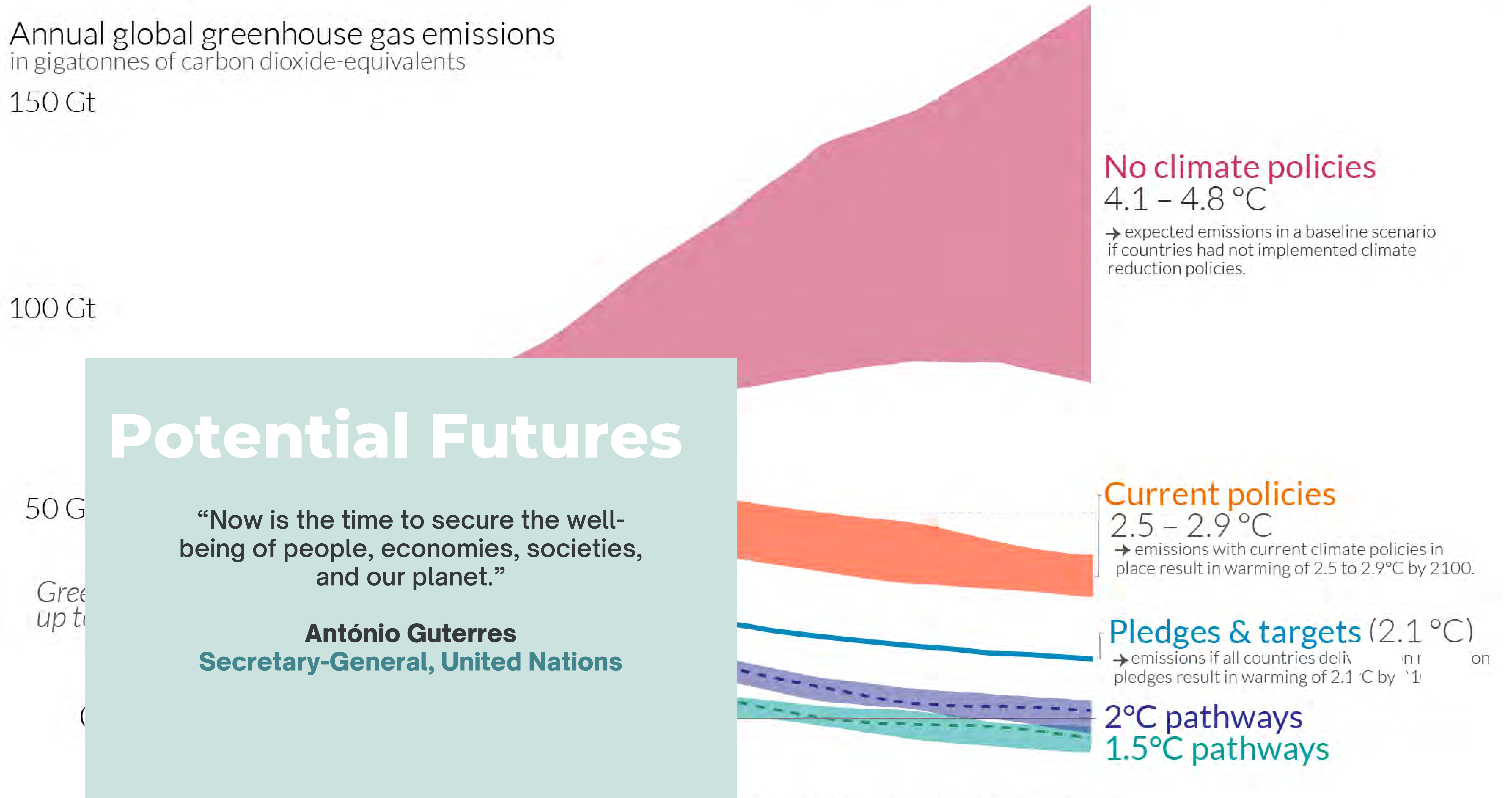
The presentation emphasises the necessity of collaboration among stakeholders, from port authorities to shipping companies, to achieve emission reductions, meet sustainability goals, and adhere to TCFD guidelines in the pursuit of a resilient and environmentally conscious maritime sector.

SESG

Climate Risk Analysis

Presented by
Jackie Spiteri

– Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.



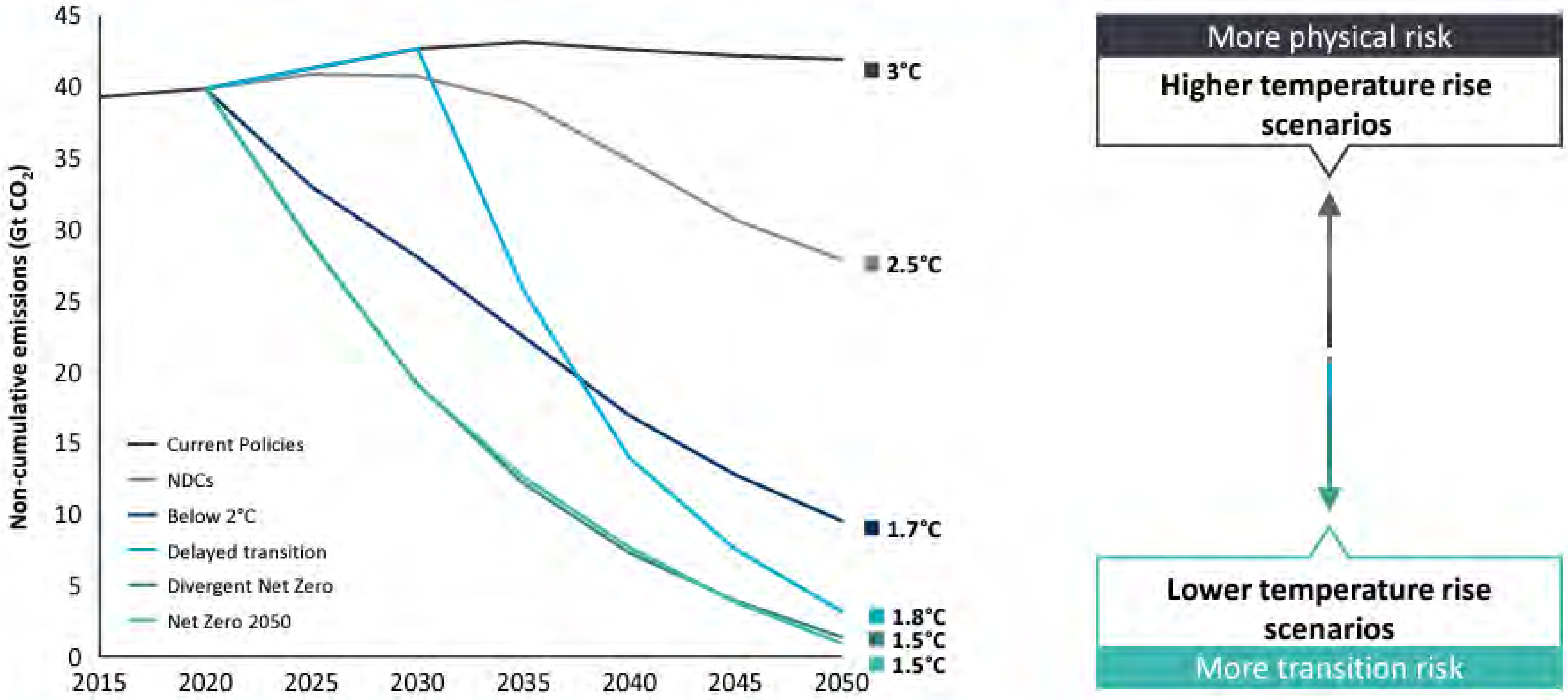
Potential Futures

"Now is the time to secure the well-being of people, economies, societies, and our planet."

António Guterres
Secretary-General, United Nations

SESG

CO_2 Emission Trajectory and Corresponding Temperature Rise from Pre-Industrial Levels



Note: These are potential temperature rise scenarios, which are not predictions of the future

SESG

Risk and Opportunity

Physical Risk

Acute risk: the immediate and severe impact of extreme weather events.

Chronic Risk: The gradual long-term impact of climate change.

Transition Risk

Technological Risk

Market Risk

Financial Risk

Policy and Legal Risk

Reputation Risk

Supply Chain Risk

Opportunities

Resource Efficiency

New Energy sources

Products and Services

Markets

Resilience

Climate Risk	Likelihood	Severity	Impact
Intense heatwaves			
Sea level rise			
Extreme weather events			
Change in rainfall patterns			
Increased drought			
Heat related illness			
Reputational Damage			
Financial			
Change in customer sentiment			
Technology			
Emissions regulations			

Shore Power

Shore power for commercial vessels offers significant opportunities for mitigating the impacts of climate change and improving port-related environmental issues.

However, it also comes with risks and challenges related to infrastructure, compatibility, energy sources, operations, and economics.

Assessing Risk and Opportunity

Measuring risks associated with climate change can be challenging because it involves assessing the potential impacts of a wide range of factors that are subject to uncertainty.

Measurement

You cannot manage what you do not measure.

TCFD

Taskforce for Climate Related Financial Disclosures

 # 1

Disclose the company's governance around climate-related risks and opportunities

#2

Disclose the actual and potential impacts of climate-related risks and opportunities on the company's businesses, strategy, and financial planning

#3

Disclose the processes used by the company to identify, assess, and manage climate-related risks

#4

Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities




SESG

Reporting and Disclosure

ISSB SUSTAINABILITY STANDARDS = IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information + IFRS S2 Climate - related Disclosures

UN SDGs

Ensure access to affordable, reliable, sustainable and modern energy for all

7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

10.2 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities

Take urgent action to combat climate change and its impacts

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

SESG

Thank You

www.sesg.co
info@sesg.co
+61 405 116 999

JULIA HINWOOD

Julia Hinwood is the Director, Infrastructure at the Clean Energy Finance Corporation, focusing in particular on improving energy efficiency and reducing emissions in the transport and infrastructure sectors. Before joining the CEFC, Julia worked at National Australia Bank, where she most recently led the export credit financing team. Prior experience also includes the Toronto Dominion Bank. Julia has significant experience in investment strategy, origination and structuring both domestically and offshore, including Hong Kong. She has more than 15 years' experience in project finance across a range of industries including infrastructure, resources, energy and utilities. Julia has a Bachelor of Commerce (Hons) and Bachelor of Arts from University of Melbourne and is a graduate of the Australian Institute of Company Directors.

FINANCING CONSIDERATIONS FOR SHORE POWER

The presentation will cover key focus areas for financiers, in particular:

- Risk and cost / revenue allocation, including who pays for, who owns and who operates the infrastructure?
- Where and why funding gaps may arise due to risk allocation
- How to structure arrangements to attract wider pools of financing
- Potential funding structures
- Benefits, costs and issues associated with these structures

Shore Power – Financing considerations

PIANC – ANZ Shore Power Workshop

Presented by: Julia Hinwood

15 August 2023

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4	Potential Structures - Considerations	6
5	Potential Financing Structures	7 - 9
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7	CEFC Infrastructure Team	11

The CEFC has a unique mission to **accelerate investment in Australia's** transition to net zero emissions.

We invest to lead the market, operating with commercial rigour to address some of Australia's toughest emissions challenges.

Leading investment, delivering returns

Our investment impact

Economic impact

$11.7b
Commitments

$4.6b
Capital available for ongoing activity

$3.8b
Capital returned

Clean energy impact

>285
Investments

5.2 GW
New renewable energy capacity

>240 $mtCO_2$-e
Est. lifetime abatement

Market impact

$42.8b
Transaction value

~$2.62:$1.00
Leverage

$215m
Innovation Fund

Clean energy technologies

$6.5b
Powering renewable energy

$4.0b
Delivering energy efficiency

$1.2b
Low emissions technologies

Lifetime investment commitments to 31 December 2022

cefc

Who is the owner? Who is the operator? Who pays?

Multiple stakeholders and potential revenue models

To identify appropriate financing options, we need to determine:

- Who owns what parts of the infrastructure provided?
- Who is responsible for operations?
- Who pays for the infrastructure installation and the ongoing use of the infrastructure?
- The perceived risk of the stakeholder arrangements – will identify the financing products available as well as the cost of those products

Investment categories

1 Debt

- Debt for a corporate risk rated entity will attract a margin of ~1.6% – 2.2% plus the base rate (5 years currently ~4.3%) i.e. all in ~5.9% to 6.5%
- Typically, the lower the risk of nonpayment of debt, the higher level of gearing the borrower will be able to attract

… However, there are a range of debt structures and conditions attached to debt financing that can influence whether debt is the best path and which type of debt will work

2 Equity

- Equity investors will typically require a return of 8 - 11% when taking on equity risk on infrastructure assets

Debt is generally cheaper than equity, so it is more efficient to priorities debt over equity to achieve the maximum funding for lowest overall cost. However, approaches by the investors for both debt and equity will be different in terms of risk appetite and return sought.

Potential Structures - Considerations

Multiple stakeholders and potential revenue models

➢ *The financing structure will be determined by who the sponsor is, which port is bearing which risk and where the revenue streams are being sourced*

Stakeholder	Interface arrangements	Interface decisions
Ports/Terminal	• Installation of infrastructure requirements (e.g. cabling, substations, cable management systems etc.) • Connection point to ships • Connection point to grid / other port power sources • Sourcing of significant additional power demand o Grid, renewable, behind the meter?	• Payment for all or a portion of the capital cost of infrastructure? • Does the infrastructure owner pay upfront and receive payments over time from the infrastructure users? Should this come from the Stevedores or the ships? • Shared infrastructure across multiple port operators? • Who owns the infrastructure?
Ships	• Ship's onboard connection	• Payment for use of power e.g. variable payment based on usage and current power price charged by the port • Payment for infrastructure maintenance costs e.g. via capex charge
Operations and maintenance	• Operator/Stevedore or Port owner responsibility?	• Do port/stevedores charge a maintenance fee to the ships

Potential Financing Structures (i) – Corporate Finance

Port is the borrower and developer

Key Elements

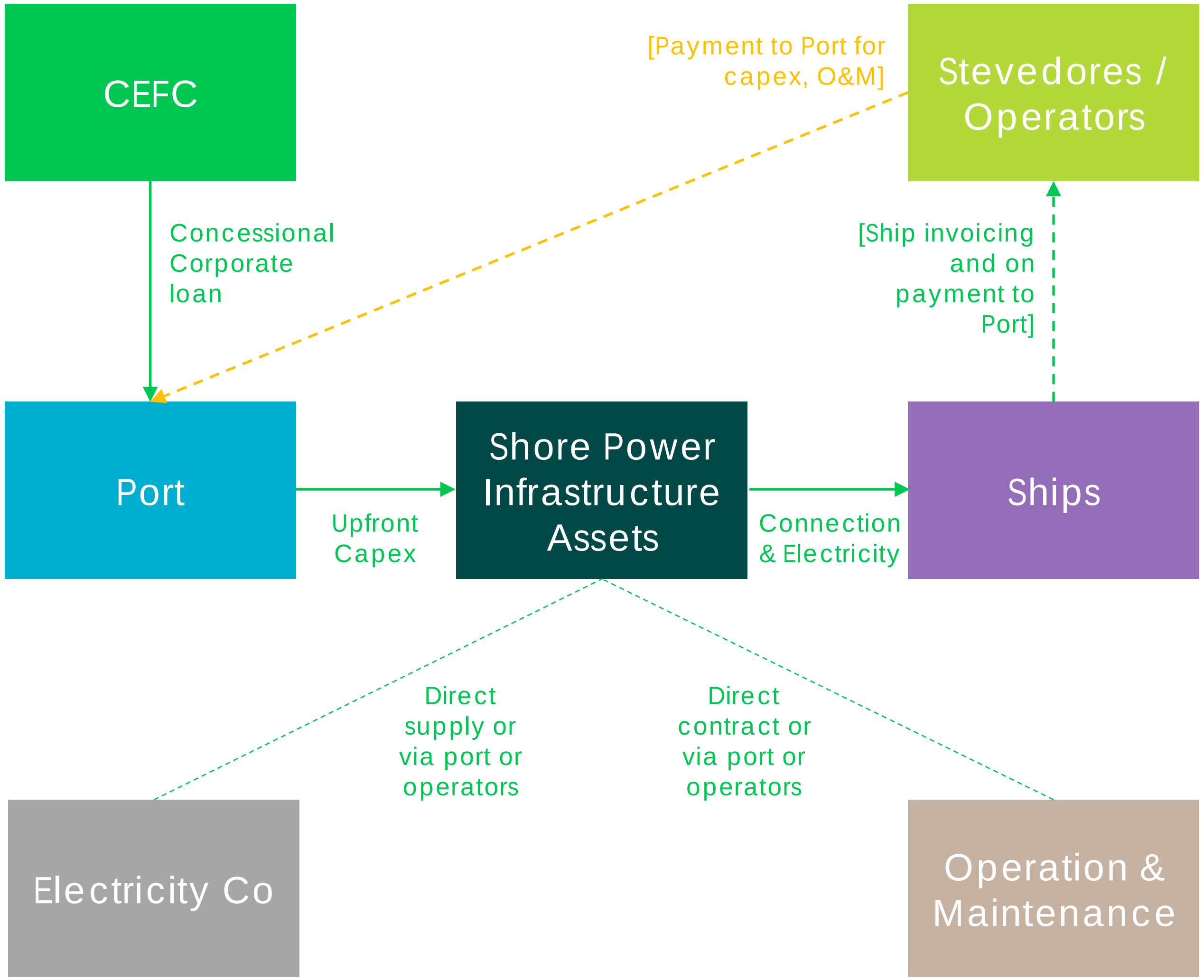
- Port builds the short power infrastructure and arranges for its operation and maintenance
- Assumes shippers pay a floating charge for electricity use and O&M
- Electricity provided either via the port or via direct contract through Stevedores/operators
- CEFC provides corporate finance loan to cover capex costs at (asset or corporate level). Concessionality applied to assist in offsetting capital cost. Tenor and amortisation to be considered in context of revenue model

Benefits

- Ports typically have very good credit risk profiles so funding will be cheaper and gearing can be higher than for other models
- Commercial banks may also have appetite, including for Sustainability Linked Loans
- Documentation is relatively simple as existing structure can be used

Issues & Questions

- Port takes all development risk and depending on the model used may not recoup costs over time.
- Does the port seek a capital charge from shippers or stevedores for provision of the infrastructure?
- Who bears risk of volatile electricity prices? Port, Stevedore or Ships – can this be a full pass through to Ships?



cefc

Potential Financing Structures (ii) – Corporate Financing

Stevedores are the borrower and developer

Key Elements

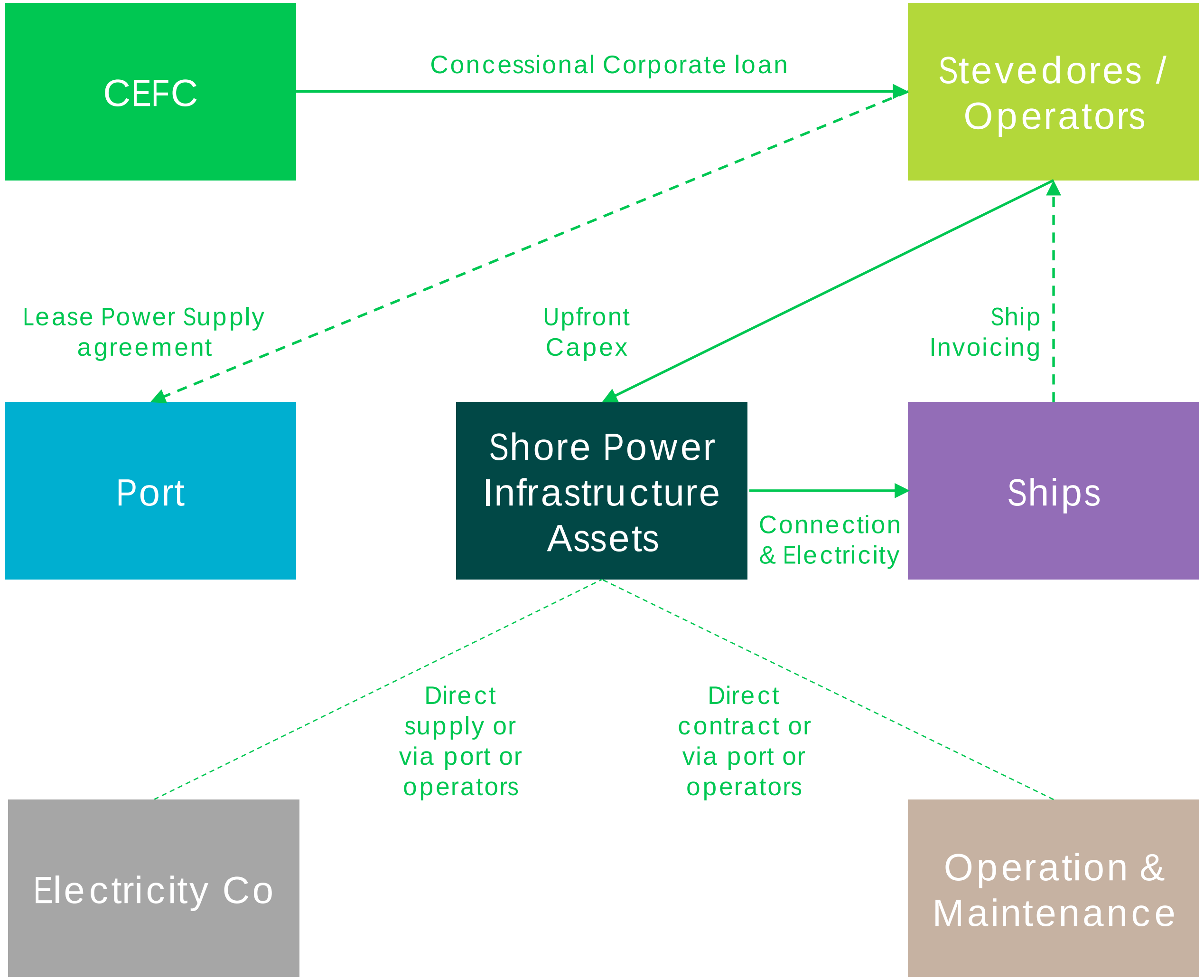
- Operator/ Stevedores contract to build the shore power infrastructure and arrange for its operation and maintenance
- Lease of site from Port
- Assumes shippers pay a floating charge for electricity use and O&M
- Electricity provided either via the port or via direct contract through Stevedores/operators
- CEFC provides concessional corporate finance loan to cover capex costs at (asset or corporate level) to Operator Co. Concessionality applied to assist in offsetting capital cost

Benefits

- Stevedore credit risk profiles vary so funding may be more expensive than direct to the Port if their credit profile is higher risk. Gearing may also be lower for the same reasons
- Commercial banks may also have appetite, including for Sustainability Linked Loans
- Documentation is relatively simple as existing structure can be used

Issues & Questions

- Operator takes development risk and depending on the model used may not recoup costs over time.
- Will costs be potentially higher than under a port developer model if port also charges for use of land?
- Does the port seek a capital charge from shippers?
- Who bears risk of volatile electricity prices?



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Potential Financing Structures (iii) – SPV secured finance

Risk share between Ports, Operators, Ships

Key Elements

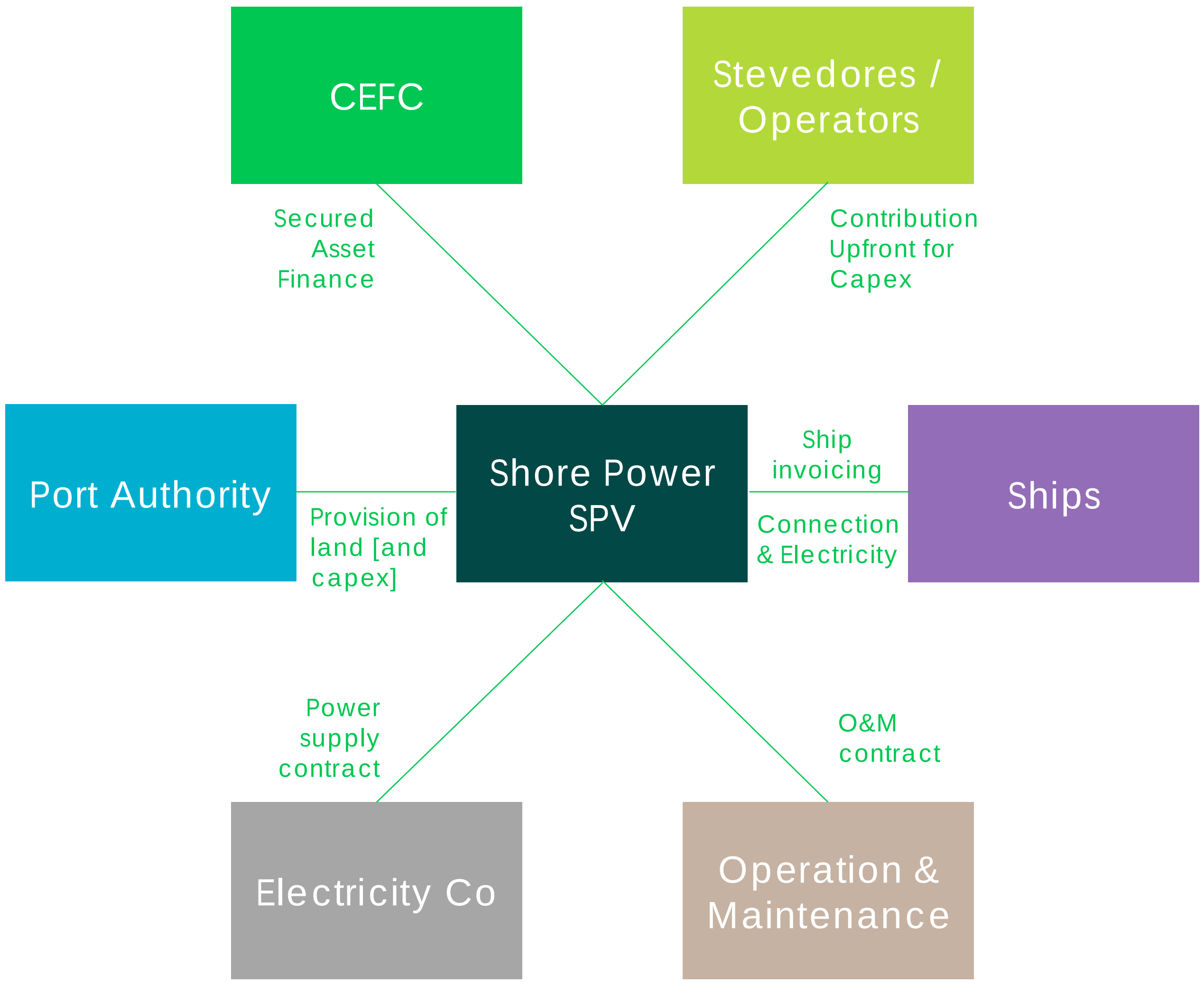
- Creation of a special purpose vehicle ("SPV") to own and operate the shore power infrastructure
- SPV owned by the Port Authority and Operators
- CEFC provides upfront finance at asset level, incorporating a concessionality component

Benefits

- Removes concentration of risk for delivery to a shared model between the port and operator
- Potential for greater coordination of asset use and other associated arrangements (e.g. electricity sourcing / load sharing) if working across entire port including all operators

Issues & Questions

- Weaker credit profile of the SPV against Port Authority impacts:
  - Financing costs will be higher
  - More complex to document – structurally and from a financing perspective
  - Banks will require security or parent company guarantees
- Does the port seek a capital charge from shippers?
- Who bears risk of volatile electricity prices – SPV or Ships?



Takeaways

Sorting out who bears development, operating and revenue risk is a key determinant of the amount, tenor and pricing of debt. The better the credit risk profile of the Borrower, the cheaper and more favourable debt terms will be. Corporate finance will be cheaper than ring fenced/secured SPV structures.

Revenue to support loans will need to come via - the Port; the Operators; or via an SPV structure that is owned by these entities. Financiers will not be eager to take revenue risk against individual shippers. Analysing this risk will be too complex and revenues will not be certain at the outset when funding is needed.

Ports / operators should be passing on charges for electricity usage and potentially and O&M charge to the ships

Can Ports / Operators charge for the capex of installation to ships? This would take longer to recoup than a debt tenor but would provide an opportunity for partial recoup of costs

CEFC has potential appetite to contribute via concessional lending. Commercial lenders may have appetite to provide Sustainability Linked Loans.

Other questions to resolve:

- Are there any current government grant schemes that could contribute to reducing the upfront capex costs?
- Can electricity companies be encouraged to offer concessional rates to be part of the decarbonisation process?

CEFC Infrastructure Investment Team

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Disclaimer

This document is intended for discussion purposes only and the terms of the proposed investment described below may change through the course of such discussion. This is not an offer of funding and any such offer may only be made following satisfactory due diligence, formal investment approvals, satisfactory documentation and confirmation or evidence satisfactory to the CEFC that the proposed investment will be a complying investment for the purposes of the Clean Energy Finance Corporation Act 2012. Neither this document nor discussions in respect of the matters contemplated in this document create any binding legal obligations unless and until a definitive written agreement is executed by the CEFC.

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ENERGY

Jack Kotlyar,
EnergyAustralia

JACK KOTLYAR

Jack Kotlyar is a seasoned professional with over 23 years of experience in the energy sector. As Head of Green Transport at EnergyAustralia, he is responsible for leading the company’s efforts to decarbonise the transport sector by identifying and scaling products and services for EnergyAustralia's Green Transport offerings. Jack has a track record of driving strategic initiatives and has held various leadership roles throughout his career, including Head of Strategy, Head of Reputation and Head of NextGen at EnergyAustralia, and Head of Strategic Planning for Siemens Energy business.

His expertise in business analysis, finance, M&A, and change management has been honed through various roles at Siemens, Jemena, and Alinta, where he played a key role in shaping the strategic direction of these companies. Jack's finance background and MBA from Deakin University further augment his ability to make informed and impactful decisions.

DECARBONISING AUSTRALIAN PORTS: FROM PIPE DREAM TO REALITY

The presentation outlines areas for consideration around Shore to Ship electrification, including a brief consideration of why. The type of charging infrastructure, leveraging the new assets, ensuring energy certainty and the structure of energy retail contracts are considered. We will briefly provide an overview of EnergyAustralia's role within the National Electricity Market which applies to all electricity retailers.

A number of infrastructure decision points around growth requirements, raising capital, port design and maintenance are discussed. The investment in electrical assets and their size will also spark a conversation around demand management and network capacity. The leveraging of new assets considers the broader opportunities within ports, such as port side vehicles (cranes etc) as well as through traffic of trucks and buses that can be serviced with electric vehicle charging points in the future.

Finally, there are points around renewable energy issues such as onsite renewable energy generation and storage (batteries) as well as carbon offsets and green energy certificates.

Decarbonising Australian Ports:

From pipe dream to reality

August 2023

Jack Kotlyar

Head of Green Transport

EnergyAustralia

LIGHT THE WAY

Shore to Ship electrification:

The considerations

Why invest in shore to ship power?
Port Authority of NSW has set the stage

Photo credit: Govt News

- From 2024, ships docking at Sydney's White Bay Cruise Terminal will be able to connect to shore electricity that is entirely made up of certified renewable energy.
- According to Port Authority of NSW – "Through the renewable energy precinct at Sydney's Bays Port shore power will remove up to 14,000 tons of CO2 over a 12-month period"
- Presently, 35% of cruise ships globally are fitted to use shore power and operators of cruise ships and bulk ships visiting Port Authority of NSW's berths have pledged to retro fit or build ships with shore power capability.

EnergyAustralia
LIGHT THE WAY

Clean energy transition for shore to ship can be complex

Photo credit: Rostock Port/nordlicht

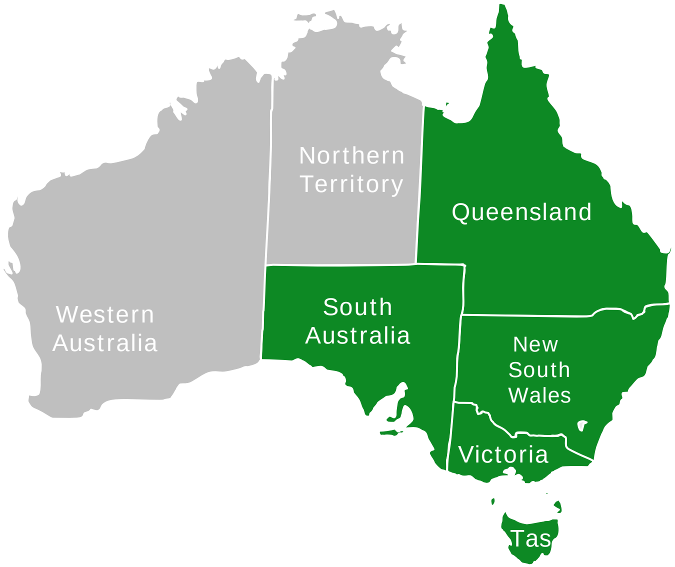
- ❑ What kind of new electric charging infrastructure would you need to keep your commercial electric fleet moving?
- ❑ Is your retail contract best suited for ship to shore power?
- ❑ How do you leverage your ship to shore electric infrastructure Investment?
- ❑ How will you ensure energy certainty?

EnergyAustralia
LIGHT THE WAY

New Electric Charging Infrastructure:

Where do you start?

The Electricity Grid – what is the NEM?



NEM (National Electricity Market)

Generation	Transmission Distribution	Retail	Green Transport
Our portfolio has a mix of coal, gas, solar and wind energy representing ~5,000MW of capacity (~1,000MW in renewable and battery energy sources	We collaborate with Distributors to deliver grid stability and solutions	We service the energy needs of ~1.6m electricity and gas customers across residential, small business and large commercial businesses	We deliver innovative solutions to customers who are embarking on the clean energy transition

EnergyAustralia
LIGHT THE WAY

New electric charging infrastructure

- **Growth requirements:** What would your port look like in the next 5 to 10, years' time
- **Raising capital:** Upfront capital investment to procure the assets and funding the installation of the infrastructure? What are your options?
- **Port design:** Port design to ensure effective performance
- **Maintenance and upkeep:** of the EV charging assets

EnergyAustralia
LIGHT THE WAY

Ensuring energy certainty:

Managing demand

Is your grid connection equipped to meet additional demand?

- Network capacity
- Regulatory framework
- Costs and financing
- Integration with renewable energy sources
- Reliability and resilience of the grid connection
- Collaboration and communication

Energy retail contract:

Does it meet your port’s new requirements?

Energy retail contract

Customised contracts: Securing a more cost-effective energy supply tailored to specific operations.

Wholesale energy contracts customised to meet the specific needs of a shore-to-ship powered port.

Price stability: Wholesale energy contracts based on medium to long term agreements providing more predictable and stable energy prices, minimising exposure to market volatility.

Energy procurement strategy: Linked to energy consumption patterns, risk tolerance, and sustainability objectives.

EnergyAustralia
LIGHT THE WAY

Supplementing your energy with renewable energy generation:

Is it possible?

Solar and battery combo could help manage grid constraints

- Onsite energy generation
- Cost-benefit analysis
- Energy management systems
- Peak demand management
- Backup power
- Carbon offsets & Green Energy certificates

EnergyAustralia
LIGHT THE WAY

Leverage your shore-to-ship electric infrastructure investment – What do you need?

Return on EV infrastructure investment

Photo credit: Autoweek

- Public charging
- Commercial electric fleet charging
- Port vehicle fleet charging
- Demand response
- Trading energy

EnergyAustralia
LIGHT THE WAY

For more queries connect with us at:

greentransport@energyaustralia.com.au

Thank you

Lets do some Q&A

EnergyAustralia
LIGHT THE WAY

ENGINEERING & TECHNOLOGY

James Goh
Cavotec

JAMES GOH

James Goh is the Shore Power Regional Product Manager for Cavotec covering South East Asia, Oceania and India region. He is a Mechanical Engineer with 15 years experience in the Ports & Maritime and Oil & Gas sector. With great passion in environmental sustainability, he has extensive experience and knowledge in the ports & maritime electrification solutions.

SHORE POWER CONNECTION TECHNOLOGY

Cavotec is the leader of decarbonization of the Ports & Maritime sector with more than 40+ years delivering connection, electrification, and automation solutions. This presentation would focus on Cavotec's shore power cable management systems (CMS) used for Ferry/RORO, Cruise and Container Terminals. A basic overview of worldwide shore power regulations and IEC-80005 international standards would also be introduced. The presentation would also cover the constrains and limitations faced by terminals/ships, and our solutions to address these concerns by providing a flexible cable management system.

Cavotec : Shore Power Connection Solutions

James Goh
Shore Power Regional Product Manager
SEA, Oceania & India

CAVOTEC®
We connect the future.

CAVOTEC in a nutshell

Leader of the decarbonization of the ports and maritime sector for more than years, we design and deliver connection, electrification & automation solutions.

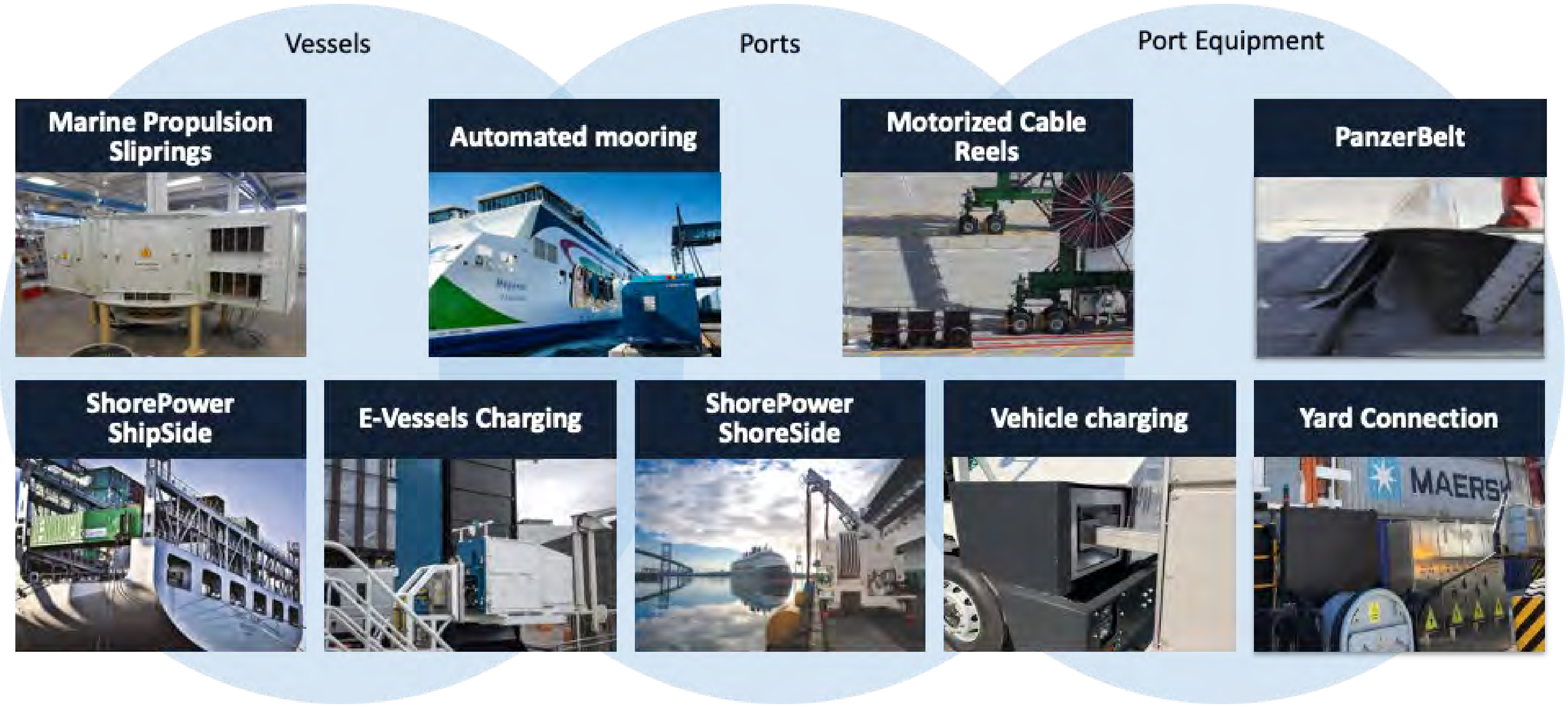
40+
Years

85
Services experts

80+
Countries served

24,000
Installations worldwide

147,8M
Revenues in 2022

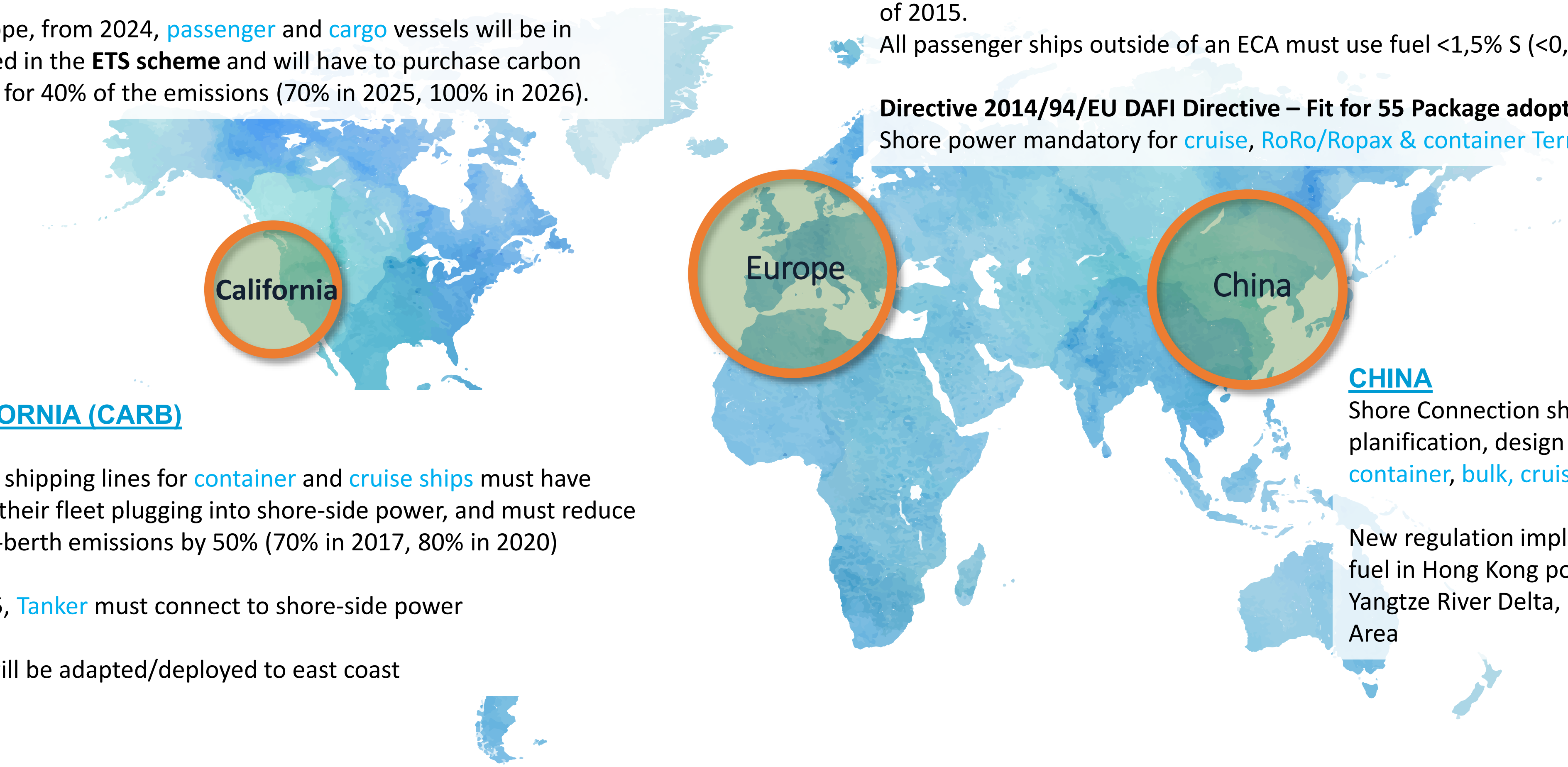


Worldwide Regulations

ShipSide

IMO introducing & enforcing diverse schemes for CO2 reduction
CII, EEDI, EEXI.

In Europe, from 2024, passenger and cargo vessels will be in included in the **ETS scheme** and will have to purchase carbon credits for 40% of the emissions (70% in 2025, 100% in 2026).



CALIFORNIA (CARB)

In 2014 shipping lines for container and cruise ships must have 50% of their fleet plugging into shore-side power, and must reduce total at-berth emissions by 50% (70% in 2017, 80% in 2020)

By 2025, Tanker must connect to shore-side power

CARB will be adapted/deployed to east coast

EUROPE

Directive 2005/33/EC:
Since 2015, all ships in an Emissions Control Areas (ECAs) must use fuel <0,1%S as of 2015.
All passenger ships outside of an ECA must use fuel <1,5% S (<0,5% as of 2020)

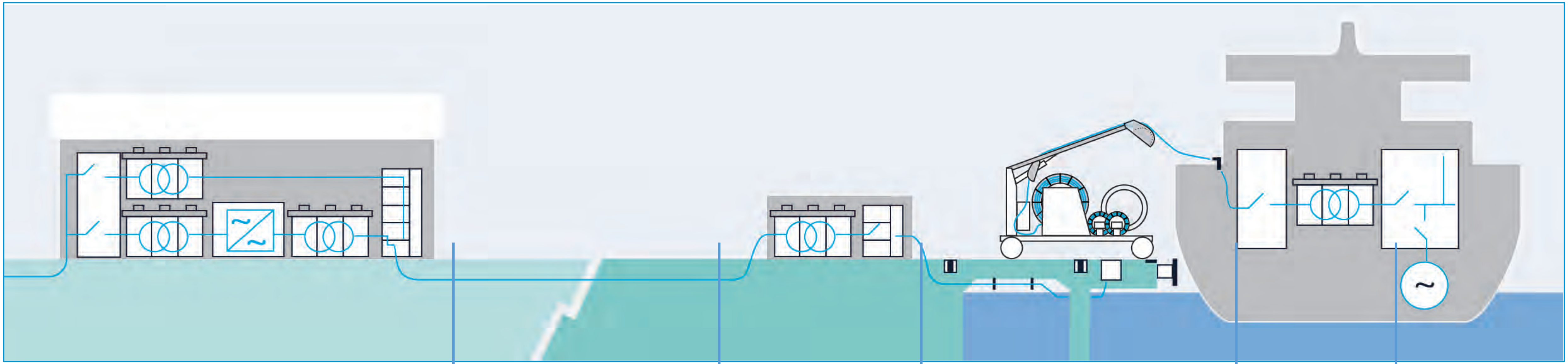
Directive 2014/94/EU DAFI Directive – Fit for 55 Package adopted in 2023
Shore power mandatory for cruise, RoRo/Ropax & container Terminals by 2030

CHINA

Shore Connection should be included in project planification, design and construction for new container, bulk, cruise and ropax terminals

New regulation implemented in 2016 mandates 0.5% fuel in Hong Kong ports and Shanghai and within the Yangtze River Delta, Pearl River Delta and Bohai Rim Area

Shore Power solution. What does it look like?



Availability of power from grid?

Port electrical infrastructure

Berth distribution (Circuit breakers, transformers and if needed Frequency Converters)

Cable management system on shore or on ship

Socket box on shore and on ship

Space availability on quay side?

On-board distribution (Retrofit only)

ShorePower main principles are defined by IEC/ISO/IEEE 80005 standard

International Standard has been published as 80005 Series:

IEC/ISO/IEEE 80005-1: High Voltage Shore Connection – implemented since 2012
IEC/ISO/IEEE 80005-2: Data Communication for monitoring and control – Draft
IEC PAS 80005-3: Low Voltage Shore Connection

Referring to:

IEC 62613-1/2: Plug socket-outlets and ship couplers for high-voltage shore connection systems
IEC 60309-5: Plugs, socket-outlets and couplers for industrial purposes

IEC/IEEE80005-1 Standard Main Requirements

Vessel Type	Nominal SSE Voltage	Maximum Power Requirement	Frequency	Number of MV Cables to Feed Vessel	CMS Location
Ro/Ro Ro/Pax	11kV, 6.6kV acceptable for waterborne transportation	6.5MVA	50Hz or 60Hz	1	Berth
Container	6.6kV	7.5MVA	50Hz or 60Hz	2	Ship
Cruise	6.6kV and/or 11kV	20MVA – (16MVA suggested)	50Hz or 60Hz	4	Berth

Ensure a worldwide **compatibility**
Ensure a **safe** connection

PowerReach

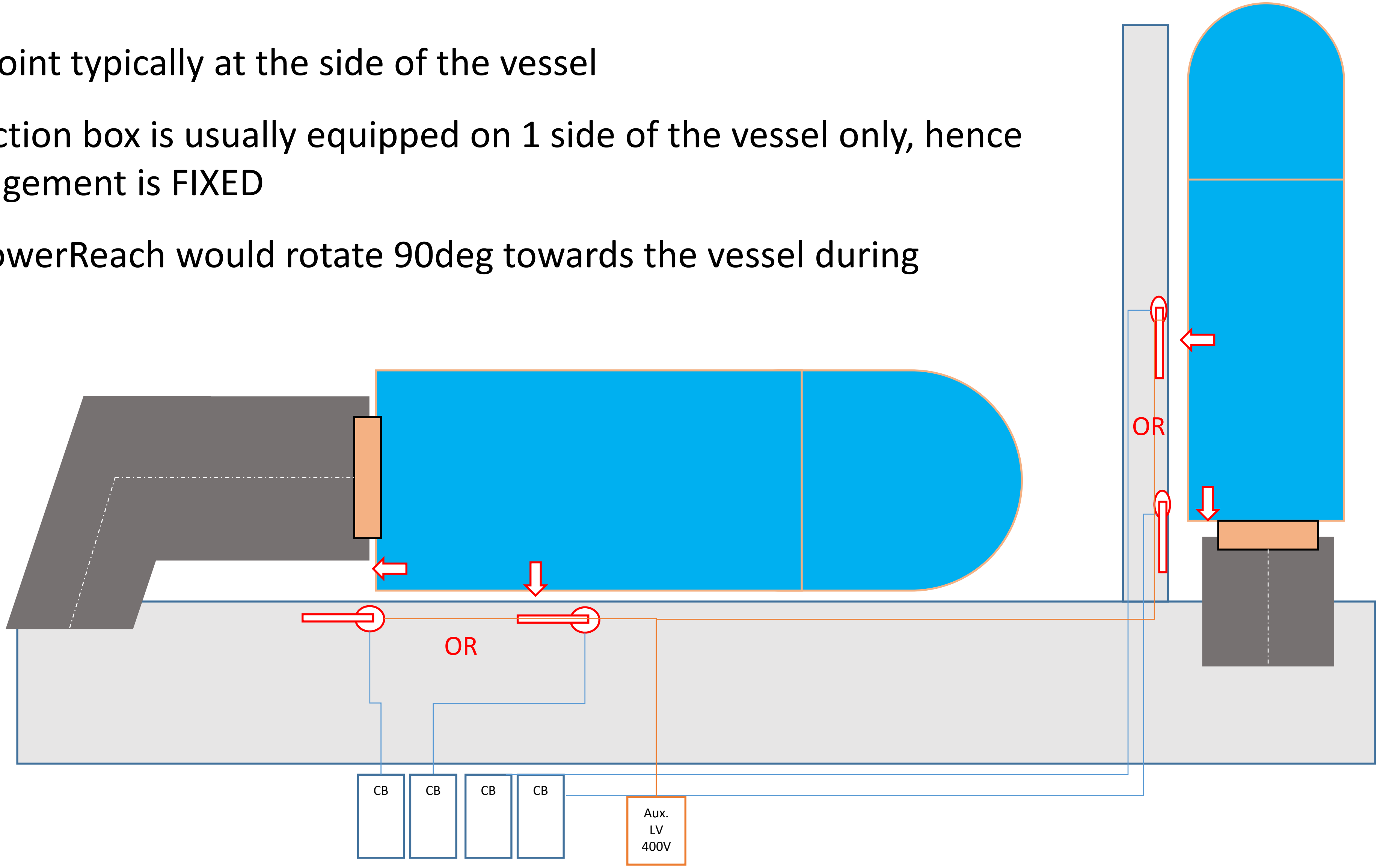
Solution for connecting **Ferry/RoRo/RoPax vessels berthing at a fixed location**

- **PowerReach** is tailored to serve 1 specific connection area for the ship (or ships)
  - Fix berthing place
  - Similar hatches position
- 1, 2 or 3 cables depending on the application
- Small footprint on the quay
- No crew/work needed onshore thanks to a radio remote control which could be controlled from the ship

Connection/Disconnection in 2-4 min

Typical CMS Installation Overview for RoRo/RoPax/Ferry

- Connection point typically at the side of the vessel
- Vessel connection box is usually equipped on 1 side of the vessel only, hence docking arrangement is FIXED
- Arm of the PowerReach would rotate 90deg towards the vessel during connection



Port of Melbourne

Terminal : RoRo/RoPax
Year : 2020
Voltage : 11kV HV
Height : 17.5m
Cables : 1
Power : 5MVA

- First end user in the region to adopt Shore Power
- The PowerReach was installed at both Melbourne and Burnie to connect 2 ferries at both locations
- This is one of the highest CMS Cavotec has supplied

Port of Stockholm, Kapellskar

Terminal : Ferry/RoPax
Year : 2023
Voltage : 11kV HV
Cables : 1
Power : 5MVA

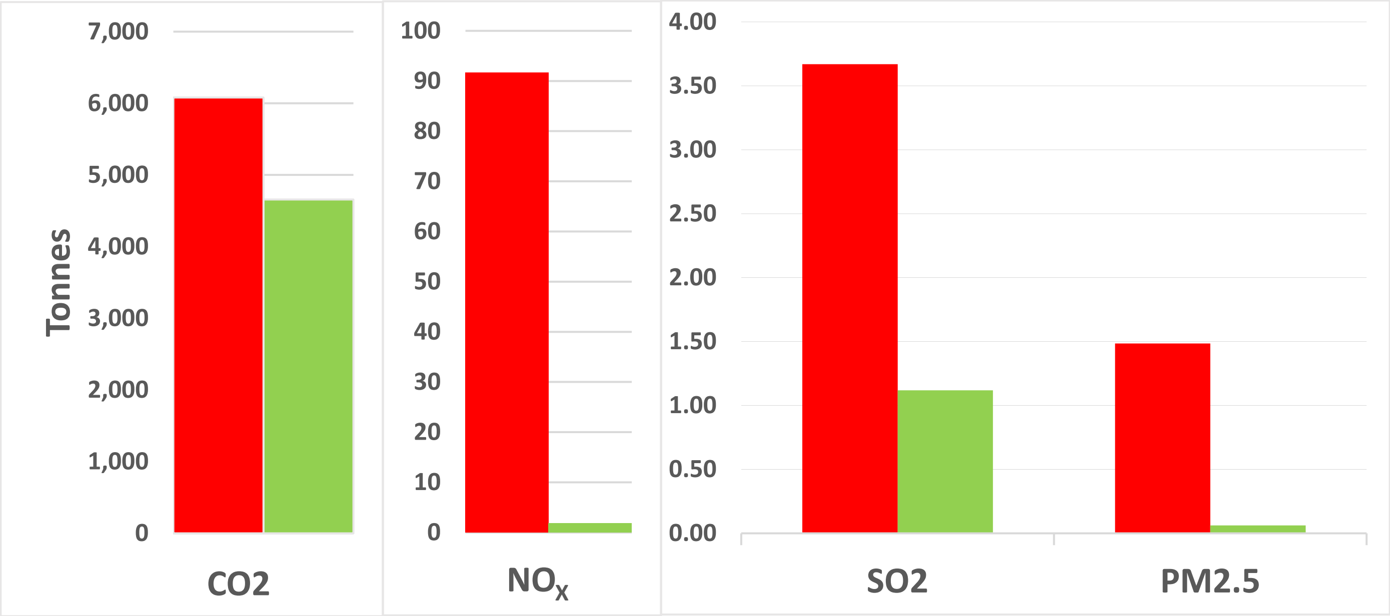
- Our first NxG (Next Generation) dispenser design
- Designed to be aesthetically pleasing.
  Ideal for installations in city centre
- Equipped with energy meter, temperature and humidity sensor, HMI touch screen etc
- Integrated with Cavotec Connect for remote monitoring of sensor based information to benefit operational activities

Comparison of Annual Emission for a RoRo Vessel Utilizing Shore Power

Australia grid derived from 51% Coal, 18% Gas, 2% Oil, and 29% Renewables

CASE STUDY

Type	Hotelling Load, kW	Hours per call	Calls per year
RoRo	2,000	24	182



Annual emissions of Tier 2 aux engine using MGO 0.1% Sulfur

Annual emissions of a shore connection based on Australia electricity generation

- 23.42% (1,424 Tonnes) reduction in CO_2 from using Shore Power
- 69.52% reduction in SO_2 and 97.96% reduction in NOx from using Shore Power
- Reduction of CO_2 is equivalent to the amount of CO_2 emitted by 310 passenger vehicles annually
- Reduction of CO_2 is equivalent to the amount of CO_2 absorbed by 65,404 matured trees annually

CAVOTEC
We connect the future.

PowerMove

Solution for connecting **cruise vessels**

- **PowerMove** is a versatile mobile **CMS**, it can be towed or self propelled and is able to adapt to berth condition, cruise vessels, and tidal variation
- **PowerMove** has been design to manage shore connection at high voltage and power as required from cruise vessels
- It is positioned next to the cruise vessel during connection and than stored in a different area when not in use
- **PowerMove** guarantee: maximum flexibility, safety, easy to use equipment
- Already 13 ports equipped and 22 **PowerMove** delivered

PowerMove as a flexible design

PowerMove – Telescopic crane

- Cable translation up to 55m
- Ship & shore cable management reels
- Passive tidal compensation
- Towable or Self Powered
- Large range of motion

PowerMove – Cable guide

- Cable translation up to 40m
- Ship & shore cable management reels
- Passive tidal compensation
- Towable or Self Powered
- Small range of motion

PowerMove - Articulated crane

- Cable translation up to 40m
- Basket plug support
- Shore cable management reel
- Passive tidal compensation
- Towable or Self Powered
- Moderate range of motion

PowerMove - Micro crane

- Cable translation up to 35m
- Shore cable management reel
- Passive tidal compensation
- Towable or Self Powered
- Small range of motion

PowerMove connects to PowerFeed

Overview:

- HV/LV connection point connecting PowerMove to fixed yard power infrastructure.
- Installed above or below quay-level

Port of Valletta, Malta

The first shore power system for cruise in the Mediterranean!

- Emissions reduction in port by **90%**
- Noise reduction
- **EU funded** initiative
- Stakeholders: Infrastructure Malta, Nidec, Cavotec
- Solution: **5 ShorePower Mobile CMS** (PowerMove)
- Scope: 5 berths, 5 conversion substations, extensive civil work

"The CMS is the only product the end user sees !"

- Infrastructure Malta

Port of Miami (In Progress)

Application

- Customer: Port of Miami
- Date: Delivery in 2023
- Max Power: 20 MVA @ 11kV, 14.5MVA @6.6kV
- Number of cables: 4 for MV power + 1 for neutral

Cavotec Offer

- PowerMove, 50m translation shore side, telescopic crane vessel side; towable & self-propelled
- Single design for 4 different quay and >20 different cruise vessels

Benefits

- Operational flexibility & aesthetic design
- Possibility to disconnect and store when not used
- Capable of service with offset trench orientations
- Repeatable design for easy maintenance and interoperability

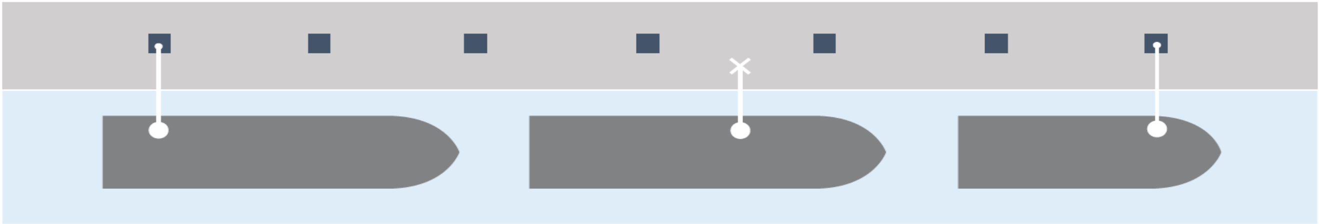
CAVOTEC
We connect the future.

PowerFeed - Typical OPS Architecture for Container Terminals

Fix connection points – PowerFeed

- ShorePower Outlet boxes are installed on the quay at fixed locations.(on top or underground)
- SPO Boxes are installed with an interval between 80m to 200m depending on:
  - Size & Mix of vessel connecting
  - Frequency of calls
  - Need of flexibility in the berthing location

Vessel shore connection with shore pits only



- Historically, the need of flexibility (unknown ships or location) was low. OPS was installed on terminals with regular and known traffic

\+

- Simple to install
- Compact
- High Safety level
- Reliable
- Economic

–

- Vessel docking position imposed (+/- 15m)
- Possibly labour intensive (when vessel & connection point not aligned)
- Risk of no connection possible
- Cost increases with flexibility

PowerFeed installation – Above/below quay level

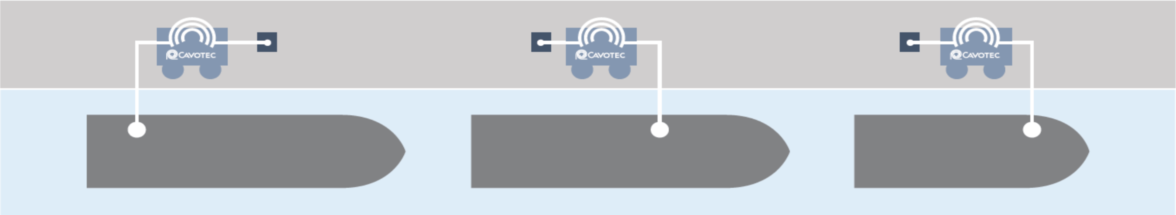
- Above ground – with protection poles against the mooring lines & collision with vehicle on deck
  - Pros: limited civil work, faster connection, cheaper and faster installation
- Below ground – in vault or pits, with covers on top (easy lift <15kg)
  - Pros: less likely to be damaged, allows vehicle traffic on top, cover offer protection from arc flash

PowerExtend - Typical OPS architecture for container terminals

Fix connection points – with Cable Management Extension Shore side

- ShorePower Outlet boxes are installed on the quay at fixed locations.
- SPO Boxes are installed with an interval between 80m to 200m depending:
  - Size & Mix of vessel connecting
  - Frequency of calls
  - Need of flexibility in the berthing location

Vessel shore connection with shore pits and Battery-Driven PowerExtend



- An additional device, CMS shoreside, connected between the SPO Box and the vessel, extends the range of connection via cables laid on the floor

\+

- Simple to install
- Compact
- Economic
- More Flexibility (+/- 60m around each point)
- Still reliable (simple system, only exposed when in use)

–

- Manual labour but less intensive (when not aligned)
- Requires space on the quay front (between crane and quay edge)

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We connect the future.

PowerExtend self-propelled or battery driven

PowerExtend is the perfect solution to connect **container vessels,** for terminal needing higher flexibility in the position of the vessels/shore connection points.

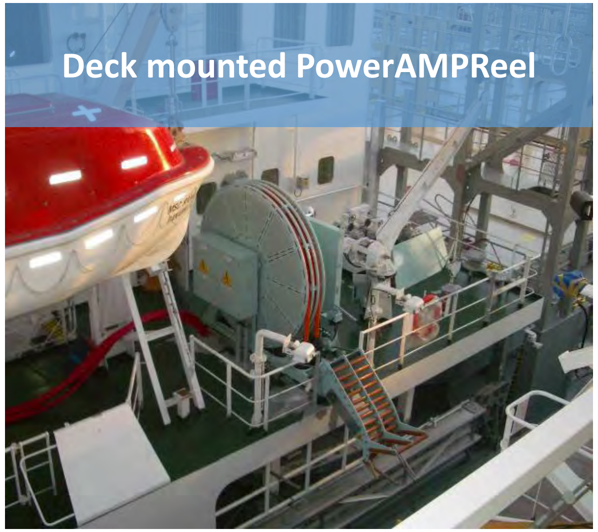
Up to 30m extension from a fix connection point (PowerFeed)

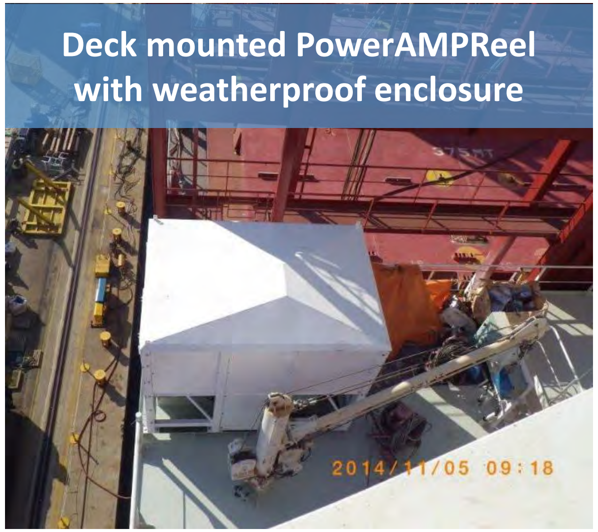
Battery powered & self-propelled system

Narrow width to fit on a busy dock (1.33m)

CAVOTEC
We connect the future.

PowerAMPReel, the ideal solution for new-built vessels!


Deck mounted PowerAMPReel



Deck mounted PowerAMPReel with weatherproof enclosure


Handling of PowerAMPReel skid mounted and lifting up to the vessel deck

- Typically installed on container and bulk vessels
- Could be supplied in fixed or moveable design
- Equipped with mechanical hydrodynamic drive for cables automatic tidal compensation (black-out safe system)
- Retractable cable guide extends beyond vessel hull for ease of cable dispensing to terminal junction box

High flexibility
PowerAMPReel can be stored in the port and moved up-and-down from ships that want to be connected

PowerFit - The ideal shipside containerized solution

- Fixed or moveable design
- Moveable design would enable vessel to only install 1 CMS, but 2 JB are required at both PS and STBD
- Equipped with shore side PowerAMPReel, HV SWBD, control panel, Shipside CMS (if moveable)
- Installed in either 20” or 40” HC container

LV Configuration

- Able to include a transformer into the PowerFit for LV supply to vessel. Ideal for vessels with no onboard free space for the retrofitting of a transformer

ShorePower turnkey retrofit onboard ships

Your partner for turnkey ship retrofit

- One single point of contact from design up to vessel's first shore power connection in port
- Global service team to support your worldwide operations
- Capable of retrofitting on-voyage to minimize ship operations disturbance

Shore power retrofit process:

1. Retrofit enquiry →
2. Vessel information collected →
3. Technical and budgetary offer →
4. Project approved →
5. Vessel survey →
6. Final offer and approval →
7. Retrofit either in drydock or at sea

Thank you for your attention!

ENGINEERING & TECHNOLOGY

- *Kesevan Muruganandan, Arup*
- *Manuel-Jesus Lopez, Hitachi Energy (Spain)*

KESAVAN MURUGANANDAN

Kesavan Muruganandan is a senior electrical engineer with Arup based in Melbourne, Australia. He has 10+ years' experience in the design of electrical systems for buildings and infrastructure projects. He is passionate about the development of sustainable energy systems for a net zero carbon future and is currently exploring solutions for port electrification and shore power. Kesavan has a Master of Science degree in Construction Economics and Management from UCL, London and a Bachelor of Engineering degree in Electrical and Computer Systems from Monash University, Melbourne.

INTEGRATING ENGINEERING SOLUTIONS FROM EARLY STAGE TO IMPLEMENTATION

Maritime transportation is currently undergoing a transformation as the sector decarbonises with organisations exploring the feasibility of shore power for ocean going vessels. Shore power presents an opportunity for vessels to reduce their emissions at berth, reduce noise and improve air quality around the port area.

Utilising a case study approach from a recent shore power assessment at the Port of Melbourne, this presentation will focus on integrating engineering solutions for shore power, focusing on the landside infrastructure considerations for shore power, ownership model and insights from other ports globally that have implemented shore power.

Key technical and commercial challenges will be examined in deploying these technologies including the required port infrastructure, demand on local energy systems, capital expenditure considerations, resilience implications, and considerations of the complex stakeholder environments.

ARUP

Integrating engineering solutions for shore power

PIANC Workshop: Decarbonisation of Ports – The Feasibility of Shore Power

Kesavan Muruganandan

15 August 2023

ARUP

Contents

Introduction

Integrating engineering solutions

Shore power demand

Power supply strategy

Landside infrastructure considerations

Capital expenditure

Ownership models

Case study: Port of Los Angeles

ARUP

Our firm

Dedicated to sustainable development, Arup is a collective of 19,000 designers, advisors and experts working across 140 countries. Founded to be both humane and excellent, we collaborate with our clients and partners using imagination, technology and rigour to shape a better world.

Arup Worldwide

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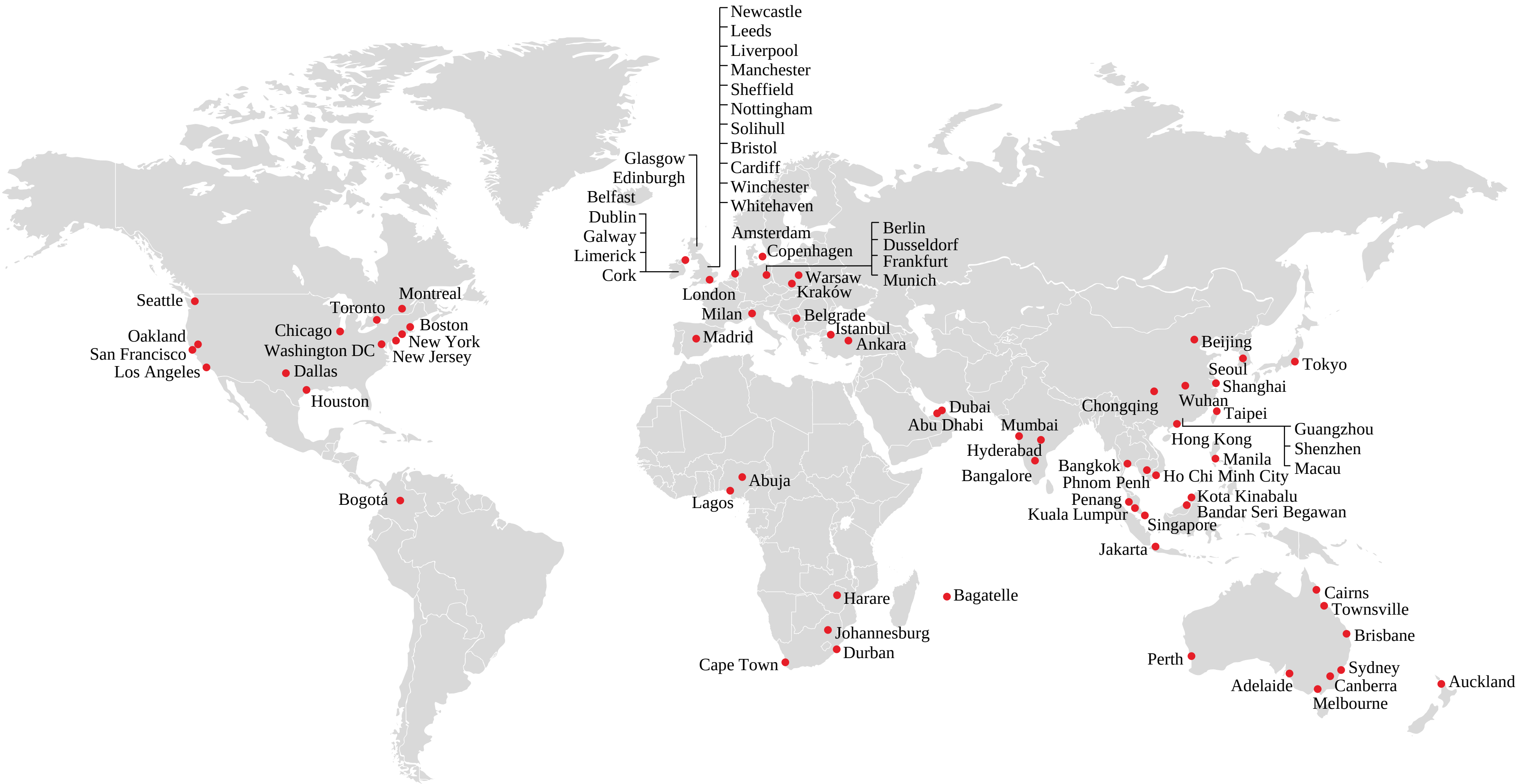

July 2023

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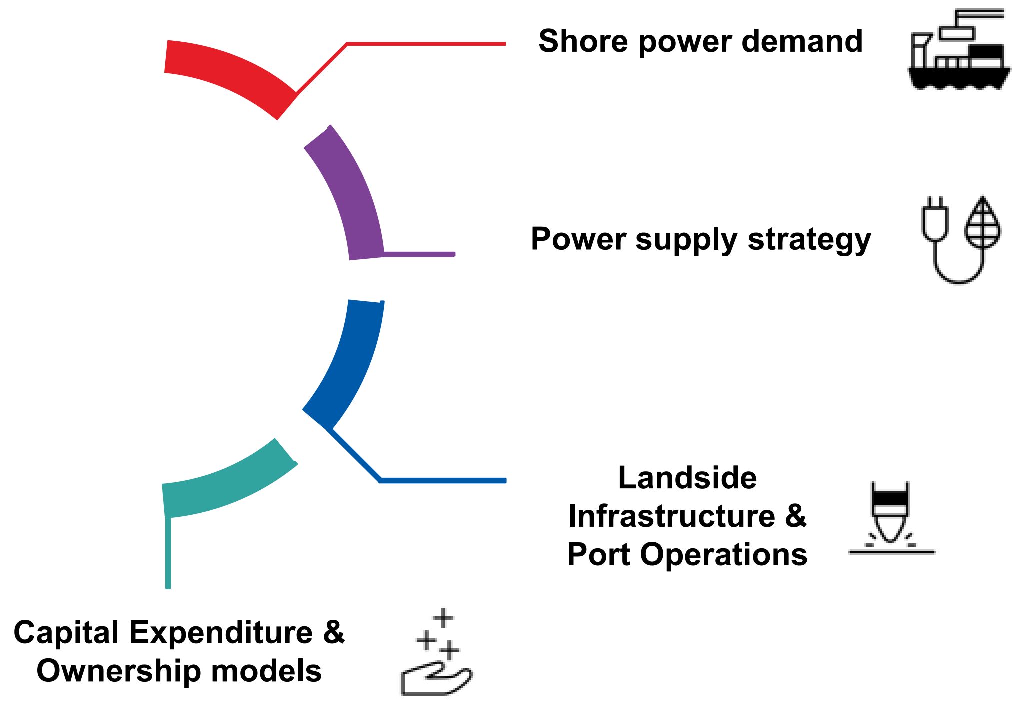
Integrating shore power

Landside infrastructure considerations



Drives maximum power requirement at berth. Demand can vary based on vessel size, age or type.

A step change in energy consumption when ships are connected to the grid.

Challenges with infrastructure planning and operations.

Significant cost uptake and introduction of new energy consumer into the port energy mix.

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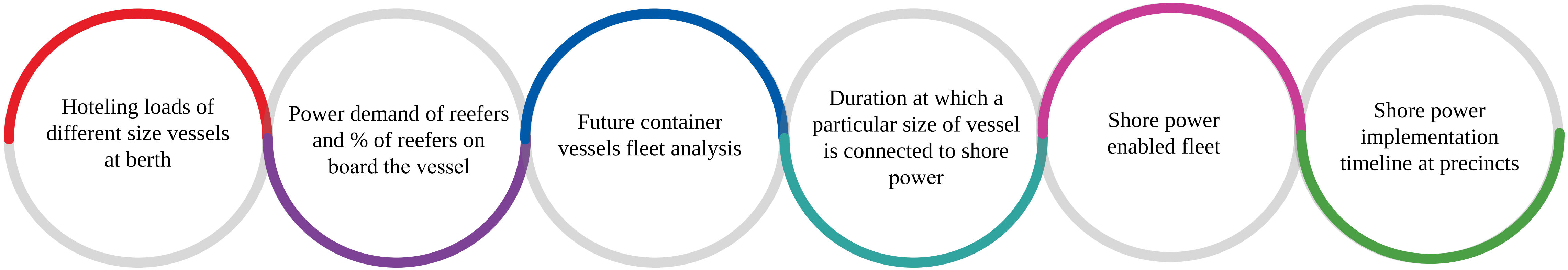
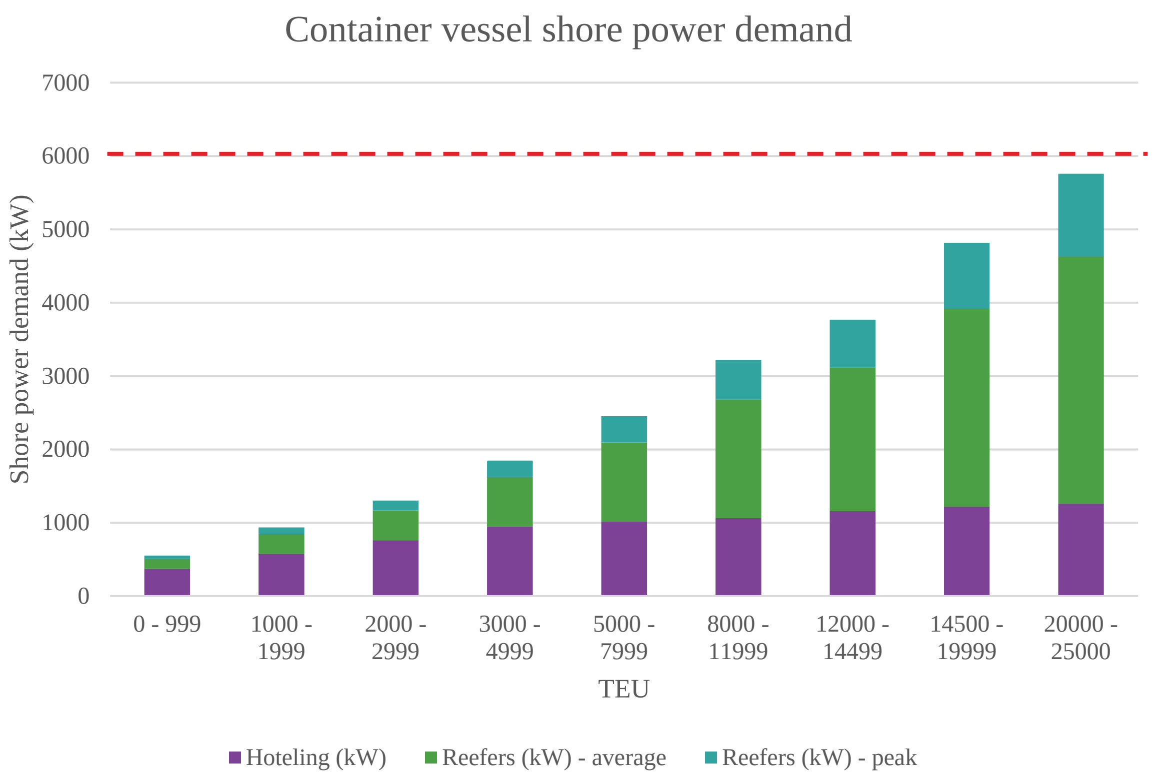
Assessing energy consumption

Port of Melbourne Container Terminals



Shore power demand

Container vessels



- Red dotted line: IEC 80005-1 maximum power demand for container vessels
- Vessel size (TEU) range: varied power demand
- Components of power demand:
  - Hoteling loads
  - Reefer on board
  - Reefer exchange

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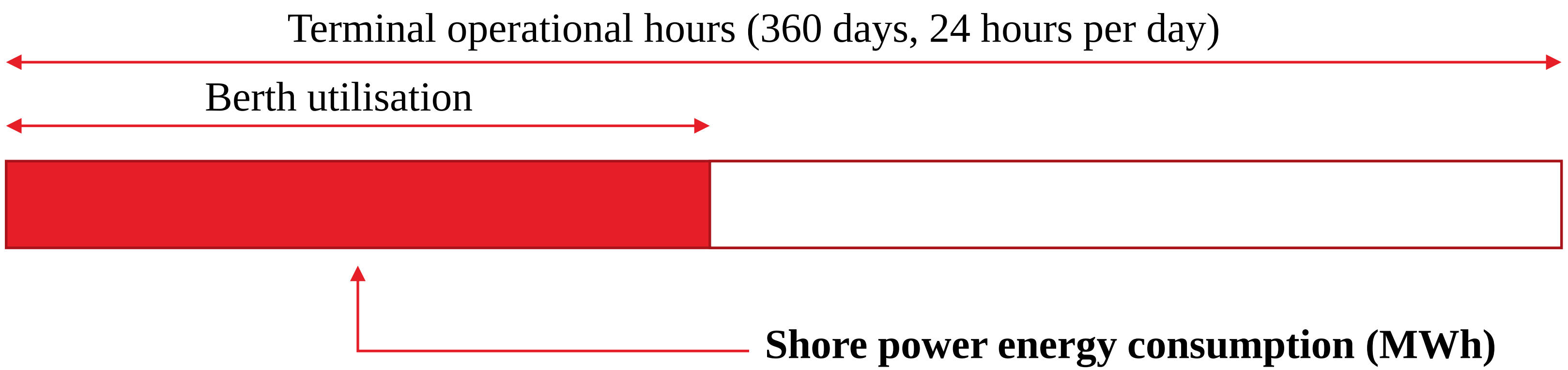
Energy

Power supply strategy and planning



Shore power energy consumption (MWh)

- Hoteling loads based on vessel type/size
- Reefer loads and reefer trade movements.
- Number of vessel calls and trade growth
- Shore power connection duration
- Shore power enabled fleet forecast

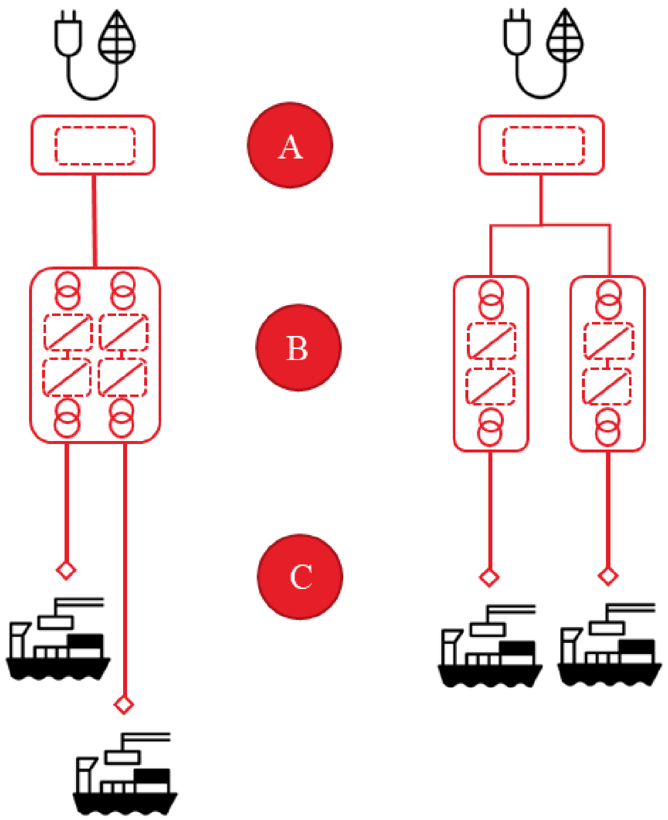
Berth utilisation and shore power parameters informs energy consumption.

A 14,000 TEU vessel with 5% total reefers can consume between 25 MWh to 73 MWh per day.

Landside infrastructure

Shore power substation

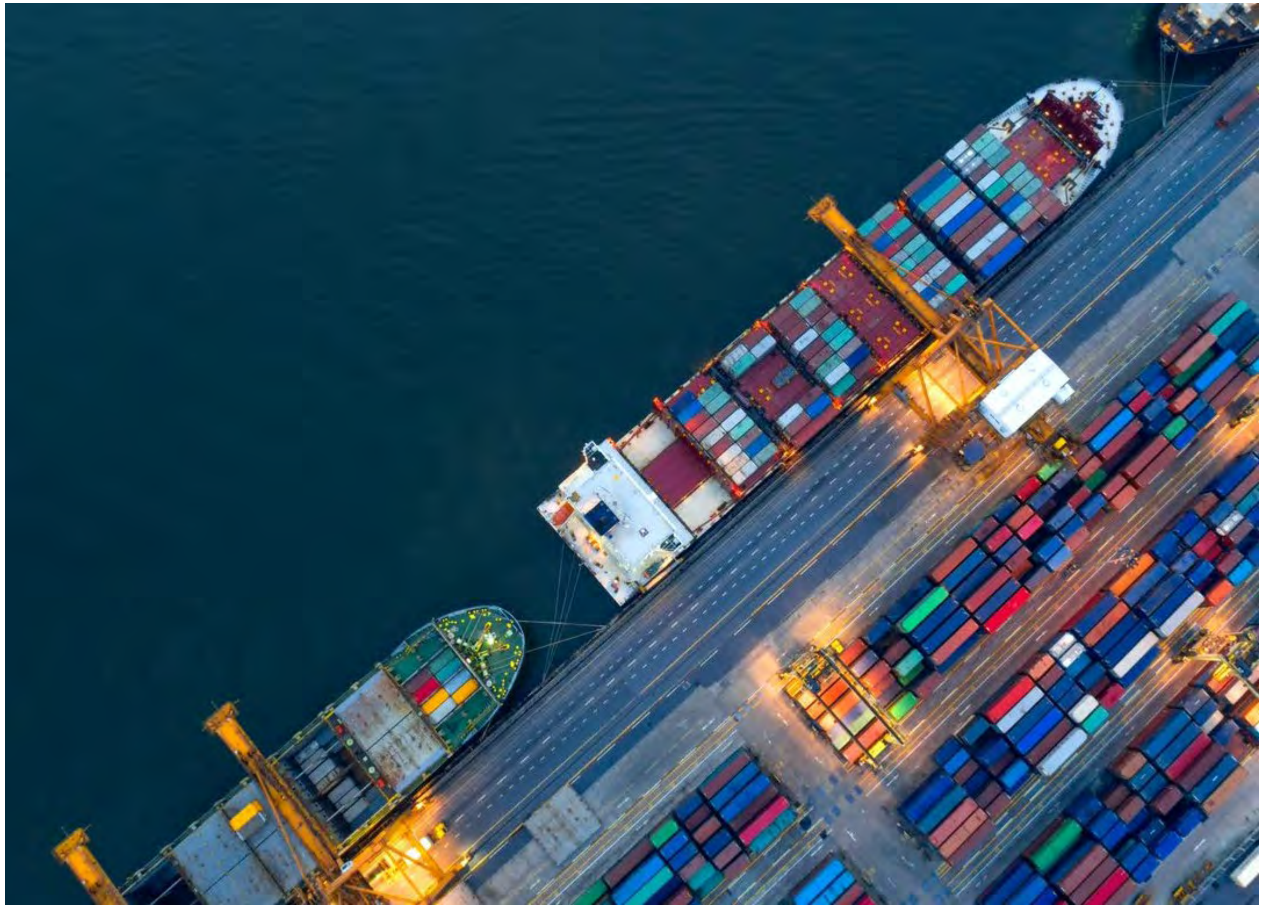
Component	Description
A – Precinct grid main substation	Electrical switchroom located adjacent to distribution network service provider substation. Functions as the grid interface point and provides utility metering
B – Shore power substation	The shore power substation can be designed to different topologies and configurations. Conditions power supplied to vessel in terms of voltage and frequency.
C – HVSC receptacle (vessel interface point)	Vessel interface points located on the wharf – either via receptacle or directly to ship to shore gantry crane.



Landside infrastructure

Considerations at the wharf

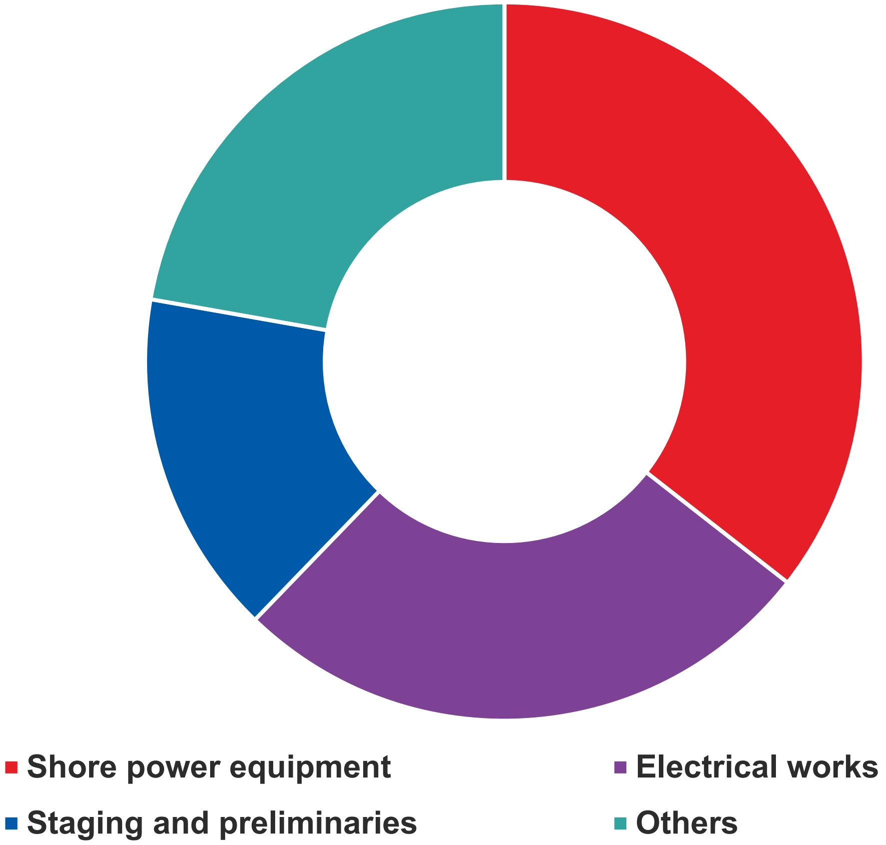
- Cable management system – on board / shoreside.
- Connection point(s) on the wharf with:
  - Port operations – e.g. STS cranes
  - Vessel mooring lines
  - Connection location on vessel
- Connection point(s) linked to shore power substation via conduit network through wharf and yard.



Capital Expenditure

ARUP

Breakdown for typical container terminal



Significant share of cost breakdown for shore power goes towards specialist electrical equipment.

Optimisation and early configuration of shore power system is key to understand constraints and obtain early-stage estimations.

Shore power ownership model

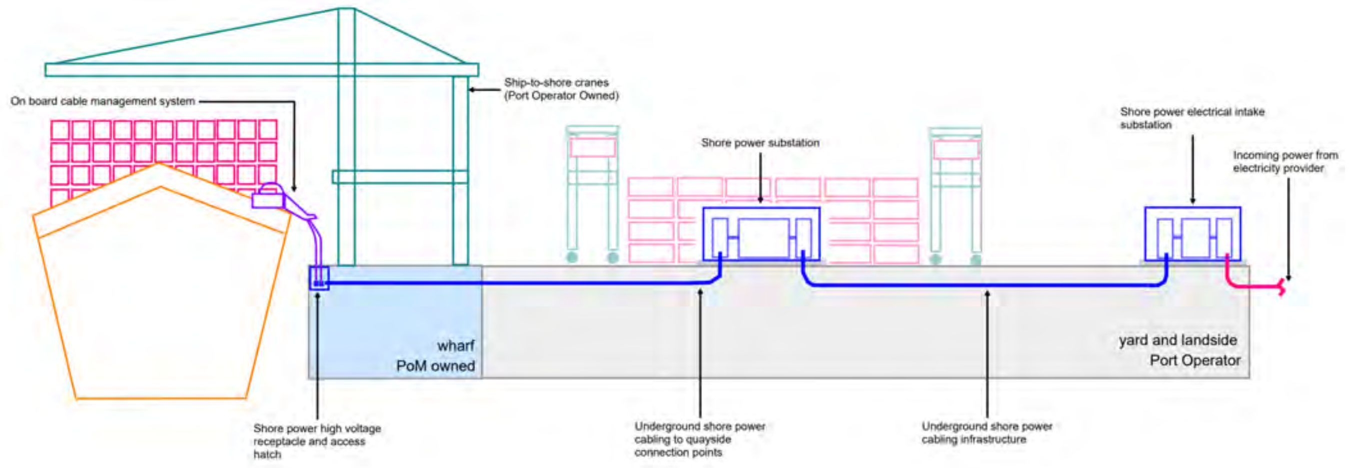
Implications

Ownership of shore power infrastructure is dependent on various factors such as:

- Investment
- Ownership of asset
- Charging mechanism for shore power usage
- Operation and maintenance of shore power

Considerations to ownership model:

- Can vary with different port operators
- Requires similar approach to power purchase from network operator for port operations to reduce complexity in arrangements.
- Shore power pricing depends on $ per kWh remaining competitive and affordable for shipping lines to switch from marine fuel oil.
- Government incentives and regulation.
- Operational control of the wharf face



Shore power globally

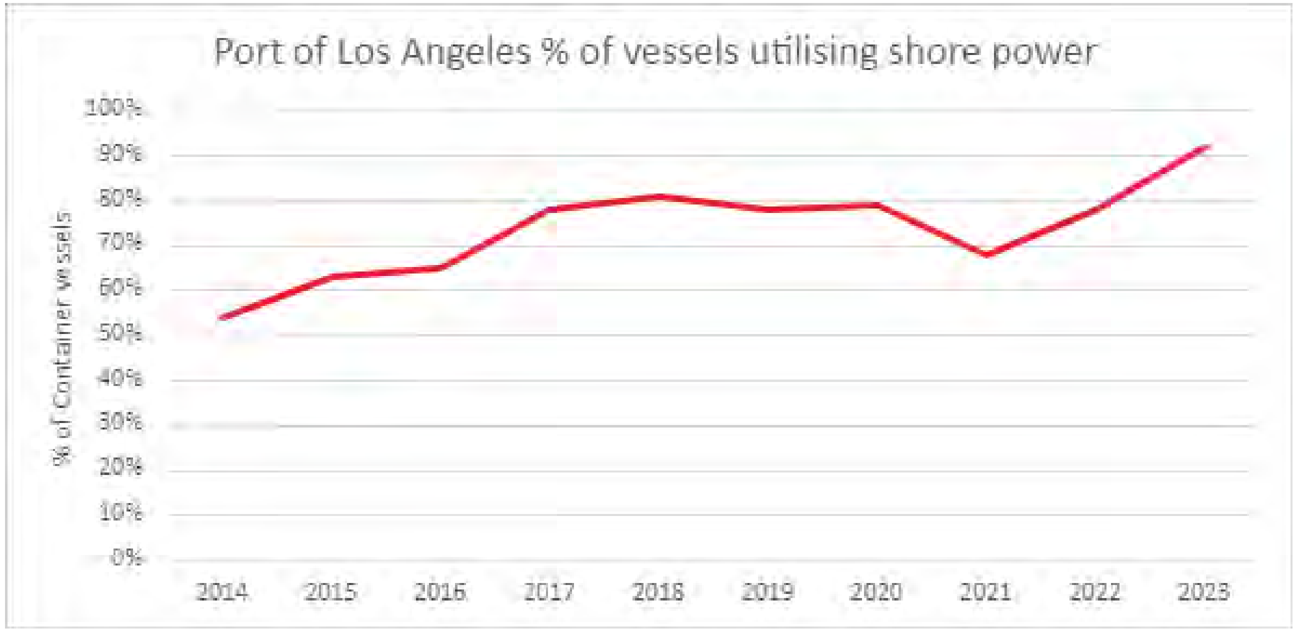
Existing installations and outlook

Source: US EPA shore power assessment, 2022

- Early development and implementation of shore power led by US/Europe with ports in China increasing uptake of shore power.
- Recent EU 'Fit for 55' proposals expected to influence and mandate the use of shore power.
- Shore power has been in operation for almost a decade in the west coast of USA.

Port of Los Angeles

Case study example



Source: Alternative Maritime Power (AMP) | Air Quality | Port of Los Angeles

- First berth with shore power in 2004. As of 2020, 79 shore power installations are in operation.
- The California Air Resources Board (CARB) is the primary driver for emissions control.
- Collaboration between government, ports and shipping lines is crucial for shore power implementation.

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Port of Los Angeles

Existing shore power installation

HVSC receptacles for shore power connections located in constrained areas on the wharf. Coordination required with STS cranes, mooring lines, port operations, and existing infrastructure.

Image source: The Port of Los Angeles

Port of Los Angeles

Existing shore power installation

Conduit routes below wharf. Not all wharf structures have similar arrangement.

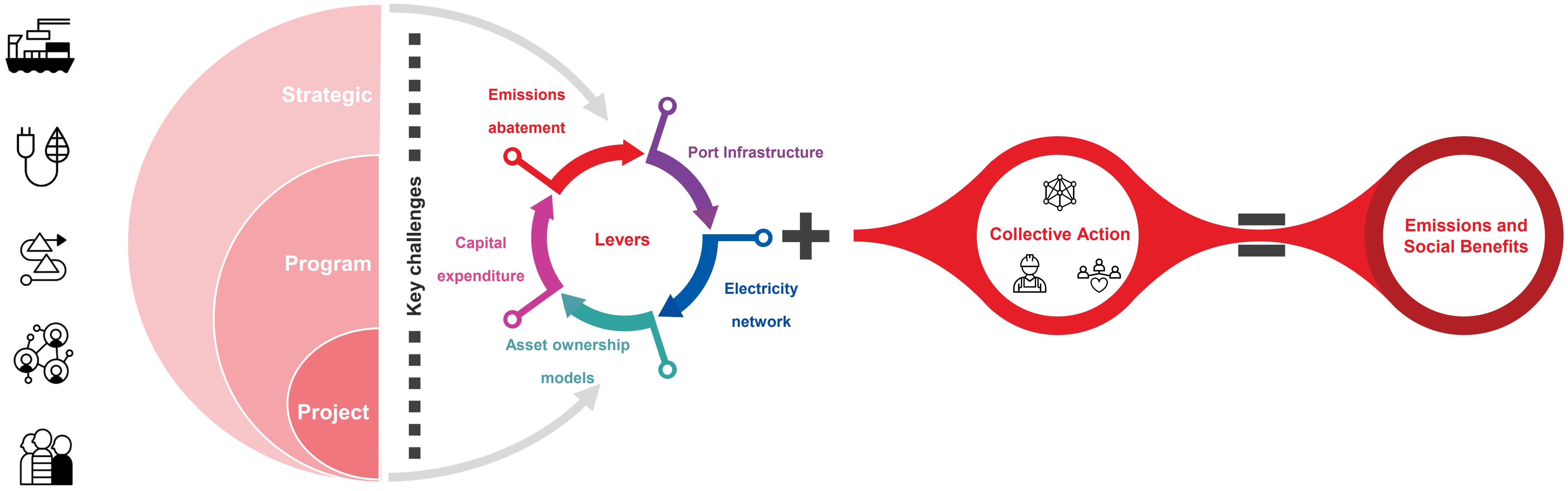
Conduit routes at the wharf area.

HV cabling from vessel connects into HVSC receptacle.

Image source: The Port of Los Angeles

Shore power integration

An ecosystem approach



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Contact

Kesavan Muruganandan

Senior Engineer

ARUP

MANUEL- JESUS LOPEZ

Master in Industrial Engineering with Certificate in Advanced Studies in the Doctoral program of Electrical Electronic and Control Systems.

He has over 20 years of consulting experience across various sectors and organizations:

- Electrical utility company - Planning and investment department for electrical grid developments.
- Digital consulting company - Analyst of business strategy services and re-engineering processes.
- Power Grids senior advisor for a multinational company. Providing assessment and solutions in electrification challenges.
- At present he is working as a Principal Consultant with Hitachi Energy and managing the Advanced Assessment team.

During his professional career, he has been involved in wide range of segments and technologies related to:

- Electrification challenges in renewable integration, application of power electronics and converters solutions, Hydrogen, railway systems and eTransport, engineering design, investments, and market regulation.
- As well as Digital applications such as control systems, database and data analytics.
- Sustainability strategies in CO_2 mitigation, regulation and efficiencies. LCA analysis and environmental impacts assessments

SOLVING CHALLENGES IN PORTS ELECTRIFICATION FOR SUSTAINABLE DECARBONIZATION

Presentation will review different electrification challenges for the Australian port industry with the goal to facilitate the decarbonization and reach the strategic sustainability targets in CO_2 emissions.

A wide overview analysis of different applications will be introduced. The applications will cover alternatives as: shore-to-ship, eVehicle electrification, Hydrogen, power demand and renewable integration management, linked to a regulatory and environmental perspective. The overview will get into some key detailed implications and solutions to make technically and financially successful applications of the solutions.

The combination of different technologies, development of users related to the shipping industry, agents of the electrification port-tools and other suppliers of electrical energy services, will define the operational possibilities and economical relationships.

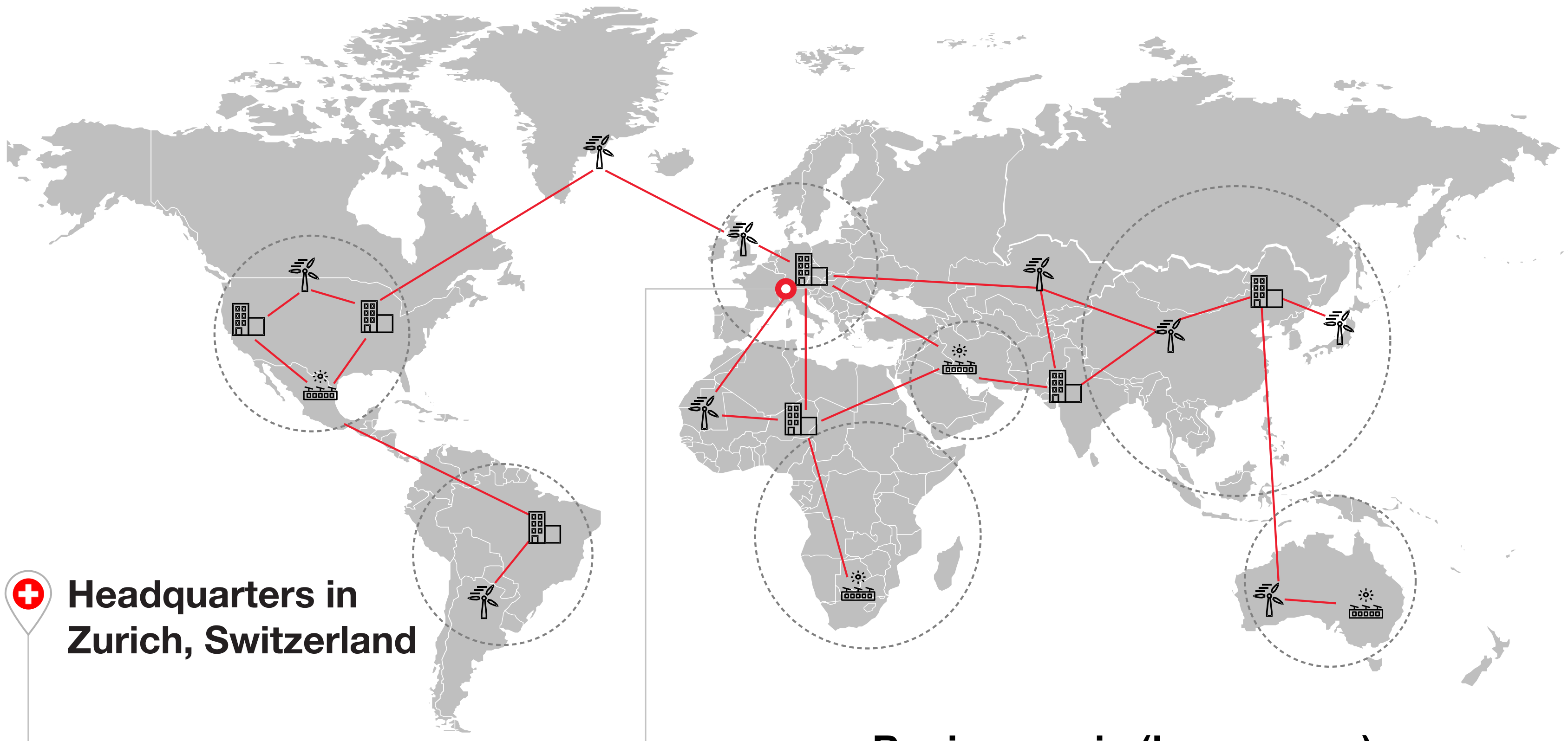
Solving challenges in ports electrification

Sustainable decarbonization

Hitachi Energy

1. Introduction Hitachi Energy
2. Decarbonization commitment
3. Marine ports decarbonization solutions
4. Shore-to-ship
5. Hydrogen
6. eTransport
7. Power supply flexibility and renewable integration
8. Decarbonization market and regulation

About Hitachi Energy



Headquarters in Zurich, Switzerland

40,000 employees

90+
countries with 200 offices

~250
years' heritage combined

5,500
sales employees & field engineers

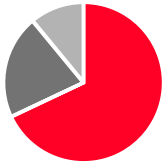
2,000
engineers & scientists in R&D

Four Business Units

Grid Automation	**High Voltage Products**
Grid Integration	**Transformers**

Business mix (by revenue)

Customers



- Transport & Infrastructure
- Industry
- Utilities

Offering

- Services
- Software & Automation
- Systems
- Products

Geographies

- Asia, Middle East & Africa
- Americas
- Europe

Power Consulting

HITACHI
Inspire the Next

Mission

We help solve the power industry's most complex issues and challenges. We do this by conducting detailed technical and economic studies with our clients and are present early in the network planning process when system level issues are initially discussed or evaluated.

Utilizing their strong industry recognized experience and talent, our consultants then evaluate, analyze and recommend solutions and strategies to empower our customers to improve network performance, mitigate risks, optimize investment decisions and drive financial savings.

Building Blocks:

- **Power systems domain expertise**
- **Independent and objective consulting**
- **Comprehensive set of customizable solutions**

Impartiality

- We provide our customers with the optimum solution for their needs, regardless of the origin of the equipment or systems used in its implementation

Confidentiality

- We ensure that all information obtained from our customers remains absolutely confidential and will never be passed without their prior consent

Compliance

- We are always committed to full compliance with all relevant regulations, codes and standards that apply to the solutions we provide.

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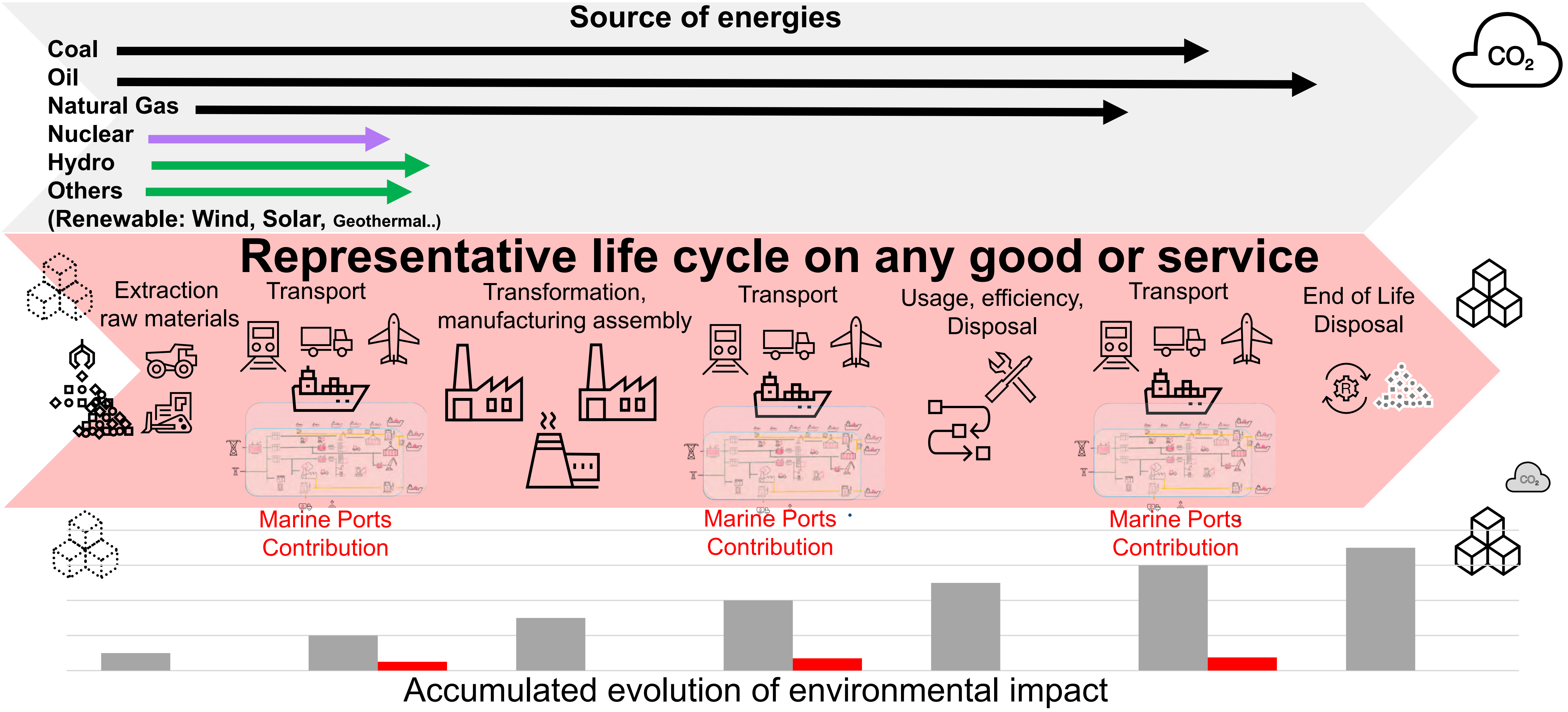
Decarbonization commitment



Hitachi Energy

Decarbonization commitment

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WPSP

World ports sustainabiliy program

WG1 EFFICIENCY	WG2 POLICY	WG3 POWER 2 SHIP	WG4 FUELS	WG5 CARGO HANDLING EQUIPMENT
Los Angeles, *Rotterdam*, Valencia, Vancouver	**Antwerp, Hamburg, Gothenburg, Le Havre, Long Beach, Los Angeles, *Rotterdam*, Valencia, Vancouver, Yokohama**	**Antwerp, Hamburg, Le Havre, Los Angeles, *Rotterdam*, Valencia, Vancouver**	**Antwerp, Barcelona, Gothenburg, Le Havre, New York/New Jersey, *Rotterdam, Vancouver, Yokohama***	**Long Beach, *Los Angeles*, New York/New Jersey, Valencia, Vancouver, Yokohama**
Increase efficiency of supply chains by development of digital tools to optimize	Ambitious (public) policy on emission reductions	Feasible renewable power-2-ship solutions or other zero emission	Sustainable low-carbon fuels. Electrification ship	Decarbonize the cargo-handling facilities in our ports

IMO

International Maritime Organization

+80%

Worldwide merchandise transported by sea

2.8%

Worldwide GHG emissions come from the maritime sector.

40%, 70%

Reduction of maritime emissions by 2030, 50

ON Shore power

Powering with electrical engines

7,66%

Reduction of fuel consumption

5,2 t

Reduction of CO_2 emissions per quantity of consumed fuel. As well reduction in NOx, SOx

1,9%

Reduction in maintenance and operation costs

On shore power supply

48% - 70%

Reduction of CO2 emissions. And NOx, SOx

800,000 t CO2

Could be mitigated annually

= 1 million

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Marine ports decarbonization solutions

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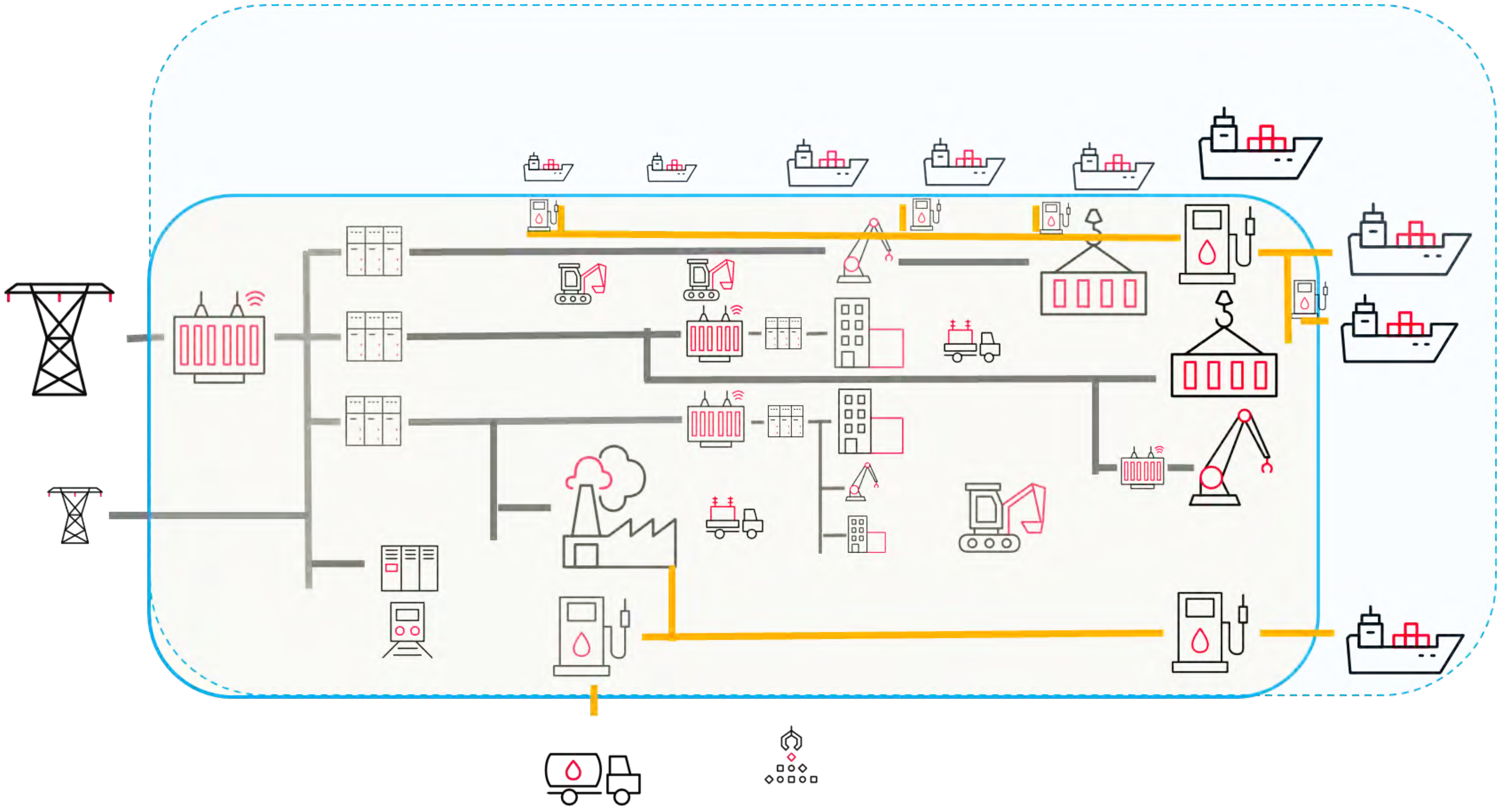
External energy sources

Electricity (green/no green)
Oil (Diesel,…)
Gas, Coal
District Heating

Port and services

Port services
(Container, Transport, Cranes..)
Auxiliaries
Energy sources supply
(Heat, cold, electricity..)
Ship/Cruiser/Cargo dock
Industries operating in port
(Factories, Shipyard, food, others)



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Marine ports decarbonization solutions

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External energy sources
Electricity (green/no green)
Oil (Diesel,…)
Gas, Coal
District Heating

Port and services
Port services
(Container, Transport, Cranes..)
Auxiliaries
Energy sources supply
(Heat, cold, electricity..)
Ship/Cruiser/Cargo dock
Industries operating in port
(Factories, Shipyard, food, others)

Energy sources

Integration of renewable
- **Solar**
- **Wind**
- Others

Industry conversion
(Oil, gas, coal, to green electricity or green fuel)
- **Shore to Ship**
- **Hydrogen H2**
- **eTransport**
- eBoilers
- Other bio-fuels

Efficiency

Digital solutions
- **Demand forecast**
- **Generation forecast**

Operation optimization
- **Traffic digital optimization**
- Cranes reversible energy
- Cranes optimal smart operation

Compensation solutions
- **Storage ESS**
- **Storage H2**

Grid development
- Installation asset assessment
- **Optimal & feasible grid development**
  (Grid connection, architecture, compensation solutions)
- **Smart grid and Microgrids**
- Emergency infrastructure and redundance

Engagement

Port energy dealer
- **Electrical supply contract and electricity prices**
- **Supply of electricity services**
- **Port taxes and Eco**
- **H2 supply prices and market**
- **Electricity generation hub**
- **Electricity other markets hub**
- **H2 hub (Industries)**

Other solutions
- Carbon capture
- Carbon net-zero agreements

Hitachi Energy

Marine ports decarbonization solutions

Ports decarbonization solutions

Shore-to-ship

H2 Solution

eVehicle

Power supply and renewable integration

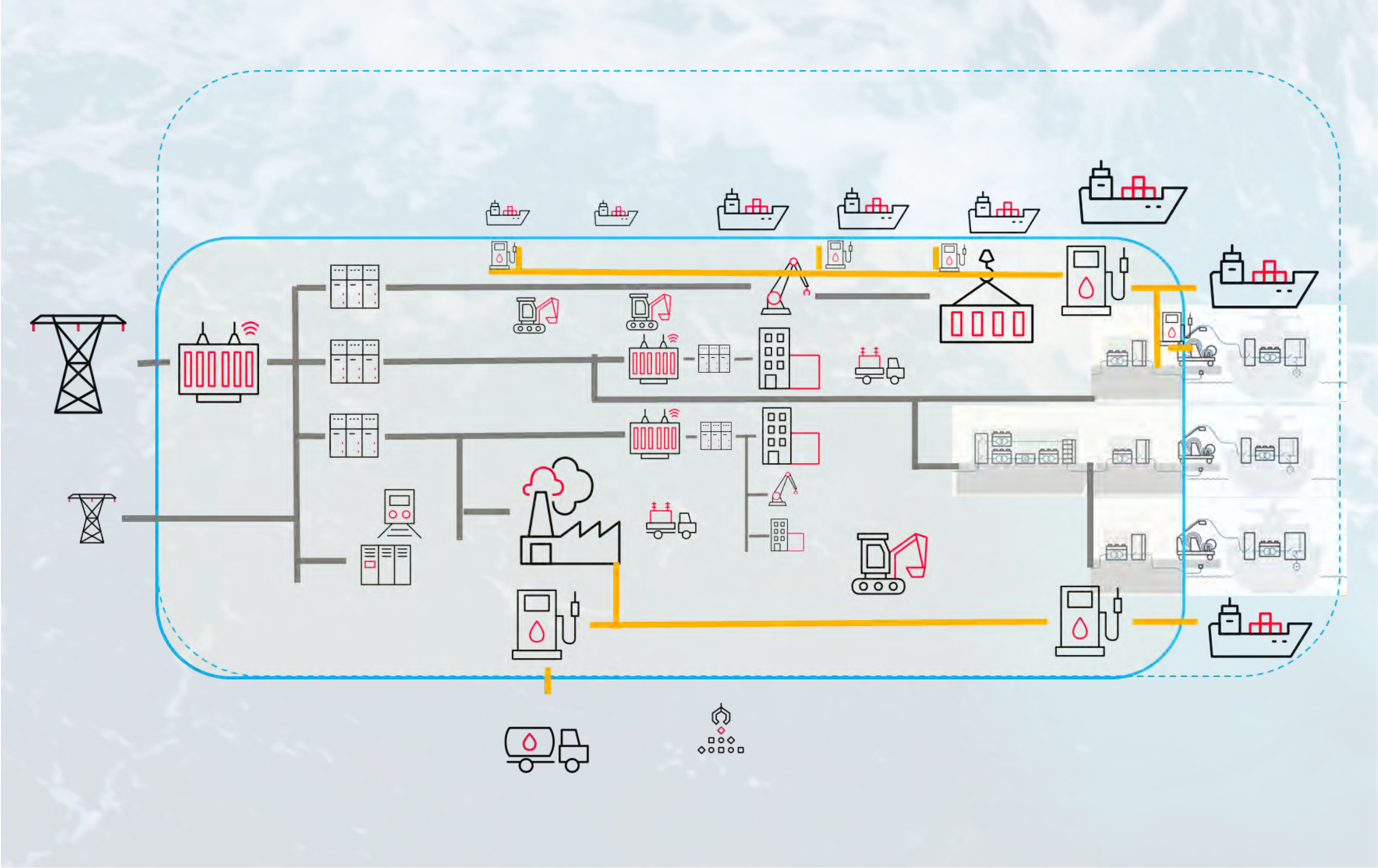
Decarbonization market and regulation

Internal

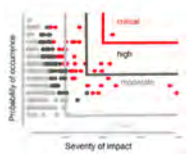
Hitachi Energy

Shore-to-ship solutions

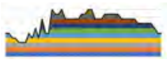
HITACHI
Inspire the Next



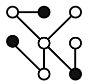
Shore to ship challenges



Audits and assessment.
Criticality and reliability
Status of installations

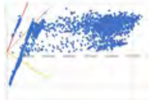


Operation and performance
Demand forecast



Operation and grid expansion and integration

- Location and definition areas of connection.
- Connection standardization
- Integration in existing grid and supply architecture
- External connection upgrade



Power quality, Harmonics
Smart network and digital applications

Sizes and functionalities
Voltage: 11kV; 6,6 kV or low voltage
Max Power consumption: 0,1-20MVA
Frequency: 60, 50, 60&50 Hz
Transformer: Onboard, onshore
Load profile: Controlled, not controlled or partially
Technologies: IGBT, IGCT, Synch., black start

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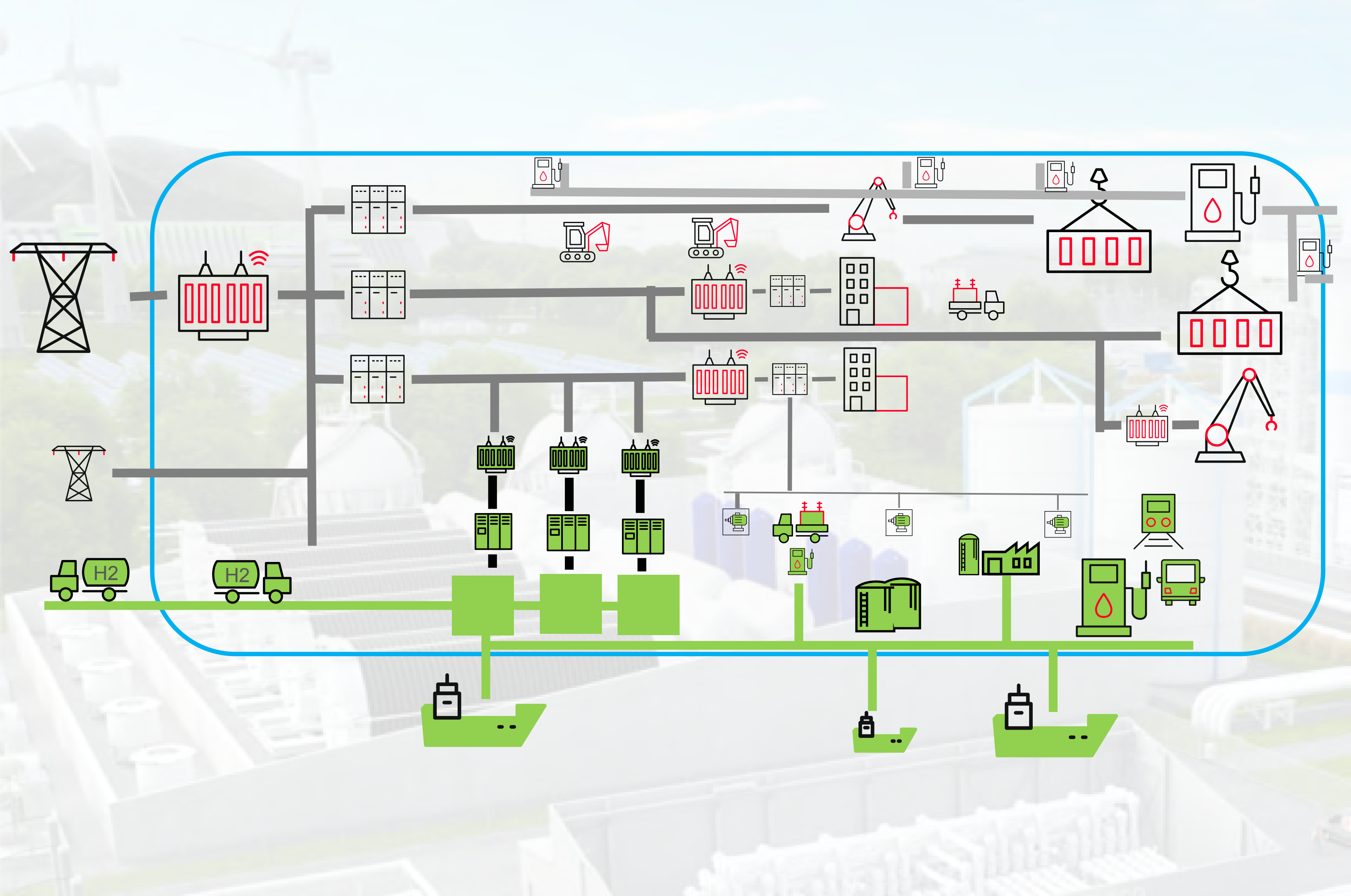
Hydrogen solutions



H2 decarbonization perspective

Hydrogen Hub strategy
- Hydrogen supply
- Hydrogen production

Supply in port: cycles and forecast
- H2 cargos
- H2 trucks

Supply out of port: cycles forecast
- Terrestrial transport
- Pipe connection
- H2 consumers: Industry, transport

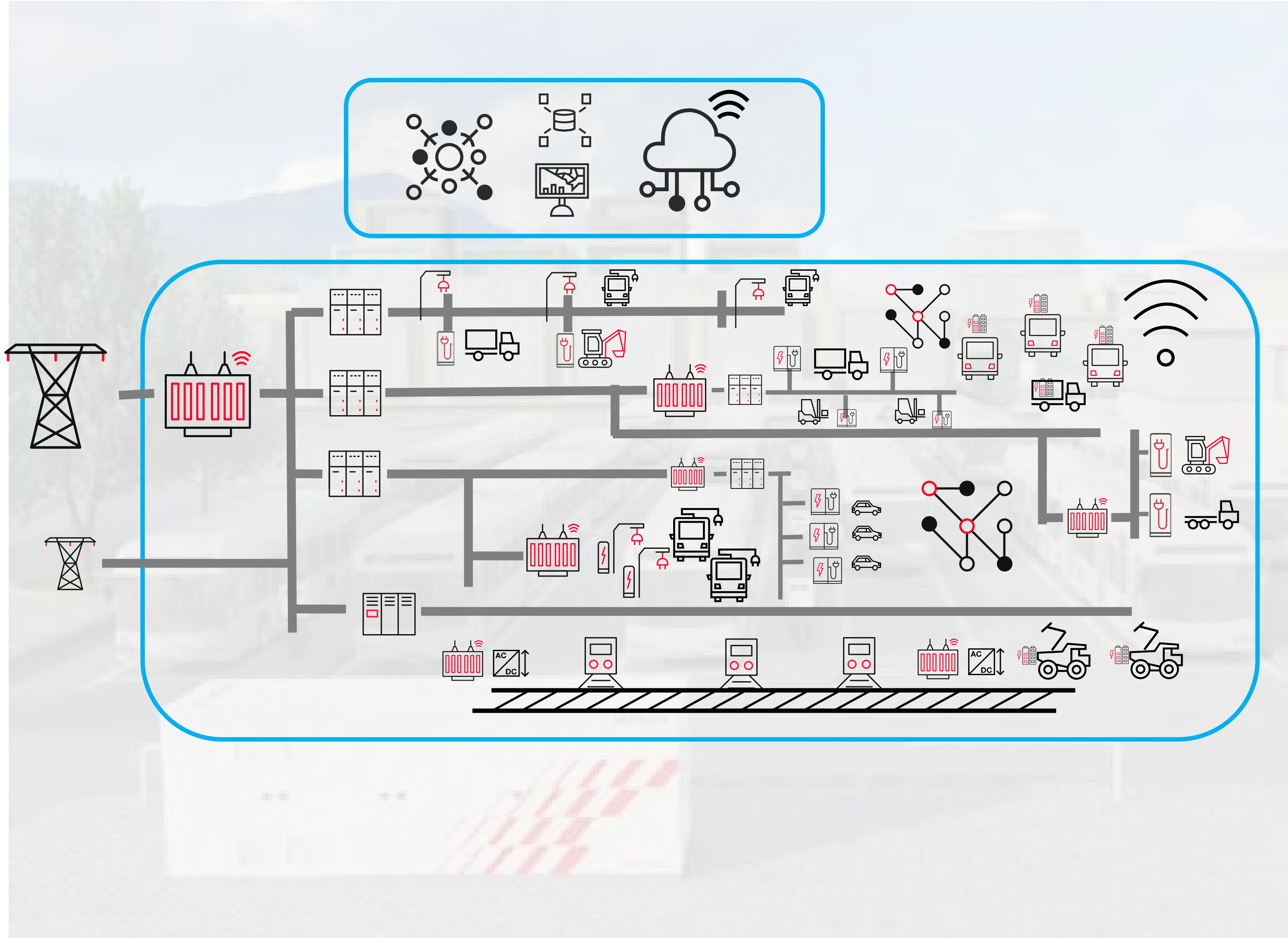
Decarbonization strategy

Electrification for production
Electrification for auxiliaries

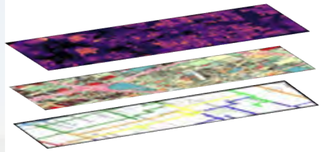
Grid design and external grid impact
Renewables integration
H2/Electricity Storage

H2 Markets and costs

Vehicle electrification solution



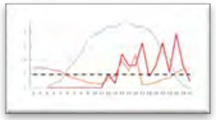
eVehicle: Electrification strategy



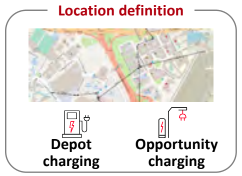
Goods, loads movements
Routes identification, optimization

Demand forecast density and optimal location

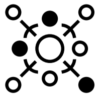
Vehicles and transport technologies



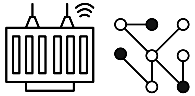
Optimized charging strategy
Hybrid solutions and decarbonization strategy



Definition of charging strategies and location



Digital and system optimization and efficiency. Smart charging



Electrification solution
- External grid
- Electrical distribution grid
- Challenges and solutions

Power supply flexibility and renewable integration

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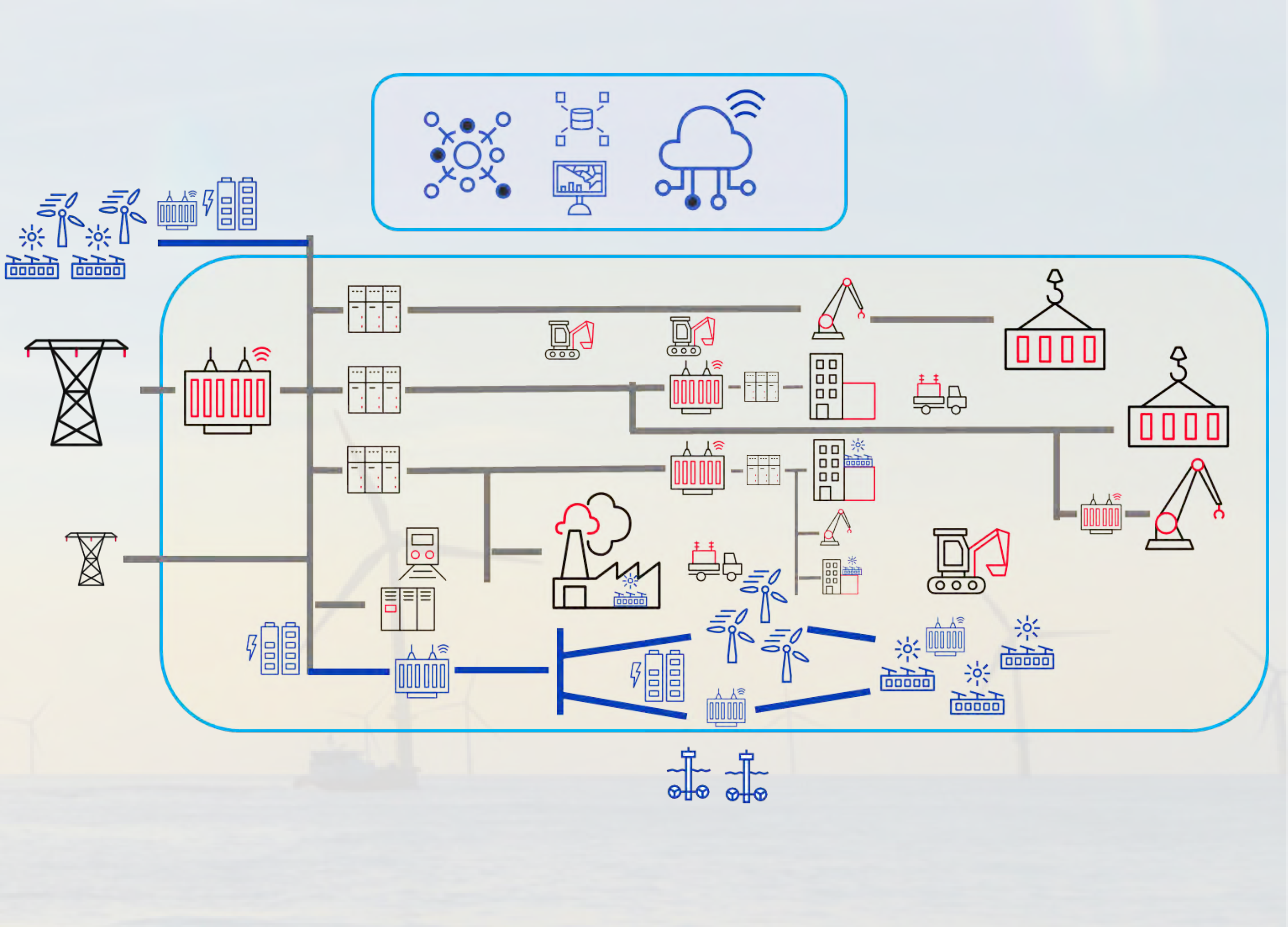

Renewable sources management

Energy demand and generation forecast

Market and energy prices vs. investment.
Storage solutions and optimal use
Commercializing electricity

Electrification solution
- External grid impact and dependency and power balance
- Grid code compliance and regulation
- Electrical distribution grid for power sources integration
- Voltage stability
- Reactive power compensation
- Contingencies and redundancies
- Power quality harmonics

Digital and system optimization and efficiency.

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Decarbonization market and regulation

Port acquisition

Electricity prices

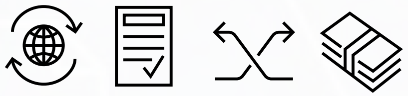
- Energy costs historical evolution and forecast.
- Permits rights.
- Reactive power penalties.
- Others complements.

Sustainable regulation and future taxes

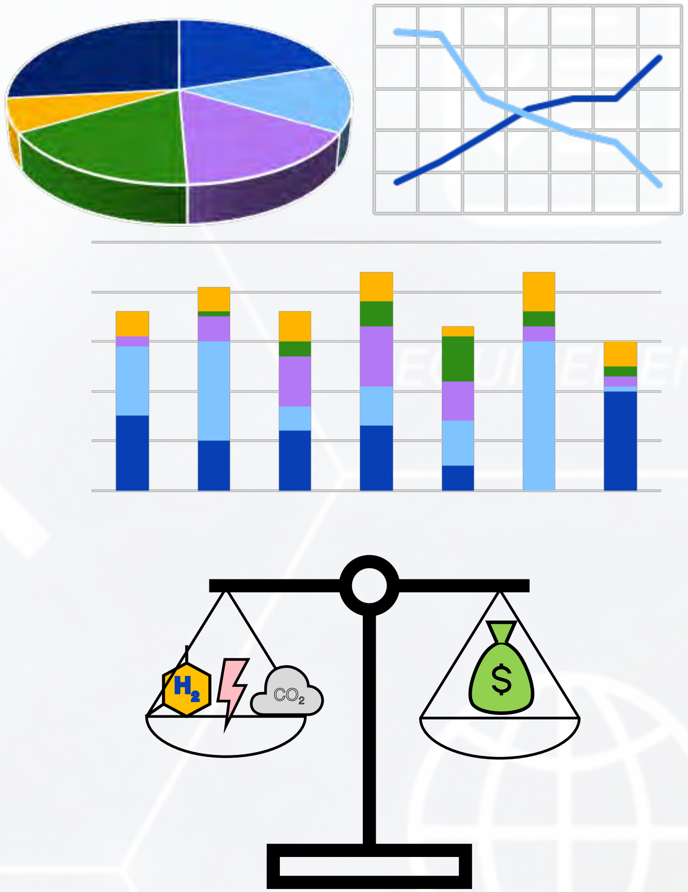
- Prices and CO2 taxes. Right emissions
- Emissions markets trading.

Hydrogen market and commercialization.

- Production costs



Monitoring strategy and balance



Port return policies

- Electricity commercialization services
  - Shore-to-ship
  - Others
- Hydrogen commercialization services
- Port taxes and strategies
  - Products life cycle improvement
  - Emissions taxes

Additional improvements

- Energy efficiency
  - Reversible breaking
  - Optimal use of renewable
- Emissions reduction solutions
  - Direct carbon capture
  - Net carbon emissions solutions

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DECARBONISATION OF THE SUPPLY CHAIN

- *Dr Chris Wooldridge,*
  EcoPorts SLC (United Kingdom)

DR CHRIS WOOLDRIDGE

With an academic background in university lecturing and research, Chris is also qualified as a trainer in Environmental Management Systems and has delivered academic modules and industrial training courses on Port Environmental Management in all the maritime states of Europe, as well as in Colombia, Taiwan, Ivory Coast, Vietnam, Thailand, Laos, Cambodia, India, Malaysia, USA, and Kuwait. He was Director of Studies, Marine Geography in the School of Earth and Ocean Sciences, Cardiff University, UK until 2011.

His experience in the maritime sector includes applied research in close collaboration with the port sector and associated marine industries for 40 years. He served for six years as visiting lecturer at the World Maritime University, Malmö

While at Cardiff University he was one of the original researchers who, along with port sector colleagues, other academics, and his research students, was involved in the development of the International Quality Standard of Environmental Management System, EcoPorts PERS.

DECARBONISATION OF THE SUPPLY CHAIN

Based on data analysis from responses to the EcoPorts Self-Diagnosis Methodology (SDM) which is a component of the EcoPorts International Quality Standard Environmental Management System, PERS, the presentation identifies the current status, availability, and usage of OPS facilities along with the outstanding challenges required to develop its uptake further so that it becomes a fundamental aspect of the port's business strategy. Details are given on the factors that have most influenced the uptake of OPS, the types of vessels using it, and the technical challenges faced. Drawing on data from port network members of EcoPorts both inside Europe (www.ecoports.com) and outside Europe (www.ecoslc.eu), developmental options are considered with particular reference to the strategic, business case of OPS within port activities and operations. .

ECO SLC
Sustainable Logistic Chain

OPS – READY – STEADY – CHARGE!

Today and tomorrow

Christopher Wooldridge
Senior Trainer, ECO-SLC, Nederlands
Joint Science Coordinator, EcoPorts, Brussels, Belgium
(Wooldridge@cf.ac.uk)
&
Herman Journée
Chairman ECO Sustainable Logistics Chain Foundation
(herman.journee@ecoslc.eu)

Contents

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- Context and strategies
- Database and network
- Influences and Options
- Usage
- Challenges
- Trends

OPS IN THE CONTEXT OF PORT EMS

- Compliance
- Cost and risk reduction
- Control of Significant Aspects*
- Voluntary self-regulation*
- Delivery of continuous improvement*
- Market opportunity
- Each port is unique
- Provide evidence*
- Stakeholder engagement

INSTALL OPS AND OPERATE A QUALITY EMS

WHO WANTS TO KNOW?	WHAT'S IN IT FOR THE PORT?
Regulators & Courts	Compliance
Marine Governance Agencies	Cost & Risk reduction
Investors/Operators	Sustainable development
Insurance/Banks	Market opportunity
Auditors	Positive image
Community	License to operate

PRIORITY ENVIRONMENTAL ISSUES

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	2017	2018	2019	2020	2021	2022	2023
1	Air Quality	Air quality	Air quality	Air quality	Air quality	Climate change	Climate change
2	Energy Consumption	Energy Consumption	Energy Consumption	Climate change	Climate change	Air quality	Air quality
3	Noise	Noise	Climate change	Energy efficiency	Energy efficiency	Energy efficiency	Energy efficiency
4	Water quality	Relationship with local community	Noise	Noise	Noise	Noise	Noise
5	Dredging: operations	Ship waste	Relationship with local community	Relationship with local community	Relationshi p with local community	Water quality	Water quality
6	Garbage / Port waste	Port development (land related)	Ship waste	Ship waste	Water quality	Relationship with local community	Ship waste
7	Port development (land related)	Climate change	Garbage / Port waste	Water quality	Ship waste	Ship waste	Relationship with local community
8	Relationship with local community	Water quality	Port development (land related)	Garbage / Port waste	Dredging: operations	Garbage / Port waste	Port development (land related)
9	Ship waste	Dredging: operations	Dredging: operations	Dredging: operations	Port developme nt (land related)	Port development (land related)	Garbage / Port waste
10	Climate change	Garbage / Port waste	Water quality	Port developmen t (land related)	Garbage / Port waste	Dredging: operations	Port Development (water)

August 2023

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ECOPORTS

DATA BASE AND NETWORK

ECOPORTS: www.ecoslc.eu & www.ecoports.com

EcoPorts SELF-DIAGNOSIS METHOD
Checklist & Framework of good practice

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www.ecoslc.eu
www.ecoslc.com

- Policy
- Environmental Aspects*
- Objectives and targets
- Resources and budget
- Organization and personnel
- Awareness and training
- Communication
- Operational management
- Emergency Planning
- Monitoring
- Review and Audit
- Green Services*

NEW COMPONENTS via EcoSLC

- UN SDGs
- Climate Change
- Sustainability

August 2023

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ECOPORTS

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Sustainable Logistic Chain

ECOPORTS PORT ENVIRONMENTAL REVIEW SYSTEM
International Quality Standard of EMS

The only EMS quality standard specifically developed for the port sector

(SDM → PERS (Audited by Lloyd's Register Quality Assurance)

Recognized by:

- **ESPO, AAPA, IAPH, WPSP,**
- **World Bank (European Investment Bank, and European Bank for Reconstruction & Development)**
- **United Nations Environment Programme (UNEP)**
- **African Ports Association**
- **Arab Sea Ports Federation**
- **Taiwan Ports International Corporation (TIPC)**
- **InterAmerican Committee for Ports (Organization of the American States).**

(7 Australian Ports are Members of Ecoports Network)

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TRENDS OF AVAILABILITY OF OPS - EUROPE

Indicator	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)
Is On-shore Power Supply (OPS) available at one or more berths?	53	48	51	53	58	57	55	57
High voltage*	38	40	47	48	46	46	49	49
Low voltage*	90	84	82	86	88	82	86	86
By fixed installations*	--	--	96	96	93	93	100	100
By mobile installations*	--	--	13	16	16	14	14	18
Does the port plan to offer OPS during the next 2 years?	--	--	27	29	40	46	48	52

Port responses between Europe and Outside Europe generally within 2.3% with exception of 2-year plan (52/39%)

FACTORS INFLUENCING THE PROVISION OF OPS

Rank	Influence
1	Voluntary agreement with shipping
2	Battery charging/swapping
3	Pressure from Authority/Community
4	Obligations from Authority
5	Tax exemption

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TYPES OF VESSELS USING OPS

EUROPE

Rank	Type of vessel
1	Utility (Towers/mooring)
2	Inland Navigation
3	Ferries
4	RORO/ROPAX
5	Fishing
6	Bulk
7	Cruise
8	Tankers

OUTSIDE EUROPE

Rank	Type of vessel
1	Utility (Towers/mooring)
2	Bulk
3	Ferries
4	Fishing
5	Inland navigation
6	RORO/ROPAX
7	Tankers
8	Cruise
8	Container

CHALLENGES FACED IN CONSIDERING INSTALLATION AND OPERATION OF OPS

- Unavailable/Insufficient grid infrastructure
- Inadequate capacity of infrastructure
- Frequency conversion Shore:Ship
- Business case – operational costs
- Business case capital investment

NAVIGATING AHEAD

1) **Dynamic transition**
2) **Climate change***
3) **Business Plan**
4) **Renewable energy**
5) **Efficiency**
6) **Competition**
7) **Multifactorial**
8) **Stakeholders**

- **Sustainability***
- **Phased & Integrated**
- **UN SDGs**
- **Materiality***
- **ESG approach**
- **Cost-effective**
- **Port-Shipping-Chain**
- **‘Level playing-field’**

*(Port Sustainability Strategy Development Guide, Ports Australia. June 2020).

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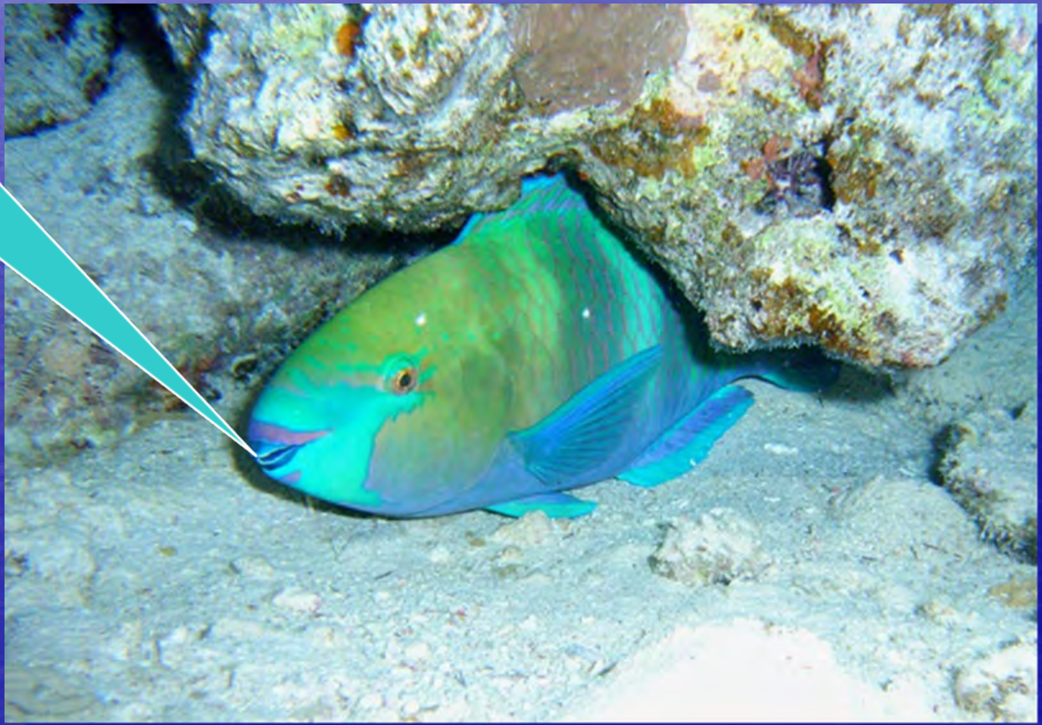
Sustainable Logistic Chain

Thank you for your attention!



NATIONAL WRAP UP

Mike Gallacher, CEO
Ports Australia

MIKE GALLACHER

Mike Gallacher started his working life as a police officer at the age 19. He worked in various areas of the force during his 16-year career including internal investigations, criminal investigations and special operations.

During his time as an officer Mike also became involved in the local Liberal Party Branch. He eventually ran for a seat in the NSW Legislative Council in 2003 and won. In 2005, he was appointed Shadow Minister for Police in the New South Wales Shadow Cabinet and was appointed the portfolio of Shadow Minister for the Hunter in April 2007.

Winning government in 2011, Mike was appointed Minister for Police and Emergency Services, Minister for the Hunter, and Vice-President of the Executive Council, Leader of the Government in the Legislative Council.

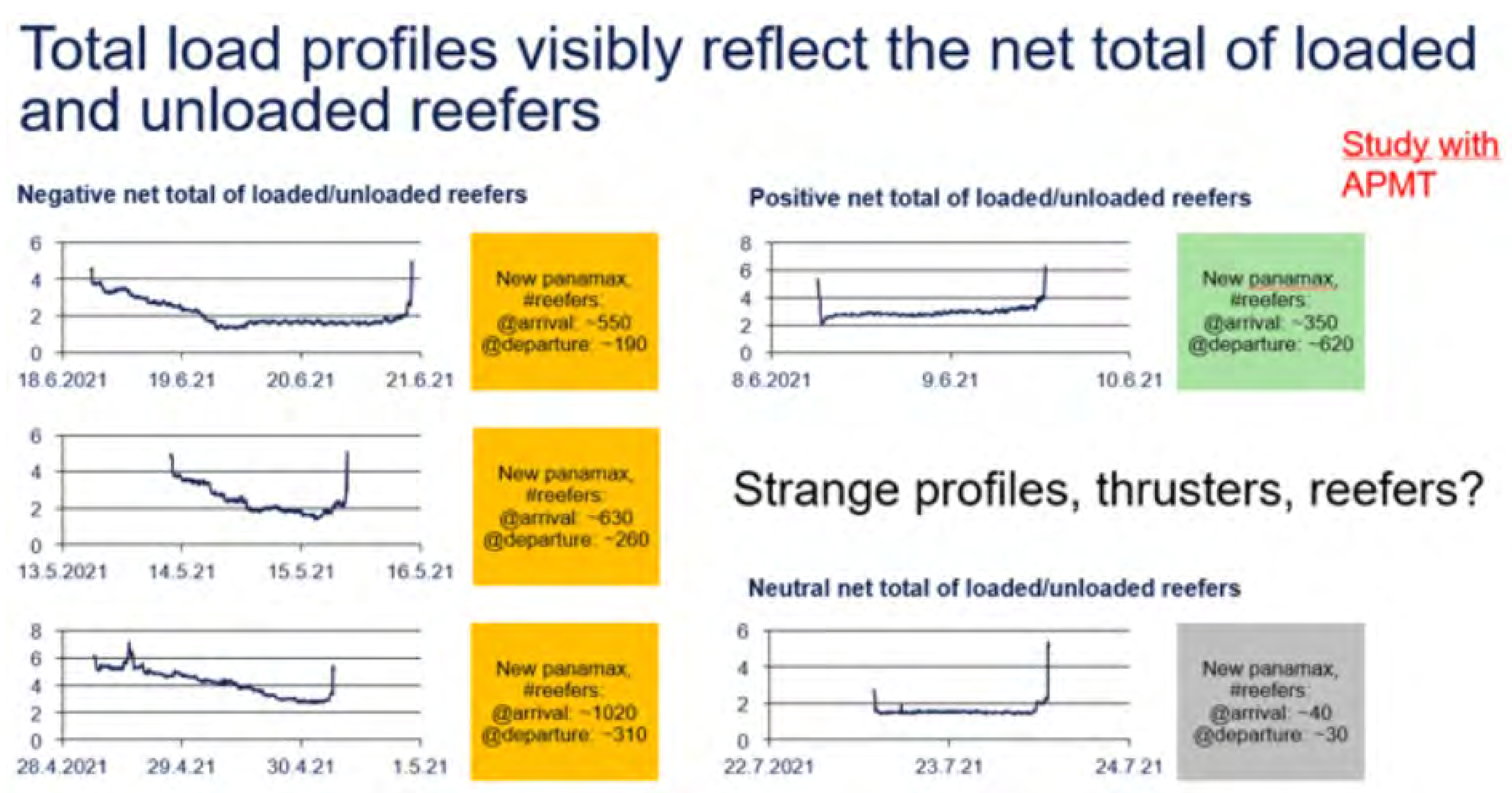
Leaving Parliament in 2017 he has now taken the role as CEO of Ports Australia, the peak industry body for the Australian Ports sector. Over the past five years Mike has been a strong and successful advocate for the port industry.

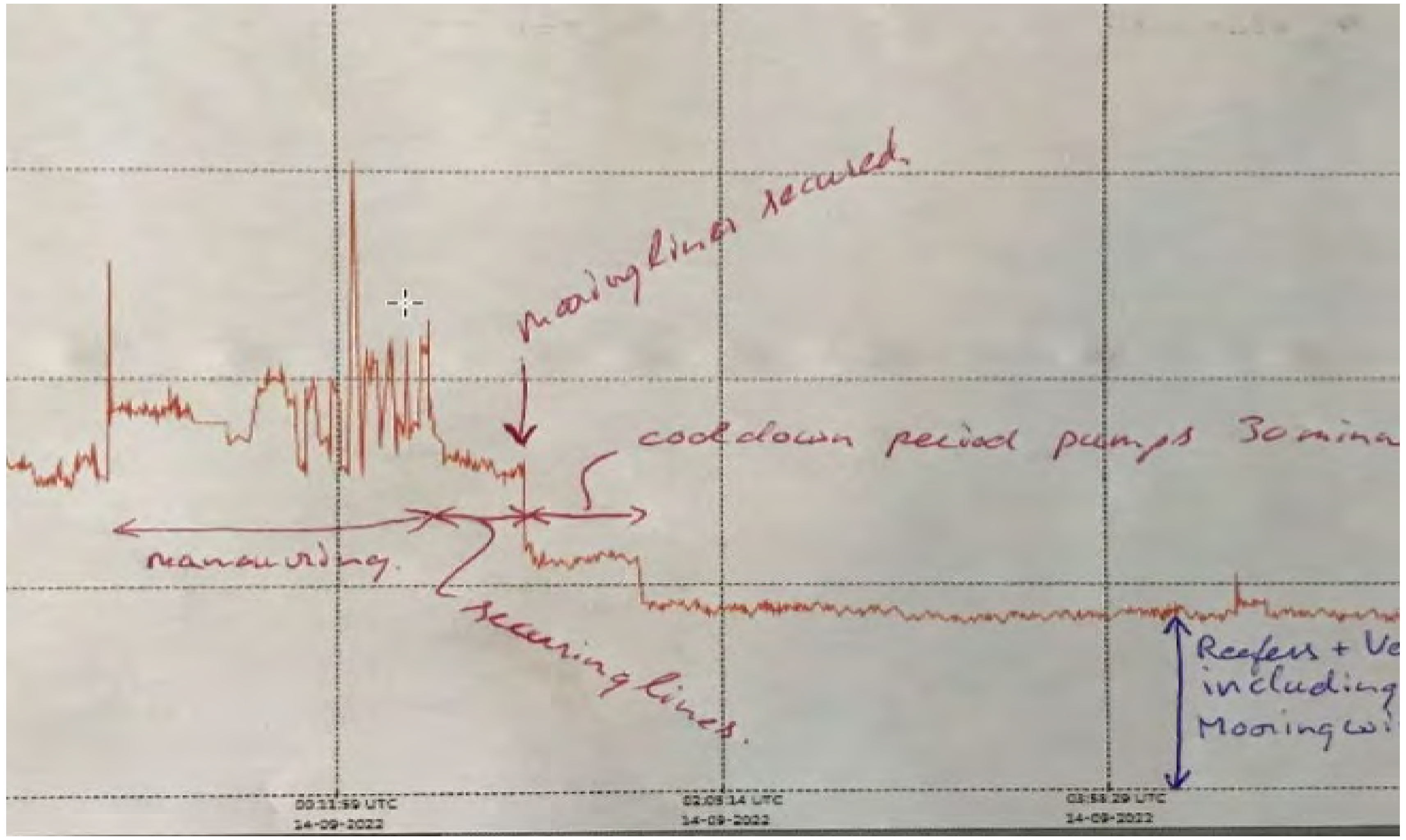
Container vessel load profiles

- Steady or peaky
- Base and reefer loads
- Fuel costs

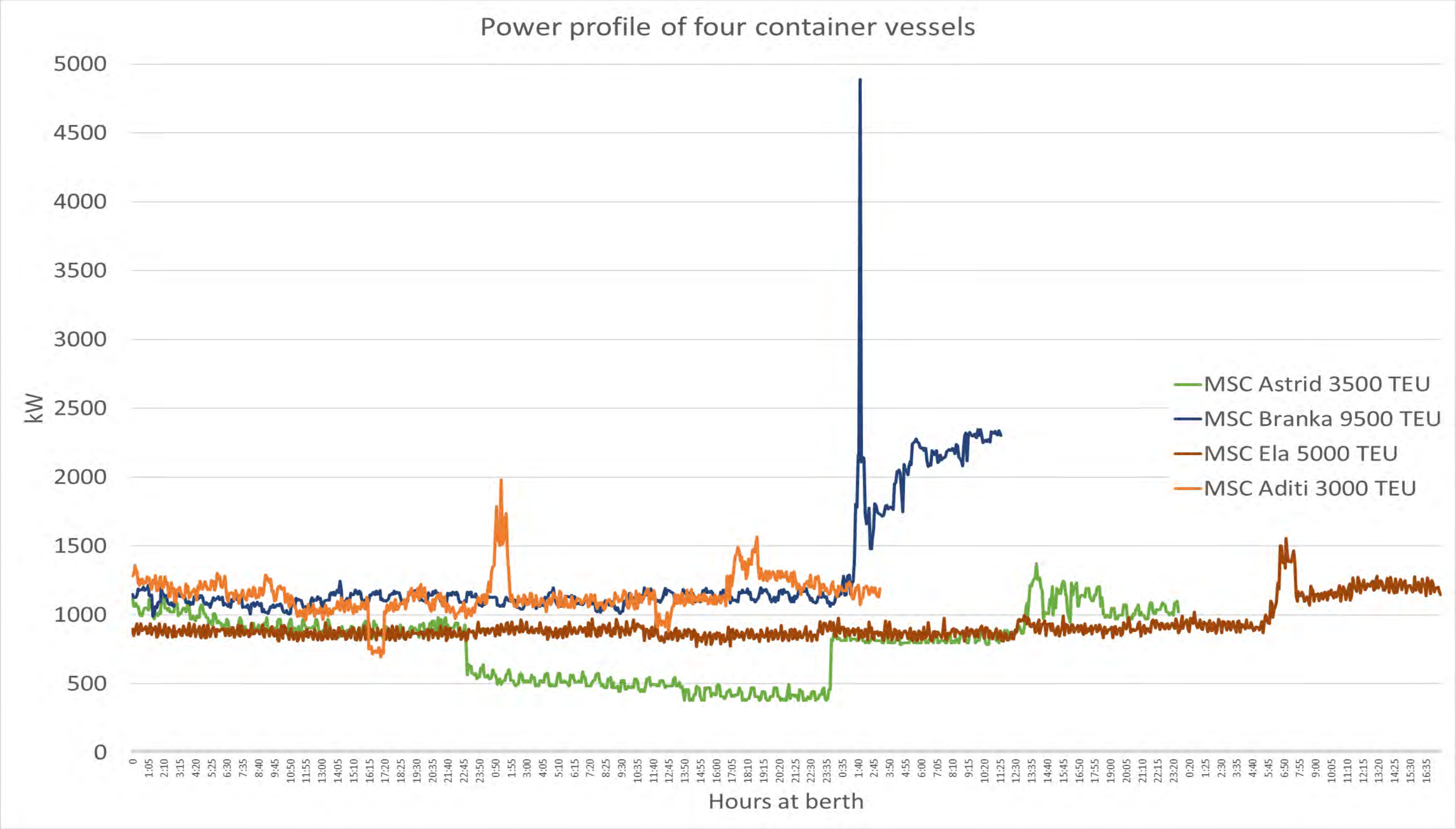
What is the cost of electricity generated on board a vessel?

Vessel load profiles

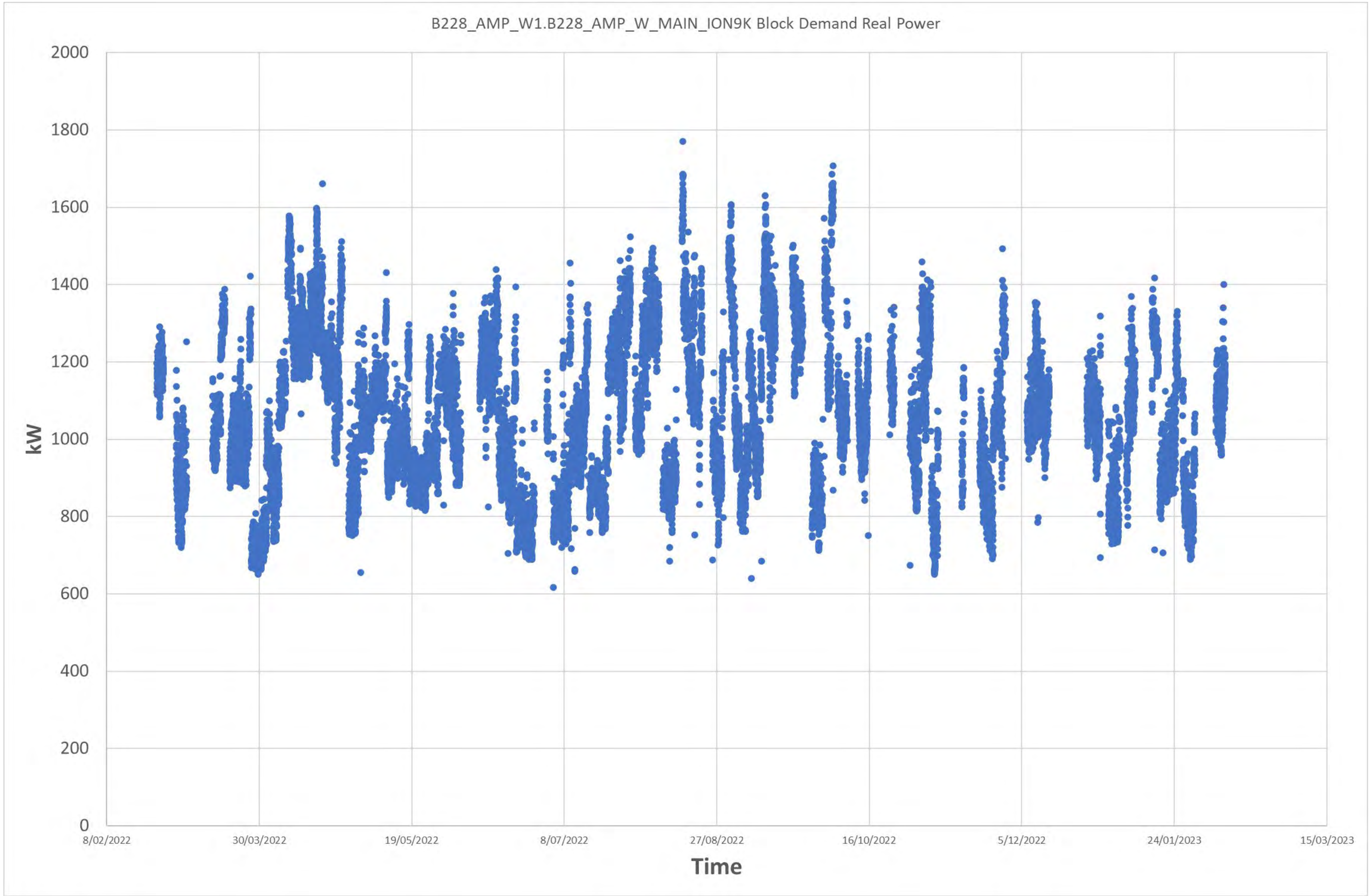




Vessel load profiles

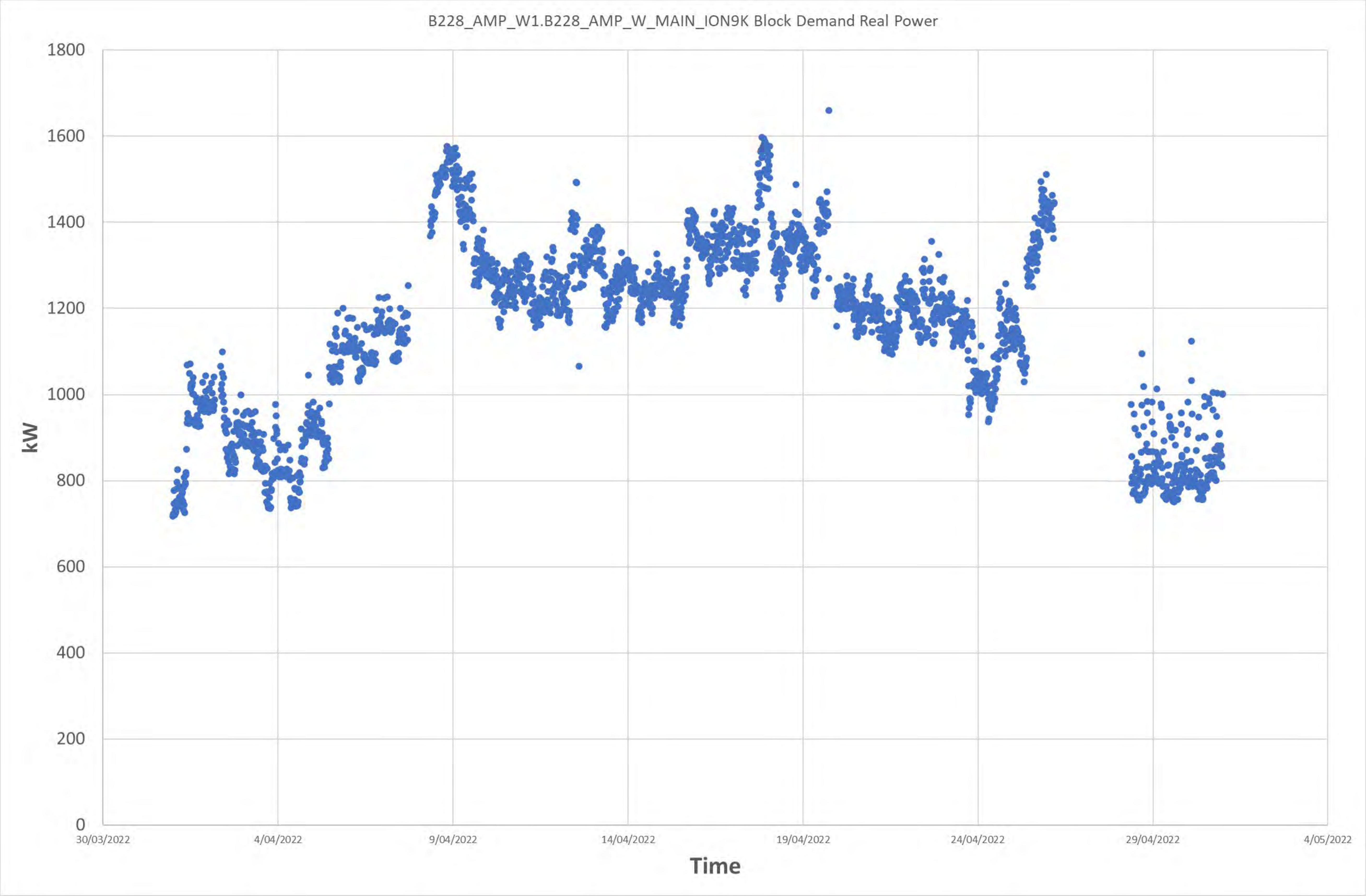


Vessel load profiles



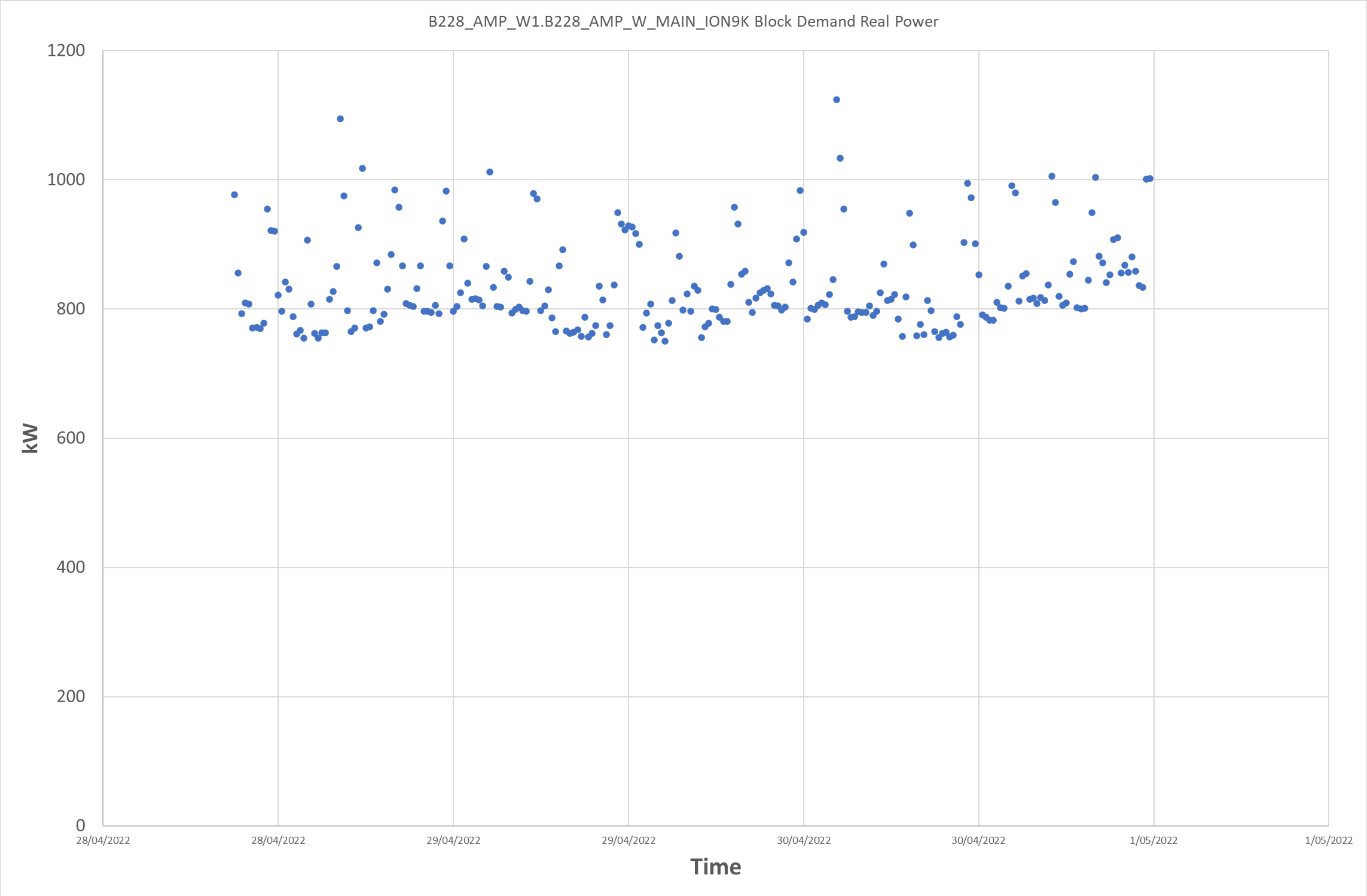
12 months 2022

Vessel load profiles



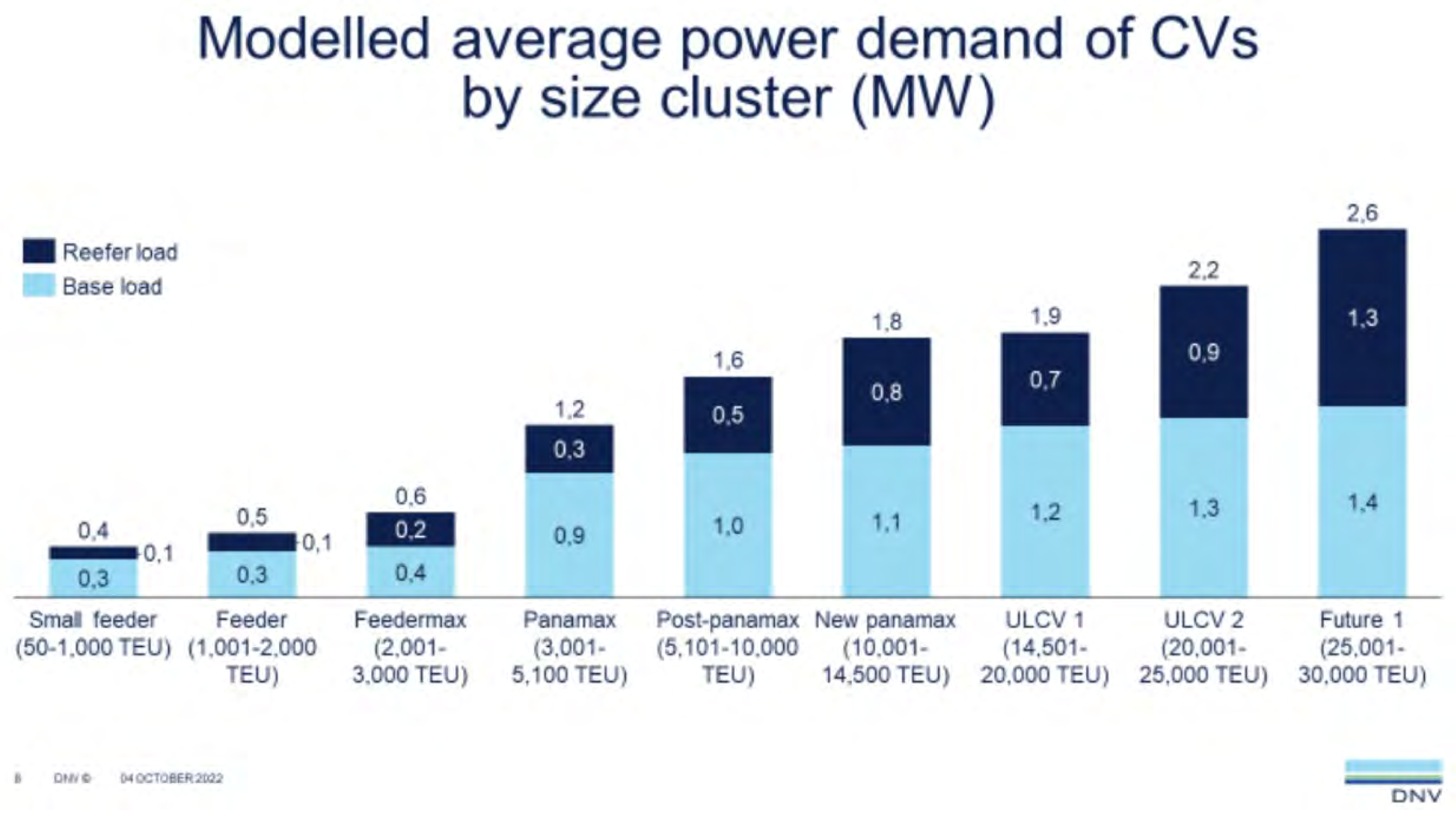
1 month April 2022

Vessel load profiles



1 vessel 28-30 April 2022

Vessel load profiles



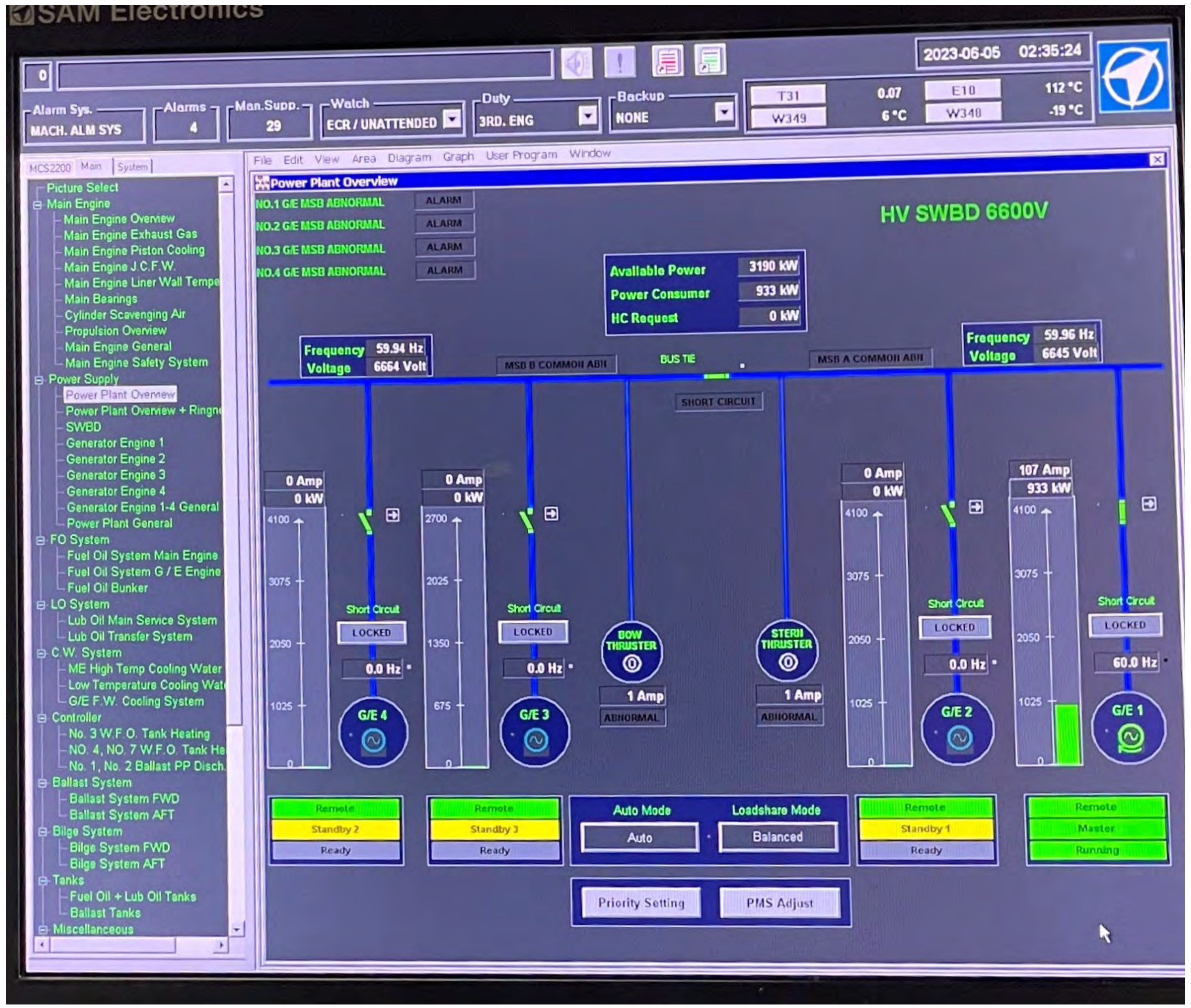
Vessel fuel consumption

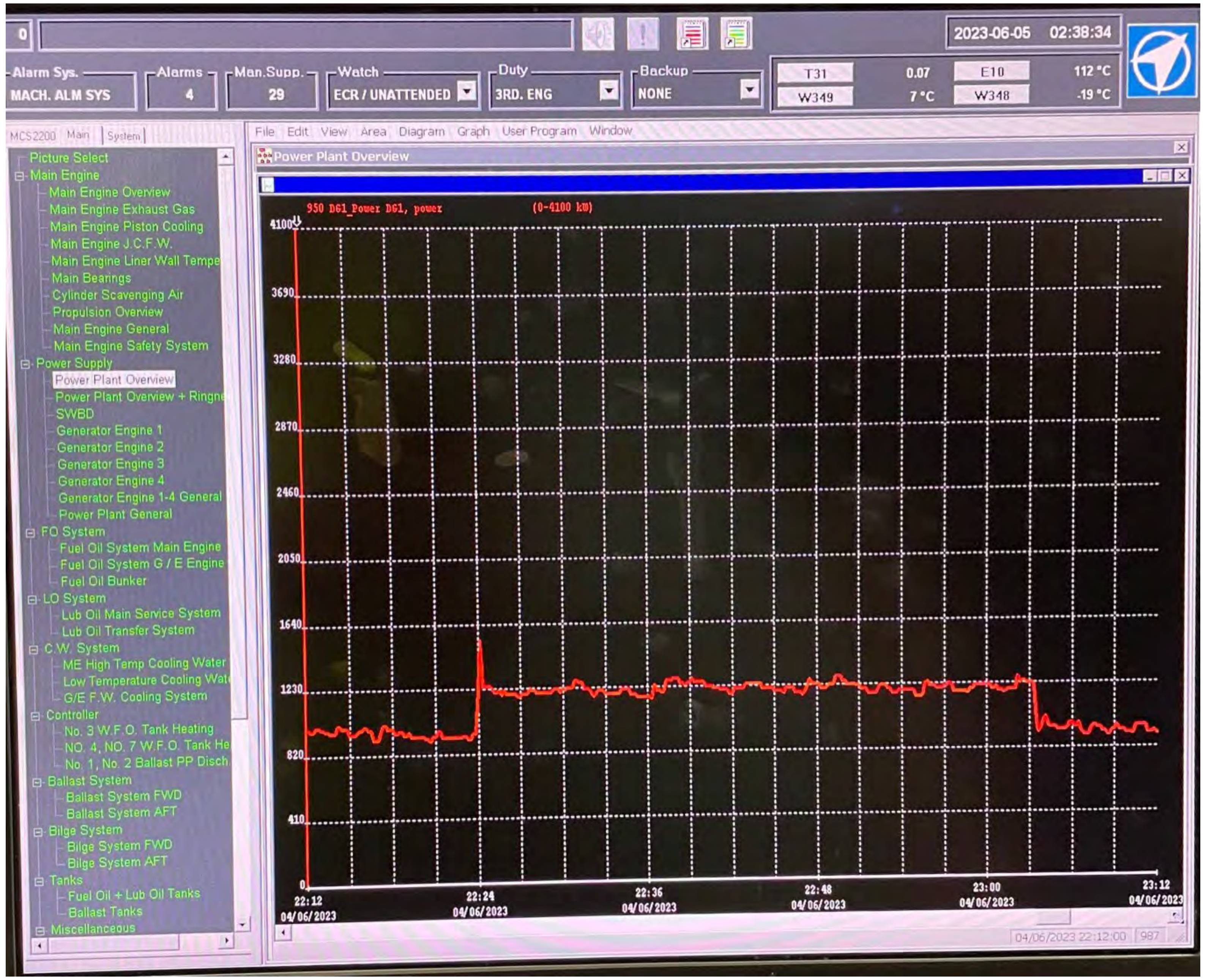
- Site visit to a container vessel
- Fuel consumption auxiliary engines
- Fuel costs

What is the cost of electricity generated on board a vessel?


AC 6600 V/
Panel 13
No. 20 REEFER / TRANSFORMER / RPD-20
Panel 12
No. 18 REEFER / TRANSFORMER / RPD-18
Panel 11
No. 16 REEFER / TRANSFORMER / RPD-16
Panel 10
No. 14 REEFER / TRANSFORMER / RPD-14
ATTENTION!
BEFORE EARTHING, MAKE SURE THAT
THE OPPOSITE VCB IS SWITCHED OFF

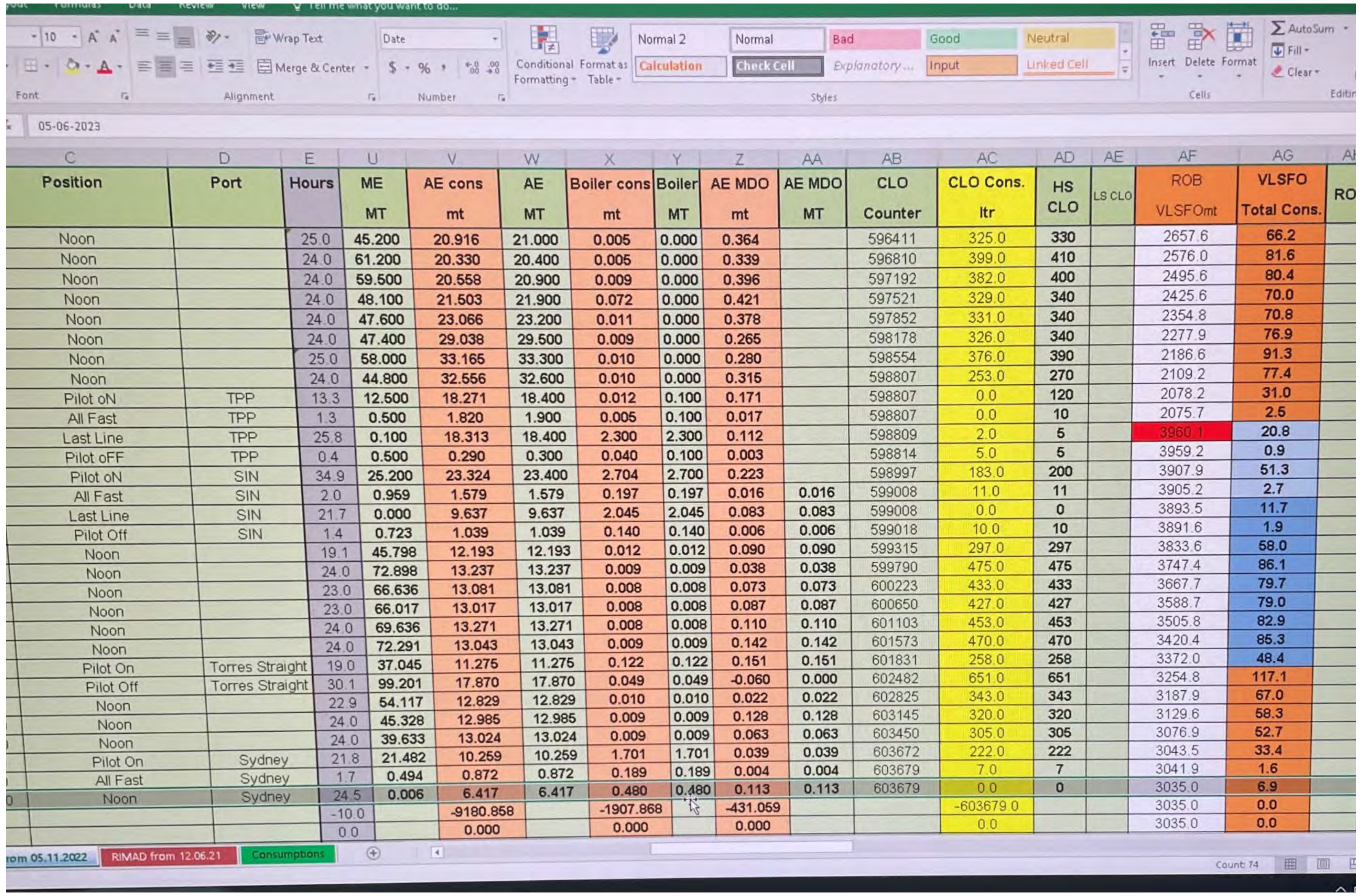
Vessel fuel consumption

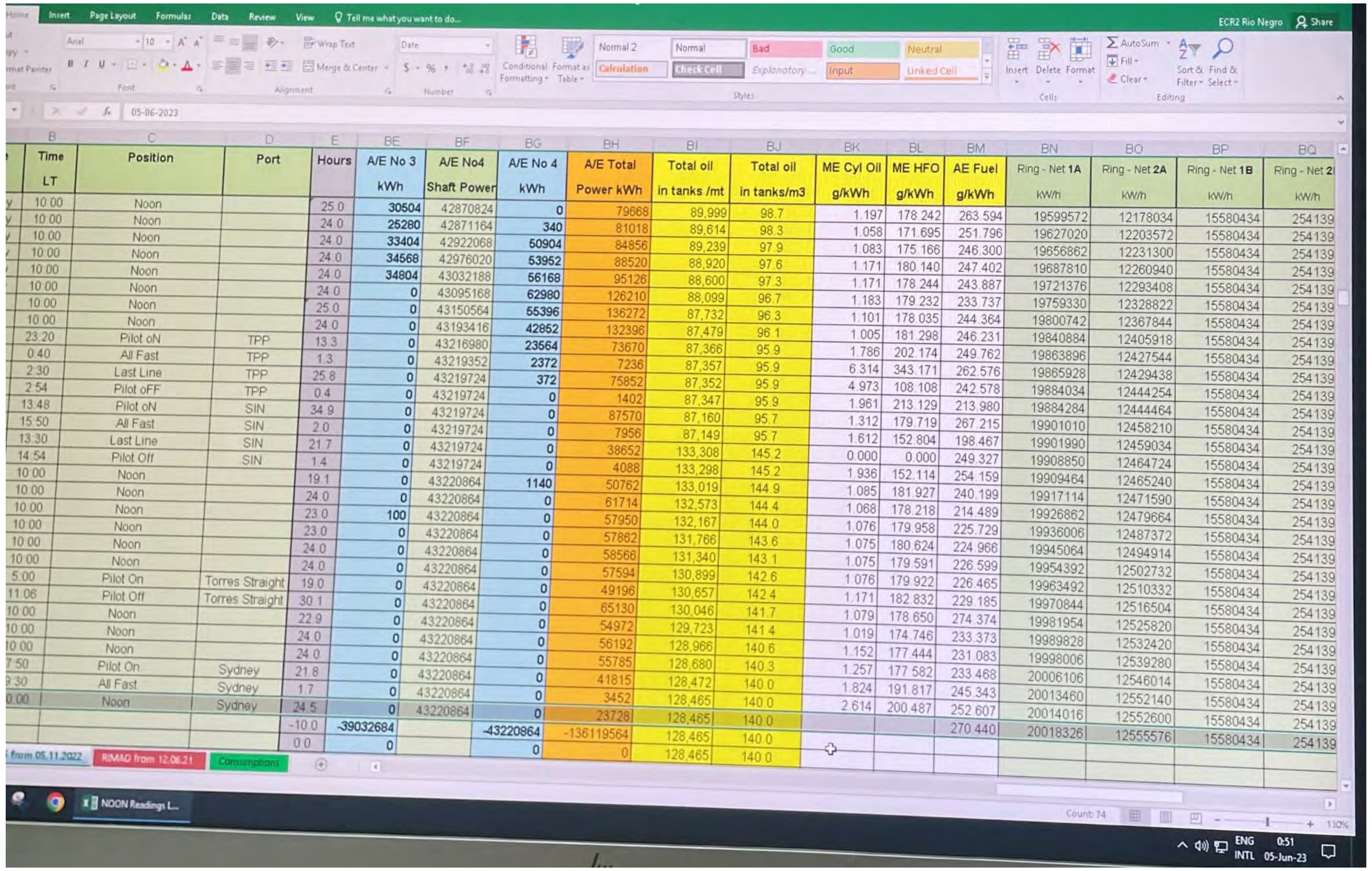




- One of four auxiliary engines was running at 30% capacity
- Container vessel ancillary engine running at 933 kW
- Jumped to 1230 kW for 40 minutes was lube oil heater; timing can be controlled by Chief Engineer

Vessel fuel consumption

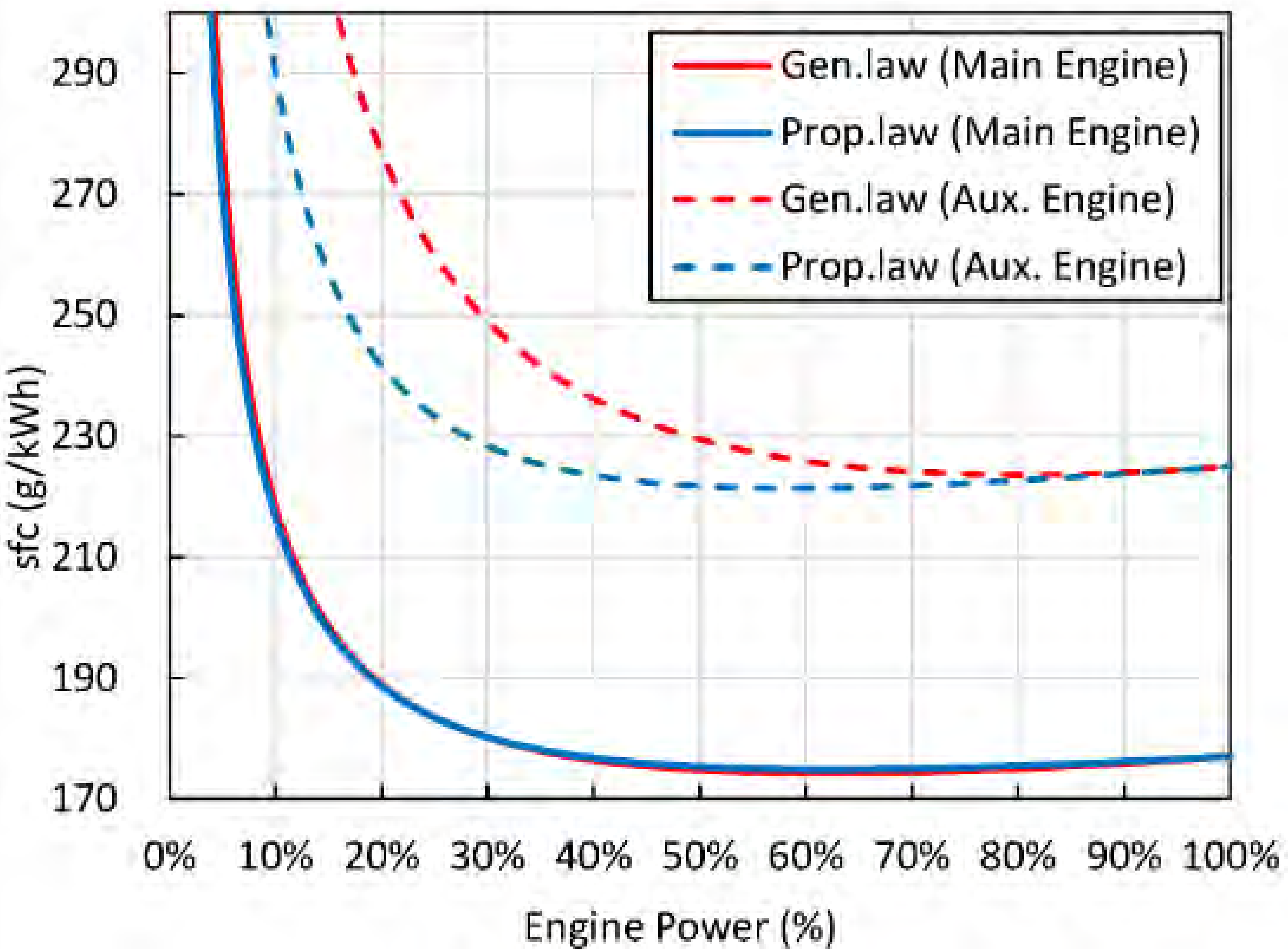




- Alongside for 24.5 hours, fuel consumption auxiliary engine 6.417 tonnes (= 6.3 t/day)
- Total energy produced: 23,728 kWh. Fuel consumption efficiency of auxiliary engine = 270 g/kWh
- Previous recorded consumption rates average circa 250 g/kWh

Vessel fuel consumption

Figure A3. Specific fuel consumption of main engine and auxiliary engines.



Fuel Consumption and Emissions of Ocean-Going Cargo Ship with Hybrid Propulsion and Different Fuels over Voyage
https://www.mdpi.com/2077-1312/8/8/588

Cost of on-board generation of electricity

Feb 16, '21 - Aug 2, '23	High	Low	Average	Spread
Singapore - VLSFO	$1 142.75	$477.25	$666.00	$0.00
Singapore - MGO	$1 383.25	$508.00	$820.00	$0.00

- Typical fuel consumption of auxiliary engines = 250 g/kWh
- Singapore VLSFO rate = $666 USD = $1000 AUD/tonne
- Singapore MGO rate = $820 USD = $1230 AUD/tonne

- Electricity costs using VLSFO fuel = 25 ct/kWh
- Electricity costs using MGO fuel = 31ct/kWh

- Fuel costs vessel 6,000 TEU = $6,300/day
- Fuel costs vessel 8000 TEU (@ 1500 kW) = $9,000/day

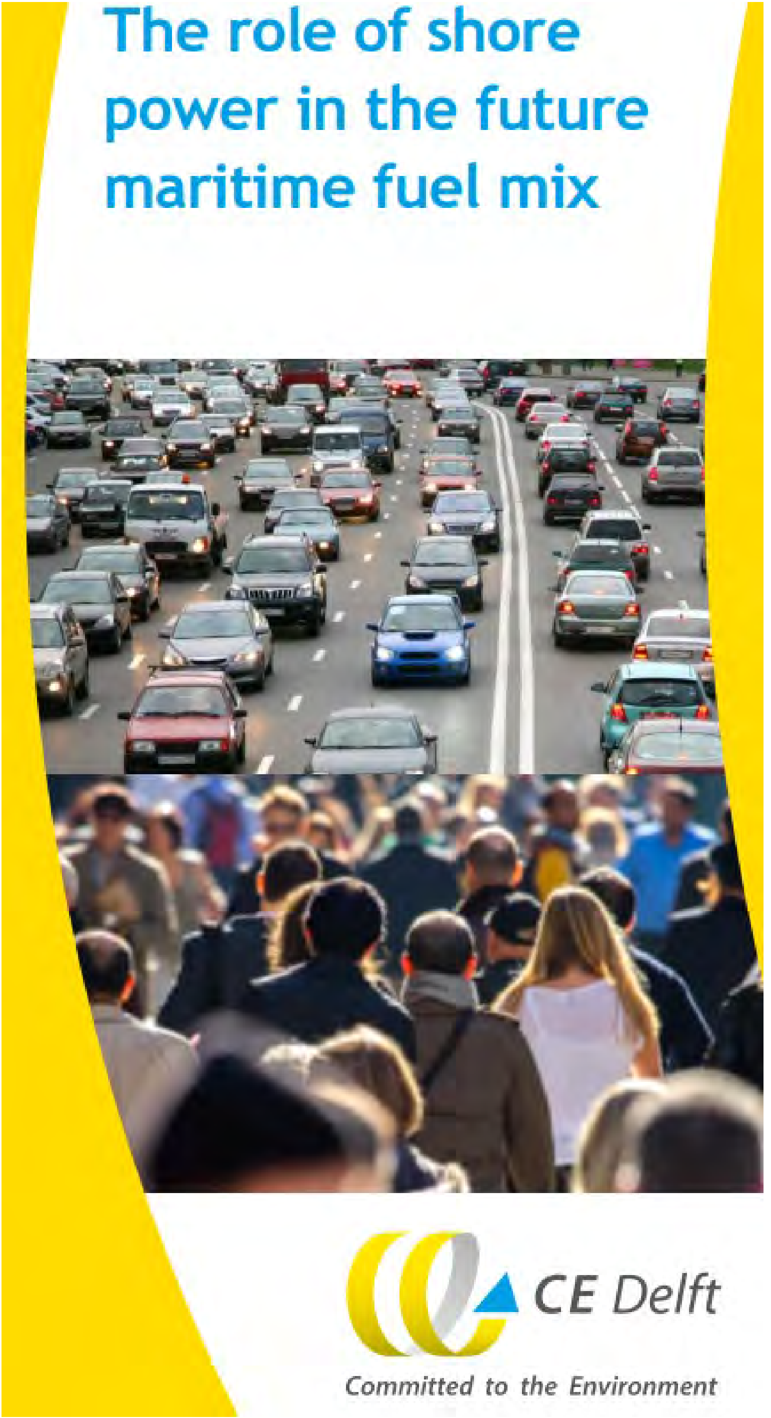
https://shipandbunker.com/prices/apac/sea/sg-sin-singapore#MGO

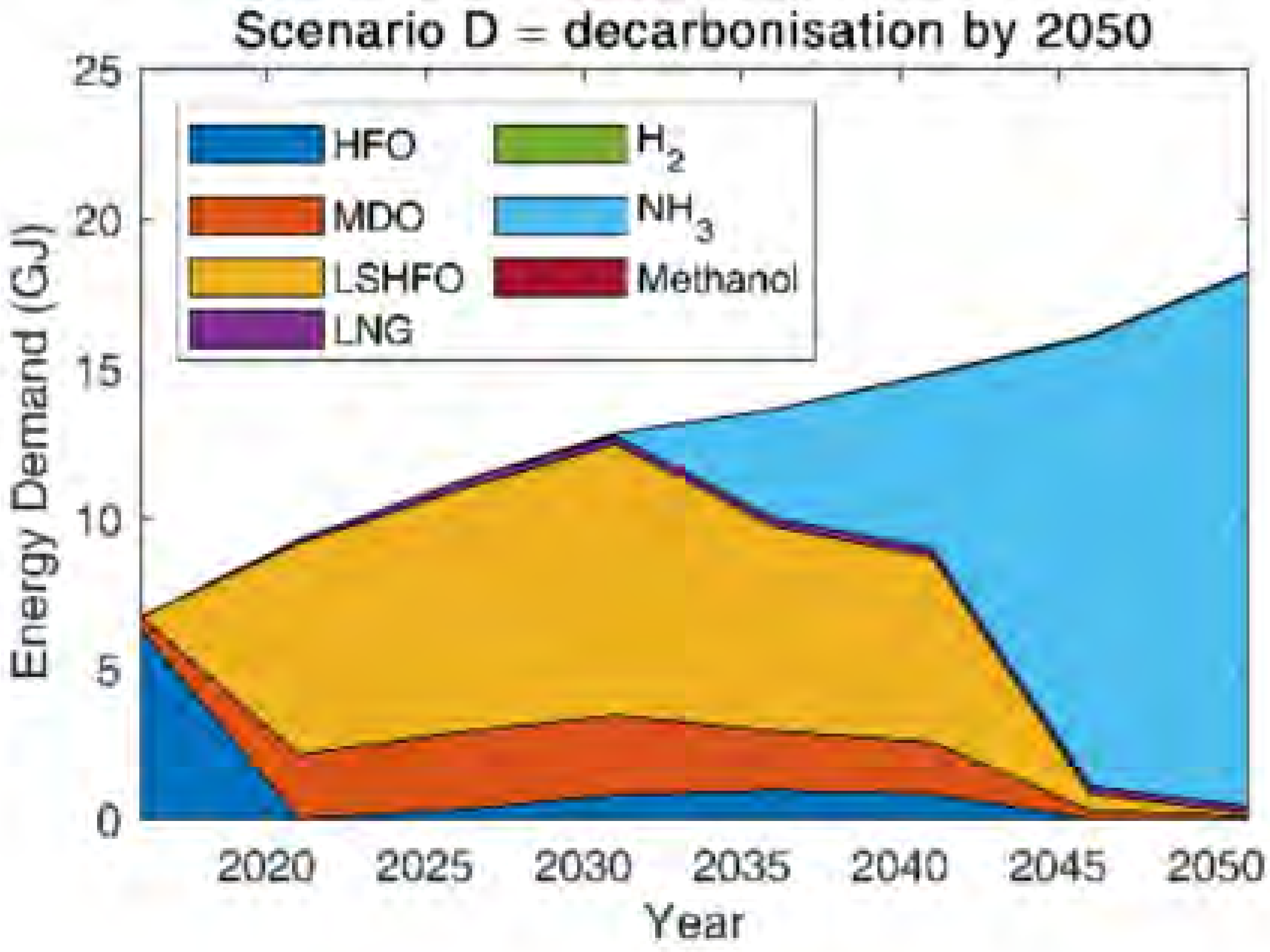
Shore power and future fuels

- Future green fuels in shipping
- Uptake of green fuels
- Cost comparison of electricity generated from renewables in the grid or from green fuels on board a ship

Will shore power infrastructure become a stranded asset?

Shore power and future fuels





Source: Raucci et al., (2020).

https://cedelft.eu/wp-content/uploads/sites/2/2023/04/CE_Delft_210314_The_role_of_shore_power_in_the_future_maritime_fuel_mix_DEF.pdf

Shore power and future fuels

This report has analysed the economics of onshore power supply in order to assess the risk of onshore power supply units becoming stranded assets when the shipping sector undergoes a transition from fossil fuels to zero-GHG fuels. After all, when ships sail on zero-GHG fuels, which often also have significantly lower emissions of air pollutants, the benefits of OPS become smaller, which may result in exemptions from requirements to connect to OPS.

The report finds that there are several reasons which make it unlikely that OPS becomes a stranded asset.

First, shore power is projected to be cheaper in Europe than electricity generated on board with a green fuel on a variable cost basis, even when the fuel is produced and bunkered in regions with very low renewable electricity prices, as long as both bunker fuels and electricity are exempt from energy taxes.

Second, ships that sail on fully renewable fuels may still have air pollutant emissions, especially when the renewable fuels are used in internal combustion engine with a pilot fuel. Depending on the precise regulation, these ships may not be exempted from an obligation to use OPS.

Third, in all scenarios of decarbonization of shipping, a significant share of maritime fuels will still be fossil by 2040. Depending on the projection, the share ranges from 20 to 70%, with lower percentages associated with scenarios that model full decarbonization by 2050 and higher percentages with scenarios that model decarbonization at a later date. Ships sailing on fossil fuels are likely to still be legally required to connect to shore power at berth.

Delft, CE Delft, November 2022