

Policy Brief

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The Nordic industrial sector is at a critical stage in the green transition. Growing electrification, ambitious climate targets, and the phase-out of fossil fuels are increasing electricity demand, while limited grid capacity and congestion create challenges for connecting industrial energy needs with available infrastructure.

Although the Nordic electricity system benefits from strong regional integration and complementary renewable resources, rising shares of variable renewable energy require greater flexibility in electricity consumption, storage, and transmission. Significant investments in grid infrastructure are planned across the Nordic countries, but these developments will take time and may not keep pace with growing industrial demand.

At the same time, European and national policy frameworks are evolving to support industrial decarbonisation. Initiatives such as the EU Port Strategy promote energy cooperation, shared infrastructure, and local energy solutions in industrial and port areas. These developments create opportunities for *Sharing and Sustainable Energy Initiatives*, such as *Positive Energy Districts (PEDs)*, that can improve resource efficiency, strengthen energy resilience, and accelerate the transition towards a low-carbon industry.

A PED can be defined as an area which is energy efficient and energy flexible and produces more energy than it consumes. They can range in scale from a group of buildings to an entire urban district. Three types of PEDs have been defined by Nikolic et. al¹ and their interaction with the surrounding energy system varies:

- **PED Autonomous** operates without any external energy exchange
- **PED Dynamic** produces energy within the area while still importing and exporting
- **PED Virtual** source renewable energy from outside the area

When modelling the PEDs, the main criterion is that annual energy production exceeds the annual energy consumption. The PEDs include the sectors industry, buildings, and transport. For the transport sector, however, transport of goods is excluded, as the associated energy consumption is also supplied from outside the geographical boundaries of the PED area.

Cases

This policy brief examines two industrial areas to explore how the development of PEDs can help overcome the challenges that these areas face. The cases are Port of Frederikshavn in Denmark and Port of Eigersund in Norway. Both ports experience grid congestion, are significant for the local community and are located in a Nordic country. The two cases represent different contexts, barriers, and opportunities. Together, they provide insights into how PED development can support industrial areas with different contextual conditions in ensuring a sufficient energy supply increasing local energy resilience, and supporting the transition towards more sustainable industrial ports.

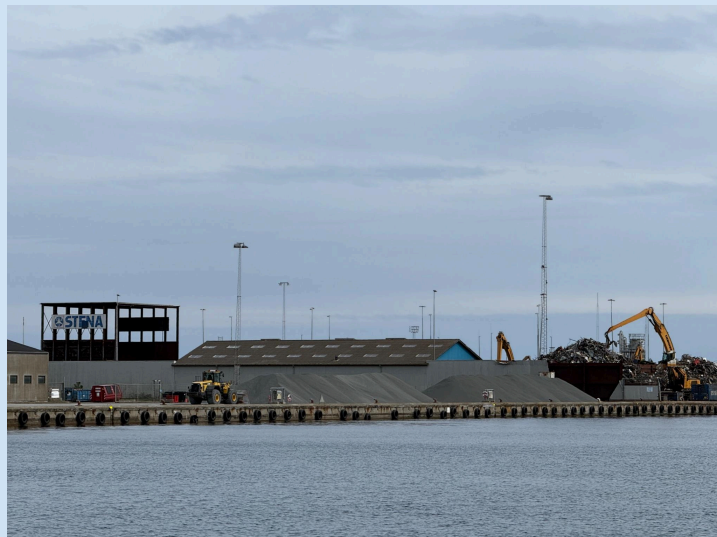
¹ Jelena Nikolic, Jakob Zinck Thellufsen, Peter Sorkn.s, Poul Th.is Madsen, and Lasse Schytt Nørgaard. Let's make ped work - how current knowledge can contribute to future positive energy districts. Sustainable Cities and Society, 132:106817, 2025. ISSN 2210-6707. Doi: <https://doi.org/10.1016/j.scs.2025.106817>. URL <https://www.sciencedirect.com/science/article/pii/S2210670725006900>

Port of Eigersund



In Port of Eigersund the industrial area consists of heavy industry, light industry, sales and service companies as well as offices and similar buildings. The area has a total annual energy demand of approximately 180 GWh, which is currently supplied through imported electricity. Within the area there is a potential for 36.5 MW of rooftop solar panels. If this potential is fully utilised, there is still a need for the equivalent of ten wind turbines to achieve PED Virtual status. The area also has significant potential for industrial symbiosis through energy sharing, surplus heat recovery, and coordinated energy infrastructure. One example is the significant amount of surplus heat currently discharged from local industries. This energy could support future heat-demanding industries, but current regulatory and economic frameworks make it more attractive to generate new heat with electricity and heat pumps than to utilise available local surplus heat.

Port of Frederikshavn



In Port of Frederikshavn the industrial area consists mainly of light industry, sales and service companies as well as offices and similar buildings. There are also a few heavy industries as well as two ferries operating from the port. The area has a total annual energy demand of approximately 260 GWh. This demand is supplied by a combined heat and power plant, four wind turbines and imported electricity. Within the area there is a potential for 40.1 MW of rooftop solar panels. If this potential is fully utilised, there is still a need for the equivalent of nine wind turbines to achieve PED Virtual status.

Barriers and Opportunities

Based on the contextual analyses of the two ports and 19 interviews with key personnel from the ports, industries, and enterprises located there, the barriers to achieving a sufficient energy supply and the opportunities for developing a PED to address these barriers have been identified. The analysis identified 19 barriers and 13 opportunities. Most barriers exist in both ports, while four are specific to Denmark and Frederikshavn, and six are specific to Norway and Eigersund. Five opportunities are identified for both ports, while five are identified in the Danish context and four in the context of Norway and Eigersund (See Figure 1).

Policy Issues

The identified 13 opportunities can be strengthened, and the 19 barriers mitigated or removed through six targeted policy issues. These policy issues are:

- **Strengthen stakeholder collaboration:** Strengthening stakeholder collaboration can reduce investment risks by enabling stakeholders to share costs, risks, and knowledge, while creating a common vision and facilitating coordinated decisions.
- **Support long-term, holistic planning of the electricity grid:** Long-term grid planning can address congestion, improve security of supply, and support business development. It can also reduce uncertainty through better demand forecasts and zoning, while prioritising grid expansion and renewable connections.
- **Increase local acceptance:** Early citizen involvement, transparent decision-making, and local ownership can strengthen trust and build on positive attitudes towards PV and BESS. This will increase local acceptance, which facilitates PED development by reducing opposition and delays.
- **Increase energy sharing possibilities:** Increasing energy sharing can accelerate PED development by improving grid flexibility, reducing capacity constraints, and enabling greater use of local renewable energy. It can also make PED investments more attractive.
- **Support project oriented management of ports:** Project-oriented port management, a central development organisation in Eigersund, accelerate PED development.
- **Determine political direction:** A clear political direction create favourable conditions for PED development by aligning investments, improving coordination, and enabling regulatory adjustments. It can also strengthen incentives for renewable energy investment through targeted support.

In Figure 1 the connection between barriers, opportunities and policy issues are shown. For most of the policy issues the two ports can learn from each other. Port of Frederikshavn could draw inspiration from Norway's rules on sharing renewable electricity, as well as from Port of Eigersund's project-oriented organisational structure, which supports coordinated development and stakeholder collaboration. Conversely, Port of Eigersund can benefit from Danish approaches to local involvement, particularly to increase public acceptance of wind turbines and PV installations through participatory planning and ownership models.

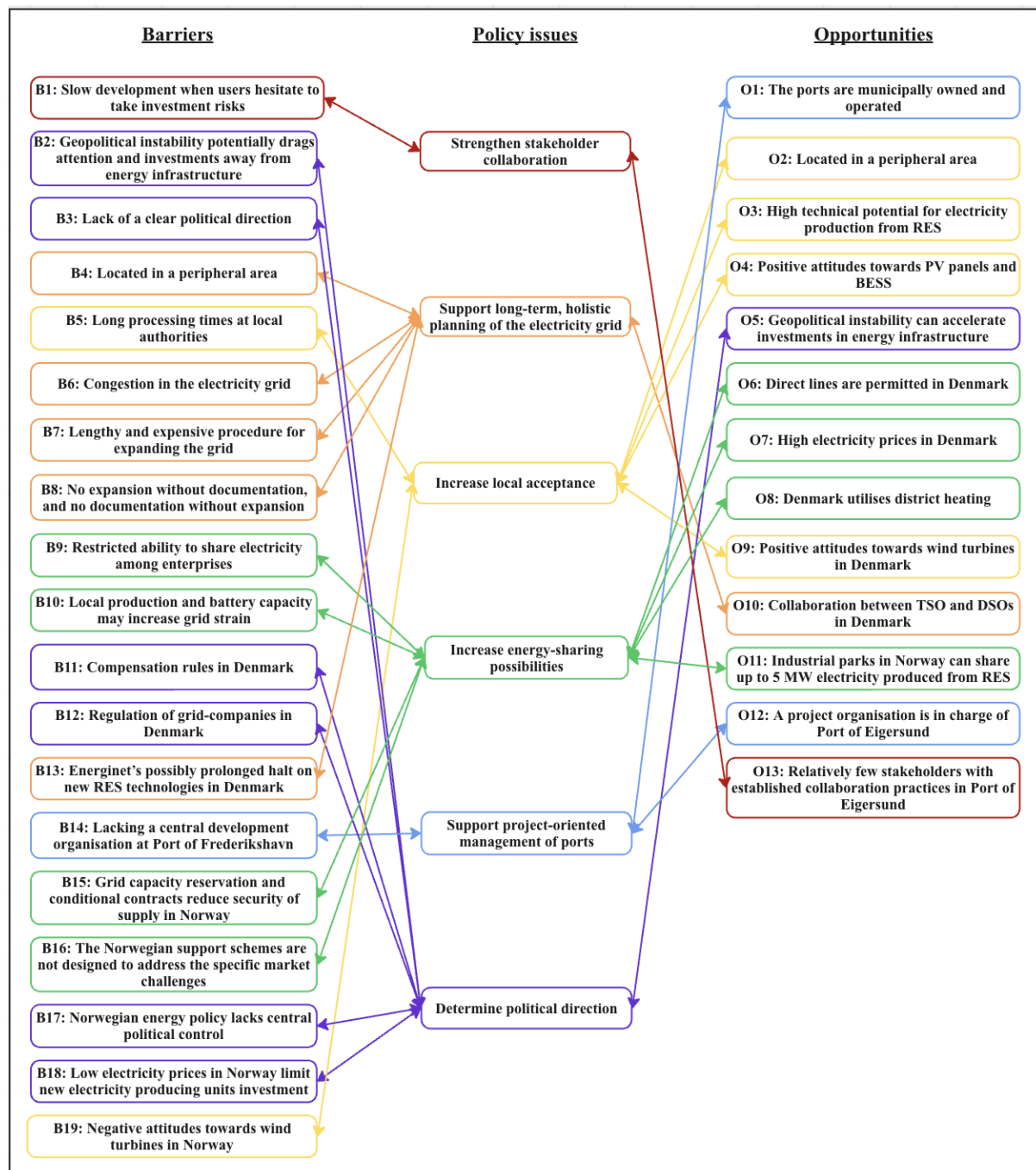


Figure 1: Overview of which barriers are solved or minimised and which opportunities are utilised or strengthened by the six policy issues. Based on the discussion with inspiration from Bergek et al. (2008)

Conclusion

Overall, the findings of the thesis demonstrate that both ports face significant challenges related to electricity supply, but that PED status can be achieved. This will enable the businesses at the ports to be supplied with sufficient electricity. However, whether ports can achieve PED status depends on aligning technological solutions with local contextual conditions, supported by policy issues.