Electrification of petroleum installations
Commercial justifiable and necessary for the climate

Power and productivity
for a better world™

No less than 25 per cent of CO2 emissions in Norway come from petroleum installations on the Norwegian continental shelf. Electrification of new installations is the most effective way of meeting national climate targets and reducing emissions globally. Moreover, the lower operating costs of electrified installations is also commercially profitable in the long term. Reduced safety risks and environmental risks and a reduced need for staffing at sea are other benefits. With an increasing surplus of renewable energy on land, conditions are good for electrification of offshore installations in Norway.

ABB is of the opinion that electrification must be assessed from three perspectives:
1. Climate and energy efficiency
2. Business administration and economics
3. Health, safety and the environment

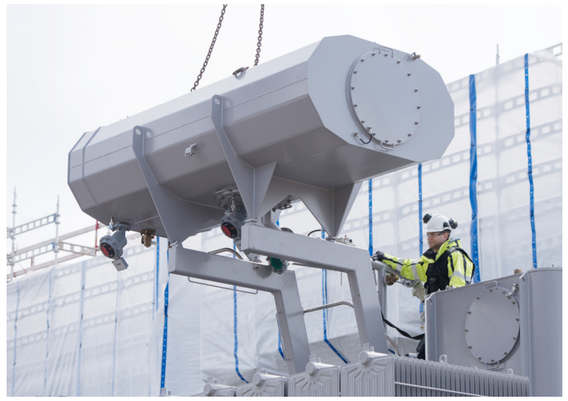
Electrification, or power from shore, is a powerful tool for the people who manage our oil and gas resources. Given the fact that we will have oil and gas operations for many decades to come, this provides an opportunity to extract natural resources from the sea bed more carefully, while also giving us the maximum possible energy from each cubic metre of gas produced.

For the oil companies, the most important drivers for electrification are:
- Better energy efficiency and reduced greenhouse gas emissions
- Lower operation and maintenance costs, more uptime and more gas for sale
- Greater safety and a better work environment

Whether the emphasis is on the climate or economy, electrification is an investment in the future. If the power comes from renewable sources, electrification will almost always be a positive thing from a climate perspective. Electrification will always be favourable as regards health, the environment and safety. In the longer term, electrification will often be commercially profitable.

The power industry, led by Statnett, confirms that there will be enough electricity based on renewable sources available to cover the increased need on the Norwegian continental shelf as a consequence of the electrification of future developments.

For the Troll A platform, Statoil has twice selected power from shore with ABBs direct current system, HVDC Light, to run gas compressors on board. Electrification is eco-friendly and cost-effective, and hence represents a shortcut to a more sustainable and profitable oil and gas industry.



From the installation of an ABB transformer at the new converter station at Kollsnes in Hordaland.

Cars on the roads have become far more energy-efficient over the past few years. For most car owners, it matters whether their car uses half a litre or a whole litre of fuel every ten kilometres. Why should this same principle not be applicable elsewhere – streamlining the things we can streamline?

1. Climate and energy efficiency
Cars on the roads have become far more energy-efficient over the past few years. For most car owners, it matters whether their car uses half a litre or a whole litre of fuel every ten kilometres. Why should this same principle not be applicable elsewhere – streamlining the things we can streamline? A large-scale gas-fired power plant on land will always have more chance of being energy-efficient than an offshore gas-fired power plant.

In the third part of the Fifth Assessment Report on climate, the UN's Panel on Climate Change writes that emissions must be reduced by 40-70 per cent in the period to 2050, before then being reduced to zero towards the end of the century.

In practice, the only thing which affects the entire carbon inventory is how much power we get out of each unit of gas produced, along with the option for CO2 capture and storage.

- Around 18 per cent of Norway's total emissions of greenhouse gases are due to offshore gas turbines.
- Electrification may eliminate major point sources of greenhouse gases and is a measure which makes a difference, permitting Norway to develop new fields while also meeting its climate obligations.
- At full load, offshore gas-fired power plants typically have an efficiency level of 38 per cent and in the majority of instances will be less energy-efficient than gas-fired power plants on land, which may have an efficiency level of up to 78 per cent. Offshore gas-fired power plants rarely operate at full load, but if they did they would be even less energy-efficient.
- This means that we get more energy out of every unit of gas on land, even taking into account losses in the transfer of gas to the continent and losses in the transfer of power out to the platforms.
- With power from shore, more gas is left over for sale, and more gas available in the market may suppress more polluting power sources.
- Gas power produced at the most efficient gas-fired power plants has around half the emissions of a modern coal-fired power plant.
- For the same reason, gradually replacing coal-fired power with more gas-fired power is a development which the UN's Panel on Climate Change would like to see as this would significantly reduce greenhouse gas emissions in the short and medium term.
- With a given volume of gas to be extracted, we face a fundamental choice of how much energy we want to get out of each unit of gas. The more energy we get out of each unit of gas, the more coal-fired power – for example – we can replace.
- Gas-fired power plants on land permit full-scale CO2 capture and storage, but implementing this at sea is not realistic.

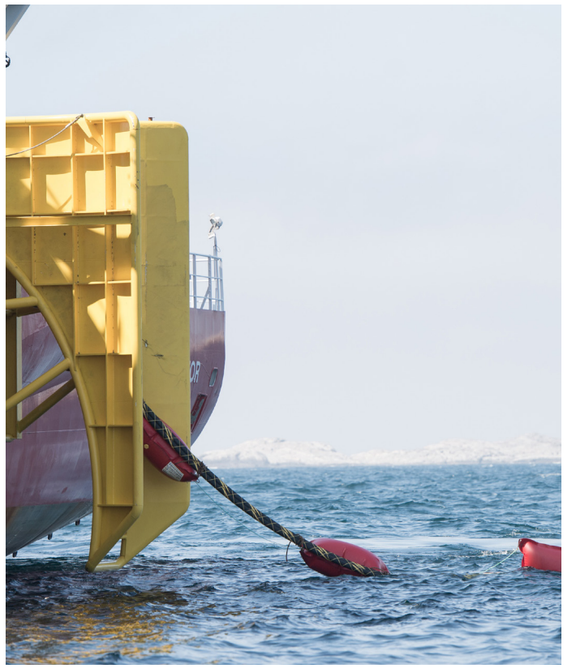
2. Business administration and economics

Life cycle costs are often lower in the case of electrification compared with the use of offshore gas-fired power plants. Although electrification results in a higher investment cost, it also results in significantly lower operating costs. This means that the recovery rate in our reservoirs could increase as production will be profitable even with lower volume. The field can therefore operate for longer with lower production. However, whether electrification is commercially profitable will vary from field to field.

Just as the offshore industry is concerned with a long-term approach and predictable conditions, a far enough perspective must also form the basis for electrification calculations. With an increasing power surplus on land, short-term cash flow is often the only thing against the electrification of relevant fields.

Electrification is normally more profitable in new fields than in existing ones as power from land is taken into account right from the design and construction phase. Normally a new field will also have a longer payback time, i.e. several years over which to divide the investment costs and several years of lower operating costs. But electrification has been carried out successfully on older installations too.

- In commercial terms, electrification is often profitable. The internal rate of return, and thus the time frame, is decisive.
- Targets for short-term high cash flow and risk assessments may make electrification unprofitable in the short term, but choosing a power supply solution which has higher service life costs goes beyond the total return for the owners in the longer term.
- If electrification is commercially profitable, it will also be economically profitable due to higher income to the State. The economy is influenced positively as power from shore is more reliable than power generated offshore, resulting in lower operating costs and more production days for the platform.
- Greater reliability is linked with fewer mechanical parts on board, resulting in lower costs in respect of production stoppages, maintenance, repairs and the transport of service staff out to the platform. Greater regularity and fewer disruptions mean better earnings.
- Electrified petroleum installations give more gas for sale as they do not consume gas themselves for their own power production or other purposes.
- If area solutions are relevant – i.e. electrifying several fields at the same time – the economy will be further influenced positively as the costs are divided over multiple installations and organisations.



The new DC power cables to the Troll A platform, lowered into water just outside Kollsnes.

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- The optimum case for electrification involves an area solution for entire new field developments, not too far from shore or too deep, and with a long anticipated production period.
- The Ministry of Finance is about to revise the level of discount rate and cost for CO2 emissions reducing the cost of action and increasing anticipated profitability. It is likely that costs for CO2 emissions will increase in future.
- There is a risk that economically profitable projects will not be implemented as the framework conditions will not result in commercial profitability, but this must be dealt with at a political level.

3. Health, safety and the environment

From an HSE perspective, electrification of oil platforms will always be beneficial. Gas turbines cause both noise and vibration which offshore employees avoid by using power from shore. There is also less risk of fire and explosion as the risk of gas igniting is reduced.

Electrical systems consists of fewer moving parts than offshore gas turbines and hence there is less need for maintenance and repairs. This means that fewer people have to travel offshore, hence a reduced risk for individuals and less need for noisy, polluting traffic to the platforms.

- Electrified installations are safer for people and provide better working conditions than gas-driven installations due to less noise and vibration and fewer sources of ignition.
- Reduced maintenance needs reduce the need to transport people from land in order to carry out repairs and servicing.

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Available clean power

Everyone carrying out calculations for the Nordel area with green certificates shows that there will be a significant supply of energy that does not contribute to CO2 emissions in the relevant areas in years to come, given that policy will continue in this area. More power available from renewable sources must be used for something if it is to be suitable, and only then can it help to replace more polluting power.

- There will be enough available power in the grid to supply planned new fields with power from shore.
- Statnett has ensured that the central grid in the areas in question will have more than enough capacity to handle an increase in demand for power.
- A large-scale upgrade, i.e. capacity increase, will take place within the field of Norwegian hydroelectric power in years to come, in parallel with significant upgrading of the power grid.
- More and more new, renewable energy is being integrated into the grid.
- The power surplus on land is increasing still further as more green energy is phased in.
- The most energy-efficient utilisation of new, renewable energy is when it can be used locally to replace power production based on polluting fuel, like an offshore gas turbine.

The Gjøa platform receives power from shore through a 100 kilometer long AC connection to Mongstad in Hordaland. This is from the preparation at Stord.

Projects

ABB is a pioneer in the field of transfer and control systems power. The company is involved in all five of the major electrification projects on the Norwegian continental shelf – Troll A, Gjøa, Valhall, Goliat and Martin Linge – and has supplied to a number of the projects internationally. Over the last ten years, developers on the Norwegian continental shelf have indicated six times that full or partial electrification of their fields is making their operations more profitable and eco-friendly:

- 2005*: Troll A (Statoil)
- 2010: Valhall (BP)
- 2011: Gjøa (GDF Suez)
- 2014: Troll A, phase 2 (Statoil)
- 2015: Goliat (ENI)
- 2016 Martin Linge (Total)

* Year of commissioning

These six projects alone represent a reduction or elimination of CO2 emissions totalling around 1.2 million tonnes per year.

Electrification is not specific to Norway. Electrification projects are taking place in Saudi Arabia, Qatar and the USA and are about to be delivered. Studies have also been carried out which are linked to electrification of offshore installations in Malaysia and Abu Dhabi in the United Arab Emirates.

Area electrification

The power systems used for electrification have been developed over the course of many decades. These are already tried and tested and have documented regularity which surpasses locally produced power on the platforms. Up to now, electrification has solely been used to power individual installations from land. To make electrification even more attractive, we can “think bigger”; for instance, by electrifying entire areas via a single cable from shore to a “hub” which distributes the power on to other installations nearby.

This will result in lower costs compared with supplying similar fields with parallel individual cables, not least because the cost of the cabling will constitute a major element in the equation.

Just as work is currently in progress on developing advanced power systems for the sea bed facilities of the future with a single cable with meets the entire power requirement for the underwater installation, so the supply of power to multiple surface and underwater installations in a given area can be covered by a single power connection to shore. Essentially, this is no different to the structure of the power supply system on land.

Area electrification on the Norwegian continental shelf will also provide invaluable experience for a similar or much bigger project in the Barents Sea which is dependent to an even greater extent on oil and gas extraction which is as careful and as sustainable as possible.

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Cost of action

Estimates for the cost of action, i.e. the cost (present value) per future reduced tonne of CO2 from electrification, vary widely. This is an indicator of how complex the task of devising profitability calculations for electrification is.

BP’s Valhall complex receives power from shore through a 292 kilometer long HVDC Light system from ABB.

Calculations of the cost of action in this connection are used to compare the financial effects of various measures, in this instance in connection with the reduction of CO2 associated with petroleum production. According to EnergiNorge, what is known as the present value method is used as a basis. The following parameters are included as part of the calculation data:

investment and operating costs for power from shore, power price, emissions costs, transport costs for gas minus investment and operating cost for gas power on board and sales income for released gas.

Employment

The need for flexible, energy-efficient power systems will increase as the demand for power grows. This means workplaces today, but in the future as well, as greater emphasis on electrification is reinforcing elements of the knowledge we need for sustainable continuation of the Norwegian oil adventure and, not least, what we will have to live on once the age of oil is no more.

We already have the greatest density of electrified offshore installations, and there is major interest on a global level in what Norway has achieved. Norway already has a strong electrotechnical environment which will be reinforced and extended if we continue to lead the way in the use of electricity in oil and gas operations. Focusing on electrification is reinforcing and extending expertise which is already an important export commodity and which will become even more important in the future, irrespective of industry.

The principle behind electrification involves replacing gas-fired power plants on the platforms with eco-friendly power from land, supplied via an underwater cable. Given our access to hydroelectric power and other renewable energy, conditions are particularly good for the development of power from land in Norway.

The concept

The principle behind electrification involves replacing gas-fired power plants on the platforms with eco-friendly power from shore, supplied via an underwater cable. Given our access to hydroelectric power and other renewable energy, conditions are particularly good for the development of power from shore in Norway.

Power from shore can be supplied via an alternating current (AC) system or a direct current (DC) system. AC is simpler and cheaper to install, but it is not as effective as DC over long distances.

Summary

The electrification of oil and gas installations at sea is a positive aspect for the global climate and often favourable on a commercial level, and will definitely improve working conditions offshore

- Electrification has a beneficial effect on climate due to lower global emissions overall and because more power is produced for every unit of gas produced.
- Electrification has a positive effect on commercial considerations for the fields in the long term due to lower operating costs and increased recovery.
- Electrification has an immediate positive effect on health, the environment and safety for everyone working offshore.

Electrification is eco-friendly and cost-effective, and hence represents a shortcut to a more sustainable and profitable oil and gas industry.

HVDC systems take alternating current from the land grid and convert it to direct current at a land installation before transmitting the electricity in cables out to the platform. The power is converted there back to alternating current which can be used by the offshore systems. A direct current system is preferred where there is a need to transmit large amounts of power in an energy-efficient manner.

Assuming that the gas will be recovered regardless, and can be used instead to produce electricity in far more efficient gas-fired power plants on land, we will get more power out of the same amount of gas. Typically, we can extract twice as much electricity out of the same amount of gas in a gas-fired power plant on land. A large-scale gas-fired power plant will also permit future large-scale CO2 capture and storage.

An increased percentage of gas power in the energy mix may supplant more polluting sources such as coal power, or cover increasing electricity requirements more carefully. In other words, electrification gives more power per unit of CO2 emissions. This is applicable even when all the negative effects have been taken into account, such as losses during the transport of power or gas.

As well as the obvious environmental effects, power from shore results in benefits in the form of lower maintenance costs, reduced noise and vibration offshore – and more gas for the oil companies to sell.

In the fields in which electrification is selected as the best solution, this will result in improved working conditions for the people working offshore and higher income from tax for society.

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