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OG21 Strategy - A New Chapter

INNHOLD

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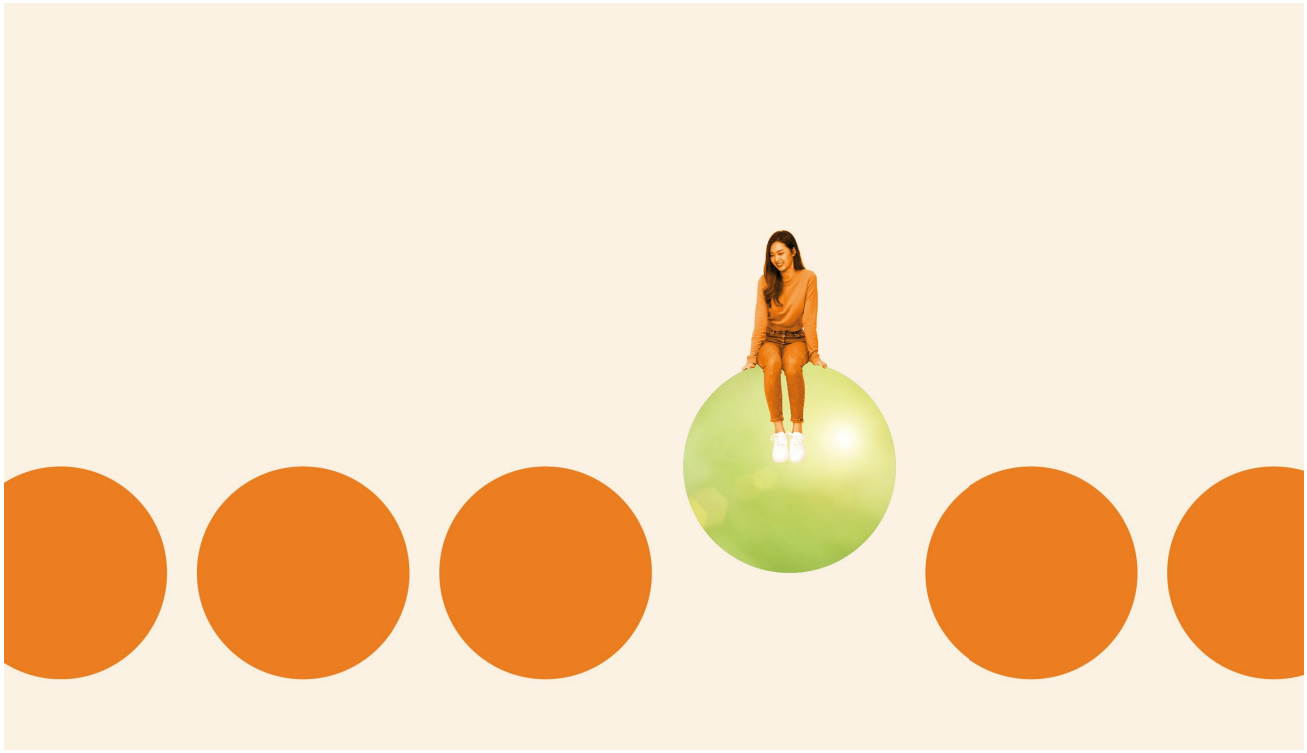
The future of petroleum in the energy transition



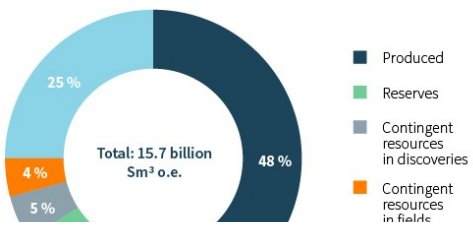
The role of the Norwegian petroleum industry in the energy transition

Climate change is occurring, and the world needs to curb GHG emissions. Since fossil fuels are a main contributor to GHG emissions, the petroleum industry needs to contribute to addressing the challenge. Emissions from production should be reduce and new industries should be developed to support the energy transition.

The inertia in the energy systems is however significant. For instance: A typical fossil fueled power plant operates for at least 25 years; an internal combustion engine (ICE) car has a life expectancy of more than 10 years; the electrification of societies requir massive investments in power grids and buildings and will take time. In addition, oil and gas is hard to replace for many end-uses such as for fertilizers and industry products. This means that even with global decisions to curb emissions, there will be demand for oil and gas for many decades to come. How fast the transition will go and how the oil and gas demand will be impacted, is dependent on: (i) how successful global leaders are in developing and implementing policies and binding agreements, and (ii) co and technology advancements of low-emission alternatives both on the energy supply and demand sides.

Less than half of the estimated resources on the NCS has so far been produced, and the NCS is currently highly competitive in the market with low lifting costs and low CO_2-emissions per barrel o.e.

Figure 2. Resources on the NCS (NPD, 2020)



OG21 believes that the NCS and the Norwegian petroleum industry can continue to deliver value to the Norwegian society in terms of revenue and jobs along three dimensions:

1. Successfully compete for market shares in the oil and gas markets. Future markets and prices are uncertain, and to stay competitive the production needs to be highly cost-efficient, and the industry needs to deliver on the ambitious GHG emissions targets set forward by Konkraft (2021).

2. Secure deliverables to the European market for natural gas by de-carbonizing the gas. CCS is a key technology to de-carbonize natural gas, either into low-emission hydrogen or electrical power.

3. Contribute with competencies and solutions to the development of new industries, e.g. blue hydrogen and ammonia, CCS, offshore wind power and marine minerals mining. Developing such industries would assist in the energy transition and shoul take place in parallel with the further development of the petroleum industry to leverage synergies.

Development of resources on the NCS should continue. The NCS offers stable and secure supply in addition to among the lowe CO_2-emissions in the world.

Energy policies setting the direction

2.2.1 National policies

Several governmental and industry policy documents for the Norwegian petroleum sector have been published or updated in recent years. Combined they describe a Norwegian petroleum industry that will:

1. Continue to be important for the Norwegian society in the coming decades, although with a gradually declining relative importance for the society.

2. Need to reduce its CO_2-emissions, both in the production phase and along the value chains.

3. Contribute with technology, competence, and solutions to enhance its own competitive edge and also to develop new industries.

The Governmental white paper launched in June 2021 on *long-term value creation from Norwegian energy resources (Meld.St.3 (2020-2021)),* describes four main objectives:

- Value creation that provides new jobs in Norway. The Government wants the Norwegian renewable energy resources, to the largest extent possible, to be utilized and refined in Norway.

- Electrification to make Norway "greener". A new electrification strategy is launched as part of the white paper. It aims at findin a balance between the need for more power and improvements to the grid and the associated environmental consequences and concerns.

- Establishment of new profitable industries, such as hydrogen, offshore wind, CCS and battery production.

- Further development of a petroleum industry fit for the future and aligned with Norwegian climate goals. In addition to continue stable frame conditions, the Government wants to actively contribute to R&D on good resource utilization and lower operatior GHG emissions. The Government also wants to continue the established exploration policy of making new areas available in regular licensing rounds.

In *"Perspektivmeldingen 2021"*, the Government describes which challenges the Norwegian society faces towards 2060 and the Government's strategies to address those challenges. Climate change and its impact globally and locally receives high attention the white paper. It describes a need for ambitious national measures as well as a need for global cooperation. To meet the goals in the Paris Agreement, large and expensive emission cuts must be implemented globally and nationally. The white paper nevertheless predicts that there will be a continued need for new investments in oil and gas, and that the consequences for the Norwegian oil and gas activities therefore could be modest, (Meld.St. 14 (2020-2021)).

In the white paper *"Klimaplan 2030"*, the Government presents its plan for how Norway will achieve climate goals and green

growth towards 2030. The climate plan has a main emphasis on emissions that are not part of the EU quota system, i.e. transpo waste, agriculture, construction and parts of the emissions from industry and oil and gas activities. It does however also address some emissions that fall under the EU quota system, including emissions from the oil and gas activities. The Government describes in the white paper that it will increase the CO_2 tax so that the combined levy, including quotas, reach 2000 NOK/ton CO_2 by 2030, (Meld.St. 13 (2020-2021)).

The industry employers' organization NHO and the labor organization LO have together published a white paper, *"The energy a industry platform"*, on the transformation of the industry to a low-emission society (NHO/LO, 2021). In the report NHO and LO emphasizes that the Norwegian industries' competitiveness depends on:

- An energy policy that stimulates ambitious industry development, and includes strengthening and upgrading of the power grid increased renewable power production, and new measures to improve energy efficiency.
- Access to renewable energy at competitive prices.
- A further development of a safe and efficient Norwegian power system that is based on principles of business and socio-economic profitability, but which provide the opportunity for industry production to be scaled up in response to demand and fo a corresponding faster development of the power grid.
- A holistic electrification strategy that combines industrial opportunities, climate goals and improvements in the power system.

Konkraft published early 2020 *"A climate strategy towards 2030 and 2050"* for the NCS, with support from all its members: the Norwegian Oil and Gas Association, the Federation of Norwegian Industries, the Norwegian Shipowners Association, the Confederation of Norwegian Enterprises and the Norwegian Confederation of Trade Unions. A status report was published in 2021. The strategy sets forth ambitious climate reduction targets of 40% reduction in operational GHG emissions by 2030, furth reduced to near-zero by 2050. It also suggests how the petroleum industry can contribute to reducing GHG emissions along the value chain of hydrocarbons and simultaneously create new industries, (Konkraft, 2020) and (Konkraft, 2021). The 40% target f 2030, was further strengthened to 50% reductions by 2030 through a Parliament request forming part of the Corona stimulus package for the petroleum industry, agreed in the Parliament in June 2020.

2.2.2 Global policies influencing the energy sector

Norway is one of 196 countries that have adopted the legally binding international treaty on climate change developed at the UN COP21 meeting in Paris in 2015. The goal of the agreement is to limit global warming to well below 2 degrees Celsius, and preferably to 1.5 degrees Celsius, as compared to the pre-industrial levels. The Paris Agreement forms the basis for EU as well a Norwegian energy policies.

The 6th assessment report from IPCC is being developed. The contributing report from IPCC's Working Group 1 on the physical science of climate change, released early August 2021, further strengthens the call for action to curb GHG emissions (IPCC, 2021).

The 2030 Agenda for Sustainable Development, adopted by all the member states of UN, is another UN policy document with high impact. Its 17 Sustainable Development Goals are widely referred to in regional and national policies and strategies.

2.2.3 The EU Green Deal is transforming the European energy landscape

The European Green Deal (EGD), the climate and growth strategy for EU, was launched in December 2019. The EGD and its related targets, measures and strategies are aimed at securing a green and digital transformation of the EU society, economy, a industries. (European Commission, 2019b).

The EGD has transformational impact on all sectors in EU, including the energy sector. The energy sector today contributes witl around 75% of EU's GHG-emissions. The transformation from a fossil-fuel based energy system to a system based on renewab energy is therefore an essential part of the EGD.

At the core of the EGD is a new EU climate law which put forward a target of making EU carbon-neutral by 2050. On the path there, GHG emissions shall be decreased by 55% within 2030. The law passed the EU Parliament in May 2021 and entered into force in July.

Numerous and comprehensive plans, programs and underlying strategies have been developed to support the EGD and set strategic direction. The next step is to transform the EGD supporting strategic documents into directives and regulations. The "F for 55" package presented in July 2021 is part of that.

The EGD impacts Norway both through the adoption of regulations and directives, and through changes to physical and financia value chains. For enterprises and organizations historically involved in the Norwegian petroleum industry, impact on at least thre areas could be envisaged:

1. **Production costs:**
   - Revision of the ETS quota system will increase costs of CO_2-emissions. Impact on petroleum production in Norway will depend on how the CO_2-tax in Norway is adjusted.

2. **Access to capital and financing:**
   - The EU Taxonomy, the strategy for sustainable financing and the directive for non-financial reporting, could make investments in petroleum projects less attractive.

   - Research and innovation funding may create opportunities for enterprises and organizations that have growth strategies that align with EU's strategies, see Section 2.6 for details.

3. **Access to market & new industry opportunities:**
   - The EU demand for natural gas could be reduced unless the natural gas is de-carbonized and delivered as other energy carriers, see section 4.

   - The EU Hydrogen strategy opens for blue hydrogen (produced from natural gas with CCS) in a transition period, but the strategy's main objective is to make green hydrogen competitive.

   - The EU Offshore renewable energy strategy aims at making offshore renewable energy a core component of Europe's energy system. It addresses various types of offshore renewables, but offshore wind is expected to be the major contributor.

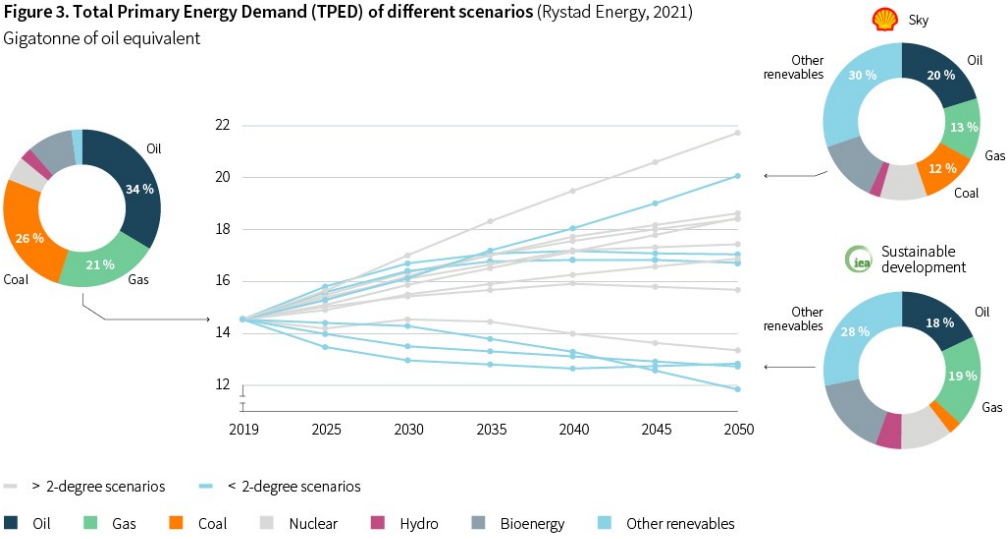
The energy transition – global forecasts

2.3.1 Wide span in global energy forecasts

The global total primary energy demand (TPED) in 14 scenarios provided by 5 well recognized organizations[1], is shown in Figu 3. There is a considerable spread in the forecasts towards year 2050, depending on the assumptions they are based on. The assumptions on whether the world meets the targets and ambitions of the Paris-agreement and to which extent CCS is implemented, are the most important.

With exception of the Shell Sky scenario, which assumes an even more extensive use of CCS than the other "less than 2 degree scenarios, the "less than 2 degrees" scenarios describe an energy future where the world's energy demand peaks before 2035. They describe a future where renewables such as hydro, bioenergy, solar power, and wind power, dominate the energy mix and where coal has largely been phased out. The relative contribution of oil and gas is smaller than today, but still significant, typicall 30-40% of the energy demand. In all the scenarios where the world meets the 2-degree target, CCS plays an important role.

Figure 3. Total Primary Energy Demand (TPED) of different scenarios (Rystad Energy, 2021)
Gigatonne of oil equivalent

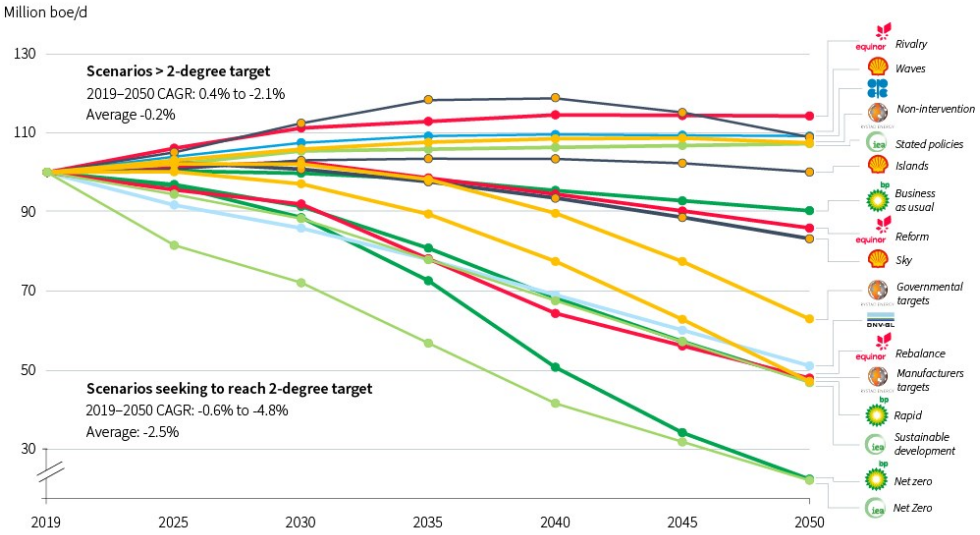


2.3.2 Oil and gas demand during the energy transition

Oil and gas are likely to continue to play an important role in the global energy mix in the decades to come, but the long-term demand is increasingly uncertain. Figure 4 shows the large span of liquid demand scenarios from recognized sources such as IEA, DNV GL, Equinor, BP and OPEC (Rystad Energy, 2021).

The scenarios compared can largely be grouped into two: those describing a transition to an energy mix that meets the 2 degre target of the Paris-agreement, and those that do not meet the target.

Figure 4. Global liquid demands in different scenarios* (Rystad Energy, 2021)

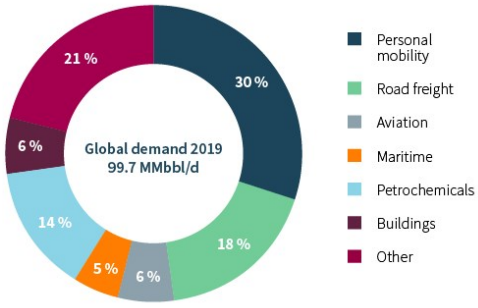


** Indexed to IEA 2019 levels as different providers define units and markets differently EIA not included as they don't have any updated post-COVID scenario, making it less relevant and comparable.*

The "low carbon" scenarios reflect major technological and investment shifts both on the energy supply and the energy demand side. For instance, and as Figure 5 indicates, large scale electrification of road transportation could alone address nearly half of today's oil demand (30% of the 2019 oil production was used for fueling light vehicles and buses and 18% was used for light and heavy trucks). Provided that the electricity is generated from renewables or de-carbonized fossil fuels, electrification of the transport sector is becoming increasingly more attractive, both from an emission and an economic perspective.

Other parts of today's oil use could be more challenging to replace. Maritime transport and aviation require a much denser energ storage than what today's electric batteries can offer, and further advancements of batteries, biofuels, hydrogen, and hydrogen-derived fuels will be important. Furthermore, oil is used in petrochemical and other industries where it could prove hard to replac For such industries, the search for cost-efficient alternatives to oil as well as re-cycling of oil-derived products, will be important reduce demand.

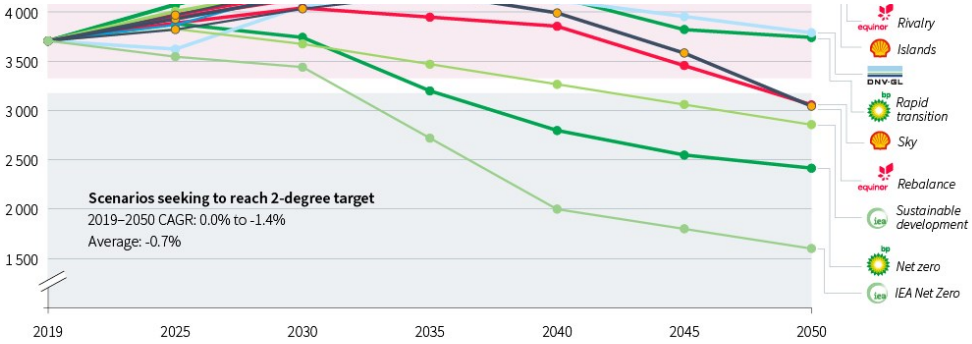
Figure 5. What oil was used for in 2019 (Rystad Energy, 2021)



The transition to net-zero societies globally is therefore going to take time, and oil is likely to be needed for many decades to come.

The future demand for natural gas is also uncertain as Figure 6 shows. However, all scenarios that aim at meeting the Paris-agreement 2-degree target, predict that also global gas demand will peak by 2035 and decline towards 2050.

Figure 6. Global gas demand scenarios* (Rystad Energy, 2021)



** Indexed to RE 2019 levels as different providers define units and markets differently.*

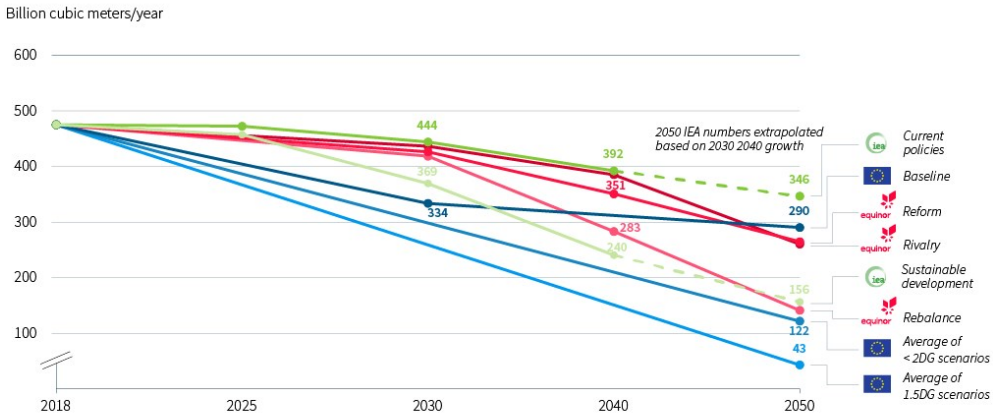
Gas markets are regional to Asia, the Americas and Europe. Long distances between the regional markets, lack of import/expor infrastructure and high shipping costs limit the trade between the markets.

More than 95% of Norway's gas production is piped to the European market, with the remainder shipped as LNG to other markets. The European market is therefore of key importance for the sales of natural gas from the NCS.

Most scenarios show robust demand for natural gas in Europe near-term and until year 2030. The use of natural gas in modern gas power plants results in only half the CO_2-emissions from coal-fired power plants, and as such natural gas is an important energy carrier to reduce European emissions in the short to medium term.

However, EU is implementing its Green Deal with a zero-emission vision for 2050, and in the scenarios supporting the vision, natural gas without CCS plays a limited role. De-carbonizing natural gas would therefore be crucial in a long-term strategy for th Norwegian gas. Gas-to-X technologies (blue hydrogen, electricity or other energy carriers) with CCS are key elements of such a strategy.

Figure 7. European (EU+UK) gas demand in different scenarios* (Rystad Energy, 2021)



**Indexed to IEA EU28 gas demand as definitions vary across scenarios. Source: Rystad Energy research and analysis; IEA WEO 2020; EU Commission; Equinor Energy Perspectives 2020*

2.3.3 The IEA Net Zero by 2050 scenario

The IEA Net Zero by 2050 scenario (NZE) has drawn significant attention since its release in May 2021. It provides a roadmap t achieve net zero CO_2 emissions by 2050, and the path described meets the 1.5 degrees ambition of the Paris Agreement with a 50% probability.

The NZE predicts a peak in global energy demand by 2023 before a reduction of 10% towards 2050. With a growing population the energy demand per capita would over the same period be reduced by 25%. Oil and gas would in 2050 contribute with 8% a 11% respectively of the total energy supply (8% natural gas with CCUS, and 3% without).

The NZE hinges on many uncertain assumptions. IEA highlights large behavioral changes on the individual level, modern bioenergy and its associated large land-use, and a fast pace of CCUS adoption, as the three most important. Several other assumptions stand out in addition, most notably the need for alignment and concerted efforts on a global scale, massive investments e.g. in electricity systems, a rapid maturing and broad adoption of new technology such as hydrogen, and access t sufficient quantities of rare earth minerals and critical metals.

To facilitate an orderly transition to zero-emission societies it is going to be important that policies to curb supply are aligned wi

policies to curb demand. In a comment to the NZE, Jason Bordoff of Columbia University writes: *"Unless both supply and demar change in tandem, merely curbing the oil majors' output will either shift production to less accountable producers or have potentially severe consequences on economic and national security interests while doing little to combat the climate crisis"* (Bordoff, 2021). Bordoff bases his analysis on the fact that only 15% of the oil delivered to the market is produced by internationa oil companies (IOCs). The bulk of the oil (57% in 2018) is produced by national oil companies in OPEC countries plus Russia, ar the remainder is produced by independents (OG21, 2020b).

The NZE assumes an oil price decline from 37 $/bbl in 2020 to 24 USD/bbl in 2050 to balance supply and demand, and states: "*The rapid drop in oil and natural gas demand in the NZE means that no fossil fuel exploration is required and no new oil and natural gas fields are required beyond those that have already been approved for development*". Following the arguments of Bordoff in his evaluation of the NZE, the assumed oil price decline would have to be driven by reduced oil demand resulting from substitution with low-emission energy sources outcompeting fossil fuels on costs, and not by curbing oil supply. As such, the eliminated need for new investments in exploration and field development in the NZE should be a *consequence* of CO_2-pricing and large-scale development of low-emission energy, and not a result of unilateral political decisions on banning exploration and field development.

If the NZE projected price trajectory should materialize, it is not a given that remaining resources in existing fields are more cost and emission effective than resources in new fields. For the NCS, new resources close to existing infrastructure could very well be economically viable within the 30-35$/bbl oil price range projected by the NZE in the period 2030-2040. This is the likely period much of the remaining resources on the NCS would be realized. The associated GHG emissions from such new resource could be substantially lower than from some of the contingent resources in existing fields globally.

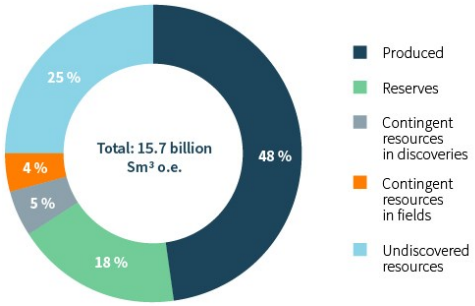
The NZE is one of many scenarios describing the on-going and necessary global energy transition. When evaluating petroleum technology needs for the future, it should be treated as such, although with a considerable weight given the potentially high impa it may have on policy development.

[1] IEA WEO 2020, IEA NZE, Shell Scenarios 2020, OPEC WOO 2020, Equinor Energy Perspectives 2020, DNV GL ETO 2020.

Norwegian petroleum resources – less than half produced and sold

Even though the NCS is maturing, less than 50% of the potential economically viable resources have been produced (NPD, 2020).

Figure 2. Resources on the NCS (NPD, 2020)



As Figure 2 shows, 18% of remaining resources are booked reserves, 4% are contingent upon investment decisions in producin fields, and 5% are contingent upon investment decisions in the existing discovery portfolio. The contingent resources add up to more than 9000 million boe, equivalent to more than 4 times the volumes of the Johan Sverdrup field.

25% of estimated resources are yet to be found. The Barents Sea dominates this category, although related with a high uncertainty span. Half of the Barents Sea estimate is from unopened areas far North. The North Sea and Norwegian Sea are believed to still hold significant, undiscovered resources. The continued discovery trend of small, but still commercial fields, supports this belief.

Improved subsurface understanding, new technology in all disciplines described by OG21's technology groups as well as chang to work processes are all important elements in the maturing of contingent resources and finding and maturing new resources t cost-efficient production with relatively low GHG-emissions.

There are considerable remaining resources on the NCS. Still, in a global context, the NCS resources are rather modest. The bu of remaining resources globally is in the Middle East and the Americas.

Figure 8. Remaining resources on the NCS as compared to other basins (Rystad Energy, 2021)

** Total volumes in fields in production, under development or discovered, but not yet produced as of 1.1.2021.*

On OG21, its vision and the strategic objectives

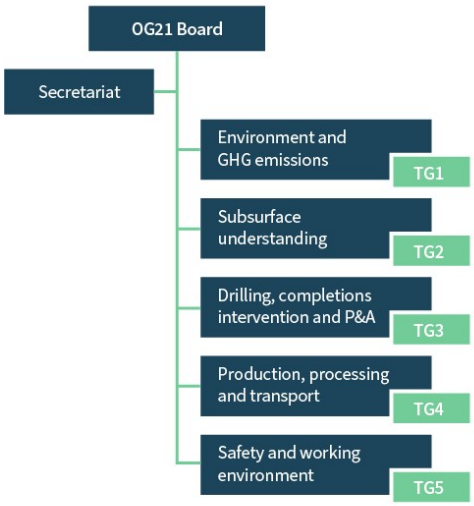
2.5.1 Mandate and organization

OG21 has its mandate from the Norwegian Ministry of Petroleum and Energy (MPE). The purpose of OG21 is to *"work for efficie safe and environmentally friendly value creation from the Norwegian oil and gas resources. This will be achieved through a coordinated engagement of the Norwegian petroleum cluster within education, research, development, demonstration, and commercialization. OG21 will inspire the development and use of new and improved competence and technology aligned with a energy system in transition and the goal of reduced greenhouse gas emissions".*

OG21 brings together oil companies, universities, research institutes, suppliers, regulators and public bodies to prepare a comprehensive national technology strategy for the petroleum sector which will guide the industry's and the authorities' technology and research efforts.

Technology opportunities and challenges are being identified, described, and prioritized by technology groups (TGs) within the themes shown in Figure 9. The TGs have members from oil companies, universities, research institutes, suppliers, regulators, an public bodies.

Figure 9. Organization of OG21



2.5.2 Vision and strategic objectives

OG21's vision and strategic objectives are shown in Figure 10.

Figure 10. OG21's vision and strategic objectives

OG21's vision *"Technology enabling the future of petroleum"*, expresses a desire to continue providing petroleum, solutions and services to the global energy markets, but with the understanding that the markets are changing: Technology will be essential to align with a future where GHG emissions related to production are dramatically reduced, petroleum products are de-carbonized reduced demand for oil and gas have pressed oil and gas prices down, and stakeholders have expectations of excellent safety and environmental performance.

The vision is supported by three strategic objectives that combined bring us to this future.

The strategic objectives have formed the basis for the identification and prioritization of technology and competence needs described in Section 4.

2.5.3 Funding

OG21 is co-located with the Research Council of Norway. In addition to hosting OG21, RCN provides administrative assistance t OG21.

The Ministry of Petroleum and Energy is OG21's main sponsor. In addition, OG21 receives funding from energy companies. Funding energy companies in 2021 are Equinor, Vår Energi, Lundin Norway, OMV, ConocoPhillips and Neptune Energy.

The OG21 budget, income and spending is disclosed in the annual reports published on the OG21 website.

2.5.4 Interfaces with other 21-processes

OG21 has important interfaces with other strategy processes:

Figure 11. Interfaces between OG21 and other 21-processes

Energi21 is the national technology strategy for renewable energy and transportation. OG21 has interfaces with Energi21 on energy efficiency, carbon capture and storage (CCS), power transmission and grids, and use of renewables for power supply.

Maritim21 is the national technology strategy for the maritime industry. Interfaces with OG21 include marine operations, mobile drilling units, gas transport, emergency preparedness technologies and automation and autonomy.

Prosess21 is the national strategy for the process industries. Interfaces include energy efficiency, CCS, and power transmission and grids.

Digital21 is the national strategy for digitalization of Norwegian industries. Interfaces include all OG21 prioritized technologies wit a high degree of digitalization. Digital21 emphasize 5 key strategic technologies that all are highly relevant for OG21: AI, big data, internet-of-things, autonomous systems, and cyber security.

Representatives from the other 21-processes have been engaged throughout the development of this OG21-strategy.

The 21-processes are organized in accordance with the sectoral approach to R&D in Norway, discussed in section 5.2.1. It come with some obvious benefits such as ensuring alignment between industry, academia and the ministry on objectives and priorities As such the approach has proven efficient to produce results with significant impact.

The sectoral approach also has some drawbacks, especially related to cross-industry coordination and holistic goals. It could therefore benefit from being supplemented with elements from a mission-oriented approach on societal challenges.

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Neste side →

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