INNHOLD

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Summary of recommendations

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Details on technology and knowledge priorities are provided in Section 4. The 30 priorities can be summarized into **8 prioritized technology areas**:

1. **Improved subsurface understanding** and tools are fundamental for the attractivity and competitiveness of the NCS. The technology area has important ties to all disciplines: it will improve identification of opportunities and exploration for resources; improve well positioning and aid in the completion of wells; improve drainage of reservoirs; reduce water production which is the main contributor to energy use and GHG emissions on the NCS installations; and reduce safety risk associated with drilling. It is also fundamental for efficient carbon capture and storage (CCS).

2. **Cost-efficient drilling and P&A** address two major cost elements of offshore operations. More cost-efficient drilling requires improved methodologies and tools for well construction, more efficient drilling technologies for subsea wells, improved completion solutions, and better subsea well intervention technologies. In addition to reducing costs, such methodologies ar tools could also reduce emissions and improve recovery from challenging reservoirs. Plugging and abandonment of wells (P&A) represents a potential high future cost for oil companies and the Norwegian state, and it is a pressing need for development and application of significantly more cost-efficient technologies.

3. **Utilizing existing infrastructure** efficiently will be key to produce remaining reserves in the fields and to realize contingent resources. Contingent resources could be in fields, in the NCS discovery portfolio, and in new near-field discoveries. Existing infrastructure should also be evaluated for re-purposing when approaching end of production, for instance for late-life deposits of CO_2 in relation to CCS. The technology area includes technologies and knowledge for process optimization and integrity management, for instance: improved process simulators, condition-based monitoring, risk-based maintenance and improved understanding of materials and material degradation mechanisms.

4. **Unmanned facilities and subsea tie-back solutions** include technologies such as flow assurance models to extend the possible tie-back distances, subsea processing technologies and unmanned production facilities.

5. **Energy efficiency and cost-efficient electrification** are of paramount importance to meet the industry's ambitious GHG emission target of 50% reduction by 2030. Electrification from shore and use of offshore renewables are the most importan technologies to reduce operational GHG emissions. There are many costly technical challenges to be solved such as powe transfer through FPSO turrets, subsea HVDC converters and long-range AC transmission. Electrification hubs and large grid systems could also reduce costs. Energy efficiency can be improved for instance with technologies to reduce water production, water processing downhole or subsea, combined cycle gas turbines, and the use of low carbon fuels in gas turbines.

6. **Carbon capture and storage (CCS**) is a key technology area to reduce CO_2-emissions. Firstly, CCS provides an opportunity to de-carbonize natural gas either onshore or offshore (gas-to-X where X could be either blue hydrogen or electrical power) Secondly, an opportunity to apply CCS directly to offshore gas turbines to reduce operational emissions, should be explored In addition, CCS represents an industrial opportunity for broad multi-industry application.

7. **World leading HSE and environmental performance** is a fundamental value for the industry and a pre-requisite for society acceptance. It includes improved knowledge to understand and mitigate risks related to adoption of new technologies and new business models, better tools for understanding major accident risks and uncertainties, improved management of cyber security risks, and the continual effort to understand and reduce working environment risks.

8. **Digitalization** spans across all disciplines. The technology area is fundamental for improved and faster decision processes, which will reduce costs, increase the resource base, reduce GHG emissions and improve safety. The development and application of new tools and solutions such as artificial intelligence, robotics and drones, and digital twins, are key to achiev a digital transformation of the industry. To get there, there is a need for acquiring and processing data more efficiently, a nee for more collaboration on data access, data formats and data quality, and a need to change work processes and business models to fully utilize the potential of new technology.

Section 5 provides several **policy and leadership recommendations** as summarized below:

- Industry enterprises should have visible "**technology champions" at the executive level**. Technology responsibility should sta at the executive level and be distributed throughout the organization. Executive level technology managers should make sure that technology opportunities are identified and communicated to potential technology providers in a timely fashion.

- OG21 supports the idea of supplementing the well-established and efficient sectoral approach to R&D&I, with **cross-sectoral "missions"** to guide R&D&I efforts on societal challenges reaching across sectors.

- The RCN should evaluate new and **more agile approaches to R&D funding to complement the current system** and identify fo what types of projects and calls such approaches could be applied. New approaches could for instance include open-ended calls (no proposal deadlines), and parallel funding of competing projects/concepts up to a selection gate after which only the better project(s) receive funding.

- To better understand the value of new technologies and how technologies depend on system integration, petroleum research programs should encourage **holistic R&D approaches**, including system perspectives.

- Collaboration across disciplines such as science, technology, engineering, mathematics, and social science spur innovation OG21 encourages **cross-discipline R&D collaboration** when relevant.

- **Public funding through Petromaks2 and Demo2000 should be increased**. Historic data suggest that there is sufficient research capacity and high-quality R&D project ideas to accommodate a significant increase of the annual budgets.

- The industry should collaborate on developing **procedures and standards that enable data interoperability and efficient data sharing**.

- The larger oil companies need to have a **portfolio rather than a project approach** to new technology. Petoro should advocate for technology collaboration across the wide range of licenses they are involved in. The NPD and the PSA should leverage the influence on technology development and adoption in licenses.

- To harvest the value of digitalization the work force must understand the technology, its opportunities, and its limitations. Such competence development is a life-long endeavor, and the industry therefore needs to **educate and train its employees to master and adopt new digital technologies.** Industry enterprises should as part of this look for ways to collaborate with universities to develop their staff.

- The industry needs to **improve its attractiveness to young professionals**. They need to be offered exciting and meaningful jobs, and be convinced through tangible results that the industry takes climate change seriously.

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