5. Future production of petroleum in the Arctic under alternative oil prices

Lars Lindholt and Solveig Glomsrød

The Arctic is one of the world's most important petroleum provinces. Obviously, the petroleum resources are important to the Arctic countries and regions as sources of income and resource rent. However, the importance of the Arctic petroleum goes beyond the regional and national economies. Large net-importers of petroleum like the US and the EU look to the Arctic for petroleum to relief stress from dependence on a very limited range of suppliers. However, petroleum production in the Arctic is facing harsh conditions and high costs compared with other producing provinces. Moreover, the challenges will be even higher in the future, as production increasingly takes place offshore and in more remote areas lacking infrastructure for transportation.

The global demand for oil and gas increased considerably until recently as a response to rapid economic growth in population rich countries like China and India. Supply seemed to be be unable to meet demand, facing capacity constraints in oil producing countries outside OPEC and surging maintenance and investments costs associated with the long upswing in the global economy. The IEA Upstream Investment Cost Index doubled from 2000 to 2008[1]. Exploration and investments had lagged behind due to a relatively low oil price in previous years and contributed to the high oil price from 2006 onwards. From July 2008 the oil price fell drastically and the financial crisis and economic downturn brought considerable uncertainty as to future levels of demand as well as supply over the next few years. The generally high cost of petroleum production under harsh Arctic conditions makes the region particularly vulnerable to falling oil prices. However, production activity in areas with available infrastructure like the North Slope of Alaska and West Siberia and Pechora Sea in Russia are less vulnerable.

Family Fishing in Tyonek – A father teaches his sons to pick fish nets outside Tyonek in West Cook Inlet. Although a sometimes tenuous relationship, the oil and gas industry has provided jobs and income to residents of Tyonek for over 50 years. Photo: Davin Holen

The International Energy Agency assumes that the oil price will not stay low for a long time. The IEA World Energy Outlook[2] argues that the oil price will tend to rise again in the near future and average 100 USD per barrel in real 2007-dollars over the period 2008-2015 and further to rise in a broadly linear manner to USD 122 in 2030. IEA adds, however, that rarely has the outlook for oil prices been more uncertain than during fall 2008.

Climate policies are also expected to affect the petroleum industry. In line with The Kyoto Protocol, Annex B countries have committed themselves to reduce emission for the period 2008-2012 compared with the base year 1990. A future agreement on emission reductions is not expected to be in place before the Conference of the Parties of the Kyoto Protocol meet in Copenhagen in 2009 at the earliest. However, the global warming perspectives point to strict future emission control and costly cleaning technologies. Irrespective of policy measures used, the cost of consuming fossil energy will increase and is likely to cause a decline in demand relative to a business as usual scenario. This might

particularly affect high cost regions like the Arctic and adds another reason to develop scenarios for petroleum production in the Arctic.

However, scenarios for petroleum production in the Arctic are important not only to see how petroleum can contribute to income of Arctic countries and to the world's consumption of energy. Petroleum exploration, production and transportation cause considerable emissions to air and are important variables in regional Arctic emission inventories of greenhouse gases being used in climate scenarios. The geographic location of emissions of carbon dioxide (CO_2) has no impact on the warming potential. For particles (black soot) on the other hand, the location of the emissions is important. Black soot from fuel combustion is deposited on snow and ice and reduces the albedo effect, i.e. the capacity of the earth's surface to reflect heat radiation and thus mitigate global warming.

The West Arctic regions are particularly important to the private international oil companies. In these regions the oil companies can buy licenses and thus get access to the petroleum reserves. Globally, the state owned so-called National Oil Companies (NOC) now control the majority of the petroleum reserves, and service contracts rather than reserves are increasingly offered the international companies in many provinces.

Increasingly larger areas that formally were reindeer pastures become detoriorated by oil prospecting and production activities. Varandey area, Nenets Autonomous Okrug. Photo: Yasavey

The petroleum sector is also important to the Arctic region as a source of employment and income, and indirectly as a source of transfers from the Arctic countries to the Arctic sub-regions. The Arctic regions of Russia and Alaska have economies that rely particularly heavily on petroleum. Although the resource rent may to a large extent be transferred out of the regions, there is no doubt that the petroleum activity leaves a marked footprint in the producing regions, through supply chains, taxes and transfers.

Table 5.1. **Estimates of undiscovered oil and gas. USGS2008 vs. USGS2000. Btoe**

Arctic Canada	+ 29
Alaska	+ 31
Greenland	- 33
Arctic Russia	+ 9

Petroleum reserves in the Arctic

Whereas proven reserves are fully identified and economically viable resources, the so-called undiscovered resources are estimated based on geological data and criteria. There is large uncertainty associated with resource estimates in the Arctic, where a substantial share of the resources are under sea and ice, and exploration drilling consequently is costly. During recent years a few comprehensive assessments have been carried out with somewhat different results.

Wood Mackenzie assessed the undiscovered reserves in the Arctic regions and questioned the high importance of the Arctic as one of the last great oil and gas frontiers[3]. For oil, the study concluded that estimated undiscovered resources were only a quarter of earlier estimates made by USGS 2000 for North America and Greenland. However, the estimates for natural gas in West Arctic regions were raised compared with USGS 2000 assessment. The West Arctic region would, according to the assessment, in the most likely scenario peak about 20 years from now at 8 million barrels of oil equivalents per day (boe/d) with 40 percent oil and 60 percent gas. A higher share of gas would mainly consist of remote gas too expensive to transport to markets. According to the Wood Mackenzie assessment, undiscovered reserves are mainly located in either ice-free or seasonal ice-free areas, which require modifications of technology only – not new solutions. Subsea drilling will be used for the greater share of the resources.

In 2008, the USGS completed a Circum-Arctic Resource Appraisal (CARA), which assessed the undiscovered petroleum resources north of the Arctic Circle[4]. The study was limited to areas expected to have more than 10 per cent probability of one or more significant oil or gas resources, i. e. containing more than 50 mill boe. Further, the study excluded resources where production will have to rely on technology that is not yet available, and did not consider the specific challenges associated with the ice cover.

Undiscovered petroleum reserves were estimated by USGS 2008 to be 36 btoe or 8.5 per cent higher than in their 2000 estimate. In particular, estimates for Canada and Alaska have been raised, but the estimate for East Greenland were reduced by half in the 2008 survey.

The effect on Arctic petroleum production of a shift in the oil price

In the following we discuss the potential scale of future petroleum production in the Arctic regions based on a model of the global petroleum market. The FRISBEE-model[5] describes demand and supply of oil globally as

Prudhoe. Alaska Oil Deadhorse. A young grizzly bear ambles through the industrial trappings of Deadhorse, Alaska. Photo: Charles Mason/NYT /Scanpix

a function of the oil price. In the natural gas markets the price is solved endogenously. From these data we derive future production profiles, based on investment and production decisions.

The global petroleum industry is modeled as one single investor, who allocates a share of the annual cash flow to new fields by maximizing net present value of returns. It is important to be aware of the simplification to assume that national oil companies like the Russian apply the same investment rule of profit-maximization as private international oil companies. In general, social and political priorities are perceived to have a stronger hand on the national oil companies.

The model distinguishes between basic investments up-front and later investments in enhanced oil recovery (EOR) to modify the rate of decline in production after the peak level. In the future, a growing share of crude oil production will come from smaller and offshore fields with higher declines rate. Hence, steadily increasing investments in EOR are needed to keep up production recovery rates.

In the study, supply and demand are estimated for 4 field categories in 15 regions. Field categories are defined according to size of reserves, and location onshore or offshore at various depths. There are the 5 Arctic regions, West Russia, East Russia, Arctic Canada, Alaska and Arctic Norway. In the Arctic regions there is one field category only. More than 80 percent of the undiscovered resources in the Arctic are located offshore.

In the model, the OPEC region acts as a residual supplier, who regulates supply to support a certain presumably preferred level of the oil price that is fixed by assumption in the model. The gas price is endogenously determined in regional markets.

The time horizon of this study goes to 2030 and is based on the assumption that the considerable undiscovered resources of East Greenland will not be in production before 2030. Offshore production in these regions has a serious climate and cost challenge, and even depend on new technology development. On this background we assume that East Greenland resources will not be on-stream within the time horizon of our study. Likewise, we assume that the vast majority of

Figure 5.1. **Total Arctic oil production. Reference scenario (80 USD per boe) 2000-2030**

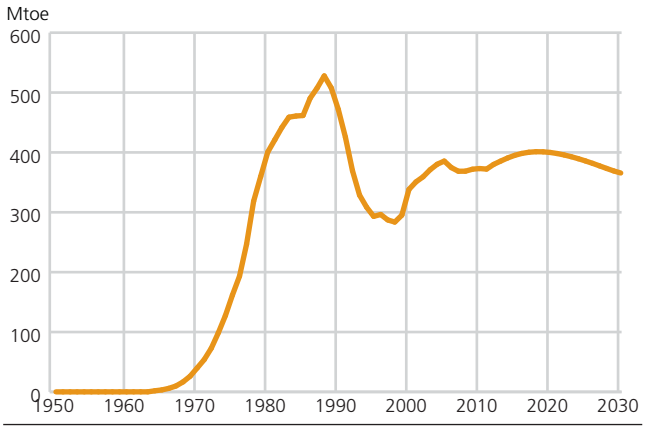


Figure 5.2. **Regional distribution of arctic oil production. Reference scenario**

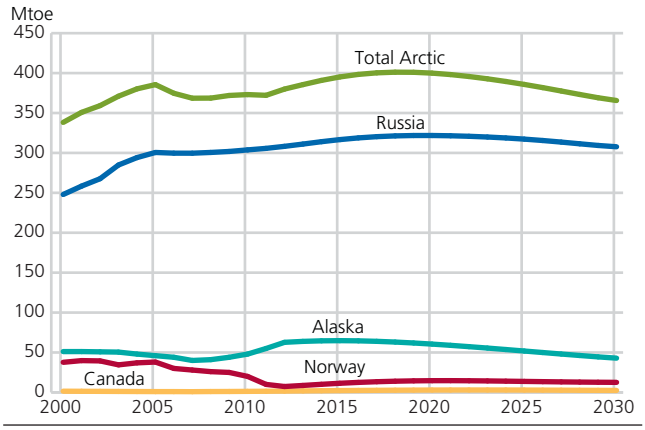


Figure 5.3. **Total Arctic natural gas production - reference scenario**

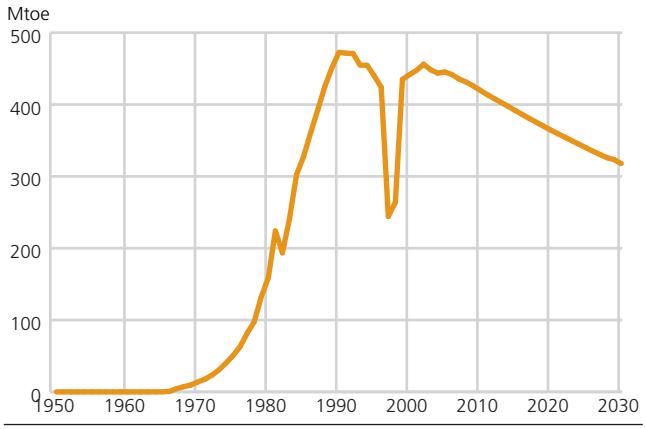
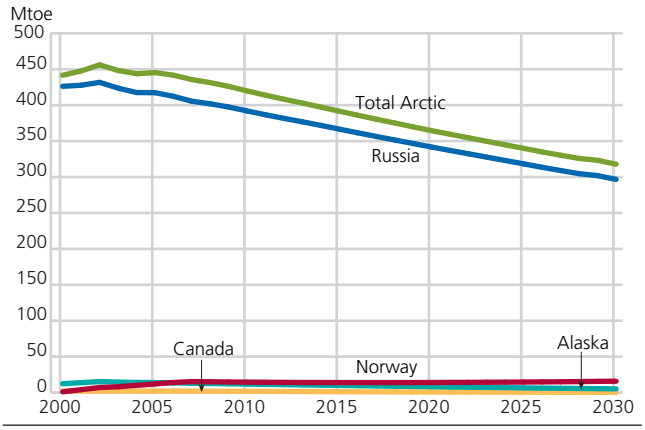


Figure 5.4. **Regional distribution of Arctic gas production. Reference scenario**



Russian production activities will take place in their western parts within our time frame.

The 2008 estimates of undiscovered reserves by US Geological Surveys are used in the model. In a base case scenario, the oil price is assumed to be 80 USD (2000) per barrel, and additional scenarios are run with alternative oil price levels at 40 USD and 120 USD.

Results

Figure 5.1 shows that Arctic oil production really started to increase in the mid-sixties up to around 1988. The break-up of the Soviet Union led to a decline in oil production from then on, before it started to increase in the late 1990s. Due to the dominant share of Arctic Russia in total Arctic oil production, this is clearly reflected in aggregate production at circumpolar level. In the reference scenario of our model simulations, future production of oil in the Arctic never reaches the production levels of the 1980s.

Figure 5.2 shows the future production in the various arctic regions. The estimated production levels fit relatively closely to the observed development in the different regions up to 2007. We see that total production increases somewhat up to 2018 and then falls gradually back to the 2007 level by 2030. Continuously in this process, producing fields are being emptied and new fields are being discovered and developed. Oil production in the Arctic is around 10 per cent of global oil production initially. However, because oil production in other regions increases somewhat, the Arctic share of global oil production is falling to around 7 per cent in 2030. Of total accumulated arctic oil production from 2008 to 2030, around 81 and 14 per cent will come from Russia and Alaska, respectively.

Figure 5.3 shows total Arctic natural gas production. Similar to oil, gas production increased from the mid-sixties to 1988. Production in the beginning of the 2000s was almost as high as the record levels reached

Figure 5.5. **Arctic gas production outside Russia - reference scenario**

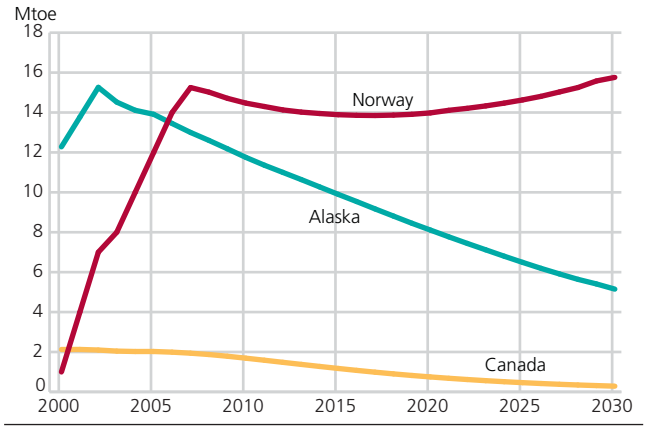
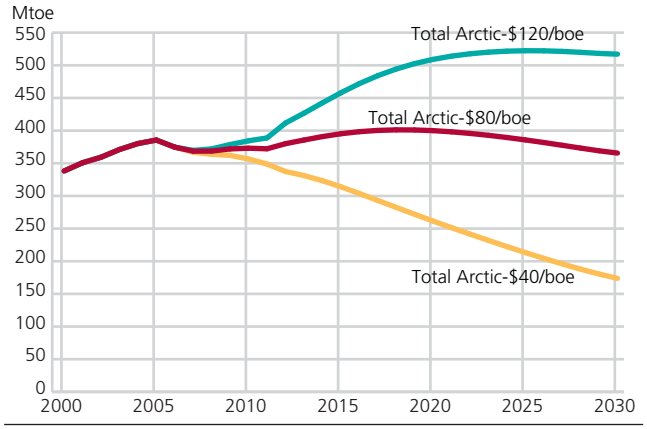


Figure 5.6. **Total Arctic oil production with alternative oil prices**



in the late 1980s. Future gas production declines over the whole projection period in the reference scenario.

In our model projections, global gas production increases in most regions outside the Arctic up to 2030. Hence, the Arctic share of global gas production actually declines from around 21 per cent in 2008 to around 9 per cent in 2030. When it comes to gas, Russia is even more important than for oil. Around 94 per cent of accumulated Arctic production from 2008 to 2030 comes from Russia alone (see figure 5.4). Total arctic gas production in 2030 is slightly higher than presented by Wood Mackenzie.

Figure 5.6 shows the effects on Arctic oil production when future oil prices rise to 120 or decline to 40 USD-2000 per boe. In the high price scenario, the Arctic share of global oil production stays around 11-12 per cent up to 2030. Total accumulated oil production is around 23 per cent higher in the 120 USD scenario than in the reference scenario. The relative increase in production is higher in Russia than in the other Arctic regions.

In the low-price scenario, the Arctic share of global oil production declines from 11 to 5 per cent over the projection period. The oil production in the low price scenario is thus only marginally higher than the production level in 2030 presented in Wood Mackenzie (2006). Total accumulated oil production in our 40 USD-2000 per boe scenario is around 32 per cent lower than in the reference scenario. The relative decline in production is more or less the same across regions.

Concluding remarks

In our model oil and gas producers base their investment and production decisions on profit maximization and detailed information about the access to fields worldwide. The producers might invest in new fields or increased oil recovery from existing fields. The assumption that investments first target the most profitable reserves leads to a geographical spread of oil extraction.

We have focused on the Arctic and examined how different oil prices influence future investment and production in the different regions up to 2030. Different studies have different conclusions about the future of the Arctic as an oil and gas producer. Our study gives a comprehensive description of how future oil and gas prices will affect petroleum production in this region.

Notes

[1] OECD/IEA (2008): World Energy Outlook 2008, Paris
[2] OECD/IEA (2008): World Energy Outlook 2008, Paris
[3] Wood Mackenzie (2006): Future of the Arctic - A new dawn for exploration. Oil&Gas Journal (2006) Nov 13, p. 18-30
[4] USGS (2008): Fact Sheet 2008- 3049, http://energy.usgs.gov/arctic/
[5] Aune, F.R., Glomsrød, S., Lindholt, L. and Rosendahl, K.E. (2004): The oil market towards 2025 - can OPEC combine high oil price with high market share? Mimeo. Statistics Norway

Raipon – The Russian Association of Indigenous People of the North Photo by Gérard Duhaime