Kildn

Kildn has the ambition to become a zero-emission port, functioning as a hub for the regional passanger transport and fjord tourism in Western Norway.

Electrified ship traffic will require significant amounts of grid capacity. Since a new grid connection implies high investment contribution ("anleggsbidrag"), there is a need to minimse peak load demands, and potentially consider backup power solutions. Being a passenger port with associated hotels and office buildings, the share of thermal energy needs (heating) is large, creating opportunities to unload the power grid by avoiding electrical heating.

Energy demand. Cruise ships require 5-12 MW of onshore power supply (OPS). The heating demand represent 25-40% depending on the season. With two cruise ships being connected at the same time, the extreme maximum load is 24 MW in the summer. For charging of speed boats (fjord metro), a battery swapping carusell with a constant load for charging at around 4.5 MW is assumed. The peak load demand for buildings, including heating and electricicty, is around 2 MW in the winter season. Thus, the total peak power demand for Kildn with two cruise ships at berth can be as large as 28 MW, occurring in the summer season.

Investment options for the port in a *baseline scenario*: grid connection (incl. investment contribution), local solar PV production, batteries, as well as heat pumps and thermal energy storage (TES) for heat supply to buildings. Two more scenarios were evaluated; "*heat2cruise"* considering investments in a heat pump and TES, for heat supply to cruise ships, and "reserve power" considering investment in a power generation unit fuelled by, for example bio-oil.

Recommended investments: Investing in heat supply to cruise ships enables to reduce the peak demand by 5 MW; however, this scenario is unlikely due to the limited number of cruise ships with possibility to connect to external heat supply. Investing in a reserve power unit is recommended to minimize peak load and increase security of supply. Also, investing in building-integrated PV and TES for space heating and hot water is recommended.

Figure 1 presents the total annual costs, including capital costs, and operational costs for energy use and maintenance. The scenario with heat supply to cruise ships has the lowest total cost, followed by the reserve power scenario.

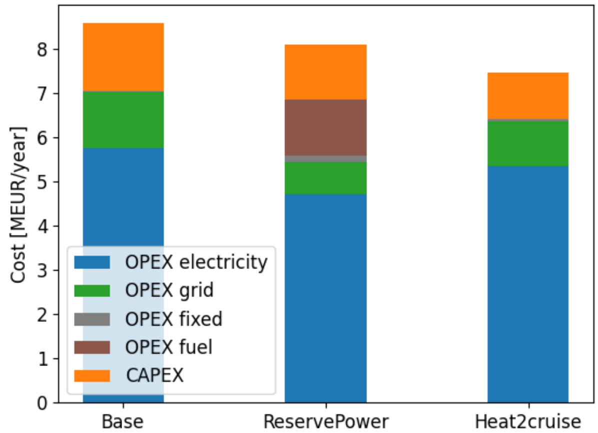

Figure 1. Total annual costs, including CAPEX and OPEX for electricity, grid fees, fuel and maintenance.

Table 1. Added capacity (MW for production, MWh for storage units) for the different technologies in the three scenarios. *TES = thermal energy storage, HP = heat pump, HW = hot water, SH = space heating.*

	Battery	ElGrid	HP_{cruise}	HP_{hw}	HP_{sh}	PV	Reserve power	TES_{cruise}	TES_{hw}	TES_{sh}
Base	0.13	27.82	0.00	0.10	0.46	3.13	0.0	0.0	0.62	3.83
Reserve power	0.33	17.18	0.00	0.10	0.46	3.13	10.0	0.0	0.49	3.83
Heat2cruise	0.00	22.83	5.74	0.10	0.46	3.13	0.0	5.0	0.78	3.83

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INTERPORT PROJECT

Assessment of **INTERPORT** ***goals*** and ***key performance indicators***

Note that since Kildn is a non-existing port, several of the KPIs are not applicable

Reduced Carbon Footprint *(target 50% in 2030, 100% in 2050)*

- ***Reduced CO_2 emissions***: Not applicable
- ***Increased share of renewable energy usage:*** Not applicable

Reduced energy losses *(target 20%)*

- ***Recovered energy:*** Not applicable.
- ***Increased total energy efficiency:***
    - Heat pumps for heat supply to buildings reduce the electricity supply to buildings by 2.9 MWh (22%).
    - Thermal supply to cruise ships reduces the electricity supply to cruise ships by 4.15 MWh (17.5%).

Lower peak demand *(target 30%)*

- ***Peak load reduction:*** Thermal supply to cruise ships allows a peak load reduction of 5 MW (19 %).

High flexibility and reliable supply - ***self-sufficiency*** and ***storage capacity***

Scenario	Self-sufficiency ratio [%]	Storage capacity [MWh]
Baseline	3.1	0.13 battery / 4.4 TES
Reserve power	20.0	0.33 battery / 4.3 TES
Heat supply to cruise	6.6	0.0 battery / 9.6 TES

Cost-efficiency: ***annual costs*** and ***levelized cost of energy*** (LCOE, including electricity and heat):

	Annual costs [MNOK/year]						LCOE
Scenario	**Investment**	**Electricity**	**Grid tariffs**	**Service**	**Fuel**	**Total**	**[NOK/kWh]**
Baseline	17.9	66.8	14.7	0.3	0.0	**99.8**	**3.15**
Reserve power	14.4	54.7	8.5	1.6	14.8	**94.2**	**2.64**
Thermal supply to cruise	12.2	62.0	12.0	0.6	0.0	**86.8**	**2.51**

Sector Coupling

- ***Degree of sector coupling,*** calculated as the share of electricity supply that goes to heat pumps: Baseline, and reserve power scenario: 1 %. Heat supply to cruise ships: 4 %.
- ***Stakeholder involvement:*** Port developer is in dialogue with grid and energy companies. Ongoing dialogue with Port of Bergen, public transport, local and regional authorities. Possible high degree of socio-technical couplings.

Space utilisation

- ***Increased share of nature areas in the port:*** Minimizing nature impacts has a high priority in the port design.
- ***Infrastructure space requirements:*** Infrastructure for heat supply to cruise ships, particularly the TES tank, would increase space demand. The same applies for reserve power generation and the associated fuel demand.

Facilitate uptake and use of alternative fuels and energy carriers

- ***Supply capacity of alternative energy carriers:*** Reserve power generation unit (10 MW) requires biofuels (or H_2)
- ***Port acceptability:*** Mixed socio-political acceptance. Synergies with regional development and tourism. Positive signals for market acceptance. Positive signals from cruise lines and support for Fjord Metro, but concerns of high costs and dependence on tourist demands. The original area plan for Kildn port was substantially larger and met with resistance from environmental organizations. The current downscaled plan has faced less resistance.
- ***Port-city relationship:*** Aims to relive Bergen from cruise congestion. Some tensions with Port of Bergen, as both a potential operator and competitor. Envisions a new type of port-city symbiosis. The city supports the ambition to move a substantial part of the regional passenger traffic from road to the sea, thus reducing area and nature impacts from road construction. The port plans have been accepted by the local council's executive committee.

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