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E-port Work Package 1

Baselining and Projecting Electricity Demand

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Executive summary

Electrification of ports can reduce particle emissions and CO2-emissions. However, electrification is complex and requires significant investments. The million-dollar question is how to support the electrification of the maritime sector as quickly and economically sustainably as possible.
Maritime stakeholders using electricity agree that transitioning to electrical operations is better for the environment, but balancing supply and demand is a chicken-and-the-egg situation, investments in supply capacity rests on commitments from the demand side, and vice-versa. Ocean Valley may help cutting this gordian knot by base-lining the demand forecast.

This report seeks to clarify future demand by drawing on open-sources and interviews, however getting access to power consumption data implicated a relatively narrow focus on CMP's activities in both Malmö and Copenhagen. Interviews with electricity experts, public authorities, and CMP's customers support the arguments deducted from collected data and vice-versa. Moreover, project participants have forwarded important material, both qualitatively and quantitively, which is incorporated into the report.

Work package 1 serves as a foundation to conduct a feasibility study.

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Conclusions deducted from Work Package 1

- The overall electricity demand in the region's port is expected to increase 8-folded compared to current consumption ratios.
- Development in electricity infrastructure is contingent upon proactive engagement and commitments from key off-takers and vice versa.
- Upcoming regulation changes demand dynamics
- The cruise industry in Copenhagen consumes a significant amount of the port's electricity consumption in the future
- Berthing container vessels adds to the depicted increase in demand by connecting to onshore power
- Future electricity use-cases include container handling equipment, truck and car charging stations etc.
- Power-to-x is still yet to materialize hence difficult to draw any conclusions on demand side. However, P-t-x is widely recognized as means to the future greener energy production

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Recommendations

- Commitments from electricity off-takers could speed up infrastructure developments, especially in the cruise and container industry.
- Significant investments are needed to be able to cover future demand from current and future electricity users. By estimating future demand-side, an incentive for investing in current electricity grid is made.

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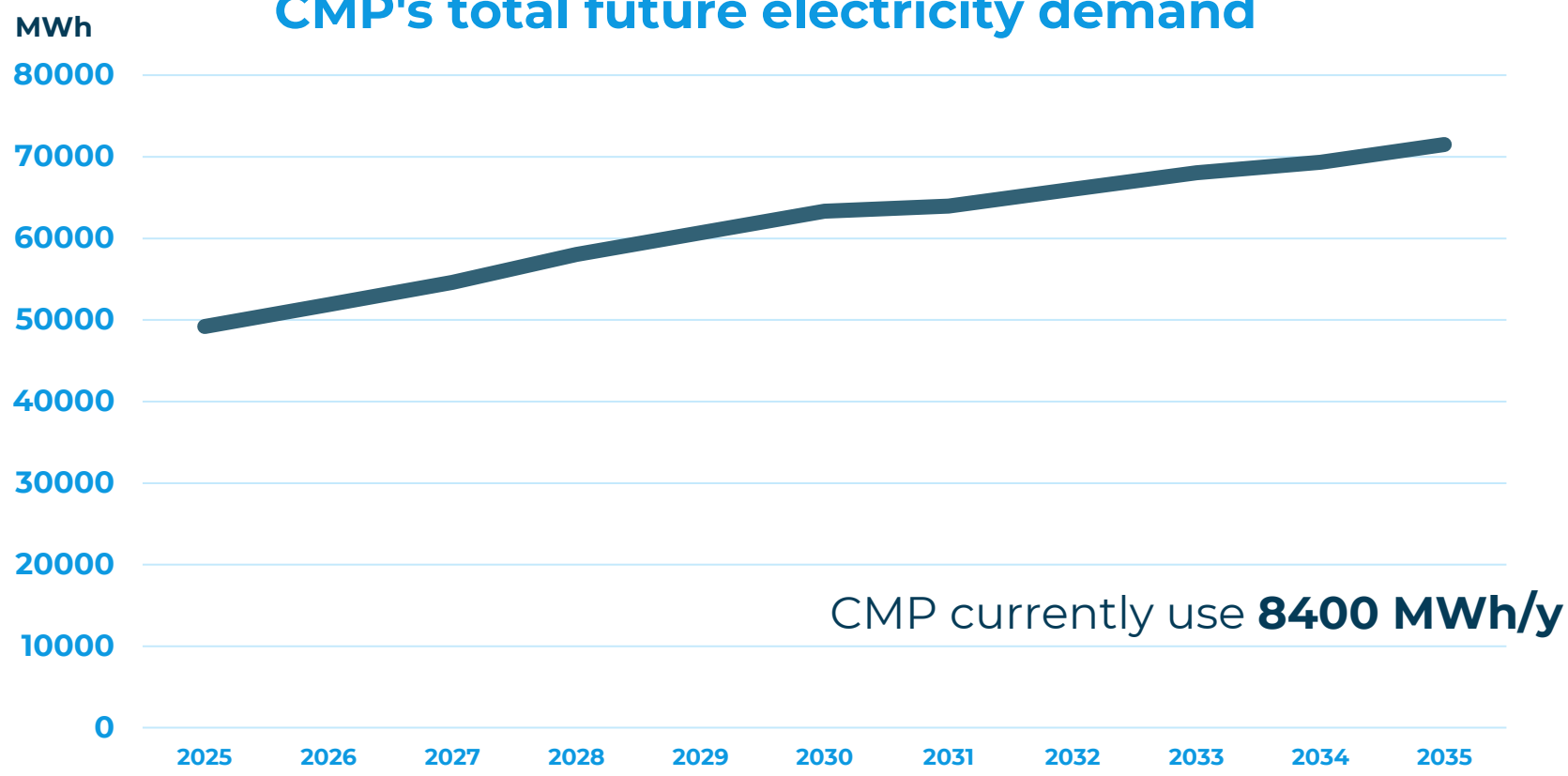
CMP's total future electricity demand



Investments in electric infrastructure capacity and grid expansions are imperative for transitioning the blue industry to a greener future. CMP's increasing electricity demands, projected based on its current and future electric port activities including the shift from fossil-heavy to electric-based operations, underscore this necessity.

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Introducing work package 1

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The maritime industry is anticipated to undergo a process of decarbonization in its activities. This transformative shift is projected to result in increased electricity demand within the sector. However, the prospect of investing in electricity infrastructure is laden with risk, as such initiatives necessitate commitments from the demand side. Conversely, securing commitments from potential electricity consumers poses its own challenges without the assurance of a robust and reliable electricity supply. The delicate interplay between these elements highlights the complex and interdependent nature of the transition towards a decarbonized maritime industry. Establishing a sustainable and balanced electricity grid requires a careful alignment of commitments from both the supply and demand sides to ensure the success and viability of decarbonization efforts within the sector.

Project Background

Workshops and meetings with maritime stakeholders across sectors have showcased an increasing interest to map future demand for electricity in a port. The current lack of data on future demand has crucial implications for the development of the supporting electricity grid. Ocean Valley initiated a project called E-port to generate more transparency and to seek if any commitments from the demand-side can accelerate investments from the supply side. Work package 1 seeks to:

1) Explore current electricity consumption at CMP to estimate current demand in a port.
2) Project future electricity demand until 2035 by mapping future e-activities and estimate potential consumption rates.

Project Approach

Work package 1 takes as its starting point off-set in CMP's activities in both Malmö and Copenhagen. With off-set in CMP's electricity data and relevant open sources, it has been possible to project future electricity demand from a port's perspective. The quantitative projections are supported by qualitative interviews with CMP's customers and various electricity users in a port.

Drawing scale ratios to understand context

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PtX in Esbjerg (under development) expected to use **6000 GWh** annually

Outcome: 100.000 t green hydrogen *or* 600.000 t green ammonia

1 KWh	1.000 Watt
1 GWh	1.000 MWh

COPENHAGEN MALMÖ PORT

Copenhagen Malmö Port use **8,4 GWh** annually (2017-2022)

Outcome:
Operate one of the largest ports in the Baltics

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Baselining CMP’s current electricity demand

Electricity is the primary energy source

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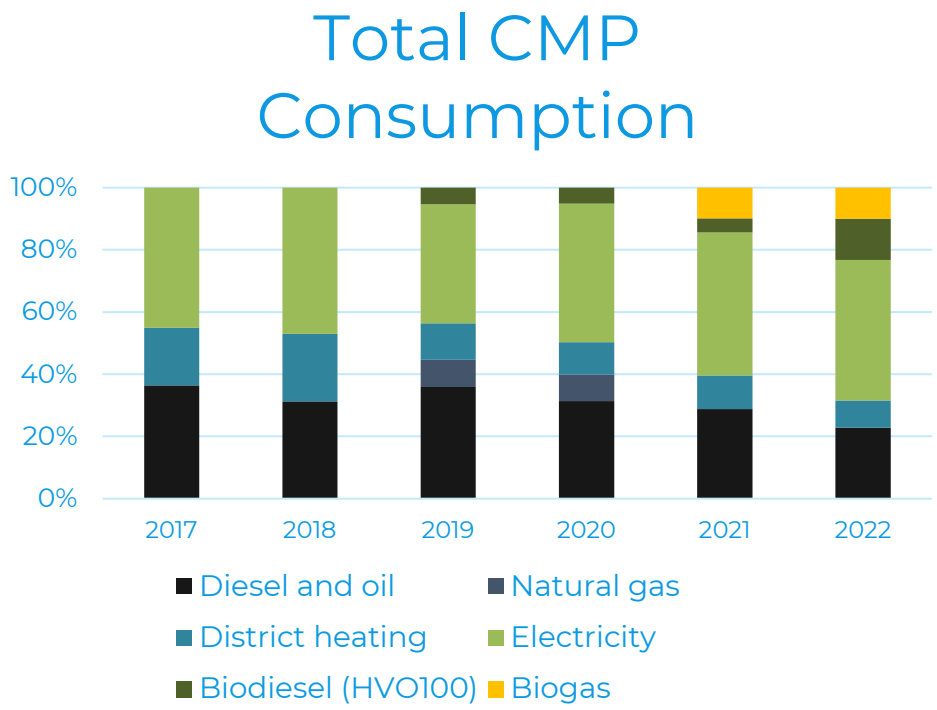

Figure 1: Overview of CMP's energy mix. Data for 2023 is not available yet but expected to be published in May 2024.

Electricity is the major power source in CMP
Electricity constitutes almost 45% of the total energy consumed in 2022 (figure 1). In other words, electricity helps drive port operations and run the global value chain. Talking to CMP's infrastructure department, there is a strong expectation that electricity plays an even bigger role in CMP's future energy mix when talking about future operations in the context of CMP's business plans.

Stable Electricity Demand Despite Decreased Diesel and Oil Usage
Despite a substantial 35% reduction in the usage of diesel and oil, CMP has maintained a stable demand for electricity. This achievement is indicative of efforts to optimize energy consumption without compromising operational efficiency.

HVO100 and Biogas Compensation Strategy
To compensate for the decreased reliance on traditional fuels, CMP has strategically integrated HVO100 (Hydrotreated Vegetable Oil) and biogas into its energy mix. Moving forward, CMP's staff anticipate a further increase in the utilization of HVO100 and biogas.

Anticipated Growth in Electricity Usage with On-Shore Connection by 2025
Looking ahead, CMP foresees a notable surge in electricity consumption starting from 2025, attributed to the implementation of on-shore connections and other e-activities playing a pivotal role in the green transition. This forward-looking initiative aligns with CMP's commitment to cleaner energy sources but also implicates a heavy peak load on the existing grid supporting CMP's activities.

Baselining Energy Consumption – CMP: 2017-2022

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Relative stable energy consumption
Despite a relatively stable electricity consumption pattern, CMP's overall energy consumption has increased by 4% from 2017 to 2022, resulting in a total rise of 740 MWh over the 5-year period. To put this figure into perspective, the average household in Denmark utilizes 4.5 MWh/year DK (for 2 adults and 2 children), meaning the accrued 5-year consumption increase is roughly equivalent to the energy consumption of approximately 164 households.

Small increase in electricity demand
However, the graph on the right illustrates a growing demand for more energy, despite a gradual increase in recent years. As previously demonstrated, 45% of CMP's energy mix consists of electricity, resulting in a modest increase (340 MWh) in electricity demand during the baselining years. CMP's infrastructure and operational departments attribute the scenario of stable electricity consumption to a concerted effort toward efficient power usage, particularly on the Danish side due to high electricity prices.

Drawing a picture for increased demand in the future
The increasing demand for more energy, as indicated on the right, may necessitate additional strain on the electricity grid. If this trend persists, it could require upgrades and expansions to the grid infrastructure to accommodate the higher loads

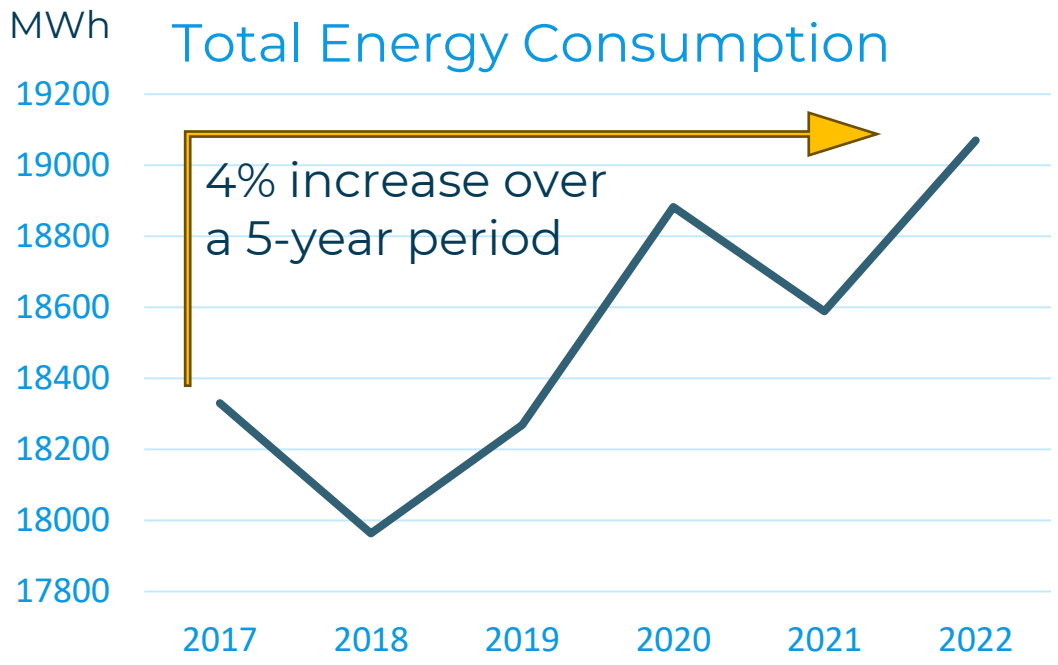

Figure 2: Overview of CMP's total energy consumption. Data for 2023 is not available yet but expected to be published in May 2024.

Estimating current electricity demand from CMP

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Stable electricity demand
The electricity pattern remains stable in both Copenhagen and Malmö from 2020 to 2023, with seasonal variations of approximately +/- 60 MWh (figure 3 & 4). These fluctuations result in a higher load during winter months compared to summer months.

Various activities necessitate distinct electricity demands. Malmö experiences a relatively high electricity demand due to illuminating port areas, and there is a lack of incentive to reduce electricity consumption, primarily attributed to low electricity prices in Sweden.

Seasonal variations create “gaps” in current demand/supply-side leaving a vacuum for other or future e-activities during summer months.

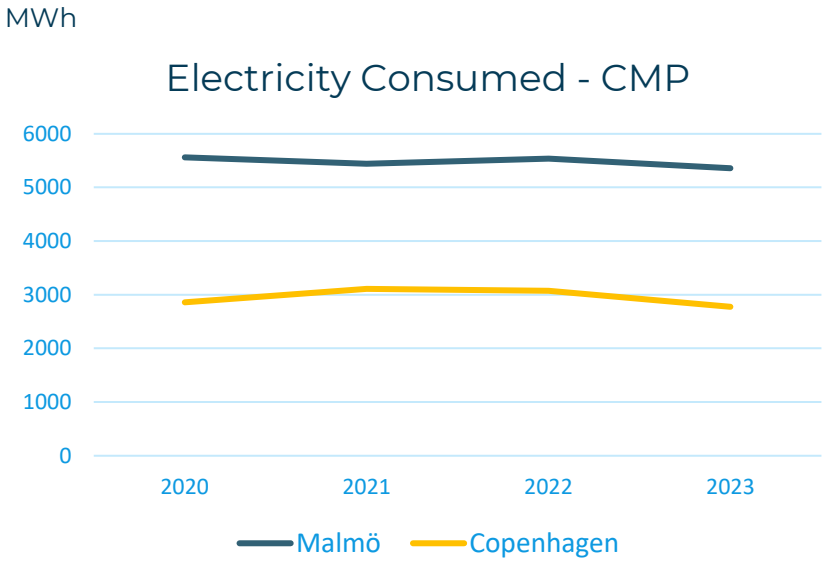

Figure 3: Overview of CMP’s consumed electricity in Copenhagen and Malmö.

Electricity prices
DK: 2,46 DKK/kWh
SE: 0,88 SEK/KWh

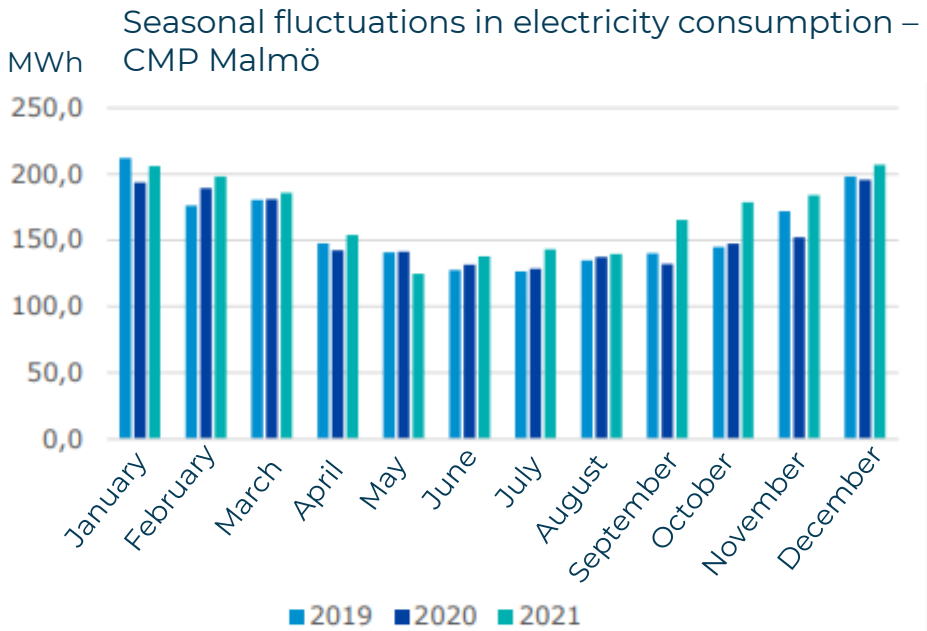

Figure 4: Overview of Malmø’s (CMP) consumed electricity over a year

Minimal fluctuations in monthly electricity consumption
Figure 4 provides an overview of the total electricity used during an entire year in Malmö. The figure illustrates minimal fluctuations in monthly electricity consumption, indicating a relatively stable pattern over the course of a year, albeit with marginal variations on the consumption scale. This leads to a relatively stable load on existing electricity grid implicating an easily predictable consumption curve at both sites (Malmö and Copenhagen) if no future e-activities arise.

Broadening the consumption scope

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Stories from consumers of electricity in a port

Consumers of electricity awaiting the “right time” of electrification

Based on interviews with CMP’s customers spanning truck companies to shipping lines operating in Oresund, there is a strong intention towards electrification of their current activities, but significant actions from customers are missing. Other consumers of electricity, beside CMP, have plans in the future to either electrify trucks or retrofit container vessels to receive onshore power, however all these actions comes with significant costs and risks. Truck companies do make requests for more charging stations and ship owners do know that upcoming EU regulation changes the supply of onshore power installations. Interviewed stakeholders mention the “right timing” of electrification, but as noted in the introduction, it’s a chicken-and-the egg situation. What should come first? Demand or supply of electricity. To de-risk investments, the demand-side wait for enough supply to ensure smoothly run operations. Contrary, the supply side await increased demand before expanding grid capacity and coverage.

Picturing implications of current consumption trends

The current electrical grid is already challenged with peak periods. In times with heavy load on the e-grid, the supply-side is challenged by capacity. Electricity consumers in ports are worried about the maximum supply capacity if more users potentially are connected to existing grids.

Navigating constraints

To effectively navigate the constraints associated with electrification, stakeholders must proactively collaborate with both supply-side and demand-side to understand their specific needs and challenges. This collaborative approach will be instrumental in formulating sustainable solutions that address both immediate concerns and long-term demands, fostering a resilient and efficient electrification infrastructure within the port.

Projecting electricity demand in the region's ports

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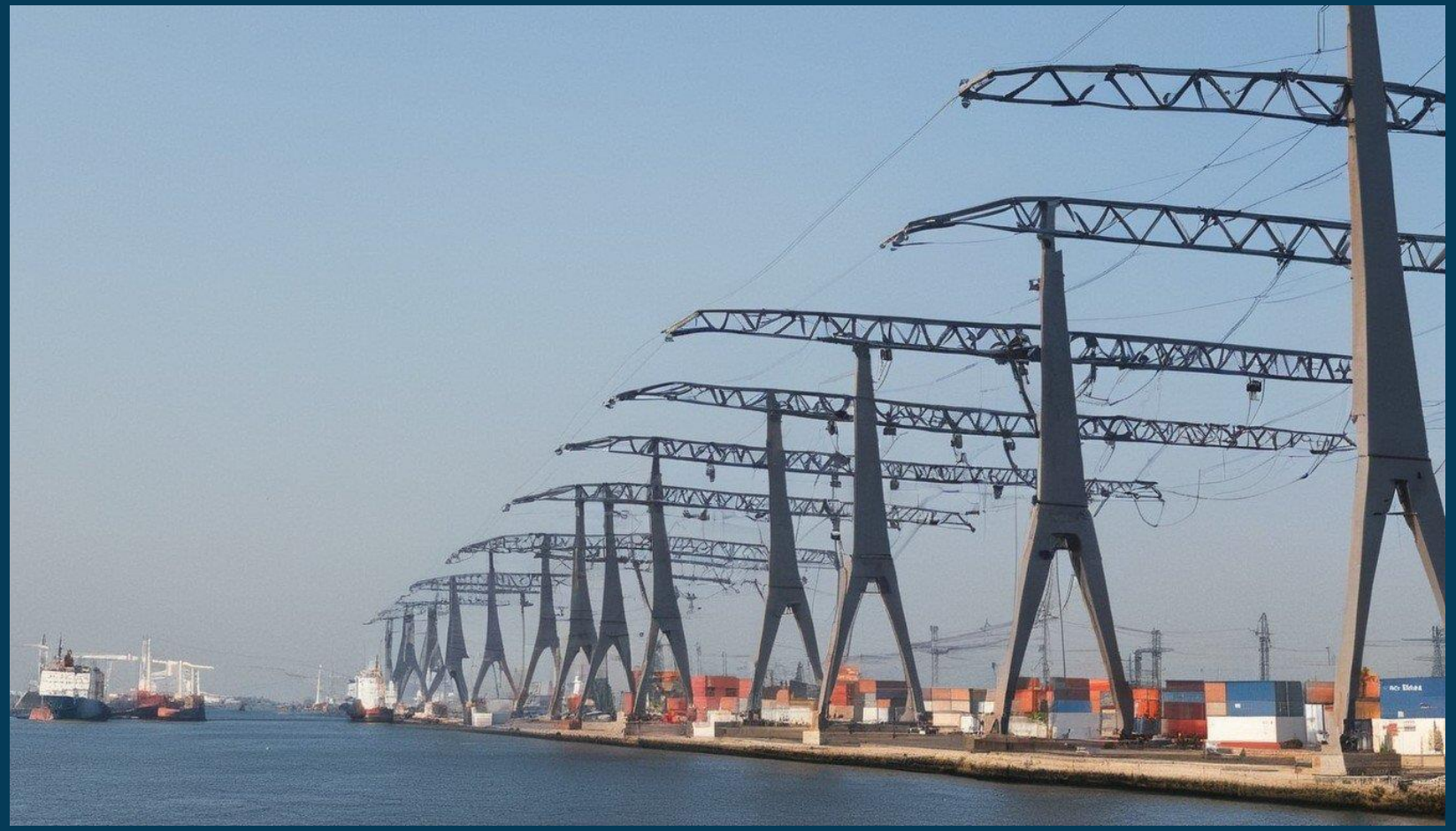
Exploring future use-cases and the attributed demand from now and until 2035



How to catalyze investments in e-grid expansion?

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In order to catalyze the expansion of electrical operations in and around the port area there is a need to qualify and validate the future demand and willingness to commit to certain electricity off-take. Mapping out future users, their need and likelihood to commit to future volumes is key to accelerate the transition to green/electrical operations in the port. It seems evident that to justify big investments in e-grid expansions there needs to be long-term and recurrent demand for electricity. Shore-power alone as demand "cornerstone" is viewed to be to ad-hoc and seasonal. Locating power-to-x sites or production of e-fuels or other heavy e-activities may be the solution to build a robust business case for e-grid investments. Feasibility studies of such activities are conducted in future work packages completed by project participants.

The purpose of this chapter is to demystify current and future users and operators' demand for electrical power in and around the port to attract investments herein.

Offset in CMP's commercial activities

With offset in the baseline study spanning the years 2017 – 2022, it is possible to project CMP's future electricity demand. Although, the projections are based on assumptions and conducted on "what needs to be true"- approach, the following pages depicts the bigger picture of future electricity demand, however with some shortcomings as future developments are notoriously difficult to predict.

To assess the future demand, the subsequent sections explore and provide detailed information on the following components:

- Electrical operations take huge leaps because of EU Regulation starting from 2030 (AFIR & FuelEU Directives).
- Electrification of container handling in alignment with CMP's sustainability strategy
- Future demand comes with seasonal and daily variations.
- Projecting total electricity demand in 2035

How does upcoming EU-regulation change ports electricity demand?

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The maritime industry has a long history of being one of the largest contributors to environmental pollution. The reliance on traditional fuels and outdated practices has led to high GHG emissions. Recognizing this historical trend, the EU acknowledges the urgency to reform regulations to bring about a more sustainable and environmentally friendly maritime sector. As a response to lower GHG emissions, the EU has implemented two reformative regulations under the “Fit for 55 package” forcing European ports and shipowners into a greener future. T

EU requires container and cruise ships to use onshore power supply

“The FuelEU maritime” was presented by the European Commission on 14 July 2021, the package aims to enable the EU to reduce its net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels and to achieve climate neutrality in 2050

From January 1, 2030: Container and passenger ships (including cruise ships) greater than or equal to 5,000 gross tonnage (GT) must connect to onshore power supply (OPS).
The use of OPS abates air pollution produced by ships and reduces the amount of GHG emissions generated by maritime transport.

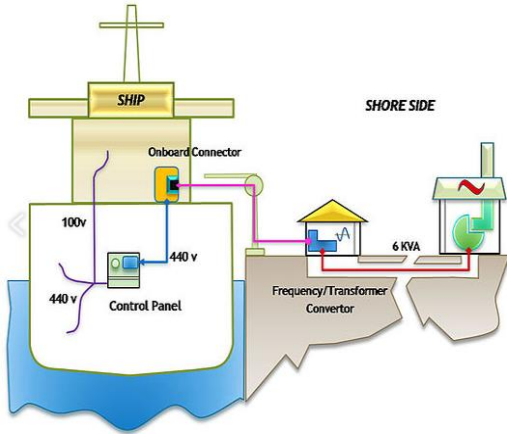

Figure 5: Overview of an onshore power supply connection.

European ports forced to install onshore power supply

“Alternative Fuels Infrastructure Regulation (AFIR)” aims to accelerate and standardize the development of charging infrastructure across the EU. The goal is a cross-border and user-friendly charging infrastructure in Europe, the use of which should be as simple as possible for consumers, including cruise and container vessels.

Maritime ports that see at least 50 port calls by large passenger vessels, or 100 port calls by container vessels, must provide shore-side electricity for such vessels by 2030.
This will not only help reduce the carbon footprint of maritime transport, but also significantly reduce local air pollution in port areas.

Onshore Power Supply (OPS) plans at CMP's sites

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OPS shall reduce the environmental impact of national and international ships in ports. While alongside berth, ships require electricity for hotel demand, cargo handling, heating, lighting and other onboard activities. Electricity is traditionally supplied by onboard diesel generators running on fossil based marine fuels and emitting among others GHG emissions (CO2) and air pollutants, which have in return an impact on climate change and human health.

An OPS facility provides a connection to the local grid via the port electricity network allowing the ships to turn off their generators and receive power in the form of electricity from the public grid. By provisioning of sustainable green energy through the grid, carbon neutral ship operations during their port stays can be realised. The following image shows a general design of high-voltage OPS facilities.

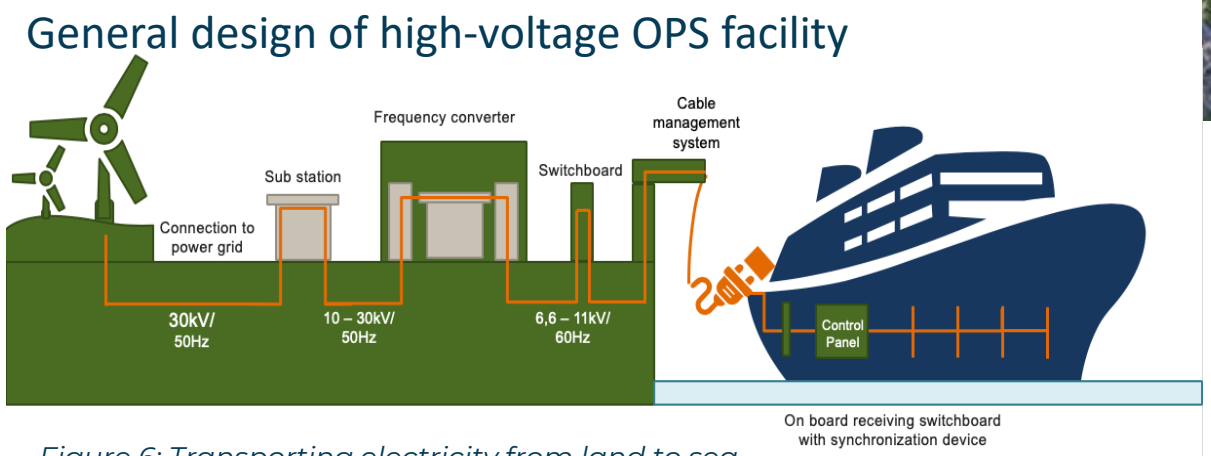

Figure 6: Transporting electricity from land to sea

Locations of the OPS at Oceankaj (marked in blue) and Langelinie (marked in red) and Søndre Frihavn (marked in green); the connection from the substation to the converter station at Oceankaj is highlighted in yellow. Currently, CMP has no current OPS plans in Malmö , partly because activities in Malmö are not directly affected by upcoming EU legislation.

Table 1: Overview of OPS projects in Copenhagen

RoPax ferry OPS in Copenhagen	**Implementation of two OPS connections at Søndre Frihavn**	**2020 -2021**	**Electricity supply to two ferry berths**
Passenger ship OPS in Copenhagen	**Implementation of five OPS connections at Oceankaj and Langelinie**	**2020 – 2025**	**Electricity supply to passenger ships during port stays**
Container ships in Copenhagen	**Implementation of OPS connections at Nordhavns Container Terminal**	**N/A-2030**	**Electricity supply to container ships during port stays**

EU-regulation changes electricity demand forcing investments into OPS

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An analysis done on behalf of CMP and its affiliated entity By & Havn forecasts a significant increase of cruise ships being capable of receiving shore power in the coming years.

The analysis showcases a best-case scenario and a base case scenario. In the best-case scenario almost 80% of the cruise ships are able to use OPS in 2030, on the contrary the percentage is only 50% in the base-case scenario.

Disputes exist, as information provided by Cruise Lines International Association (short: CLIA) and interviews with four major cruise shipping companies offers other insights. CLIA's analysis assumes that until 2030 between 85% and 95% of the passenger ships calling the port of Copenhagen will be equipped for the use of OPS.
The number of passenger ships on the market is expected to increase over the next decade, which will generate additional demand for onshore power supply in ports. These ships require on average of 2,7-3,0 kW pr. person transported.

Projecting electricity demand from cruise ships calling Copenhagen
The graph on the right indicates a substantial surge in electricity demand, primarily driven by the growing number of visiting cruise ships equipped to utilize onshore power. In line with this trend, CMP plans to offer onshore power to visiting cruise ships by 2025, contributing to an overall increase in CMP's total electricity demand. However, it is essential to note that the surplus of electricity supply during winter months, coinciding with the cruise industry's off-season, remains underutilized due to regulatory constraints adding extra taxes to non-cruise customers.

By 2025, there is an anticipated twofold increase in CMP's electricity consumption, driven primarily by the implementation of OPS installations to cruise ships. This represents an initial step in a broader initiative, with further e-activities expected to be introduced subsequently.

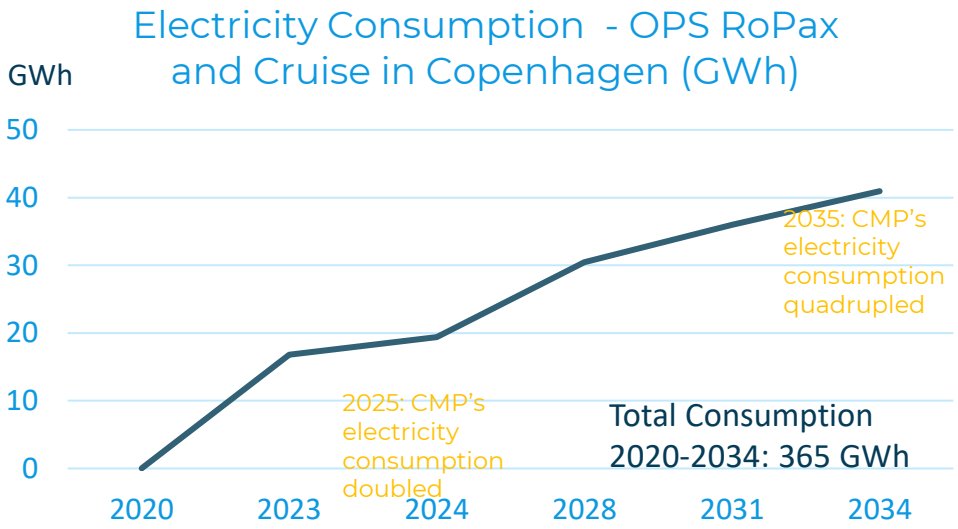

Figure 7: Projection electricity demand from cruise and RoPax in Copenhagen.

The projected electricity consumption per year is based on:
- anticipated total numbers of visiting cruise ships calling Copenhagen Port (offset in CLIA 2019 forecast for cruise industry)
- a calculated percentage of ships ability to receive onshore power.
- each person onboard consume 2,7-3,0 kW

Results
- CMP's electricity consumption by 2025 is doubled (offset in CMP's baseline)
- Optimistically, by 2030 almost all cruise ships receive shore power tripling current consumption

Exploring seasonal variations in consumption patterns

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The cruise industry is seasonal, resulting in a low electricity demand during winter months (figure 9)
It should be noted that the cruise industry's peak season in summer (3,7 GWh in July) significantly strains the existing grid. To put it in perspective, 3,7 GWh equals almost half of CMP's total electricity consumption in 2023. This trend emphasizes the cruise industry is a major player on the demand side, but demand comes with both daily and seasonal variations.

Implications of seasonal variations
Implications include excess supply during specific periods, particularly in winter months because current EU regulation prohibits other e-users to connect to the same grid connection, because the maritime industry has advantageous tax rates.
Figure 8 illustrates the annually variability of berthing cruise ships in Copenhagen while figure 9 depicts the derived demand hereof. It is assumed that each cruise passenger use 2,7-3,0 kW and the cruise industry slowly adapts to onshore power supply.

How much capacity does the cruise industry need?
In the first phase a 60MW cable will be laid from Svanemøllen power station to a new transformer station at Oceankaj. A transformer station will be constructed at Oceankaj equipped with a 50Hz/60Hz converter at 30MW. The transformer station will have a capacity to provide three terminals at Oceankaj with 30MVA power supply.

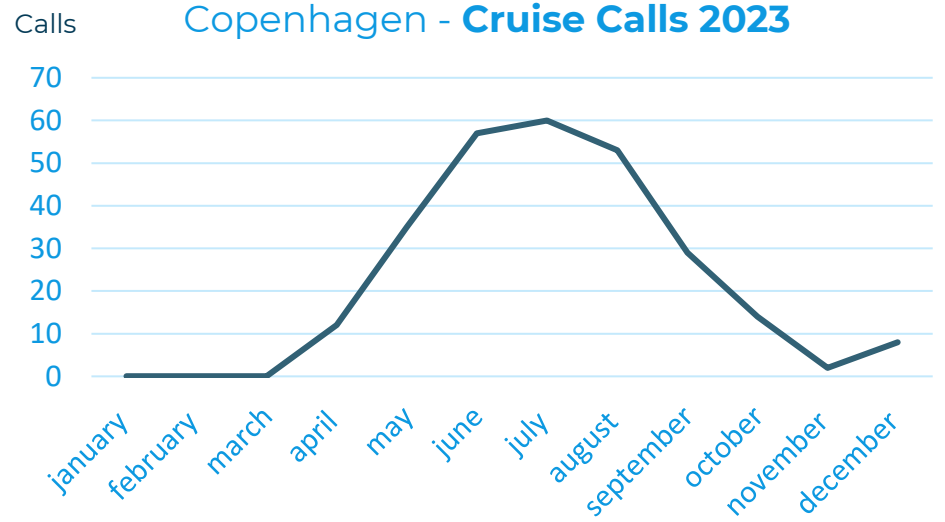

Figure 8: Annual cruise calls – Copenhagen

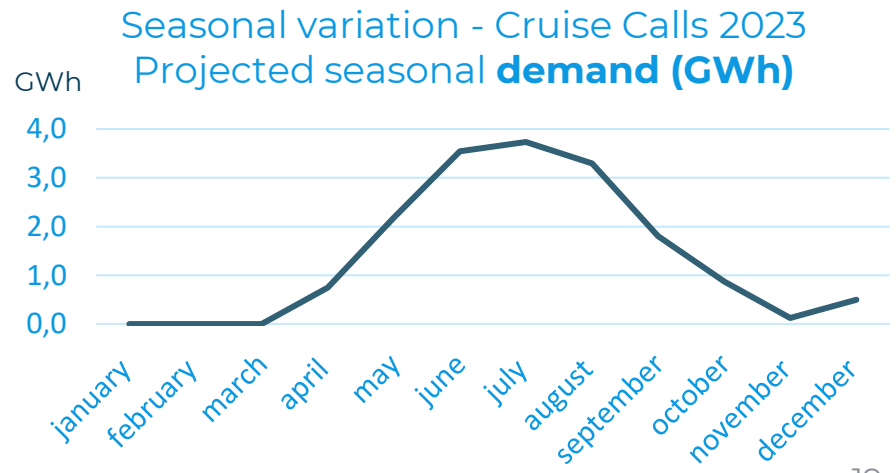

Figure 9: Projected seasonal demand from cruise industry in CPH

Showcasing daily peak loads from visiting cruise ships

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Trends in the Cruise Industry

Cruise ships typically operate nocturnally, navigating during the night hours and berthing during daylight, thereby alleviating strain on the electricity grid during off-peak periods but significantly augmenting demand during daytime hours. In the figure to the right, the electricity consumption (measured in megawatt-hours) attributed to visiting cruise ships during the high season (June) is depicted, with data sourced from 2023 statistics. Notably, between 1 pm and 2 pm, it is anticipated that visiting cruise ships would consume 12 MWh if all vessels were utilizing onshore power supply (OPS).

Correlation between Visiting Cruise Ships and Elevated Electricity Prices

The orange curve depicted in figure 10, illustrates the hourly electricity prices (in kr/KWh). This curve closely tracks the blue columns representing the hourly electricity consumption from cruise ships, indicating that visiting vessels predominantly draw power during peak-price periods throughout the day. The prevalence of high electricity prices tends to disincentivize cruise ships from opting for onshore power supply when berthed at CMP's quay, as it is more economically viable for them to rely on onboard diesel-powered auxiliary engines due to lower diesel prices compared to electricity—albeit until 2030, when the EU regulations come into effect.

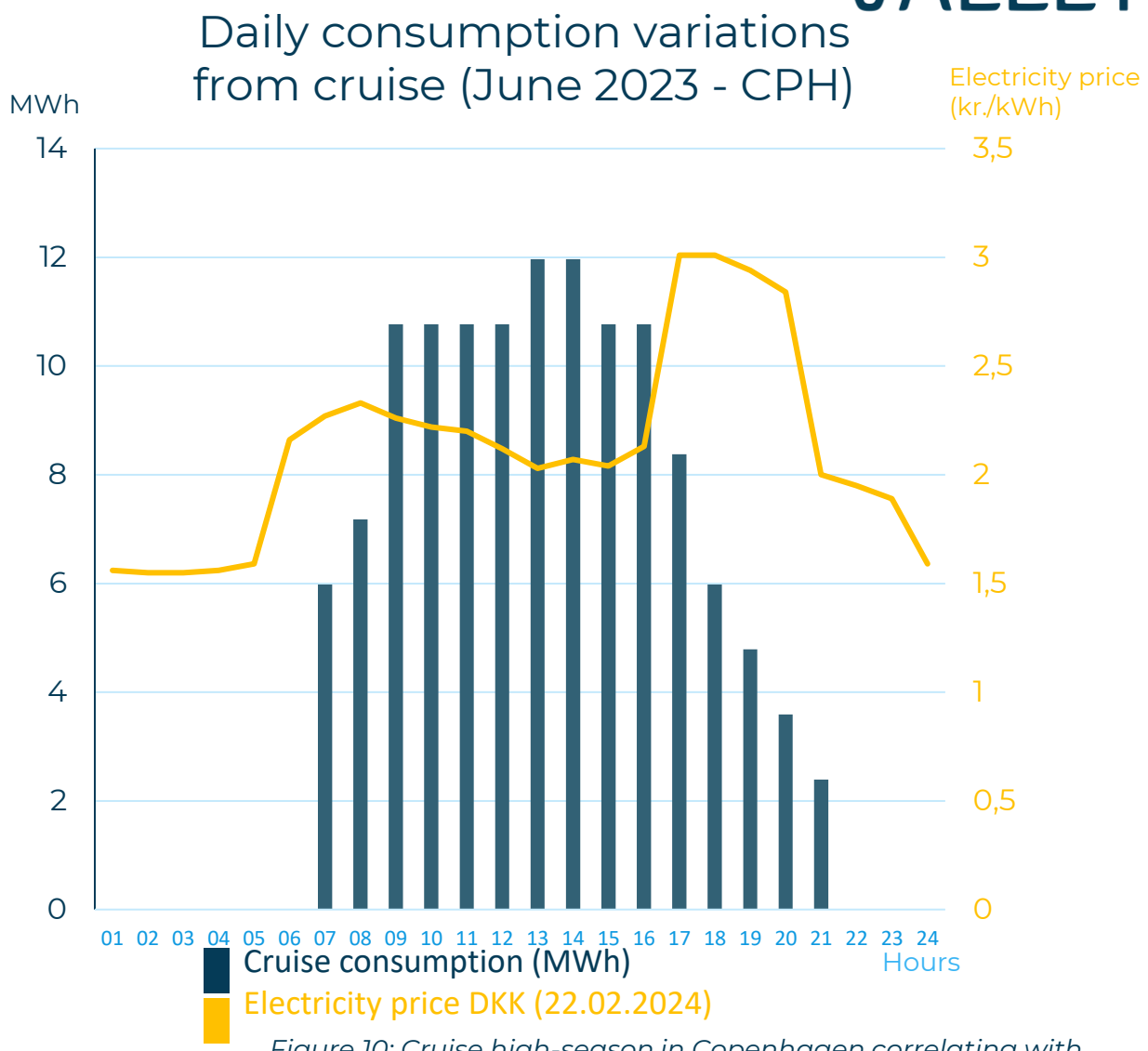

Figure 10: Cruise high-season in Copenhagen correlating with high electricity prices

Regulation changes OPS demand from container industry

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EU-regulation increases demand from container vessels
Because CMP, and more specifically Copenhagen port sees more than 100 port calls by container vessels each year and is one of EU's Core Ports in the TEN-T Network, the port must provide onshore power supply (OPS) for such vessels by 2030, according to The FuelEU maritime directive presented by the European Commission*
To comply with EU's new regulation, CMP must install an OPS facility, no later than 1st of January 2030.

Great example of current challenges in e-grid investments
Numbers shared from the Environmental Ship Index indicate that only 15% of the worlds current container vessels are able to receive OPS (Environmental Ship Index, 2020). This number is expected to increase as studies forecast an increasing trend towards retrofitting container vessels with onshore power capacity (British Ports Association, 2020). The scenario illustrates the chicken-and the egg situation, wherein ports lack the incentive to install Onshore Power Supply (OPS) due to the limited demand from smaller container vessels. Conversely, container vessels lack motivation for retrofitting, primarily attributed to the insufficient presence of OPS installations on the quay.

However, EU-regulation is expected to speed up the electrification of container vessels and ports adding to the projected heavy load on the supporting infrastructure creating specific periods with heavy electricity load.

*https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_4758

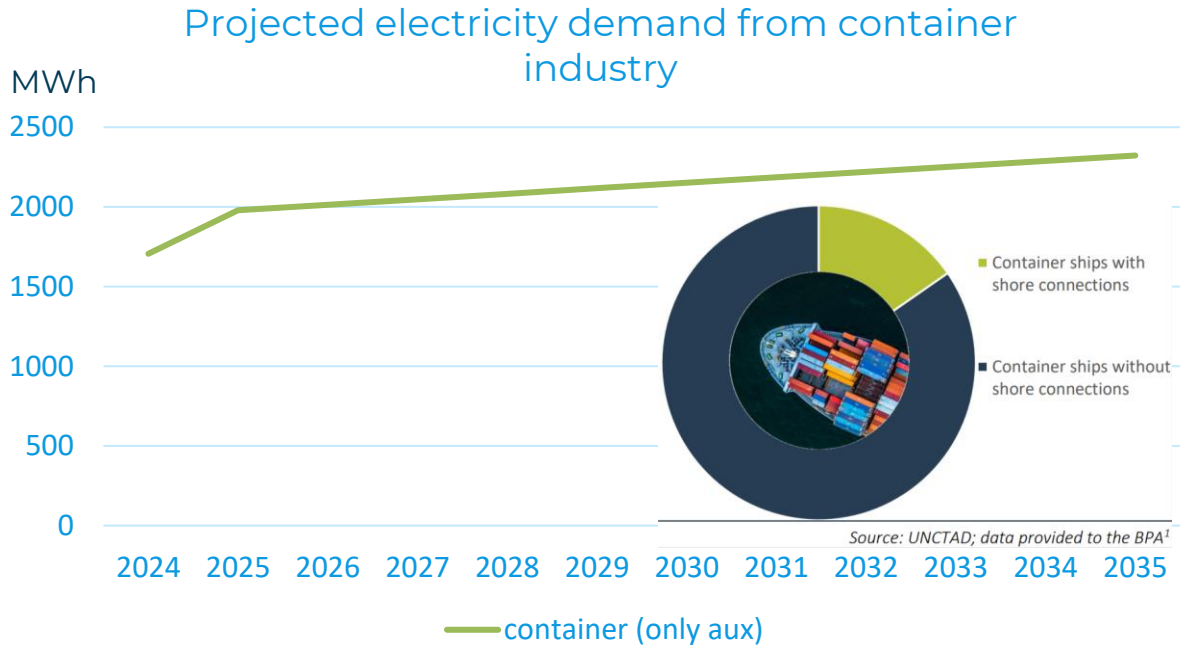

Figure 11 : Project demand from container vessels calling CMP in Copenhagen

Calculations are based on total port calls by container vessels , an average port stay of 15 hours, and an average capacity of 869 TEU pr. container vessel (average characteristics for Copenhagen Container Terminal).
It is expected that total port calls follows a linear curve and more it is expected each berthing container vessel turns off its auxiliary engine but keeps its boilers running. Average consumption rate is 544 kW for an average container ship in Copenhagen.
It is assumed that the container market in Copenhagen follows world market trends (growing at a CAGR of 4.2%).

Modelling a bigger demand scenario for container industry 1/2

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Demand increases if container vessels install electric boilers

Maximizing reduction benefits from shore power installations is only possible when shore power replaces the energy demands of both auxiliary engines and boilers. An auxiliary engine is primarily responsible for generating electrical power to for lighting, navigation equipment, communication systems, pumps etc. A boiler is designed to produce steam, which can be used for heating cargo holds or providing hot water. Almost 34% of the at-berth energy demand of container ships falls on boilers while the rest is attributed to the auxiliary engine (ICCT, 2023)

Boilers should also be retrofitted, electrified, or connected to shore power to reduce CO2 emissions contributing to a zero-emission port stay.

Adding to future electricity demand

The maritime industry foresees a forthcoming transition of container vessels towards incorporating electric boilers into their systems. However, it remains premature to provide a definitive estimate when the global container fleet will increasingly adopt electric boilers. This anticipated shift adds a layer of complexity to projecting the overall demand for electricity on these vessels, introducing a level of uncertainty in the estimation process. Nevertheless, the overall demand from electric boilers are expected to rise (figure 11) which again adds to an already big-demand side in the future when also considering the electricity demand from the cruise industry.

The successful installation of OPS for container vessels in ports necessitates commitments from shipowners. This creates a reciprocal challenge wherein the establishment of OPS infrastructure is contingent upon the proactive engagement and commitments from key stakeholders within the global shipping community.

Modelling a bigger demand scenario for container industry 2/2

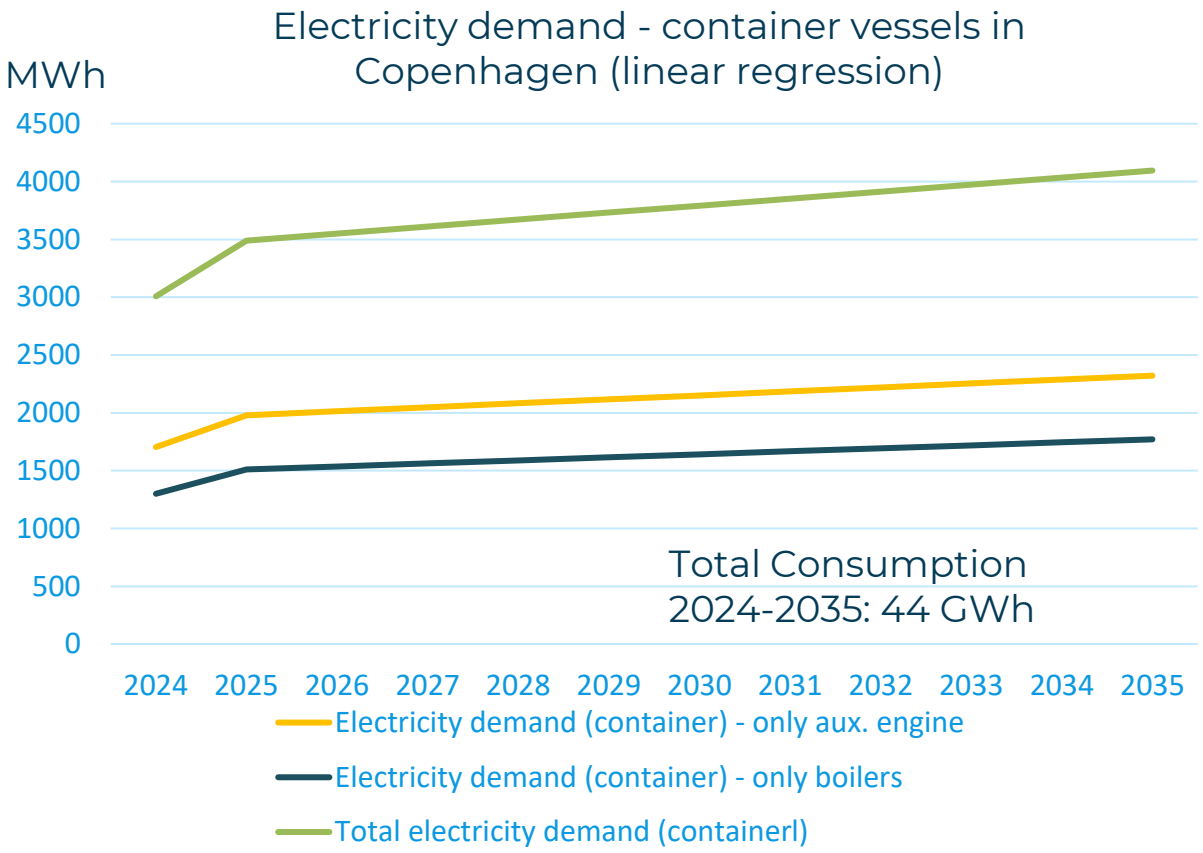

Figure 11 : Project demand from container vessels calling CMP in Copenhagen

When assessing the capacity of container vessels to adopt Onshore Power Supply (OPS) for supplying electric boilers and auxiliary engines, there is a notable escalation in the overall electricity demand.

The projection indicates an anticipated requirement of 3.792 MWh by the year 2030 to meet the expected needs of container vessels during berthing, assuming all vessels calling Copenhagen can utilize OPS for both auxiliary engines and boilers.

This represents almost half of CMP's current electricity consumption in 2022 according to baseline study.

Projecting CMP's container handling, if all equipment is electrified (1/2)

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Moving a container from A –B on land requires energy. That energy is currently based on diesel, green fuels, electricity etc.
A container is offloaded by a ship-to-shore crane (STS), moved with a straddle carrier, stacked by container stablers and tucked by terminal tractors before being shipped again or moved on a truck to other destinations.
None of the abovementioned activities run on fossil-free energy sources, except the STS crane. It is easy to anticipate a future with fossil-free container handling equipment, especially with several port's ambitions to be fossil-free in nearest future (CMP aims to be fossil-free by 2025). Uncertainty in predicting electricity demand occur because equipment is likely to also run on green fuels like HVO100, a fossil-free hydrotreated vegetable oil, decreasing demand-side. However, electrifying port activities have great potential as technology already exist if decisions are made to electrify the entire container movement chain on land. Assuming that most of the current container handling equipment would be electrified to reduce GHG emissions adds to expected increase in electricity demand.

If STS cranes, reefers, straddle carriers, container stablers and terminal tractors and refrigerated containers use electricity in nearest future, **CMP's electricity demand would increase with almost 5000 MWh by 2035 (baseline 2019: 1647 MWh used).**

Currently, CMP's container cranes and reefers (refrigerated containers) consume 1,65 gwh (in 2019) to run operations.

Projecting CMP's container handling, if all equipment is electrified (2/2)

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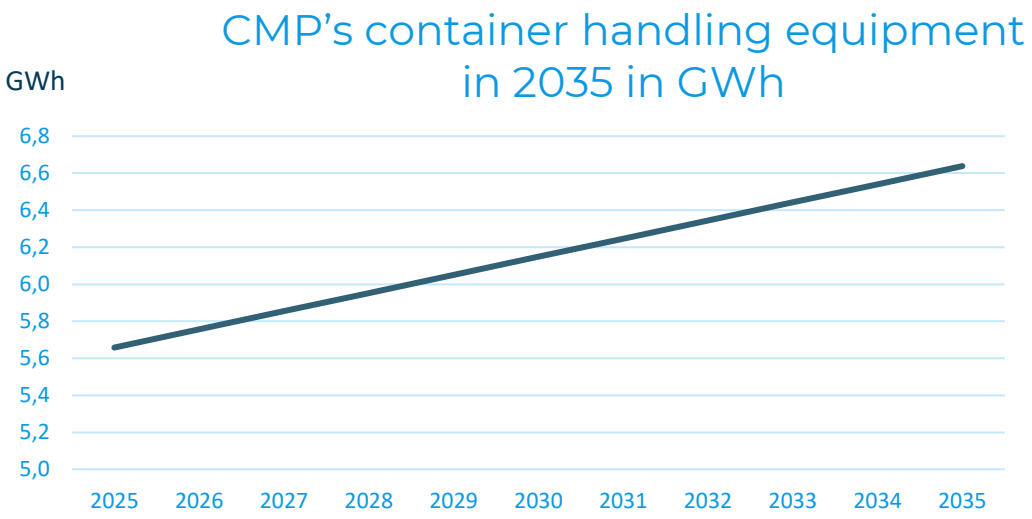

Figure 12 : The figure illustrates a scenario if all of CMP's container handling equipment turned electric and follows current container market.

By baselining electricity consumed by STS and reefers and convert the amount of energy used from diesel-consuming straddle carriers, container stablers and terminal tractors in 2019 (baseline year), it is possible to project future demand if all container handling activities were electrified.

However, this projection comes with some assumptions:
- Projection follows worlds container market development, growing at a CAGR of 4.2%.
- Expecting an increase of containers in Copenhagen creates a higher port activity level which again creates additional electricity demand to be able to move the additional containers around.

- If all container handling equipment is electrified (currently straddle carriers, container stabler, and terminal tractors run on diesel) by 2035 an excess amount of electricity is needed. This is estimated to be 6,15 gwh (2030). An increase of almost 21,25% from baseline year (2019)

How much electricity is needed by 2035? (1/2)

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8-folded increase in electricity demand (2022-2035)
When summarizing the different projections (OPS for cruise and container, handling equipment, and CMP's current baseline) it is evident, the ports consumption increases significantly.
In 2035, CMP expects to consume above 70000 MWh (current level is 8400 MWh). The increase can be explained through:

- **EU regulations:** Compliance with EU regulations necessitates shipowner and ports to adopt cleaner energy sources, thereby increasing electricity demand and supply.
- **Profitability:** Ports find it more and more profitable to embrace green practices, which often require higher electricity usage for renewable energy infrastructure. CMP aims to be fossil free by 2025.
- **Customer preferences:** Customers demand for fossil-free services and products compels ports to utilize more electricity for sustainable operations.
- **Green transition:** The transition towards environmentally friendly practices in heavy greenhouse gas (GHG) industries contributes to higher electricity demand as ports adapt to accommodate these changes.

The electrification of ports faces a significant balancing challenge, particularly highlighted by the container case. This scenario represents a chicken-and-egg situation where:

- **Electricity suppliers lack incentive**: Suppliers hesitate to install Onshore Power Supply (OPS) infrastructure because a small percentage of the worlds current container fleet are not able to receive OPS
- **Container vessels lack motivation**: They're reluctant to retrofit for OPS utilization due to the inadequate presence of OPS installations in ports

How much electricity is needed by 2035? (2/2)

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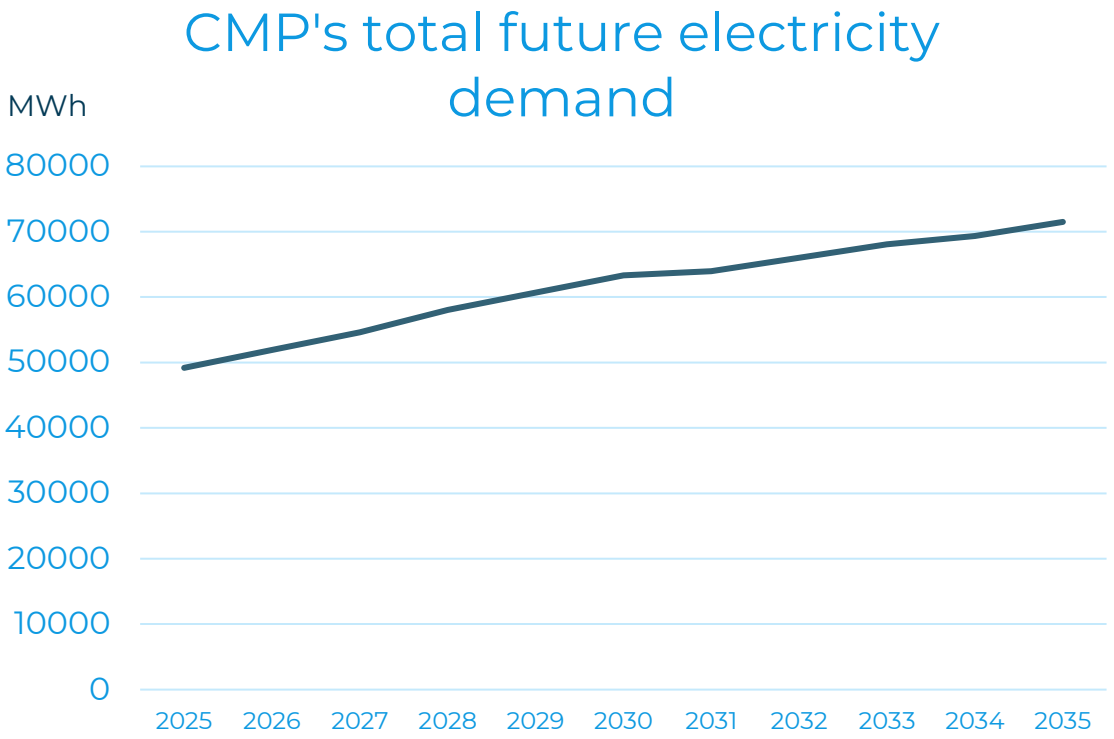

Figure 13: If all projections are summarized and added to CMP's current consumption based on 2017-2022 levels.
Included is the cruise case, container case, container handling equipment case and CMP's baseline.

What are the implications of increased demand?
The implications of increased demand for electricity in ports include potential heavy grid loads in future scenarios, particularly during certain periods characterized by seasonality and daily variations.

This situation may result in an excess of electricity supply during winter months and daylight hours.

Work package 2 explores how this identified gap van be used in the best way possible?

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Many thanks to all project participants for your valuable contributions and fruitful discussions during our meetings