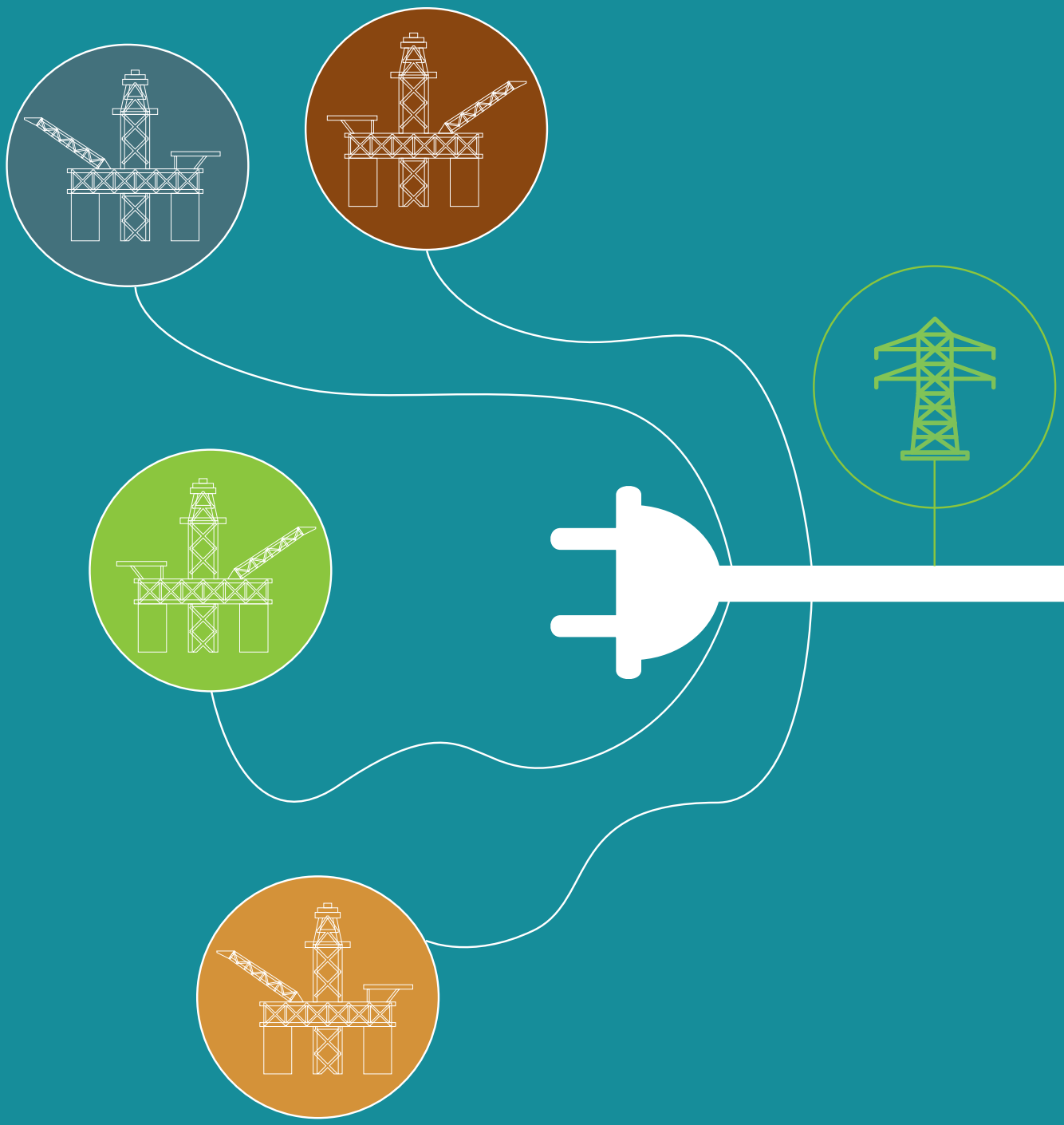
PowerFromShore

to the Norwegian shelf

Summary of report 2020



Preface

On assignment from the Ministry of Petroleum and Energy, the Norwegian Petroleum Directorate has updated the report entitled "Power from shore to the Norwegian shelf" from 2008. The update has been prepared in cooperation with the Norwegian Water Resources and Energy Directorate (NVE), the Petroleum Safety Authority and the Norwegian Environment Agency, and has resulted in the report entitled "Power from shore to the Norwegian shelf 2020", which is a joint product from the four agencies. Each agency has contributed within its areas of responsibility. The Norwegian Petroleum Directorate has coordinated the work and compiled the report.

Summary

Sixteen fields currently have, or have decided to use power from shore. All these power solutions are expected to be in operation in 2023. At this point, fields with power from shore will account for around 45 per cent of overall production of oil and gas on the shelf. This will mean that emissions in Norway will be lower than they otherwise would have been. The avoided emission volume as a result of these power from shore solutions is estimated at 3.2 million tonnes of CO_2 per year. This corresponds to about a quarter of total emissions from the petroleum sector in 2019.

Power from shore is being considered on multiple fields. Some are more suitable than others, which is why both costs and potential emission reductions vary considerably from field to field. Power from shore technology has matured since 2008. The equipment has become lighter, takes up less space, and more power can be transferred over longer distances at a lower cost. This makes the measure relevant on more fields. However, field-specific assessments of technical solutions and costs are still needed in order to determine the suitability of power from shore for the different fields.

Power from shore also has other effects beyond reducing emissions. A report published by the Petroleum Safety Authority in 2019 shows that replacing power generation on the facilities with power from shore is an overall positive for health, safety and the environment. Experience also shows that operational regularity is usually higher when a facility receives power from shore than when the power is generated in gas turbines.

1.1 Policy instruments

The primary policy instruments for reducing emissions from the petroleum sector are financial; the emissions trading system and CO_2 tax. The sum of these instruments means that the companies are facing a total price for CO_2 emissions of around NOK 700 per tonne of CO_2. This is significantly higher than other enterprises in Norway and much higher than in other countries with petroleum activities.

The CO_2 tax and emissions trading system give the companies a financial self-interest in reducing their emissions. This has helped keep emissions from the petroleum sector stable over the last ten years, in spite of more fields coming on stream. Emissions from the sector are expected to decline in the future, e.g. because gas turbines on multiple fields and facilities are being replaced with power from shore.

1.2 Abatement cost analysis

The report provides a general assessment of opportunities and costs for power from shore to selected facilities. The assessments are based on work under way or which has been carried out by the licensees.

Abatement costs have been calculated for a selection of power from shore projects the licensees have studied, but not adopted. The abatement costs express the socio-economic costs for projects per tonne of avoided emissions of CO_2.

The projects are divided into four categories: Mature projects in the planning phase, immature projects in

the planning phase, discarded projects and projects that were part of recently submitted development plans where power from shore was not chosen.

The mature projects in the planning phase are on Troll B, Troll C, Oseberg Field Centre, Oseberg Sør, Sleipner Øst and the Melkøya onshore facility. Investment decisions could come relatively soon here. All of these projects have abatement costs below NOK 1,500 per tonne of CO_2.

If the projects are adopted, more than 50 per cent of the oil and gas production in the mid-2020s could be operated with power from shore. If so, the avoided emissions as a result of power from shore are estimated to increase to around 4.9 million tonnes of CO_2 per year.

Two immature projects in the planning phase have been analysed in the report. These are on Draugen and in the Halten area. Here the licensees have carried out general studies of power from shore, but the projects require additional studies before an investment decision can be made. Both the described solutions, the technical studies and the cost estimates are considerably more uncertain than for mature projects. Further maturation could lead to changes in technical solutions and costs.

The abatement costs for discarded projects are either high or based on a solution that is no longer relevant. Abatement costs are also high for all of the projects that were part of recently submitted development plans, where power from shore was not chosen. This applies for projects on Johan Castberg, Balder and Yme.

1.3 Onshore power system

If the mature and immature projects in the planning phase are realised, this will lead to an increase in power consumption in Norway of up to 5.1 TWh per year. One important precondition for this to be feasible is that the onshore power system can handle the increase in consumption, without this negatively affecting security of supply for existing customers.

The project which entails the highest power consumption is at the Melkøya onshore facility. This project will require a new 420-kV line from Skaidi to Hammerfest. Both the Melkøya onshore facility, Troll B and C, Oseberg Field Centre and Oseberg Sør will lack redundant power supply from the grid with the planned grid measures. This means that, in some situations, the facilities will have to be disconnected from the grid and potentially use their own back-up supply. The same will apply for connecting the Halten area and Draugen to the Fosen area, until the licensed Trondheimsfjord connector is in place.

In isolation, increased power consumption will entail lower net export of power from the Nordic region to the rest of Europe, and an increase in electricity prices in Norway. This affects abatement costs for power from shore. The major increase in consumption in Northern Norway will contribute to fewer bottlenecks in the grid coming out of Northern Norway, and improve utilisation of power generation resources in the area. At the same time, this will yield the greatest price increase in Northern Norway, and result in lower differences in electricity prices between north and south in Norway.

1.4 Other technologies

In addition to power from shore, the report also addresses other solutions to reduce greenhouse gas emissions from the petroleum sector. These could be alternative methods for power supply, carbon capture and storage (CCS) from turbine exhaust and more effective utilisation of the energy generated in the gas turbines on the facilities.

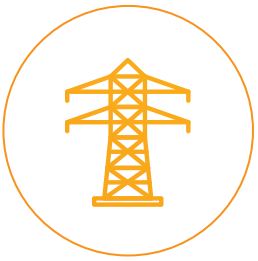
Offshore wind, energy storage and power generation from gas turbine waste heat are examples of alternative power supply. These are areas where efforts are under way to develop new, cost-effective solutions.

Energy efficiency measures will lead to better utilisation of energy on the facilities. This is both good resource management and a good climate measure.

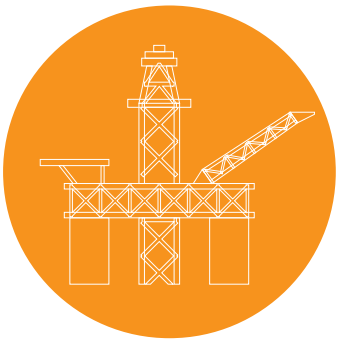
1.5 Primary findings

The most important findings in the report are summarised in the following items:

- The technology for power from shore is under development. Compared with 2008, alternating current is now used to transmit more power over greater distances. This makes power from shore projects more cost-effective and lays the groundwork for more facilities being eligible for power from shore now than in 2008. Technology has also been developed to make it possible to provide power from shore to FPSOs with turrets.



- Power from shore yields substantial emission reductions. Sixteen fields have, or have decided to use power from shore. All these power solutions are expected to be in operation in 2023. At this point, fields with power from shore will account for around 45 per cent of overall production of oil and gas on the shelf. The avoided emissions from the fields amount to about 3.2 million tonnes of CO_2 per year.



- More power from shore projects are approaching an investment decision. If the projects are adopted, the avoided emissions could increase to around 4.9 million tonnes of CO_2 per year, and more than 50 per cent of production in the mid-2020s could be operated with power from shore. The projects are on Troll B, Troll C, Oseberg Field Centre and Oseberg Sør, Sleipner Øst and the Melkøya onshore facility. All of them appear to be able to receive power from shore with abatement costs below NOK 1500 per tonne of CO_2.

- Most mature power from shore projects require measures in the power grid. Electrification of the Melkøya onshore facility requires construction of a new 420-kV line from Skaidi to Hammerfest. The Melkøya onshore facility, Troll B, Troll C, Oseberg Field Centre and Oseberg Sør will lack redundant power supply, given planned grid investments. This means that they will be disconnected in strained operating situations. The power from shore projects will lead to an increase in electricity prices in Norway, and smaller differences in electricity prices between the north and south in Norway.