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Petroleum activity in Barents Sea South-East – climate, economics and employment

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1. Introduction[1]

This report has been commissioned by Greenpeace and Nature and Youth in connection with their legal action relating to the decision on exploration and production licences of 10 June 2016 ("the Licensing Decision"). The report aims to address the following issues relating to the economic assessments performed ahead of the Licensing Decision, and which have primarily been reported in Impact Assessment Report to the Storting 36 (2012–2013) and sub-reports:

1) Assess the extent to which climate costs have been considered in the economic assessments on which the Impact Assessment is based and, if required, describe how such costs could or ought to have been considered and described.
2) Describe any errors in the economic assessments expressed in, or which form a basis for, the Impact Assessment and sub-reports.
3) Describe and evaluate whether or how the future price of petroleum, future demand for petroleum and future development costs for new production, as well as assessment of uncertainty, risk and the tax regime, have been taken into account in the economic assessments on which the Impact Assessment is based.
4) In describing the positive economic effects of petroleum activity in the areas covered by the Licensing Decision, the Impact Assessment cites future employment effects as the key socio-economic benefit. Are the socio-economic benefits from such employment effects significant and can they be quantified? Will overall employment in Norway benefit from activities based on the Licensing Decisions, or will only employment in Finnmark be affected?
5) Will petroleum activities based on the Licensing Decision have other non-valued effects?
6) Collocate key socio-economic benefits and costs for petroleum activity in Barents Sea South-East. This collocation must be based on the above points, and have a similar scope to the economic analysis in the Impact Assessment. Where there are no grounds for adopting other assumptions, the collocation is based on the same assumptions as the Impact Assessment mentioned above, including sub-reports.
7) Do the Impact Assessment and sub-reports provide a reasonable economic basis for adopting the Licensing Decision and for the opening of the 23rd Licensing Round?

In the following section we present a summary of the report's main findings. Section 3 provides a short description of the two scenarios – High and Low – prepared by the Norwegian Petroleum Directorate (OD, 2012a) in connection with the Impact Assessment. These scenarios reflect uncertainty regarding the scope of potential oil and gas finds from exploration activities in the area. The following sections then review each of the issues mentioned above in turn.

[1] We would like to express our gratitude to Klaus Mohn for his extremely useful input, and to representatives of the Norwegian Petroleum Directorate, Pöyry, Statistics Norway, the Norwegian Institute for Air Research (NILU) and DNV GL for their courteous replies to enquiries about the sub-reports that were written in connection with the Impact Assessment. This report has been written as a private commission. Consequently, the contents of this report solely represent the views of the authors, and not the views of institutions to which the authors are affiliated.

2. Main findings

Our review shows the quality of the economic assessments performed ahead of the Licensing Decision to be inadequate, and that in some cases the information provided is quite simply incorrect or misleading.

The most serious error is that revenues and expenses for petroleum activity are not discounted (to present value), and that the socio-economic costs of CO_2 emissions relating to the activity have not been taken into account. In addition, the Impact Assessment was performed in 2012–2013, i.e. before the oil price crash in 2014, and was therefore based on relatively high oil and gas prices (almost USD 120 per barrel of oil). However, the Licensing Decision was adopted in 2016, when the oil price was USD 45 per barrel and the market's price expectations had been significantly lowered. If we assume more reasonable price expectations,[2] consider costs of CO2 emissions in Norway, as well as discount future revenues and expenses, the net benefit falls from NOK 280 billion (High scenario) and NOK 50 billion (Low scenario) to NOK 41 billion and NOK -2 billion respectively. These are significant changes. We also believe that the costs relating to increased CO2 emissions abroad should be deducted, which further reduces the net present value. Additional non-valued costs also have to be considered: for example, the possibility of uncontrolled emissions.

Some of the Impact Assessment's estimates for CO2 emissions in Norway are defective and as mentioned are not included in the economic analysis. CO2 emissions in Norway have an unequivocal socio-economic cost, which we estimate at NOK 11 billion in the High scenario and NOK 2.3 billion in the Low scenario (present value 2017).

The possibility of increased CO2 emissions abroad as a result of petroleum activity is not discussed in the Impact Assessment. It is highly probable that oil production in Barents Sea South-East would result in increased CO2 emissions abroad. We estimate the climate costs relating to such emissions at around NOK 20 billion in the High scenario and around NOK 7 billion in the Low scenario (present value 2017).

The Impact Assessment contains several errors and misleading assertions, some of which are mentioned above. Another error involves the double-counting of value added effects in the Impact Assessment, where we believe that Statistics Norway's (SSB) estimates have been used in addition to OD's estimates. Furthermore, the summary of the Impact Assessment only states "gross sales value" in the two scenarios, which is extremely misleading. This becomes particularly problematical in light of the fact that the figure stated in the Low scenario is quite simply incorrect, and twice as high as the correct figure (stated in OD's original calculations in 2012). The difference between the gross sales value reported in the Impact Assessment summary and our calculation of net present value is striking: The former states revenues of NOK 270 billion in the Low scenario, while our calculation results in a negative net present value.

We believe that the figures for the employment effect are overstated. This applies in particular to the figures that are based on Pöyry's report on regional employment effects. As far as we understand, Pöyry has estimated gross employment effects of development in Barents Sea South-East, and not taken into

[2] We have applied price forecasts received from the Norwegian Petroleum Directorate; see sections 4 and 5 for further discussion.

account the fact that most people who gain employment as a result of this development would have been otherwise employed if this production did not go ahead.

Major uncertainty attaches to future oil and gas prices and to the costs of petroleum production in this area. Despite this uncertainty, the Impact Assessment does not discuss economic uncertainty or risk. With the exception of two scenarios relating to the number of oil and gas finds, the economic calculations do not assess alternative assumptions.

The Norwegian Ministry of Finance regards the petroleum tax regime as "investment-friendly", which means that the award of licences could result in the implementation of socio-economically unprofitable projects. A further significant imbalance emerges when we compare investments on the mainland with investments on the Norwegian Shelf. Projects that are sometimes extremely unprofitable under the mainland tax regime may be profitable under the petroleum tax regime. This, for example, is the case in OD's Low scenario, which is commercially profitable under the petroleum tax regime, but not under the mainland tax regime.

Based on our findings we conclude that the Impact Assessment including sub-reports does not provide an adequately thought-out basis for adopting the Licensing Decision and for the opening of the 23rd Licensing Round. We justify this on three grounds:

I. The survey contains many errors and defects, some serious.

II. Petroleum activity in Barents Sea South-East entails a number of non-valued environmental impacts that will not be adequately considered by private oil companies.

III. The petroleum tax regime is structured in such a way that investments that are not socio-economically profitable can nonetheless be implemented by private organisations.

3. Brief outline of the scenarios for petroleum activity in Barents Sea South-East

Barents Sea South-East (see “IA” in Figure 1 on the following page) was opened for petroleum activity in 2013, and the first exploration licences were issued in the 23rd Licensing Round in 2016. In connection with the Impact Assessment (IA) the Norwegian Petroleum Directorate (2012a) prepared two scenarios for petroleum activity in this area, referred to in the IA as the High and Low scenarios. Table 1 summarises the resource estimates for oil and gas under the two scenarios. As the table shows, OD expects two to three times as much gas as oil to be found in the two scenarios (1 billion Sm3 of gas corresponds to around 1 million Sm3 of oil, measured in energy units). The table also shows that in the High scenario reserves in the order of 5–6 per cent of residual reserves on the Norwegian Shelf are expected to be found, compared with just under 2 per cent in the Low scenario.

In both scenarios exploration activities start in 2017. In the High scenario production takes place in the period 2027–2050, while in the Low scenario production takes place in the period 2029–2047. While oil is relatively easy to transport from the area by ship, it is more difficult to source the correct transport solution for gas. In the High scenario two solutions are outlined, with LNG facilities deemed to be the most relevant. Here gas is transported in pipelines to land, where it is cooled down into LNG, and then transported using LNG vessels. In the Low scenario the gas is instead converted to CNG at the field, and then transported using CNG vessels to either the nearest gas pipeline or a gas terminal in the Vestlandet region.

Table 1. Resource estimates in OD’s High and Low scenarios. Percentage of residual reserves on the Norwegian Shelf as of 31 December 2016 in parenthesis.

	Oil (million Sm3)	Gas (billion Sm3)
High scenario	45 (4.5%)	120 (6.7%)
Low scenario	15 (1.5%)	30 (1.7%)

Source: OD (2012a) and www.npd.no

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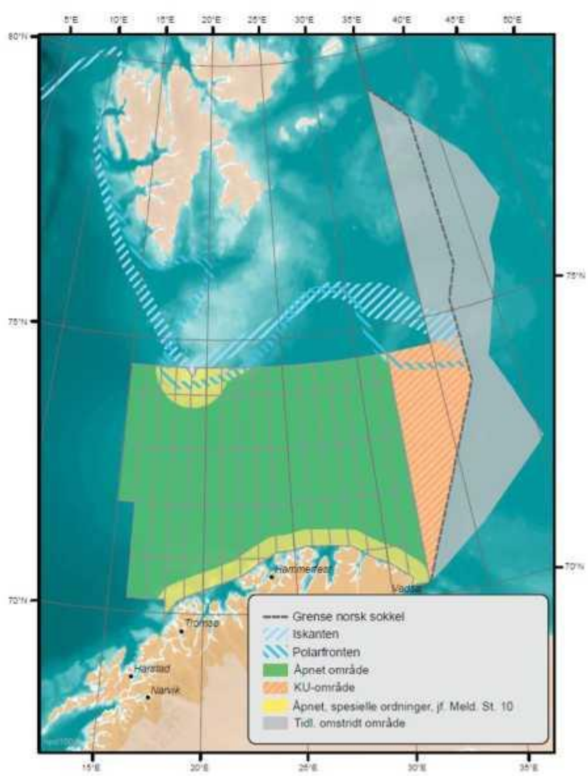
Figure 1. Map of Barents Sea South-East and surrounding areas.



Source: OD (2012a)

Norwegian Shelf border
Marginal ice zone
Polar front
Opened area
IA area
Opened, special arrangements; see Report to Storting no. 10
Previoulsy disputed area

4. Climate costs

In this section we consider the extent to which the Impact Assessment has considered climate costs, and discuss how such costs should have been taken into account. We will first consider CO2 emissions in Norway as a result of petroleum activity in Barents Sea South-East, followed by the effects of such activity on CO2 emissions in other countries.

CO2 emissions in Norway

- Some of the estimates of CO2 emissions in the Impact Assessment are defective.
- The Impact Assessment does not consider the costs of CO2 emissions in Norway.
- CO2 emissions in Norway have a socio-economic cost, which ought therefore to have been included in the Impact Assessment.
- We estimate total CO2 emissions for the period 2027–2050 at around 22 million tonnes in the High scenario and around 4.5 million tonnes in the Low scenario.
- We estimate the present value of the socio-economic costs from CO2 emissions in Norway at around NOK 11 billion in the High scenario and around NOK 2.3 billion in the Low scenario (present value 2017).

While the Impact Assessment (IA) does report some emissions of CO2 from petroleum activity (pp. 60–61), the information about CO2 emissions is nonetheless incomplete. Box 4.1 illustrates how we have estimated total CO2 emissions in the two scenarios, based on the sub-reports and other background information. We estimate total CO2 emissions for the period 2027–2050 at around 22 million tonnes in the High scenario and around 4.5 million in the Low scenario.

Costs relating to CO2 emissions in Norway have not been included in the economic calculations, either in OD's calculations of revenues and expenses,[3] or in the rest of the Impact Assessment. This is despite the fact that CO2 emissions in Norwegian territory have a clear socio-economic cost for Norway. Under international climate agreements such as the Paris Agreement, and agreements with the EU on joint measures to achieve agreed climate targets, CO2 emissions in Norway must be paid for, either directly through measures such as quota purchases or indirectly through the reduction of CO2 emissions from other sources. The Impact Assessment states (p. 60): "The petroleum sector is part of a sector that is subject to quotas, which means that emissions are defined by a number of quotas. Thus the benefits do not affect the volume of emissions in the quota area."[4] While this is correct provided that the collective quota volume is stated in full (which is open to discussion), CO2 emissions in Norway nonetheless represent a cost for Norway.[5]

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[3] Confirmed by the Norwegian Petroleum Directorate by e-mail.

[4] This "quota argument" is also incompatible with the argument that Norwegian gas helps to reduce greenhouse gas emissions in Europe by replacing coal-fired power plants (cf. footnote 16).

[5] There is a relatively high CO2 tax on the Norwegian Shelf, which applies in addition to the quota price. Here one possible interpretation is that the Norwegian authorities deem the socio-economic cost of CO2 emissions from Norwegian oil and gas production to currently be roughly equal to the sum of the CO2 tax and the quota price.

Box 4.1: CO2 emissions in Norway

High scenario:

CO2 emissions from petroleum production in the period 2027–2050 total around 8 million tonnes in the High scenario (in accordance with Figure 4.2 on p. 60 of the IA). CO2 emissions from the LNG facility also need to be taken into account. In the IA these are stated at 570,000 tonnes per year for the period 2043–2050 (p. 60). According to DNV GL, who prepared the emissions data, the fact that the report shows emissions from "2043" rather than from 2027, when gas production starts (in this scenario), must be attributable to a printing error.[6] Regular gas production in the period 2027–2050 will generate a total of 13.7 million tonnes.[7] Shipping traffic also generates some emissions. Taking these into account, total CO2 emissions for the entire period in the High scenario are estimated at around 22 million tonnes.

Low scenario:

No CO2 emissions are stated for the Low scenario in the IA, other than for the max. year, when emissions are half the volume of that in the High scenario (p. 60); however, we have received a similar figure to that in Figure 4.2 from DNV GL. Based on this figure, total emissions of CO2 for the period 2027–2050 in the Low scenario amount to around 3 million tonnes. Shipping traffic also generates some emissions, primarily relating to CNG transport. These are estimated at 55,000 tonnes in the analysis year in the defined area (i.e. Barents Sea South-East). However, the gas also needs to be transported by ship either to the closest gas pipeline or the terminal at Kårstø or Kollsnes for processing, meaning that the relevant increase in CO2 emissions must include transport for the entire distance from the production area to the delivery point. If we, conservatively, assume that the gas will be transported to the Aasta Hansteen field, the northernmost gas field connected by gas pipelines, total CO2 emissions from shipping traffic during the entire period will amount to around 1.5 million tonnes.[8] Total CO2 emissions for the entire period in the Low scenario are then estimated at around 4.5 million tonnes.

Which CO2 price should be used is not totally clear. In Box 4.2 we discuss this point, and conclude by applying a CO2 price equal to USD 100 (2015 rate) per tonne of CO2 in 2030, and assuming that the

[6] See e-mail from DNV GL.

[7] The IA assumes (p. 60) that a similar onshore facility to the one used for the Snøhvit field will be employed, adjusted for differences in production. Gas production in the High scenario is broadly in line with production at Snøhvit in recent years. However, annual CO2 emissions from the LNG facility at Melkøya have amounted to around 1 million tonnes of CO2 since 2010, and are thus significantly higher than the estimated 570,000 tonnes assumed in the IA. We have not been able to satisfactorily explain this discrepancy, which could indicate that CO2 emissions from the LNG facility have been underestimated. If CO2 emissions at the LNG facility were around 1 million tonnes a year, total CO2 emissions over the period would increase by around 10 million tonnes, and CO2 costs by around NOK 5 billion (present value 2017).

[8] This has been confirmed by an e-mail from DNV GL. If the gas is instead transported the entire distance to Kårstø or Kollsnes by CNG vessels, these emissions would increase by a further 2.5 million tonnes of CO2.

CO_2 price will increase in line with the real discount rate (4 per cent) in the relevant period (2027–2050). On this basis, the socio-economic costs from increased CO_2 emissions in Norway as a result of petroleum production in Barents Sea South-East amount to around NOK 11 billion in the High scenario (present value 2017). In the Low scenario the costs are around NOK 2.3 billion (present value 2017).

Box 4.2: Climate costs in Norway

In order to calculate climate costs relating to CO2 emissions in Norway, we must first identify the correct CO2 price (calculation price for CO2 emissions). In 2012 the Hagen Committee presented its report "Cost-Benefit Analysis" (Official Norwegian Report NOU 2012:16). The Committee was appointed by the government with a mandate that included proposing "guidelines for the pricing of greenhouse gas emissions by reference to two alternatives: a carbon price path reflecting the current expectation of the future price in the EU's quota market, and a path that supports the two-degree target to which Norway has signed up." The Committee recommended that the "calculation price" for CO2 emissions be "based on the market's expectations of future quota prices. For the years for which no prices are quoted, over time the price path ought to gravitate towards an expected two-degree path based on internationally recognised model calculations" (p. 15). The Norwegian Ministry of Finance's Circular from 2014 ("Principles and requirements for the preparation of cost–benefit analyses etc.") makes no reference to CO2 prices, and as far as we know the Ministry has not issued any recommendations on CO2 prices following the Hagen Committee's Report. The Norwegian Government Agency for Financial Management's (2014) guideline on cost–benefit analyses also contains no specific recommendations on CO2 prices. Instead we refer to the Hagen Committee (Official Norwegian Report NOU 2012:16) and previous NOUs. The Norwegian Public Roads Administration's (2014) Manual V712 ("Impact Assessments") recommends applying a CO2 price of NOK 930 (2013 rate) per tonne of CO2 for emissions in 2030 (p. 114).

The petroleum sector is part of the EU quota system, meaning that futures prices in the quota market for emissions in the coming years could provide a possible starting point for calculating the socio-economic costs of CO2 emissions; see the Hagen Committee's recommendation. However, the emissions we are talking about here do not start until 2027 and continue until 2050. Futures prices for CO2 emissions so far into the future do not exist. The Hagen Committee's recommendation therefore indicates that it would be more relevant to use two-degree prices.

A two-degree path is a scenario for future global emissions of greenhouse gases in which the temperature of the earth does not rise by more than two degrees compared with pre-industrial levels. There are many ways to calculate such two-degree paths and the CO2 prices required to achieve the two-degree target ("two-degree prices"). The UN's Climate Panel (IPCC, 2014) has presented a number of model analyses for various scenarios. In the "430_480 ppm" scenario, which is consistent with the two-degree target, the median price in 2030 is around USD 90 (2010 rate) per tonne of CO2, while in 2050 it is around USD 220 per tonne of CO2 (p. 31).

In recent years the International Energy Agency (IEA) has outlined a "450 Scenario" in its annual World Energy Outlook (WEO). This scenario has a 50 per cent probability of avoiding a temperature increase of more than two degrees. In IEA (2015) and IEA (2016) CO2 prices in 2030 and 2040 in Europe are estimated at USD 100 and USD 140 respectively (2015 rate) per tonne of CO2 in "450 Scenario" (p. 39).[9] A possible

[9] The Hagen Committee refers to the calculation prices for CO2 emissions in the United Kingdom (from 2011), which differentiate between emissions exempt from and covered by the quota system before, though not beyond, 2030 (p. 137). In 2030 and 2040 the CO2 prices (in the middle alternative) are GBP 74 and GBP 143 respectively per tonne of CO2, i.e. broadly in line with the IPCC's and IEA's two-degree prices.

counterargument to applying a two-degree price is that the probability of a two-degree scenario is limited (see discussion towards the end of section 4), due to the fact that, for various political reasons, the world's nations will not achieve the long-term target that has been agreed. The fact that the two-degree target represents an optimum means that it may nonetheless be relevant to apply two-degree prices, since these could be interpreted as the global marginal cost of CO_2 emissions. The reformulation of the long-term target in the Paris Agreement towards 1.5 degrees is a move in the opposite direction in that it indicates that the marginal cost of CO_2 emissions is even higher than the two-degree prices. IEA/IRENA (2017) presents a scenario ("66% 2 °C Scenario") with a 66 per cent probability of avoiding a temperature increase of more than two degrees – where CO_2 prices in Europe are USD 120 and USD 170 per tonne in 2030 and 2040 respectively.[10]

Based on the above, we assume a CO_2 price of USD 100 (2015 rate) per tonne of CO_2 in 2030, and that the CO_2 price will increase in line with the real discount rate in the relevant period (2027–2050). A real discount rate of 4 per cent (see below) is reasonably consistent with both IPCC's and IEA's estimates, though lower than the estimates in IEA/IRENA's "66% 2 °C Scenario".

Based on this, we believe that the socio-economic costs of increased CO_2 emissions resulting from production of oil and gas in Barents Sea South-East, including the LNG facility and shipping traffic, total around NOK 11 billion in the High scenario (present value 2017). In the Low scenario these costs total around NOK 2.3 billion (present value 2017).

CO_2 emissions abroad

- The Impact Assessment does not discuss or calculate CO_2 emissions abroad.
- It is highly probable that oil production in Barents Sea South-East will result in increased CO_2 emissions abroad.
- We estimate the climate costs relating to CO_2 emissions abroad at around NOK 20 billion in the High scenario and around NOK 7 billion in the Low scenario (present value 2017).

Norwegian oil and gas production generates significant CO_2 emissions when the oil and gas is combusted, whether this takes place in Norway or abroad. Total CO_2 emissions for the entire production period can be estimated at 370 million tonnes in the High scenario and around 100 million tonnes in the Low scenario (subsequently referred to as "direct effect").[11] Between 30 and 40 per cent of these emissions (depending on the scenario) relates to oil production, while the remainder relates to gas production. However, increased Norwegian oil and gas production could displace other fossil energy production, with the result that the net effect of global emissions would be less than the direct effect.

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10 IEA (2016) also discusses a scenario with a 50 per cent probability of avoiding an increase of more than 1.5 degrees. No CO_2 prices are stated for this scenario; however, by around 2040 global demand for both oil and gas will fall by even more than in the "66% 2 °C Scenario".

11 The CO_2 volume is a function of the produced volume of oil and gas. The estimates assume that the oil and gas is combusted, and that the CO_2 gas will not be captured and stored. The bulk of the oil and gas is used for energy purposes, and therefore combusted. However, some oil and gas will be used to manufacture products (for example plastic), in which case CO_2 is not generated until the products are combusted, e.g. in an incineration plant.

It is uncertain whether emissions relating to increased Norwegian gas production will result in higher or lower global emissions; cf. discussion in Box 4.3. Consequently, we have chosen to ignore global emissions relating to gas exports from Barents Sea South-East. Gas competes with coal, which has a higher CO_2 content than gas, but also with renewable (CO_2-free) energy and energy-efficiency measures. No doubt, as the share of coal gradually declines and the renewable share grows, gas will increasingly find itself competing with renewable energy. Petroleum activity in Barents Sea South-East is essentially scheduled to take place a couple of decades into the future. In our opinion it is more probable that gas exports from this activity will increase, rather than reduce, CO_2 emissions abroad.

The situation is different with regard to increased Norwegian oil production. It is fairly certain that Norwegian oil exports will increase global CO_2 emissions. In the vast majority of cases, increasing the supply of a product reduces prices and boosts consumption. There are no grounds to believe that the oil market would be any different in this respect. In the short term neither supply nor demand react significantly to price changes; however, over the longer term (as in this case) both supply and demand will react. Unlike gas, oil does not compete with coal to a great extent. Reduced oil consumption will therefore only marginally increase coal consumption.

Box 4.3: Effects of Norwegian oil and gas exports on emissions abroad

Gas:

It is unclear whether increased Norwegian gas production will lead to higher or lower global emissions (see discussion in Fæhn et al., 2013). On the one hand, gas competes with coal, which has a higher CO_2 content than gas. On the other hand, gas competes with renewable (CO_2-free) energy and energy-efficiency measures. There are grounds to believe that over time gas will gradually increasingly compete with renewable energy. Another relevant consideration is that Norwegian gas is primarily supplied to the European market. Here emissions from power production and industry are subject to the EU's quota market, which it could be claimed reflects total emissions (cf. the quotation from the Impact Assessment referred to at the start of section 3).[12]

Oil:

Few studies have been made of the potential impact of changes in Norwegian oil production on global CO_2 emissions. The only recent study of which we are aware is Fæhn et al. (2013, 2017),[13] which concludes that the net effect of global emissions accounts for around one-third of the direct effect. Although the size of the net effect is somewhat uncertain, Fæhn et al. (2013) concludes that there is "little doubt that the climate effect of reduced oil production is favourable". The study takes into account the fact that emissions per produced unit are lower on the Norwegian Shelf than the global average; however, this means relatively little since less than 5 per cent of emissions over the product's entire lifecycle relate to production.

Few similar studies have been made of the impact of changes in a country's oil

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[12] LNG from the Barents Sea is more flexible than pipeline gas and better suited for transport outside Europe; however, gas from fields such as Snøhvit is primarily sold in Europe. LNG is more expensive to transport than oil.

[13] While Fæhn et al. (2013) is a Norwegian report on both oil and gas, Fæhn et al. (2017) is an article in an international periodical that focuses solely on oil. However, both reports are based on the same study.

production on global CO_2 emissions. One such study was performed by the US Department of the Interior (2016), which analyses the effects of increased future offshore oil and gas production in the USA. The report essentially focuses on CO_2 emissions in the USA, but also cites the effects of global oil consumption as the most important factor influencing changes in global CO_2 emissions (p. 23). The result is broadly similar to in Fæhn et al. Another example is Erickson and Lazarus (2014), which discusses the effects of the Keystone XL oil pipeline in the USA on the oil market and global emissions. These results are also broadly similar to in Fæhn et al.

If we assume that the net effect of global emissions accounts for one-third of the direct effect for oil, this means that petroleum production in Barents Sea South-East will increase global emissions by around 40 million tonnes of CO_2 in the High scenario and by 13 million tonnes in the Low scenario. As already mentioned, these estimates are uncertain, and could be slightly higher or lower.

Whether or not CO_2 emissions abroad (due to Norwegian petroleum production) need to be considered in a cost–benefit analysis for Norway is open to discussion. The same applies to which CO_2 price should be used. The main argument against taking account of such emissions is that Norway is not formally responsible for such emissions under the Convention on Climate Change. Consequently, Norway is not held responsible for emissions abroad as a result of Norwegian petroleum exports, and is also not credited for any emissions reductions abroad due to reduced Norwegian oil production. Another potential counterargument is that countries that import Norwegian oil already have climate policies that satisfactorily regulate CO_2 emissions. It is uncertain whether this will be the case in the relevant period. For example, the countries' objectives under the Paris Agreement are not sufficient to achieve the overall targets of a maximum of 1.5–2 degrees' warming, and some of the targets are flexible.[14]

Nevertheless, there are also many grounds for arguing that emissions abroad should be taken into account. The Norwegian authorities have generally paid significant attention to greenhouse gas emissions abroad. This is illustrated, for example, by their ambitious initiatives to combat deforestation of various countries' rain forests (REDD+) and overfulfilment of the Kyoto Protocol through the purchase of extra emission-reduction quotas in emerging countries (CDM quotas). The Norwegian authorities are also keen to avoid carbon leakage, [15]and have frequently argued that Norwegian gas should be used instead of coal in the EU (thereby reducing emissions abroad).[16]

The Norwegian Government Agency for Financial Management's guidelines on cost–benefit analyses (p. 60) states the following: "In principle, anything that impacts resource consumption or the welfare of

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14 China and India, for instance, have set targets of reducing emissions per GDP of 60–65 per cent and 33–35 per cent respectively in 2030, while the USA has a target of reducing emissions by 26–28 per cent (all compared with 2005).

15 Carbon leakage refers to situations where climate policies in one country result in increased emissions in another. This could, for example, be the case if stringent climate policies in Norway/Europe result in polluting companies relocating abroad. See also Erna Solberg's speech from 2011: http://energmorge.nsp01cp.nhosp.no/bloggen-en-groenn-traad-gronntrad/hoeyre-tar-utfordringen-article8922-598.html and Norwegian Environment Minister Solhjell's statement from 2012: http://www.nettavisen.no/na24/nytt-krisetiltak-for-norsk-industri/3469570.html

16 And, the Office of the Attorney General's reply to Oslo District Court (p. 30), which quotes from Recommendation to the Storting 390 S (2011–12) in connection with the Storting's review of the *Agreement on Climate Policy*: "... Norwegian gas plays an important role in reducing Europe's greenhouse gas emissions by replacing coal-fired power plants".

citizens is included; however, restricted to effects on groups in Norway. In some cases there could also be grounds for including effects on areas or countries outside Norway. It could, for instance, be relevant to include these in analyses of global environmental impacts where Norway has made commitments under international agreements." This could be interpreted as meaning that CO2 emissions abroad as a result of Norwegian petroleum activity should be included in cost–benefit analyses. Apart from this, it is difficult to find clear guidelines on whether emissions abroad due to Norwegian activity should be considered in cost–benefit analyses.

Assuming that emissions abroad are to be included, it would be most appropriate to use two-degree prices in the same way as for Norwegian emissions (for emissions that will be made so far into the future).[17] If we assume the same CO2 price as in the section on emissions in Norway, i.e. USD 100 per tonne of CO2 in 2030 and a CO2 price that increases in line with the real discount rate, the climate cost relating to emissions abroad will equate to NOK 20 billion in the High scenario and NOK 7 billion in the Low scenario (present value 2017).

[17] See discussion in Box 4.2.

5. Errors in the economic assessments

In this section we address errors and misleading assertions in the economic assessments that are expressed in, or which form the basis for, the Impact Assessment. In the previous section we highlighted the fact that the IA does not include any climate costs. In section 7 we discuss the employment effects, and point out errors in the analyses presented in the IA. In this section we review other errors and misleading assertions. Our main conclusion in this section is as follows:

- The Impact Assessment contains a series of errors and misleading assertions.

No present value calculation

- The economic analyses do not contain any present value calculations. Revenues and expenses are not discounted.
- Discounting of revenues and expenses reduces the net cash flow from NOK 280 billion to NOK 109 billion in the High scenario (present value 2007; 4 per cent real discount rate)
- Discounting of revenues and expenses reduces the net cash flow from NOK 50 billion to NOK 19 billion in the Low scenario (present value 2017; 4 per cent real discount rate)
- Adopting more realistic price expectations for oil and gas further reduces the present value to NOK 52 billion (High) and NOK 0.1 billion (Low).

The most serious error in the Impact Assessment is probably the lack of present value calculations in the economic analyses. The Norwegian Petroleum Directorate's background report (2012b) calculates the "gross sales value" and "exploration, investment and operating expenses" for the two scenarios (p. 8). The report states the total gross sales value and total costs for the entire period (2027–2050) in the two scenarios. The "net cash flow" is also stated and defined as "gross sales value less associated costs" (p. 10).

However, the report does not state any present values, nor is there any mention of discounting. The revenues and expenses and thus the net cash flow referred to above must therefore be interpreted as non-discounted.[18]

The figures in the Impact Assessment (OED, 2013) are the same as in OD (2012b), i.e. "gross sales value", "total costs" and "net cash flow" for the entire period (p. 40). There is also no reference to present values or discounting here.

Calculating total revenues and expenses without considering their timing inaccurately portrays the economic consequences of petroleum activity. This makes present value calculations an essential and fundamental element of any economic analysis of long-term projects. A present value calculation is particularly important in this case, where expenses are essentially incurred many years before revenues are received. Revenues in particular are overstated if they are not discounted. In the worst case a positive non-discounted "net cash flow" could actually have a negative present value.

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[18] This is confirmed by a review of the Excel file we received by e-mail from OD, which shows how revenues and expenses have been calculated. OD also confirmed by e-mail that the figures in the Excel file are not discounted.

A key issue in present value calculations is which discount rate should be applied. As stated in the Hagen Committee's mandate (Official Norwegian Report NOU 2012:16 – "Cost-Benefit Analysis", p. 10): "The discount rate level has a significant impact on the profitability of long-term measures." The Hagen Committee recommends applying a real discount rate of 4 per cent: "A real risk-adjusted discount rate of 4 per cent will be reasonable for use in the cost-benefit analysis of an ordinary public measure" (p. 13). This recommendation was followed up by the Ministry of Finance (2014), which in its circular on cost-benefit analyses also recommends using a risk-adjusted discount rate of 4.0 per cent (p. 5).

The Impact Assessment calculates the "net cash flow" as NOK 280 billion in the High scenario and NOK 50 billion in the Low scenario. Applying a 4 per cent discount rate, the present value in 2017 (the first year in which expenses are incurred) is NOK 109 billion and NOK 19 billion respectively.

In addition to the lack of discounting, it is also significant that the Impact Assessment was prepared in 2012–2013, i.e. before the oil price crash in 2014, and was therefore based on relatively high oil and gas prices (see more detailed discussion in the following section). However, the Licensing Decision was adopted in 2016, when the oil price was USD 45 per barrel and the market's price expectations had been significantly lowered.

The question is which price level ought to have been applied when the decision was adopted in 2016. When we requested supporting documentation from OD for their report from 2012 we were sent a copy of the Excel file used by the Directorate to calculate revenues and expenses in the High and Low scenarios. The figures for production and expenses are consistent with OD's report (Norwegian Petroleum Directorate, 2012b), while the price forecasts for oil and gas have been adjusted downwards (see more detailed discussion in following section). We do not know why these calculations were adjusted and are not aware that these figures are disclosed in any publicly available documentation.

In OD's Excel file (including updated price levels) the "net cash flow" is calculated as NOK 167 billion in the High scenario and NOK 21 billion in the Low scenario. Applying a discount rate of 4 per cent, the present value in 2017 of these figures becomes NOK 52 billion and NOK 120 *million* respectively.[19] These amounts are illustrated in Figure 2 as the last two columns to the right under each scenario (note that the present value in the Low scenario is so small that it cannot be seen in the figure). The net cash flow in the Impact Assessment (p. 40), which was based on higher price forecasts, is shown as the second column from the left under each scenario in Figure 2.

This means that the present value of the net cash flow in the High scenario, using OD's estimated revenues and expenses, is 80 per cent lower than the "net cash flow" stated in the Impact Assessment. In the Low scenario the present value of the net cash flow is virtually zero.[20]

It should be noted that these calculations do not include the climate costs discussed in the previous section, or other external impacts of the petroleum activity.

The lack of a present value calculation is a serious error that seriously undermines the economic estimates.

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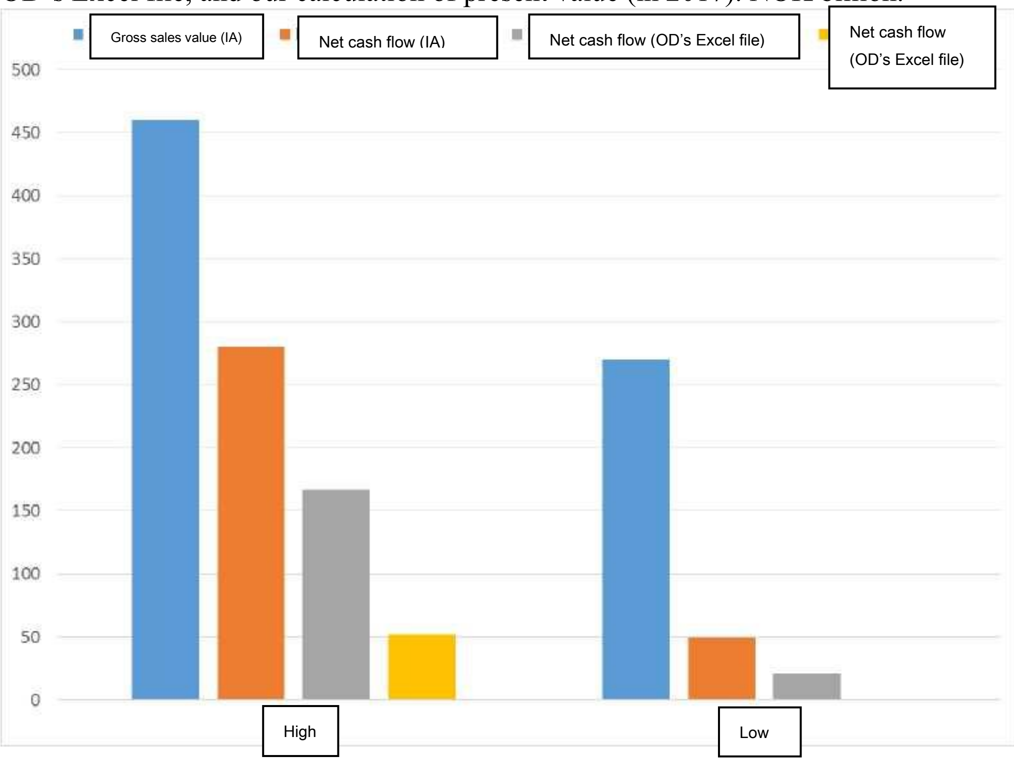
19 A marginally higher discount rate (e.g. 4.1%) would have made the present value in the Low scenario negative.

20 This difference is partly attributable to the present value calculation and partly to the downwardly adjusted price forecasts (see above).

Figure 2. Gross sales value stated in the IA, net cash flow stated in the IA, net cash flow calculated in OD's Excel file, and our calculation of present value (in 2017). NOK billion.



Double-counting of value added effects

- Value added effects have been double-counted in the Impact Assessment

The Impact Assessment refers first to OD's economic calculations, and then to a report from Statistics Norway (SSB, 2012) that calculates the annual impacts on GDP in the two scenarios. Both in the summary (p. 5) and in subsection 3.1 (p. 41) the report claims that value added, estimated at NOK 9.7 billion per annum in the High scenario and NOK 3.4 billion per annum in the Low scenario, "should be included in addition to the sales revenues from oil and gas".

This is incorrect. Summary Table 4.2a in SSB's report (p. 7) clearly shows that a significant proportion of the increase in GDP derives from the increased value added from production. The value added from production, which in the High scenario accounts for NOK 6.3 billion of a total NOK 9.7 billion per annum, primarily relates to sales revenues from oil and gas.[21] Consequently, denoting the increases in GDP of NOK 9.7 billion and NOK 3.4 billion respectively as "in addition to the sales revenues from oil and gas" involves double-counting. The increase in GDP from areas other than production is estimated in Table 4.2a as NOK 2.3 billion in the High scenario and NOK 1.0 billion in the Low scenario, while the increased intermediate consumption in the production industry is NOK 1.1 billion and NOK 0.4 billion respectively.

[21] A note in the table states: "The change in value added (or value creation) in the production industry equates to the sales value of the increased oil and gas production from the relevant activity scenario less the intermediate consumption that is presumed to directly relate to the production." This has also been confirmed by one of the authors of the SSB report.

Here it is also worth mentioning that SSB's model calculations were initially based on the same price forecasts used as a basis for OD's report. As explained above, these forecasts were adjusted significantly downwards following the oil price crash in 2014, meaning that an updated model calculation incorporating the downwardly adjusted oil and gas prices would also have resulted in lower GDP effects.

Incorrect gross sales value in the Low scenario

- The gross sales value is incorrectly stated in the Low scenario

The report from OD (2012b) states the "gross sales value" in the Low scenario at around NOK 270 billion (p. 8), and the same figure is reproduced in the Impact Assessment (p. 5 and p. 40). This figure is incorrect, probably due to an indisputable error in OD's Excel file. The correct figure (given the original price forecasts) is half as high, thus around NOK 135 billion. The correct figure has, however, been used to calculate the "net cash flow".

This error is particularly unfortunate when we consider that the Impact Assessment summary only discusses the "gross sales value" in the two scenarios (there is no mention of costs or net cash flow), and that the incorrect figure is referred to in the Low scenario (p. 5).

Misleading information in the summary

- The summary only discusses revenues, and no costs

As mentioned above, the Impact Assessment summary only states the "gross sales value" in the two scenarios. No reference is made to costs or net cash flow. This is extremely misleading. Here, net revenues (discounted to present value) are clearly the key element. The summary only states the following regarding OD's calculations (p. 5): "Oil and gas resources in the scenarios are assumed to have a gross value of NOK 460 billion in the High scenario and NOK 270 billion in the Low scenario." These are shown in Figure 2 as the left-hand column under each scenario. As mentioned above, the present value of net revenues, applying OD's calculations of expenses and revenues (including the downwardly adjusted price forecasts), is NOK 52 billion and NOK 120 million respectively (see right-hand column in Figure 2). As explained above, the present value is the key amount.

6 Input for economic assessments

In this section we take a closer look at key inputs on which the economic assessments are based, and in particular at prices of oil and gas and cost estimates. We discuss the extent to which uncertainty and risk have been assessed. Finally, we address the importance of the petroleum tax regime, and the extent to which the tax regime ensures that only socio-economically beneficial projects are realised.

Oil and gas prices

- The market's price expectations fell significantly in the period between the preparation of the Impact Assessment and the adoption of the Licensing Decision
- The Impact Assessment did not assess alternative price forecasts
- In an internal Excel file, OD adjusted the price forecasts significantly downwards, although this change is not reflected in any publicly available document

The Petroleum Directorate's background report (OD, 2012b), on which the Impact Assessment (OED, 2013) is based, assumes an oil price of almost USD 120/barrel and a gas price of NOK 2.14/Sm3 for the majority of the period (p. 3). When the OD report and the Impact Assessment were presented, the oil price was above USD 100/barrel and the gas price in Europe was slightly over NOK 2/Sm3. OD states that its report is based on OED's long-term price forecasts (p. 2). Neither OD's report nor the Impact Assessment considered the impact of alternative price forecasts.

In autumn 2014 the oil price fell strongly, and in 2015 the price was USD 55/barrel. In spring 2016, when the Licensing Decision was adopted, the price was USD 45/barrel. By the start of 2017, the price was around USD 55/barrel, while the (nominal) futures price for 2024 was less than USD 60/barrel (as of 1 April 2017). Gas prices in Europe have also fallen since 2014, though not by as much as the oil price. In other words, there is little doubt that the market's price expectations were significantly lowered in the period between the preparation of the Impact Assessment and the adoption of the Licensing Decision.

As mentioned in section 5, we have received an Excel file from OD that calculates the economic revenues and expenses from petroleum activity in the Barents Sea at a later date than the Impact Assessment, although it is not clear in which context these calculations were performed. The oil and gas prices used in this file differ from the prices on which the Impact Assessment was based. The Excel file assumes an oil price of USD 70/barrel, a USD–NOK exchange rate of 6.2 and a gas price of NOK 1.91/Sm3.[22]

The price forecasts in the Excel file (measured in NOK) are broadly on a par with the prices in the first half of 2016, when the Licensing Decision was adopted (the higher USD–NOK rate compensates for a lower oil price). Significant uncertainty surrounds forecasting oil and gas prices so far into the future. While, as mentioned, futures prices for oil remain below USD 60/barrel until 2024, IEA (2016) expects to see a gradual increase in the oil price moving forward. The same applies to the gas price, where IEA is more optimistic than the futures prices would appear to be. At the same time it is worth remembering

[22] The Excel file states the oil price in NOK, not USD, while in its e-mail OD states that the oil price used was around USD 70/barrel, and that the USD–NOK rate was 6.2. OD is uncertain when the price forecasts in the Excel file were changed; however, the USD–NOK rate would suggest sometime in the second half of 2014.

that the price of gas shipped from Finnmark will be lower than the price in Europe (due to the cost of transporting gas to the market). In overall terms it could be claimed that the downwardly adjusted price forecasts in OD's Excel file are not unreasonable; however, significant uncertainty attaches to such forecasts, as the fall in the oil price in 2014 illustrates. In this light, it is striking that the impact of alternative price forecasts was not considered (see next section).

Uncertainty and risk

- The Impact Assessment does not discuss economic uncertainty or risk
- With the exception of two scenarios relating to the number of oil and gas finds, the economic calculations do not assess alternative assumptions

As mentioned above, the report does not present any calculations based on alternative price forecasts. The same applies to production volumes and costs, apart from the fact that two alternative scenarios are presented relating to differing activity levels as a result of the finds that are made (High and Low scenarios). The probability of these two scenarios is not assessed.[23] The Impact Assessment also fails to discuss economic uncertainty or risk. However, risk relating to potential accidents and local environmental impacts is examined in some detail.

Bearing in mind that the Impact Assessment relates to activity that will take place as far into the future as 2050, it is surprising that no alternative future price scenarios are discussed for the oil and gas market, including the effect of future international climate policy and its influence on oil and gas prices over the long term. Mohn (2017) discusses the potential value of the petroleum resources in Lofoten/Vesterålen/Senja, and studies the impact of a 33.3 per cent increase or decrease in oil and gas prices against the reference outcome, and finds the effect of such a price change on net present value to be extremely high. Historically oil and gas prices have fluctuated significantly over time, as recently evidenced by the oil price crash in 2014. A number of factors would appear to point to increased price risk moving forward, in particular on the demand side. Such factors include future international climate policy and competition from renewable energy. Fossil energy has dominated the energy market for many decades. While the vast majority of people expect to see a gradual transition from fossil to renewable energy in the future, there is major disagreement as to how quickly this will transpire.

It would also seem logical to discuss uncertainty surrounding production costs for oil and gas in Barents Sea South-East. The fact that there have been several examples of significant cost-overruns, including at the only two oil and gas fields operational in the Barents Sea to date (Snøhvit and Goliat), would suggest that the uncertainty surrounding cost estimates ought to have been examined. Lorentzen et al. (2017) studied 158 projects on the Norwegian Shelf in the period 1970–2013. While some projects were completed with lower-than-estimated costs, most came in with higher costs. The average cost overrun for the period as a whole was 36 per cent. Over the last ten-year period (2003–2013) the overruns have been slightly lower, but remain at an average of 25 per cent. One potential explanation for this is that changes are made to projects once they have started; however, Lorentzen et al. also highlights skewed optimism and strategic reporting as potential explanations of why actual costs are systematically higher than estimates (on average). It is also worth pointing out that the calculations do not include asset

[23] Confirmed by e-mail from OD.

retirement expenses. These will normally be significant and ought to have been included.[24]

Investments in petroleum production are long-term in nature. A closer examination of OD's Low scenario, for example, shows that exploration activities are scheduled for the period 2017–2025. These are accompanied/followed by significant investment expenditure between 2023 and 2029. The projects do not generate revenues until the period 2029–2042. Oil and gas prices have historically fluctuated significantly. Consequently, actual prices can quickly become significantly higher or lower than the prices on which investment decisions are made. If, for example, oil and gas prices should unexpectedly drop around 2030 in the same way as in 2014, this would probably result in major financial losses, both for the oil companies and, above all, for the Norwegian state, which holds an around 80 per cent stake in the activity. A similar scenario is outlined in IEA/IRENA (2017), which investigates the effects of a sudden shift in global climate policy around 2025. This would result in significantly lower oil and gas prices than expected, and the authors conclude that such a scenario could result in "stranded" global oil and gas investment assets totalling USD 1,300 billion (p. 112). While the companies are naturally expected to assess this type of risk, it is also reasonable to expect the Norwegian authorities to actively evaluate risk given the state's overriding financial interest in the outcome. It should not be assumed that the state's and the companies' risk profiles are identical.

During the review the Norwegian Climate and Pollution Agency (Klif) criticised the OED for overseeing "... an unnecessarily rushed review process, with the majority of the background inquiries starting in summer 2012, and the final report scheduled for autumn. It ought to have been possible to set aside more time to prepare a professionally thought-out basis."

The tax regime

- The petroleum tax regime is "investment-friendly", which means that projects that are not beneficial from a socio-economic perspective may still be commercially profitable.
- The petroleum tax regime can incentivise investments on the Norwegian Shelf ahead of on the mainland.

The Impact Assessment does not discuss the petroleum tax regime, despite the fact that this is of relevance to an assessment of the opening of Barents Sea South-East for petroleum activity and the Licensing Decision.

The petroleum tax regime is based on the premise that petroleum resources are an asset owned by the Norwegian people. Since petroleum typically generates extraordinary revenues from the exploitation of a limited resource, petroleum production is subject to a significant special tax. In order to stop the high special tax from preventing socio-economic investments being realised, the state has also introduced a special deduction intended to ensure that (only) projects that are beneficial from a socio-economic perspective are also commercially profitable for companies ("neutral tax system").

There has been some disagreement as to the appropriate scope of these special deductions, which have varied somewhat over time. According to the Ministry of Finance (2016) the current deduction rules for

[24] While the future scope of these is uncertain, by way of illustration Statoil (2017), in its annual report for 2016 (p. 162), recognises provisions for "asset retirement obligations" of almost USD 11 billion at the year-end.

the petroleum tax regime resulted in tax expenditure of NOK 14.4 billion in 2016 (p. 322).[25] In 2015 tax expenditure amounted to NOK 16.7 billion. This is due to the fact that "the total deduction value is higher than it would have been under a neutral tax system." The higher the deductions, the more profitable it becomes for the companies to invest. The significant tax expenditure therefore reflects the fact that the petroleum tax regime stimulates more investments in the petroleum sector than would have been made under a neutral tax system. In other words, the tax regime can result in development projects that are not profitable from a socio-economic perspective (even without considering environmental impacts) being deemed to be commercially profitable by the companies and thus realised.

Finance Minister Siv Jensen confirmed this in an article for Norwegian newspaper Klassekampen published on 21 January 2017: "The petroleum tax is investment-friendly, and the value of the investment deductions is higher than under a fully neutral petroleum tax. This has been clearly communicated by changing governments since the Petroleum Committee's review in 2000." The Ministry of Finance (2013) also stated that "there will continue to be an investment-friendly tax regime on the Norwegian Shelf" following the change that was made in 2013 (p. 14).

The award of licences in Barents Sea South-East could thus result in companies deeming it profitable to develop oil and gas fields that are unprofitable from a socio-economic perspective (even if environmental impacts are ignored in the cost–benefit analysis). This is illustrated in Box 6.1, which also shows that activity in a Low scenario would be profitable from a private-economic perspective under the petroleum tax regime, but not under the mainland tax regime. The oil and gas prices required to make a project profitable from a private-economic perspective under the petroleum tax regime are significantly lower than under the mainland tax regime (for identical projects).

Box 6.1 Comparison of private-economic and socio-economic profitability

Our starting point is OD's calculations for development of Barents Sea South-East under the Low scenario.
Total investments under this scenario have a present value of NOK 44 billion in 2017. Revenues from the sale of oil and gas do not arise until 2029, after 12 years of exploration, followed by phased-in production and transport investments. The oil companies can immediately deduct these investments from the revenues they generate from other areas of the Norwegian Shelf. To be more precise, exploration costs can be expensed in the same year they are incurred, while one-sixth of other investments can be deducted over a period of six years. In addition, a deduction amounting to 5.4 per cent of the investment amount is given in petroleum tax over four years.[26] As demonstrated by Diderik Lund (2012), these favourable amortisation rules can result in petroleum companies realising petroleum activity that is not beneficial from a socio-economic perspective. This also applies to the development of Barents Sea South-East, as shown in the table below:

[25] According to the Ministry of Finance (2016) the tax expenditure "is regarded as permanent income from the tax asset".
[26] Alternatively, the tax deductions can be utilised in later years. In such cases the deductions attract interest in order to ensure that companies in a non-tax-paying position are not worse off than companies that are in a tax-paying situation.

Table 2. Socio-economic surplus and private-economic profit under different tax regimes, based on different price estimates. Low scenario

	Socio-economic surplus (excl. CO2 and asset retirement costs)	Private-economic profit under the petroleum tax regime	Private-economic profit under the mainland tax regime
OD's prices	MNOK 123	MNOK 2,895	MNOK -1,254.
0.2 per cent lower oil and gas prices	0	MNOK 2,868	MNOK -1,348.
26 per cent lower oil and gas prices	MNOK -13,050.	0	MNOK -11,266.
3.2 per cent higher oil and gas prices	MNOK -1,773.	MNOK -3,258.	0

Based on OD's assumptions for oil and gas prices, development in accordance with the Low scenario generates a socio-economic surplus of NOK 123 million (before CO2 costs, asset retirement costs and other non-valued effects). However, the private-economic profit is significantly higher at NOK 2.9 billion.[27] The development would not have been realised if the oil companies were subject to the same tax regime as businesses on the mainland, as the net present value in this case is NOK -1.3 billion.[28] In the event of a marginal (0.2 per cent) fall in prices, activity in the Low scenario ceases to be profitable from a socio-economic perspective. As the figures show, the project remains profitable from a private-economic perspective. As the penultimate row in the table illustrates, oil and gas prices would have to fall by as much as 26 per cent before private-economic profitability reaches zero.

The petroleum tax regime also incentivises investments on the Norwegian Shelf ahead of on the mainland. In the far right-hand column, we see that the oil and gas prices would have to rise by 3.2 per cent before Barents Sea South-East becomes profitable from a private-economic perspective under the ordinary tax regime. There is thus a significant interval for oil and gas prices in which the Low scenario is profitable from a private-economic perspective under the petroleum tax regime, but unprofitable under the ordinary tax scheme on the mainland.

Finally, the choice of discount rate for private investments on the Norwegian Shelf has been the subject of much discussion; see Lund (2012). We have therefore performed a sensitivity analysis in this area. If we adhere to OD's oil and gas prices, but increase the nominal discount rate from 6.1 per cent to 10 per cent (see footnote 27), the Low scenario becomes zero under the petroleum tax regime, while the loss under the mainland tax regime is NOK

[27] We assume an inflation rate of 2 per cent, and a real discount rate of 4 per cent. This results in a nominal discount rate of 6.1 per cent. We also assume that the oil companies will loan-finance the investments at the same interest rate (however, no more than 50 per cent of the investment's tax-written-down value at any one time, as permitted by the regulations).

[28] We apply a reducing-balance amortisation rate of 10 per cent. An increase of 20 per cent does not change the sign of the net present value under the mainland tax regime. We further assume that the loan-financing comprises 50 per cent of the investments' recognised tax-written-down value at any one time.

6.9 billion. In other words, the Norwegian tax regime favours petroleum investments, even when discount rates are higher.

7. Brief outline of the employment effects of petroleum activity in Barents Sea South-East

In this section we discuss the employment effects of petroleum activity in Barents Sea South-East, both in Norway as a whole and in particular in Finnmark. We also discuss how much weighting should be given to employment effects.

- The figures for the employment effect appear to be overstated. This is especially true of Pöyry's background report.
- The regional employment effects appear to be gross figures, i.e. they do not take account of the fact that many workers who gain employment due to development in Barents Sea South-East would have been otherwise employed if the development had not gone ahead.
- The Impact Assessment's version of SSB's report on employment effects is inaccurate, and gives the impression that employment effects are higher than in the background report.

The employment effects of petroleum activity in Barents Sea South-East are discussed in pages 41–47 of the Impact Assessment. OED's assessment is based on two reports: Pöyry (2012) studied the regional employment effects, while SSB's research division analysed the national employment effects (SSB, 2012). The two reports draw very different conclusions. Both reports start with the Petroleum Directorate's Low and High scenarios.

Gross and net employment effects

It is important to differentiate between the gross and net employment effects of a decision. By gross employment effects we mean all full-time equivalent positions created in one way or another by exploration, development and production in Barents Sea South-East. Not all these full-time equivalent positions are additional, i.e. a significant percentage of the people who fill these positions would have found other employment opportunities even if no petroleum activity had taken place in Barents Sea South-East.

We believe the Impact Assessment intends to establish the number of additional full-time equivalent positions or the net effect on employment of petroleum activity in Barents Sea South-East. However, we suspect that Pöyry's figures are stated gross. The fact that Pöyry identifies significantly higher employment effects than SSB supports this assertion. In Box 7.1 we explain SSB's and Pöyry's methods. Put briefly, Pöyry appears to assume that all activity triggered by the Barents Sea South-East development will be new activity – in other words, that anyone who works on the development would have been unemployed had the development not taken place, and that all products and services that were purchased for the development would not have been delivered to other activities. This is far from accepted professional practice for economic forecasts.

This mixture of gross and net figures for employment is evident once again when Pöyry concludes by examining the employment effects in the municipalities. Once again the authors only look at how many extra jobs they assume that the municipalities expect to create as a result of increased revenues and local settlement. As far as we understand, the report ignores the fact that many of these employees will come from the private sector, and will not necessarily be replaced by their former employers.

Box 7.1 Methods for calculating employment effects

SSB and Pöyry apply different methods. SSB’s method is based on a macroeconomic model in which oil investments are included as a variable. The oil investments are determined directly by the model user, which makes it possible to compare the outcomes for the Norwegian economy including and excluding the extra investments as a result of development in Barents Sea South-East. The model is based on SSB’s statistics for the Norwegian economy, in which the network of deliveries between different sectors and industries is explicitly modelled. This makes it possible to demonstrate how investment in a sector increases activities along the entire value chain all the way to the end product, in this case increased oil and gas production. One of the findings was that the increase in employment for Norway as a whole is significantly less than the direct employment effect of the development in Barents Sea South-East. This is attributable to the fact that people who work in exploration, development and production in Barents Sea South-East would have found alternative employment if the development had never gone ahead. The fact that the development nonetheless generates weak net growth in employment is attributable to the fact that unemployment falls slightly in the short term, and that slightly fewer people are totally excluded from the employment market.

Pöyry’s method combines two models: an in-house demand model and a macroeconomic model at the Norwegian University of Science and Technology (NTNU). Pöyry’s demand model also attempts to calculate the total demand impact of an investment, in many ways in the same way as in SSB’s model, although without covering the whole economy. Consequently, as far as we can discern, Pöyry is not able to judge to what extent a company that delivers to the Barents Sea South-East development would have delivered to another project had there been no demand from Barents Sea South-East. Increased demand from the Barents Sea South-East development will increase prices in the markets for supplier services, which in turn will reduce demand from other organisations. As long as Pöyry’s demand model does not include such effects, it will report a gross impact for demand.

In the next stage Pöyry combines its input-output model with NTNU’s macroeconomic model NAM. The purpose of this is to highlight the impacts on GDP in Norway as a whole while incorporating “macroeconomic multiplier effects”, i.e. the fact that increased overall demand will result in increased activity, which in turn leads to increased revenues, which in turn increase demand etc. NAM is a significantly simpler model than SSB’s model, and Pöyry therefore assumes that the overall demand impacts identified by its demand model are identical with a corresponding increase in public expenditure. In our opinion this vastly overstates the employment effect. The net, not gross, demand impact of Barents Sea South-East should have been input into NAM as an increase in public expenditure. As already outlined, the net impact will be much more moderate since the deliveries to Barents Sea South-East would have had to displace other deliveries to the Norwegian economy (as in SSB's model). Finally the impacts on GDP in Norway are allocated by delivery to counties in Norway based on Pöyry's input-output model. The same process is applied for employment effects.

Inaccurate representation of employment figures

In our opinion OED's discussion of SSB's analysis is inaccurate. The results of SSB's analysis are presented in Table 3.6 of the Impact Assessment (page 46) as follows:

Table 3. Employment effects of petroleum activity under the two scenarios. SSB's calculations as presented in the IA.

	Total 2017–2045		Average per year	
	Low activity	High activity	Low activity	High activity
Total effects				
Number of people employed	15,500	35,800	500	1,200
Number of people unemployed	-2,800	-6,700	-100	-200

Source: Table 3.6 of the IA

In columns 2 and 3, OD combines the figures for each individual year so that the table suggests that 35,800 more people will be employed and 6,700 fewer people unemployed as a result of the decision. In our opinion this gives a false impression. The increase in the number of employed in a year is the increase *compared with the number of people employed in the same year if the decision had not been adopted.* The same applies to the number of unemployed. Imagine that in 2023 some 2,800 more jobs are created as a result of the Barents Sea South-East development. If in 2024 we find that employment is still 2,800 higher, this does not mean that 2,800 further jobs have been created on top of the 2,800 jobs created the previous year. What it does mean is that 2,800 more people are still employed than were before the development. A more accurate description of the figures in columns 2 and 3 would have been "total impact on number of full-time equivalents".

SSB presents its figures in the following way, differentiating between the exploration, development and production phases:

Table 4. SSB's calculation of employment effects.

	Years of high (low) activity	High activity	Low activity
Exploration phase	2017–2022	400	200
Development phase	2023–2031(29)	2,800	1,600
Production phase	2032(30)–2045	600	200

Source: Tables 4.2b and 4.2c, in SSB (2012).

In our opinion SSB's figures show that any development in Barents Sea South-East will have an extremely small impact on employment in Norway, since more than 2.6 million people were employed in Norway in 2016.

SSB notes the following further changes in unemployment:

Table 5. SSB's calculation of changes in unemployment figures.

	Years of high (low) activity	High activity	Low activity
Exploration phase	2017–2022	-100	-100
Development phase	2023–2031(29)	-1,000	-600
Production phase	2032(30)–2045	+200	+100

Source: Tables 4.2b and 4.2c, in SSB (2012**).**

We find that unemployment rises again after 2032. Based on SSB's figures, a maximum of 2,800 more people are employed per year, and only for the period 2023–2031. Subsequently the number of extra jobs falls, which means that some people once again become unemployed.

SSB's figures could be somewhat overstated

We have fewer objections to SSB's analysis. SSB assumes that everything apart from the Barents Sea South-East development will carry on exactly as before. However, if Barents Sea South-East is developed, it seems reasonable to assume that this will impact other areas of the Norwegian Shelf. It is, for example, conceivable that Barents Sea South-East will displace marginal tail production projects in existing Norwegian fields. It is difficult for SSB to include such impacts in its model as long as the model user determines the petroleum investments. Irrespective of this, it is conceivable that SSB's employment figures could be slightly overstated even though they are already very moderate. This criticism also applies to Pöyry's analysis, which also fails to consider that demand from other parts of the Norwegian Shelf could be reduced.

Furthermore, the oil market is global while the gas market is regional. It would be normal to assume that some Norwegian petroleum production will be displaced by foreign production (see Fæhn et al., 2016). Consequently, it follows that if Barents Sea South-East is developed, fewer oil and gas fields will be developed abroad. These developments could be expected to demand services from the Norwegian supplier industry, which is already extensively export-based. Lower exports would reduce employment in SSB's model. Neither SSB's nor Pöyry's analyses take account of such impacts.

It is also worth noting that both the macroeconomic models used are Keynsian models, in which all increases in overall demand increase employment. As the SSB report mentions, in other words the authorities could achieve exactly the same net increase in employment as from the development of Barents Sea South-East using conventional financial policy. If the authorities have a target for employment and reduce their use of demand-stimulating policy in line with the phasing in of Barents Sea South-East, the decision will not impact overall employment levels at all.

Other elements

It is not standard practice to present employment effects as a positive ripple effect of a public measure in a cost–benefit analysis. In fact on the contrary, the employment effects will be part of the project costs, and, all other things remaining unchanged, will make projects less profitable the larger they become. The most recent guidelines for public-sector cost–benefit analyses issued by the Norwegian Government Agency for Financial Management (2014) make no mention at all of employment effects. However, in previous guidelines the principle that employment comprises a project cost could be deviated from if the measure was specifically aimed at the unemployed or at delineated geographic areas with particularly high unemployment (Ministry of Finance, Official Norwegian Report NOU 1998:16). Development of Barents Sea South-East could not be claimed to specifically target the unemployed. Furthermore, unemployment in Finnmark has not been particularly high compared with the Norwegian average. According to NAV, in 2015 unemployment was at 3.4 per cent in Finnmark and 3.0 per cent for Norway as a whole.[29] Unemployment was higher in Aust-Agder, Vest-Agder and Oslo. The level of unemployment in Finnmark had dropped to 3.0 per cent in December 2016, but was higher than this in many as six counties. This suggests that the employment effects in the Impact Assessment should be regarded as purely descriptive, and not be assigned a positive value supporting or not supporting project implementation.

Pöyry highlights increased local settlement and activity in the Finnmark housing market as further ripple effects. These impacts would also result from increased employment, and therefore as far as we can see will be lower than described in Pöyry's report, as in our view the employment effects are overstated.

[29] **https://www.nav.no/no/NAV+og+samfunn/Statistikk/Arbeidssokere+og+stillinger+-+statistikk/Helt+ledige (Norwegian)**

8. Non-valued effects

In this section we briefly discuss environmental impacts of petroleum activity in Barents Sea South-East other than greenhouse gas emissions, based on the discussion in the Impact Assessment.

- Petroleum activity in Barents Sea South-East would have to be expected to generate a significant socio-economic surplus to justify non-valued negative environmental impacts.

The Impact Assessment finds the environmental impacts in normal operation to be small. Emissions will be made to air and water; however, the Impact Assessment states that the general technical consensus is that these would have an insignificant impact on the natural environment. This is not the case with acute emissions. Here, the environmental consequences for sea birds and other wildlife could be significant, in particular if the emissions reach the marginal ice zone or land before they are captured. Acute emissions could also adversely impact fish stocks in the Barents Sea. A cost–benefit analysis should weigh such impacts against the monetised socio-economic surplus from the project.

Some Norwegian studies have attempted to value the negative impacts of acute oil discharges. For example, Lindhjem, Magnussen and Navrud (2014) values the average propensity of the general public to pay to avoid oil emissions that reach the coast at NOK 1,000 – NOK 2,400 per household per year for ten years. In 2016 there were just over 2,300,000 households in Norway. The overall propensity to pay to avoid an oil emission could thus amount to somewhere between NOK 20 billion and NOK 46 billion (present value). Even though the Impact Assessment deems the probability of an acute emission to be low, in our opinion petroleum activity in Barents Sea South-East would have to be expected to generate a significant socio-economic surplus at national level to justify the non-valued negative environmental impacts.

9. Summary

In this section we provide a brief summary of key socio-economic benefits and costs of petroleum activity in Barents Sea South-East. The summary is based on the areas discussed in the previous sections, and generally on the same assumptions applied in the Impact Assessment. Finally, we discuss the extent to which the Impact Assessment and sub-reports provide a reasonable economic basis for adopting the Licensing Decision and for the opening of the 23rd Licensing Round.

As mentioned in section 5, discounting revenues and expenses reduces the net cash flow from NOK 280 billion to NOK 109 billion in the High scenario and from NOK 50 billion to NOK 19 billion in the Low scenario (present value). Furthermore, more realistic price expectations for oil and gas further reduce the present value to NOK 52 billion in the High scenario and NOK 0.1 billion in the Low scenario; see Table 6. This is before costs of CO2 emissions are taken into account. When we deduct the costs of CO2 emissions in Norway, the present value becomes NOK 41 billion and NOK -2 billion respectively. If we also deduct estimated costs of CO2 emissions abroad, the present value becomes NOK 21 billion and NOK -9 billion respectively. The latter estimates are uncertain and could be higher or lower. The estimates do not include other external impacts. These are discussed, but not priced, in the Impact Assessment.

Table 6. Present value (in 2017) of petroleum activity in Barents Sea South-East excluding and including CO2 costs. NOK billion

	High scenario	Low scenario
Present value excluding CO2 costs	**52**	**0.1**
Costs of CO2 emissions in Norway	-11	-2.3
Present value including CO2 emissions in Norway	**41**	**-2.2**
Costs of CO2 emissions abroad	-25	-7
Present value including CO2 emissions in Norway and abroad	**21**	**-9.2**

The Petroleum Directorate's calculations, combined with the costs of CO2 emissions, indicate that petroleum activity in Barents Sea South-East will have a limited or negative socio-economic value. In the Low scenario the socio-economic value is negative even when we ignore increased emissions abroad and only consider a small percentage of the costs of CO2 emissions in Norway. In the High scenario the socio-economic value is positive before we consider external costs other than CO2 emissions. In both cases significant uncertainty attaches to the estimates.

Under the "investment-friendly" petroleum tax regime the Licensing Decision could result in companies deeming it commercially profitable to invest even if the socio-economic value is negative. In addition to the petroleum tax regime being more investment-friendly than the mainland tax regime, we can also not expect the companies to consider external costs relating to their activity. Costs of a company's own CO2 emissions will probably be internalised, though not necessarily costs of CO2 emissions abroad. This depends on future changes in the global climate regime. As far as we can see, other external costs relating to emissions and the risk of accidents and to fish resources are not fully internalised.

In our opinion, the Impact Assessment and sub-reports do not provide an adequately thought-out basis for adopting the Licensing Decision and for the opening of the 23rd Licensing Round.

We justify this on three grounds:

I. The survey contains many errors and defects, some serious. These include the lack of a present value analysis and the fact that costs of CO_2 emissions from the activity are not considered and that employment effects are overstated. All the errors and defects we have found are likely to overstate profits or understate costs.

II. Petroleum activity in Barents Sea South-East entails a number of non-valued environmental impacts that will not be adequately considered by private oil companies. This applies, for example, to the environmental impact of uncontrolled emissions, and the climate effect of a highly probable increase in global petroleum consumption.

III. The petroleum tax regime is structured in such a way that may encourage private organisations to implement investments that are not beneficial from a socio-economic perspective. Furthermore, the petroleum tax regime could provide major incentives for some investments in the Norwegian Shelf ahead of on the mainland.

Consequently, in our opinion a complete cost–benefit analysis should be performed to reveal the extent to which the petroleum activity could be expected to be beneficial from a socio-economic perspective. Such an analysis should include an assessment of future greenhouse gas costs, oil and gas price risk, the risk of cost overruns, and an assessment of the probabilities of a High and Low scenario. The cost–benefit analysis should also include a more comprehensive review of other impacts, such as the costs of any accidents and changed emissions in other countries as a result of Norwegian petroleum activity. How to prevent socio-economically unprofitable projects being realised in areas that have been opened for petroleum activity should also be considered.

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