

# CLEAN TECH SECTOR JURISDICTIONAL ANALYSIS

## IDENTIFYING REGULATORY AND SUPPORT ECOSYSTEM INITIATIVES FROM LEADING JURISDICTIONS SUPPORTING CLEAN TECHNOLOGY INNOVATION IN THE OFFSHORE OIL AND GAS INDUSTRY


## ABSTRACT

In response to the large societal and economic impacts of the COVID-19 pandemic and the collapse of the oil and gas industry, there is growing interest in Newfoundland and Labrador to diversify its own economy by leveraging its oil and gas experience to build a stronger clean tech sector. This study investigates five jurisdictions that have taken a variety of measures to foster growth within their clean tech sectors, including Norway, Gulf of Mexico, Alberta, Australia, and the United Kingdom. The study was initiated by a Newfoundland and Labrador Cleantech Working Group, including NEIA, Noia, and the province's Oil and Gas Corporation. It was implemented by a team of consultants, including energy and policy consultants, Caron Hawco and Thomas Cooper from Newfoundland and Labrador and Norwegian energy consultants, Rystad Energy.


**CARON HAWCO, RYSTAD ENERGY AND TOM COOPER**

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## EXECUTIVE SUMMARY

Governments and the public all over the world over are demanding action relating to climate change and a low-carbon energy future. Growth in hydrocarbon demand is projected to decline significantly because traditional customers are turning to alternative solutions for their needs. Investors are becoming increasingly hesitant to finance oil and gas operations.

In response, some leading oil and gas producing jurisdictions are responding to climate change challenges by advancing clean technology innovation to reduce emissions. They are also working to diversify their respective economies by investing in new lower carbon energy solutions.

As jurisdictions shift to clean, low carbon energy solutions, the energy sector is expected to see trillions in new investment dollars. According to the International Energy Agency, this is creating enormous potential economic opportunity — an estimated (USD) $13.5 trillion (CAD $17.33 trillion) of public and private investment in the global energy sector alone will be required between 2015 and 2030 if the signatories to the Paris Agreement are to meet their national targets.[1]

In response to the large societal and economic impacts of the COVID-19 pandemic and the collapse of the oil and gas industry, there is growing interest in Newfoundland and Labrador to diversify its own economy by leveraging its oil and gas experience to build a stronger clean tech sector.

This study investigates five jurisdictions that have taken a variety of measures to foster growth within their clean tech sectors, including Norway, Gulf of Mexico, Alberta, Australia, and the United Kingdom. The study was initiated by a Newfoundland and Labrador Cleantech Working Group, including NEIA, Noia, and the province's Oil and Gas Corporation. It was implemented by a team of consultants, including energy and policy consultants, Caron Hawco and Thomas Cooper from Newfoundland and Labrador and Norwegian energy consultants, Rystad Energy.

The focus is to gain an understanding of what deliberate interventions related to cleantech were made by these leading oil and gas jurisdictions to foster innovation, attract investment, diversify the supply chain, and enhance long-term environmental performance. The study also identifies jurisdictional gaps and opportunities that exist in the regulatory and support ecosystem in Newfoundland and Labrador. Overall, the study aims to assist industry stakeholders in the region to understand the possible approaches to support clean technology development and application within offshore oil and gas.

## STUDY BACKGROUND

Jurisdictional scans may be used as decision-making tools used by governments and organizations to:

- Consider how problems have been framed in other jurisdictions;
- Compare and evaluate options based on action taken in other jurisdictions in response to similar problems; and
- Identify and anticipate implementation considerations associated with options.

Jurisdictional scans are predominantly used to identify good practices and not how problems are necessarily framed in other jurisdictions.[2] More details on the approach to the study can be found in the Appendix – *Approach to the Study*.

*Identifying Regulatory and Support Ecosystem Initiatives from Leading Jurisdictions Supporting Clean Technology Innovation in The Offshore Oil and Gas Industry (Clean Tech Sector Jurisdictional Analysis)* seeks to uncover gaps that exist in the regulatory and support ecosystem in Newfoundland and Labrador.

The rationale to undertake this comprehensive review is to understand what deliberate interventions related to cleantech were made by leading oil and gas jurisdictions to foster innovation, attract investment, diversify the supply chain, and enhance long-term environmental performance.

Key success factors[3] for jurisdictional scans were undertaken as part of this project include: the inclusion of a literature review; evaluation of policy options; standardized data collection; and contact with relevant stakeholders as needed.

[1] Source: https://www.iea.org/reports/clean-energy-innovation

[2] Source: Kilian, A., Nidumolu, A., & Lavis, J. (2016). Jurisdictional scans in policy making: A critical interpretive synthesis.

There are many examples of regulatory and support systems that strategically enhance the development and application of clean technology. For example, Natural Resources Canada had an Energy Innovation Program (EIP) receive CAD $50 million over two years to support development of clean oil and gas technologies and to help develop Canada's hydrocarbon resources in sustainable ways. The purpose of the program was stated to be accelerating clean technology development as a key component of the Government of Canada's approach to promoting sustainable economic growth and to supporting Canada's transition towards a low-carbon economy.[4] In Norway, the role of the oil and gas industry in expediting alternative sources of energy has been well researched and documented.[5] Overall, in starting this project, the motivation was to identity interesting findings in other jurisdictions as well as the potential for a series of robust recommendations to address performance and opportunity gaps in the local Newfoundland and Labrador ecosystem. As we relate throughout the report, we found that there are a number of findings and critical success factors that can influence policy and industry development around clean technology in the Newfoundland and Labrador offshore oil and gas industry.

## SELECTION OF JURISDICTIONS

Global and national commitments to reduce greenhouse gas emissions (GHGs) are driving growth within the clean technology sector at an unprecedented rate. In 2014, the European Council Summit set out 2030 goals for the European Union to reduce GHG emissions by 40 per cent compared to 1990 levels. In December 2015, at the Paris climate conference, 195 countries, including Canada, adopted the first-ever universal, legally binding global climate deal. This requires countries to take measurable steps to limit global temperature increases to 2 degrees Celsius.[6] To meet these commitments, the global market for clean technology is expected to grow to a size of $2.5 trillion (CAD $3.2 trillion) by 2022.

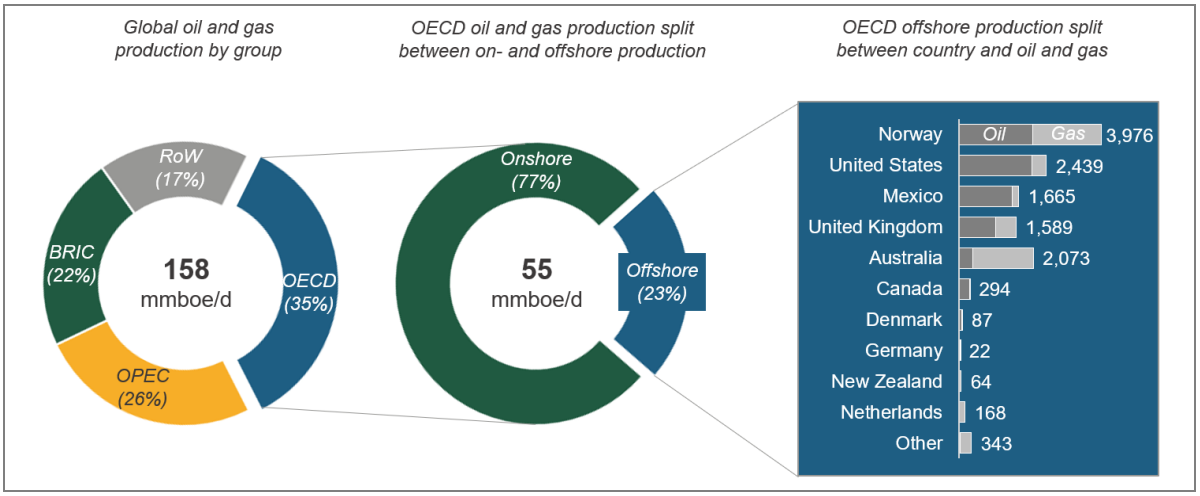



**FIGURE 1** – *Global Production by Supply Group (2020)*[7]

In 2017, the International Energy Agency (IEA) estimated a need for USD $10.5 trillion (CAD $13.5 trillion) in global incremental investment in low-carbon energy technologies by 2030 just to meet global commitments related to the energy sector alone. Since low-carbon energy technologies are only part of the broader clean technology sector, the required global investment in clean technology over the coming years – to serve the growing market - is significantly higher. Jurisdictions around the world have been accelerating the growth of their cleantech sectors and identifying niche technology strengths to meet this demand.[8] Figure 1 above was used as justification for the selection of relevant jurisdictions.

[3] Source: https://ses.library.usyd.edu.au/bitstream/handle/2123/15695/bhsc_kilian_ehpr-presentation-2016-06-21final.pdf?sequence=1&isAllowed=y

[4] Source: https://www.nrcan.gc.ca/energy/funding-grants-and-incentives/oil-and-gas-clean-tech-program/18472

[5] Source: Mäkitie, T., Andersen, A. D., Hanson, J., Normann, H. E., & Thune, T. M. (2018). Established sectors expediting clean technology industries? The Norwegian oil and gas sector's influence on offshore wind power. *Journal of cleaner production*, *177*, 813-823.

[6] Source: https://www.ontario.ca/page/ontarios-cleantech-strategy

[7] Source: Rystad Energy

[8] Source: https://www.ontario.ca/page/ontarios-cleantech-strategy

## WHAT WE LEARNED

Jurisdictions that have had the most success in progressing energy transition, diversification, and growth of their clean tech sector tended to focus on six main areas.

| Regulation and Policy | R&D Framework | Innovation Funding | Supply Chain | International Competitiveness | Innovation Ecosystem |
|---|---|---|---|---|---|
| • Carbon targets with a supported implementation plan<br>• Maximizing value creation of hydrocarbon resources<br>• Respond to problems, such as public pressures or high emissions<br>• Policies that motivate and penalize behaviours<br>• Institutional leadership to support energy transition and collaboration | • Aligned on country and industry R&D priorities<br>• Established collaborative forums to drive innovation, R&D, policy, including industry, supply chain, academia government and regulators<br>• State-owned R&D institutions to drive innovation that are accountable<br>• Projects are diversified and supported through full TRL innovation lifecycle | • Multiple funding streams to support innovation across innovation lifecycle<br>• Government in partnership with industry investing in infrastructure and innovation, etc.<br>• Shifting to scale funding – supporting winners<br>• Cleantech funds to incentivize investment | • Organizational leadership to support energy transition and supply chain participation<br>• Collaboration and use of clusters at a regional level (bottom up) | • Significant export support – funding, market access, partnership, and intelligence<br>• Home of global corporations with supporting R&D centres<br>• Picking winners in innovation for targeted export and<br>• commercialization support<br>• International collaborations | • Significant investment in big projects involving global investors<br>• Numerous innovation centres, tech parks, etc.<br>• Strong start-up activities and growth<br>• Active collaboration: universities, industry, supply chain and government<br>• Bi-lateral green collaborations: municipalities / corporations |

**FIGURE 2** – *Summary of Jurisdiction Scan*

This study confirms that among those jurisdictions that are making progress in their energy transition, there are consistent characteristics and activities taking place as well as government interventions to support the growth and diversification of these offshore oil and gas jurisdictions to the clean technology sector, including the following:

- Significant investments in large industrial projects through innovation and development partnerships between government and the private sector (Longship and Northern Lights in Norway, Gorgon in Australia.)
- Established research and development priorities at regional and national levels to drive innovation, collaboration, and support jurisdictional goals. (InnovateUK, OG21 Norway)
- Consistent, multiple streams of innovation funding to support the full life cycle of innovation. (Norway, UK, Australia, Alberta)
- Supply chain engagement, innovation and support mechanisms involving clusters based on full sector collaboration and target setting to achieve zero-emission ambitions. (Alberta, Norway, UK)
- A strong focus on supporting international competitiveness through commercialization and export support. (Innovation Norway, NERA Australia)
- Incentives: Policies and regulations that encourage positive behaviours, including tax incentives, carbon taxation, export support. (Alberta, Norway, UK, Australia)
- Disincentives: Regulations that encourage the phasing out negative behaviours and technologies and adoption of new technology. (Australia – Coal Industry)
- Established innovation ecosystems with centres of excellence / innovation centres / demonstration centres / tech parks to foster collaboration between academia and industry, including clean tech clusters, supporting the full innovation lifecycle through to commercialization (Catapult, UK; SEVA, Norway and Centre for Sustainable Energy and Resources – Australia)
- International collaboration is encouraged and supportive to remain competitive, while also focusing on an area's unique value proposition. (Alberta – Digitization, Norway – Norwep)

## SUMMARY OF FINDINGS

The following table summarizes the findings from each jurisdiction, based on the analysis of both the quantitative and qualitative data collected from each jurisdiction. It demonstrates the activities and characteristics of jurisdictions that have made strategic decisions and significant investments to foster the growth of their clean technology sectors. It also illustrates how jurisdictions can prioritize activities and possibly bridge gaps to build stronger clean tech sectors for their own respective economies.

| | Economic Position* | Regulation and Policy | R&D Framework | Innovation Funding | Supply Chain | International competitiveness | Innovation Ecosystem |
|---|---|---|---|---|---|---|---|
| **Newfoundland and Labrador** | Extreme fiscal challenges, potential for early decomissioning | Low agility and high complexity re: federal and industry regulations. Low accountability. | Strong university and operator involvement. No established R&D priorities. | Significant investment in oil and gas related R&D. Low awareness on programs. Thresholds are too high. | Strong industry support for supply chain (local content) , but industry is maintenance and operations heavy (low R&D intensity). | Strength in harsh cold ocean industries, remote sensing and characterization technologies | R&D innovation hub around for expertise. Limited support for demo and piloting. No innovation centre or tech parks. |
| **Alberta** | Struggling with downturn and high emissions. Cleantech sector is growing. | Regulation policies on initiatives related to clean technologies in oil and gas | Strong. Institutinal support around R&D in Alberta | Tied in well to federal funding programs | Supply chain has been disrupted due to the oil and gas downturn | Developing competitive cleantech for onshore oil and gas. Demand in the US. | Strong innovation ecosystem, where large amounts of capital and collaboration schemes are present |
| **NCS** | Strong capital and innovation position, pending change in carbon tax will impede growth | Maximize value of hydrocarbon while seeking carbon efficiency; Early movers on climate tech; Collaboration on economic priorities | Strong mandate and oversight. State-driven R&D priorities – reported and monitored | Significant funding. Highest GDP/capita public expenditure on cleantech R&D. | Green transition package' of NOK 3.6 billion. Significant diversification through big projects. | Significant export support; limited success on clean tech export, but early movers on floating wind; moving towards picking winners | National and regional clusters; Support for full TRL lifecycle; Complex ecosystem that is difficult to navigate |
| **UKCS** | Substantial economic strength. A hub for global companies and innovation. Economic position under stress with Brexit | Centralized policy and regulation; big industrial projects; Maximize value of hydrocarbon | Strong mandate and oversight. State-driven R&D priorities – reported and monitored | Gov funding encourages private/public; Support across innovation lifecycle; R&D expenditure to reach 2.4% of GDP by 2027 | Green transition package similar to Norway, driving change thorugh large megaprojects; significant support | Early movers on cleantech, developing competitive industries to challenge Denmark and others | National and regional clusters; Municipal investments; Strong regional leadership from Aberdeen; Support for full TRL lifecycle |
| **NWS** | Transition from coal into natural gas and further into renewables and hydrogen. | Political challenges around regulation/ policy i.e. carbon pricing. Hydrogen to Japan project. | Strong academic universities and government institutions such as NERA that help promote R&D in the energy sector | Significant private sector and public sector funding around energy transition and optimization | Geographic challenges both nationally and internationally impact supply chain in the oil and gas sector | Some success, such as tech development in the Gorgon project, but overall not as competitive as some of the other jurisdictions reviewed | Change to energy supply, i.e. reducing coal; Challenges to power grid are significantly motivating innovation ecosystem |
| **GoM** | Economically very strong, investment focus towards solar rather than cleantech for oil and gas | No major incentives for clean technology in oil and gas. Prescriptive regulation and policy. More focus on HSE and status quo. | Strong academic institutions, national laboratories, and private sector labs mean significant R&D in the clean technology sector | Some government funding, but mostly driven by private sector | Supply chain is not as defined as other jurisdictions reviewed, especially around clean technology in oil and gas | United States is known for leadership in wind and solar, but not in oil and gas clean technology | Decentralized rather than collaborative. Cleantech ecosystem is based around productivity improvement and driven by private investment. |

**FIGURE 3** – *Summary of Findings*

## ALBERTA

In a low commodity price environment, clean technology's market potential is driven primarily from numerous policy and regulatory drivers. For Alberta-based oil and gas clean technology companies, a market push was created with the announcement in November 2015 of a new economy-wide tax on carbon dioxide emissions, a total emissions cap for oil sands operations, and the potential regulations forcing energy companies to reduce their methane emissions by 45% by 2025.

Unrelated to policy and regulation, digitalization is responding to a market pull for better data, connected assets, and cost efficiencies. The digital oilfield is expected to grow significantly in the coming decade. To meet regulatory objectives, Alberta oil and gas companies will require clean technology, which will benefit cleantech sector development in Alberta.

Traditionally, the oil and gas cleantech industry in Alberta has followed a similar pattern to oil and gas production. When production increases, cleantech sales increase, and vice versa when production declines. However, it is likely that a new paradigm is emerging where oil and gas-related cleantech investments will grow based on meeting the new and evolving regulatory environment to reduce the sector's environmental footprint.

Newfoundland and Labrador should follow Alberta's approach to industry/government/investor collaboration. There is a focus on commercialization in Alberta and the province is a driver in developing/supporting clean technology companies in the oil and gas sector through tax credits, regulations, and support entities.

## AUSTRALIA

Australia's focus on strengths and advantages has particular salience for the offshore oil and gas industry in Newfoundland and Labrador. An interesting observation is how it views clean technology from an 'energy' sector perspective rather than focusing on oil and gas. Viewing the sector from an 'energy' lens also ensures that institutional supports are more comprehensive, issues can be scaled quickly, and there is more collaboration/cooperation among different stakeholders.

The International Energy Agency (IEA)[9] suggests that a shift from "oil and gas" to "energy" provides operators with a way to manage transition risks and notes that some large oil and gas companies are set to make a switch to "energy" companies that supply a diverse range of fuels, electricity, and other energy services. This also has applicability to Newfoundland and Labrador.

In Australia, as in Newfoundland and Labrador, it is important to look across the entire economy to identify and foster the cross-sector transfer of technologies. Many technologies applied in one sector – such as mining and oil and gas - have benefits in other areas, either in creating employment or underpinning adjacent businesses, all the while reducing overall emissions.

## GULF OF MEXICO

The regulations for offshore oil and gas in the Gulf of Mexico are highly prescriptive. The conventional wisdom is that the European approach, led by the United Kingdom and Norway, is more management-based (i.e., responsibility for safety is shared among industry, workers, and government), while the U.S. approach is highly prescriptive (i.e., regulation is through command-and-control technology standards governing specific safety systems). Some of the differences in regulatory regimes may be attributable to the nature of the accidents. Accidents in the United States have involved crude oil, and the damages have largely been environmental. In contrast, accidents in the North Sea have more often been caused by structural damage or gas explosions that resulted in loss of life but limited environmental damage. In our review the Gulf of Mexico, most major regulatory changes in offshore oil have been in response to accidents.[10]

United States federal and state government mandates were and continue to be focused on increasing safety and environmental stewardship. This has resulted in advanced safety regulations and practices, promoted development of safety cultures, and developed accident mitigation technologies but there has not been as much movement in clean technology development. In addition, industry has responded with the development of new and revised standards and practices that help address environmental and safety

[9] Source: https://www.iea.org/reports/world-energy-outlook-2020

[10] Bennear, L. S. (2015). Offshore oil and gas drilling: A review of regulatory regimes in the United States, United Kingdom, and Norway. *Review of Environmental Economics and Policy*, *9*(1), 2-22.

concerns. For example, industry has created the Center for Offshore Safety, which focuses on promoting the highest level of safety in offshore operations and has developed a system for auditing and sharing lessons learned from the implementation of offshore safety and environmental management systems. In our review, we did not find the same types of standards and practices in relation to clean technology. It would seem that the Gulf of Mexico's focus on safety and environmental stewardship has been to the detriment of clean technology innovation and development in the offshore oil and gas industry. Overall, it would seem that the United States' Gulf of Mexico clean technology offshore oil and gas innovation ecosystem is highly dependent on individual stakeholders, such as companies and universities, with little collaboration or coordination at a state or national level.

### NORWAY

There are many learnings that Newfoundland and Labrador can take from Norway, but it is incredibly important to understand that this is not comparing apples to apples. As a sovereign state with world leading hydrocarbon reserves and major investment capital, Norway's ability to invest in its energy transition is significantly stronger than Newfoundland and Labrador's. However, the province can learn from areas where the investment of human capital is needed, such as through strategic leadership to drive change, improve governance and policy development as well as demand collaboration and use of clusters to drive innovation and market growth. Newfoundland and Labrador should leverage the province's ocean tech and marine expertise and position itself as a potential collaborator in innovation, particularly in areas of interest for Norway, such as harsh environment, ocean innovation, clean tech, and digitalization.

Newfoundland and Labrador, like Norway, will soon solely rely on hydro electricity for its energy needs. Norway has also been a leader in the digitalization of its oil and gas industry. The province should fully investigate the opportunities relating to hydrogen and better understand how Muskrat Falls could support the Canadian energy transition. There are also important learnings the province should consider relating to its supply chain and workforce's development to support the digitalization of the province for the oil and gas industry.

### UNITED KINGDOM

There are many learnings that Newfoundland and Labrador can take from the United Kingdom, but it is incredibly important to understand that the UK, like Norway is a sovereign state, has substantial investment capital, and is making significant investments to drive its energy transition. The province can however, learn from areas where the investment of human capital is needed, such as through improved governance and policy development as well as improved collaboration to drive change. Learning from the Sir Ian Wood report, it can drive regulatory reform to improve performance, support the maximization of its resources and force collaboration across industry.

Based on our review of the UK, Newfoundland and Labrador could consider new forms of financing, such as green bonds and private sector partnerships to finance energy transition projects and the growth of the province's cleantech sector. There are also learnings from smaller municipalities such as Orkney that could serve as an analogue for how the province can grow its cleantech sector.

## SUMMARY OF OBSERVATIONS

Based on the review of the jurisdictions, some of the major findings between Newfoundland and Labrador and the other jurisdictions analyzed in this study can be found in Figure 4 - *Basin Comparison Between Newfoundland and Labrador and Identified Jurisdictions.*

**Basin comparison between Offshore Canada and peer group**

| Peer group | Similarities | Differences |
|---|---|---|
| ***Norway*** | • Mid life-cycle basin with production peak ahead.<br>• Similar facility setup like NL, with several large Concrete GBS and FPSOs forming production hubs, but also some steel platforms<br>• Low engineer intensity per produced barrel, but high share of workers that works in the oil and gas industry<br>• Harsh environment, ice challenges in Northern Barents Sea<br>• High potential for bottom-fixed and floating offshore wind | • High competence supplier industry in all service segments<br>• Very competitive tie-back discoveries that's sits low on the cost curve, low lifting costs on producing fields<br>• Very limited flaring and low emission intensity, efficient gas evacuation through partly state-owned pipeline grid.<br>• Equally weighted towards oil and gas developments |
| ***United Kingdom*** | • Harsh environment and mostly shallow water depths<br>• High potential for bottom-fixed and floating offshore wind<br>• Lower flaring levels than NL, but slightly higher emission intensity. Likely a function of more fields in tail-end production | • Most mature region among the peer group, high lifting cost and significant decom agenda.<br>• Smaller steel platforms rather than larger field centers.<br>• Close to shore and to supply bases.<br>• High competence supplier industry in all service segments, with large share of engineers per barrel produced |
| ***NW Australia*** | • Similar remoteness, far from shore, limited population near developments<br>• Local supplier industry largely centered on maintenance, logistics and fabrication<br>• Few production hubs. Compared to other peers, this is the region with the most similar production levels to offshore Canada | • Deep waters and mostly subsea to shore developments<br>• Gas heavy region, and low emission intensity.<br>• Mid life-cycle basin with flat production going forward, but infrastructure is younger than Canada |
| ***US GoM*** | • Similar basin maturity as NL and heavily weighted towards oil fields<br>• Technically challenging developments due to ultra deep waters and high pressures.<br>• Far from shore, logistics intensive in the deepwater part of US GoM.<br>• Similar emission intensity, break-even prices and lifting costs. | • Deepwater region, but benign environment outside hurricane season<br>• Limited flaring with established pipeline evacuation network for gas<br>• High competence supplier industry in all service segments |
| ***Alberta*** | • Significant emission challenge with high share of flaring and energy intensive extraction (oil sands).<br>• Under same federal regulation. | • Only onshore region among peer group<br>• Short lead and payback times (exception of oil sands) Individual well by well decisions rather than large mega projects<br>• Varied asset mix with shale, heavy oil and oil sands.<br>• Supplier industry focused on well service, a segment where Newfoundland and Labrador has limited presence. |

**FIGURE 4** - *Basin Comparison Between Newfoundland and Labrador and Identified Jurisdictions*

## THE CLEANTECH OPPORTUNITY - OPERATIONS

The unique attributes of the offshore Newfoundland and Labrador oil and gas sector combined with the characteristics of the supplier industry makes a certain technology space particularly relevant for the province. As pointed out earlier, the offshore oil and gas sector in Newfoundland and Labrador is made up solely of oil fields, have topsides that can handle more weight and equipment and is located further from shore, which results in high logistics intensity. Moreover, the onshore market has a high share of hydropower and other clean energy. The relevant technologies will need to thus target these attributes. In addition, given the particular challenges related to cost and emissions, the targeted technologies should aim to reduce emissions without challenging commerciality. With the mindset of treating uniqueness as a comparative advantage, there are several technology areas that could use offshore Newfoundland and Labrador as a testing ground.

**Limit Water Cut.** The first set of technologies are particularly relevant for oil fields. A large share of the power generation offshore is used for to process and inject water and gas back to the reservoir. Technologies that limit water cut will not only increase output, but also reduce emissions given that all power is currently generated by gas turbines offshore Canada. Water diversion (EOR measure), smart wells and AICVs are all technologies that should be relevant to apply.

**Onshore Power Mix.** The second group of technologies would take advantage of the clean energy in the onshore power mix. The power mix in Newfoundland and Labrador has a very high share of hydropower and other renewable sources, which means that a significant share of emissions could be reduced by powering the platforms from shore. However, there is a known challenge is the bringing high voltages through the turrets of the FPSOs. Furthermore, HVAC would typically be the preferred method of bringing

power from shore, but with the long distances and high-capacity requirements, this is technically challenging. An alternative is to apply HVDC, but that typically requires large topside converters.

**Topside Flexibility.** The third set of technologies targets platforms with topside flexibility. A key issue for reducing emissions offshore is the need for modifications to the topside facilities. In many cases these modifications could challenge the topside weight limitations of the facility. Examples of technologies that require large topside modules are compact topside CCS, retrofit of combined-cycle turbines and DC converters related to power from shore. Newfoundland and Labrador is in the unique position that the facility concepts developed typically can handle heavier and larger topside loads.

**Logistics Intensity.** The last set of technologies are related to the logistics intensity. The long distance from shore to the fields offshore in Newfoundland and Labrador entails a high need for logistics services, such as helicopters and vessels. In fact, the vessel use is estimated to make up around 10 percent of the total upstream emissions[11]. There are two ways to target these emissions, either through measures to optimize energy use or measures to replace MGO fuel to reduce direct emissions. There are several ways to optimize energy use from route and weather optimization to more technical solutions such as battery peak shaving and advances in vessel design. There are several pathways to replace MGO fuel, including LNG, biofuels, hydrogen and ammonia, and batteries. This could be a part of the development of a larger value chain to supply green fuels.

Similar to vessels, one other option to reduce logistics intensity is through the optimization of operations on the platforms offshore. The use of machine learning techniques to big data generated on offshore platforms aims to ensure better optimization of maintenance routines and increased prevention of unplanned equipment failure and maintenance. This will in turn reduce the need to logistics services. Moreover, this would be a good fit with the supplier industry in Newfoundland and Labrador as a large share of service companies in the region operate within the maintenance and operations space.

[11] Includes all scope 1 emissions associated with the upstream production of oil and gas, including extraction, flaring, and production drilling, in addition to emissions associated with logistics, including vessels and helicopter transport.

## RECOMMENDATIONS

The following is a summary of this report's recommendations, based on learnings from other oil and gas producing jurisdictions, to support Newfoundland and Labrador's clean technology innovation growth.

### REGULATORY AND POLICY

1. To achieve its net-zero commitments for 2050, Newfoundland and Labrador should prioritize the following:

    - Establish industry-lead organizational capacity to support the province's energy transition and growth of its cleantech sector.
    - Develop a supporting strategy with explicit emission reduction targets, a supporting implementation plan that has specific milestones and an accountability framework and includes an emissions trading system.
    - Develop policies or regulations that promote lower emitting developments, such as a natural gas royalty regime and a third-party tie-in practice.

2. Oil and Gas Regulators: Establish a regulatory culture that drives constructive collaboration to maximize the value of the province's offshore oil and gas resources, including the following:

    - Performance-based regulations that encourage more rapid development, demonstration, and adoption of clean technologies.
    - A forum or open sharing requirement where data is shared. Cross sector collaboration can develop with open data on the journey to achieve net zero.
    - Offshore acreage is awarded considering the use of best available clean technologies.

### RESEARCH AND DEVELOPMENT FRAMEWORK

1. Establish an over-arching innovation entity that is appropriately resourced and drives the province's innovation agenda.
2. Develop and steward a collaborative framework, including industry, regulators, and government, that defines targets, R&D priorities, develops strategy, achieves alignment, and establishes an accountability monitoring framework.
3. Identify and prioritize support to "winning" or strategically stronger companies/innovations. Consider breakthrough technologies or significant industrial projects.

### INNOVATION ECOSYSTEM

1. Establish an innovation ecosystem, including centres of excellence, innovation centres, demonstration centres and tech parks, which fosters collaboration between academia and industry, encourages start-ups and supports clean tech clusters and supports the full innovation lifecycle through to commercialization

2. Establish a cleantech-focused center of excellence (as part of a larger Innovation Centre) as an area of specialization to support business growth, boost provincial levels of innovation, foster international partnerships and commercialization.

3. Develop a provincial talent plan that supports job creation and the transition to a low-carbon economy, focusing on digitalization, STEM and business management skills.

### Innovation Financing

1. Ensure businesses can access government R&D, business development and growth funding: Ensure programs are configured so NL companies can meet the application criteria. Ensure local companies are aware of funding programs and are guided to avail of these funding/financing opportunities.

2. Implement investment attraction programs that include incentives to make emission reducing activities more attractive for investment, considering the following:

    - VAT reductions, angel investor tax credits and other tax incentives to make emission reducing technologies more investible.
    - Green bonds, cleantech growth funding or carbon tariffs to finance energy transition, carbon reduction measures, SME diversification and early-stage growth.
    - Incentivize existing Tier One contractors to bring corporate energy transition, digitalization, clean tech innovation and/or business growth initiatives to their NL offices

**SUPPLY CHAIN**

1. Prioritize the digital growth of the province's oil and gas supply chain to contribute to reduced industry carbon emissions, improved efficiencies and reduced costs, which will, ultimately, improve the industry's competitiveness.
2. Encourage sector collaboration through resourced industry associations and support the development of regional cluster activities to support supply chain growth.

**INTERNATIONALLY COMPETITIVE**

1. Prioritize and invest in international market development:

    - Strengthen export programs, marketing programs and international agreements to support ocean tech and cleantech services, innovation and market development
    - Prioritize NL's strong value proposition in ocean technology, biodiversity, and remote sensing to maximize funding opportunities and share learnings.
    - Market Muskrat Falls renewable opportunity to international corporations re: green hydrogen opportunity.
    - Study potential of mineral and hydrocarbon resources that could add value to clean technologies and new energy solutions
    - Position Newfoundland and Labrador as an energy hub.

Overall recommendations are divided from a prioritization standpoint as follows:

**QUICK WINS – NEXT 6 TO 12 MONTHS**

1. Establish organizational capacity to support energy transition and growth of a cleantech sector (collaboration, strategy development, funding, export support)
2. Compel regulatory and policy change to net-zero commitments (net-zero strategy and implementation, policy and regulations to support lower emission developments)
3. Investigate opportunities/Business case advancement (clusters, hydrogen, collaboration digitalization, green bonds, mineral resource review, carbon pricing)
4. Leverage programming and support networks (federal funding programs, expand international network)

**MEDIUM TERM – 12 TO 24 MONTHS**

1. Prioritize international market development (export programs, market Muskrat Falls, define value proposition)
2. Advance innovation financing strategies (investment attraction, access to capital and funding, green bonds)
3. Focus on supply chain opportunities (digitalization, sector collaboration, diversification)

**LONGER TERM – 24 TO 36 MONTHS**

1. Foster an innovation entity and ecosystem development (clean tech center of excellence, talent planning, infrastructure and systems that support innovation lifecycle, pick winners, strategic priorities)
2. Drive a collaborative regulatory culture in clean technology (maximize value of hydrocarbon resources, performance-based regulations, open data sharing, encourage using best available clean tech)

## INTRODUCTION TO THE OFFSHORE CANADIAN OIL AND GAS INDUSTRY

Offshore Canadian oil and gas production is currently isolated to the waters off the coast of Newfoundland, despite historical exploration activity along the northern and eastern coast of Canada (see Figure 5). Further east off the coast of Newfoundland is the Jeanne d'Arc Basin and the Flemish Pass Basin. The Jeanne d'Arc Basin is a liquids-rich basin that began production with Hibernia in the late 1990's and has since seen production from Terra Nova, White Rose, and most recently Hebron. During the last decade, the basin has been characterized by large maturing fields nearing tail-end production. However, the startup of the Hebron field and the development of the West White Rose field is expected to breathe new life into the region. Production here is forecasted to continue well into the 2030's with remaining commercial resources in all fields. The liquids-rich Flemish Pass Basin is expected to start producing after 2025 when Bay du Nord comes online, although the commercial feasibility of this project is at risk with uncertainty surrounding future oil demand and resulting commodity prices.

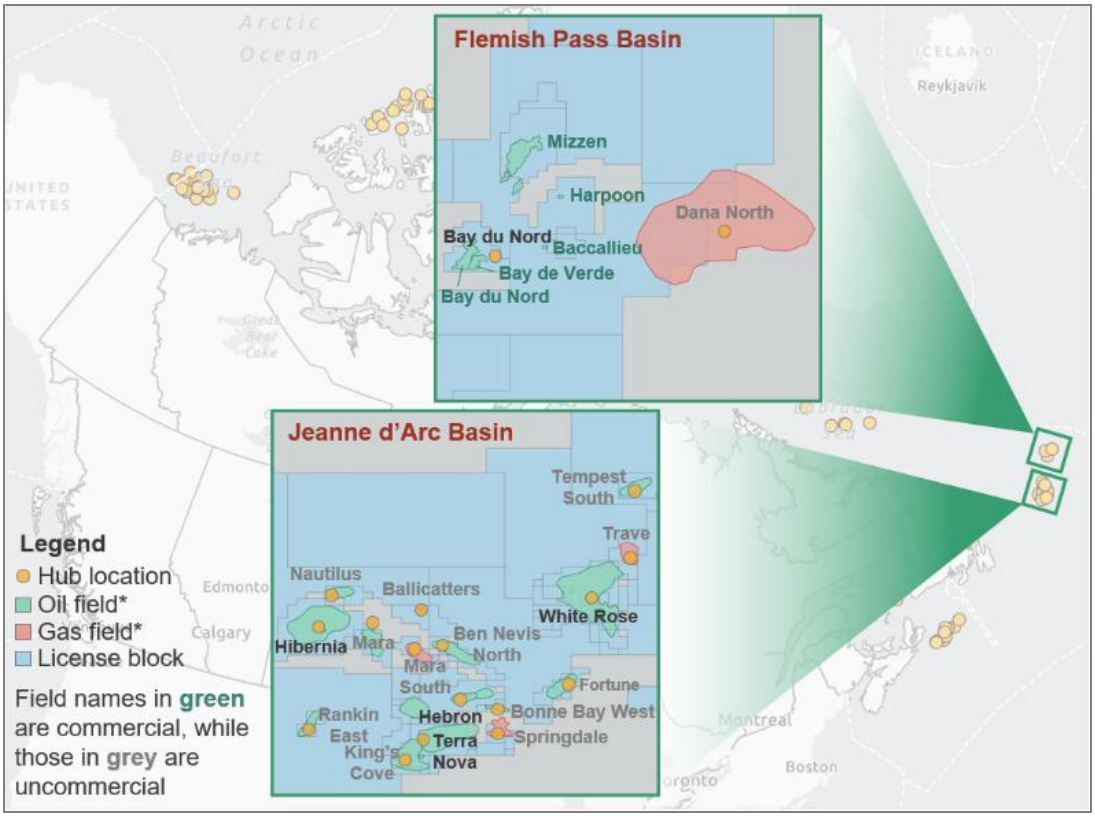



**FIGURE 5:** *Areas of interest in offshore Newfoundland and Labrador, where an oil field is defined as having initial reserves of 40 percent or more liquids.*

## COMPARABLE REGIONS AND OFFSHORE CANADA'S UNIQUENESS

When diving into the cleantech opportunity space for offshore Canada, we introduce some comparable regions to be able to see in which ways Canada stands out. The offshore regions that we compare are Norway, the UK, other North West Europe, US Gulf of Mexico, Brazil, West Africa, Middle East, and North West Australia. We also compare offshore Canada against some onshore regions, namely Alberta, the Middle East and the Lower 48 region. We look at all shale, oil sands and onshore conventional production in Alberta, and shale and onshore conventional in the Lower-48 region.

Offshore Canada has a unique set of characteristics. Firstly, it now consists solely of oil fields. Out of the benchmark regions, Alberta oil sands is the only other region where this holds true. In general, oil fields are more power intensive with a need to inject to separate and inject water and/or gas to maintain pressure support. This could allow for a more focused effort on technologies for oil fields.

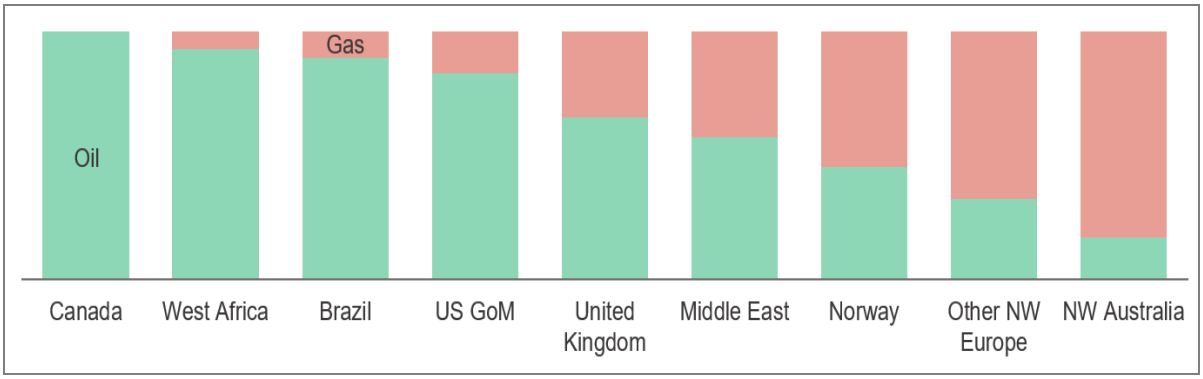



**FIGURE 6:** *Comparison of the oil and gas share of the production in 2019 for comparable offshore regions*

Secondly, around 80 percent of production in offshore Canada is produced with gravity-based concrete platforms or FPSOs. This is not found in any of the other benchmark regions and the closest comparable region is Norway with 35 percent of production stemming from such facilities. In general, these facilities allow for larger topside weight and are more readily modified compared to steel platforms and other floating production facilities. This represents a potential opportunity for technology adoption that requires large topside modifications.

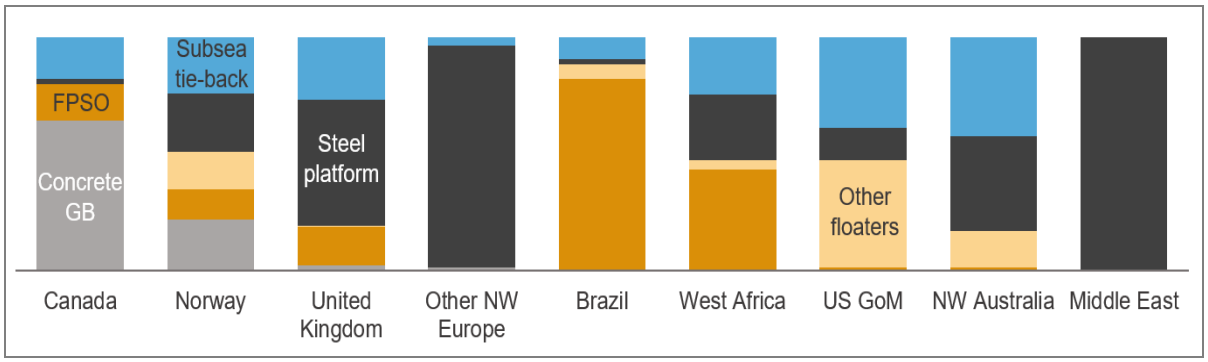



**FIGURE 7:** *Comparison of the share of facilities types weighted by production in 2019 for comparable offshore regions*

Third, the distances from the offshore Canadian facilities to the closest onshore base are by far the longest among the benchmark regions, with all distances exceeding 300 km. The production-weighted distance to base is 329 km, which is significantly longer than the second region on the list, which is NW Australia at 234 km. These long distances result in a high logistics intensity for both helicopters and

vessels. For helicopters, they are restricted to taking on fewer passengers to ensure enough fuel for the flight, which results in a higher number of flights. Vessels also have to travel further, and additional vessels are also required to be on standby for ice management.

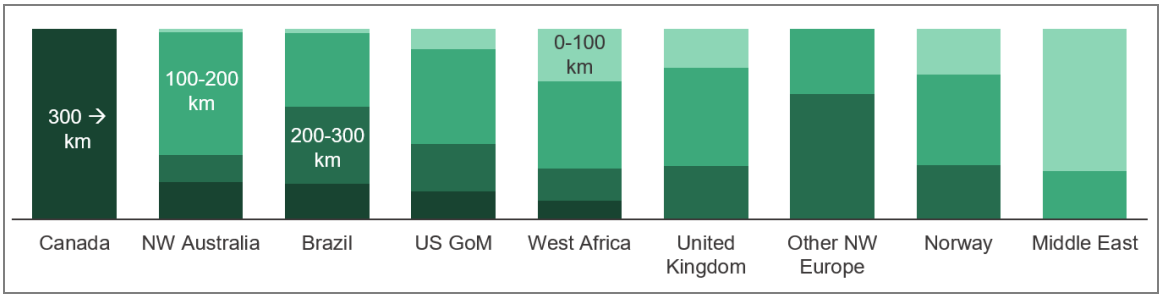



**FIGURE 8:** *Comparison of the water-depth share of the production in 2019 for comparable offshore regions*

Fourth, the climate in offshore Canada is harsh. All the facilities are located in waters where the average wave height is more than 2.5 meters. None of the other regions come close to this and the closest ones are Norway and the UK, where only 20 percent of production stems from facilities that face similar wave heights. Furthermore, offshore Canada is also among the regions with the highest average wind speeds offshore, with an average wind speed of 10.3 m/s. These wind speeds could provide the basis for clean energy production on platforms, however, challenges related to floating ice could be a barrier to this.

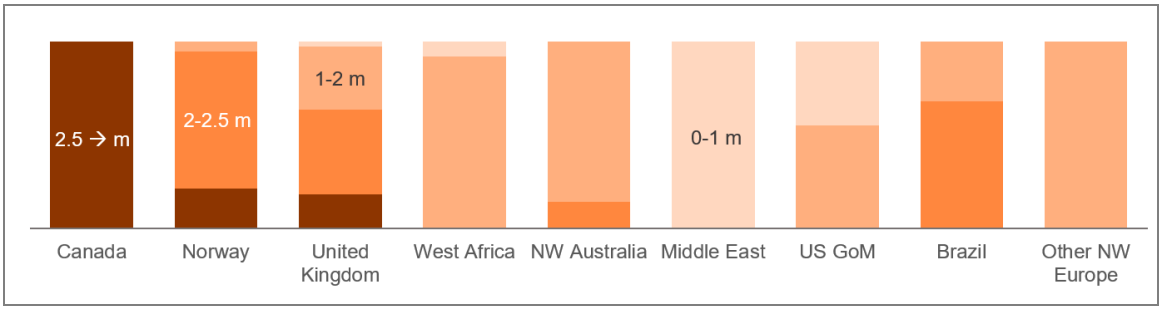



**FIGURE 9:** *Comparison of average wave height weighted by production in 2019 for comparable offshore regions*

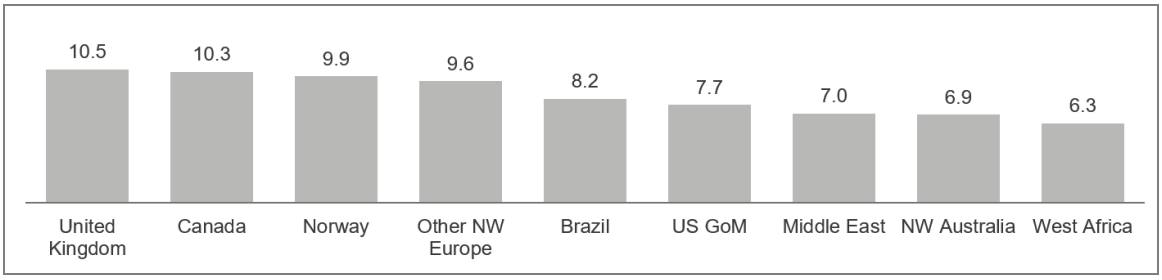



**FIGURE** *10: Comparison of the average wind speed in comparable offshore regions*

The Newfoundland and Labrador power mix is already very clean, with about 95 percent being generated by hydropower. This provides a unique opportunity to supply energy to the Canadian oil and gas industry through electrification of offshore fields, among other things.

## THE EMISSIONS AND COST CHALLENGE

The intensity of offshore Canadian assets has increased from 10 kilograms of $CO_2$ per barrel in 2000 to 17 kilograms per barrel in 2019 (see Figure 11).[12] The intensity can be reduced by producing additional volumes of oil (generally through tiebacks) or through the implementation of emission reducing initiatives, such as reduced flaring, combined cycle turbines or electrification of the hub. Since 2015, intensity reductions of around six kilograms per barrel have been observed in offshore Canada due to the start-up and ramp-up of the Hebron field.

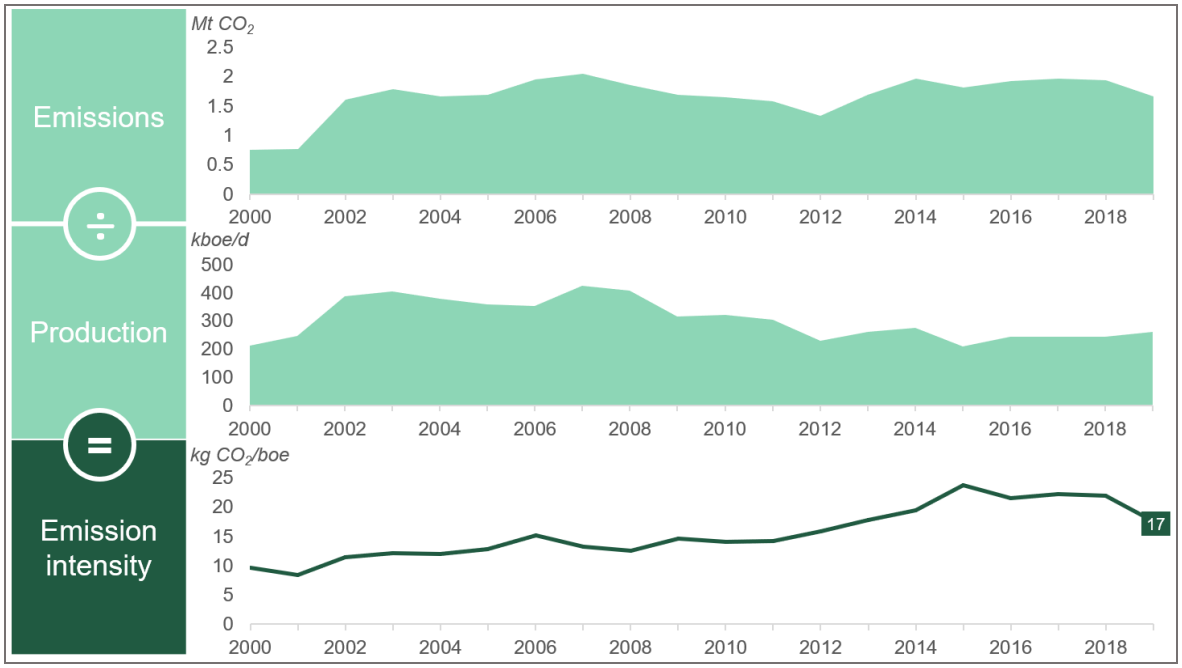



**FIGURE 11:** *Offshore Canadian emissions, production, and intensity for 2000-2019.*

[12] Intensity describes the emissions associated with each barrel of oil produced (kgCO2/boe). Unless otherwise stated, emissions in this report are defined as all scope 1 emissions (direct emissions from the activities of an organization under their control) associated with the upstream production of oil and gas, including extraction, flaring, and production drilling. Emissions associated with vessels and helicopter transport are not included in the emissions values quoted in this report.

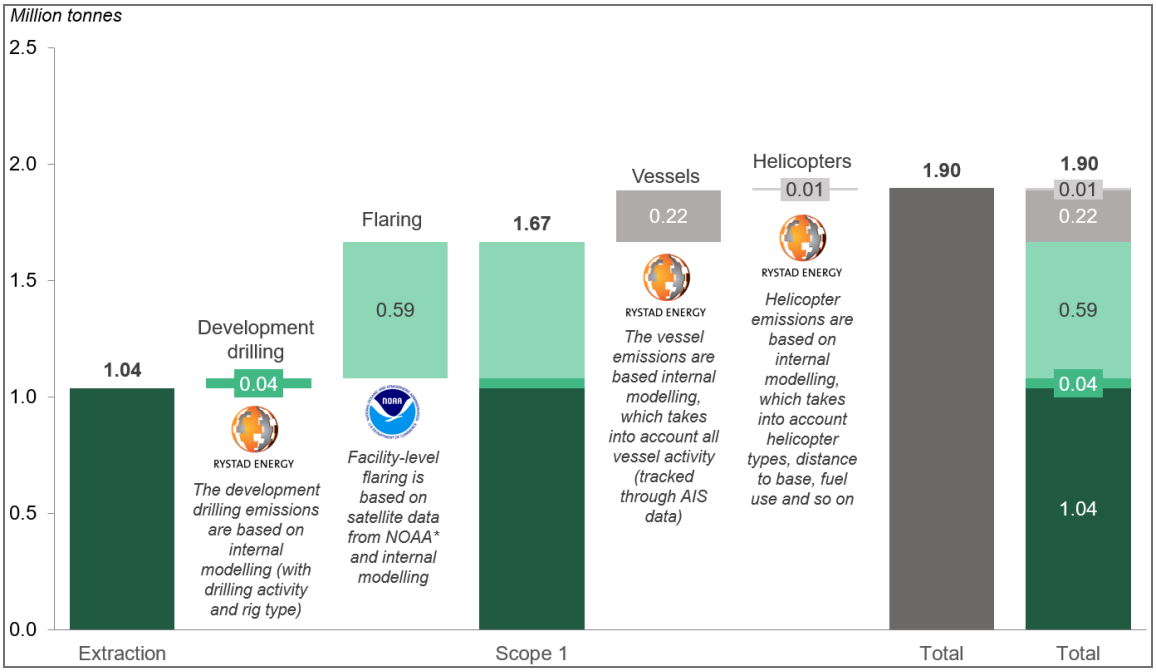



**FIGURE 12:** Breakdown of total $CO_2$ emissions offshore Canada in 2019.[13]

Scope 1 emissions from oil and gas operations off the coast of Newfoundland totaled 1.67 million tonnes of $CO_2$ in 2019 (see Figure 12). In addition, the logistics intensity related to the offshore oil and gas production amounted to around 0.23 million tonnes of $CO_2$. These emissions sources account for around 1 percent of the total upstream emissions of Canada's oil and gas industry combined.

In 2019, ExxonMobil accounted for 55 percent of the Scope 1 emissions, followed by Suncor with more than 30 percent, and Husky Energy with roughly 15 percent. The emissions associated with each barrel of oil produced varies significantly across these operators and their assets (see Figure 13). While the 2019-average for the province was 17 kilograms of $CO_2$ per barrel, Terra Nova and White Rose were significantly higher with 49 and 33 kilograms of $CO_2$ per barrel, respectively. For the same year, Hibernia and Hebron had much lower intensities at 13 and 10 kilograms of $CO_2$ per barrel, respectively. This places Newfoundland 8th for emissions intensity out of the selected peers[14], with a higher intensity than Norway, the Middle East, and NW Australia, but a lower intensity than the UK, West Africa, and conventional onshore Alberta (see Figure 14a).

[13] Data provided by the Government of Canada; National Oceanic and Atmospheric Administration (NOAA); Norwegian Coastal Administration; FlightAware; and Rystad Energy Ucube. Vessel traffic information is taken from the AIS data.

[14] Norway; United Kingdom; NW Australia; Alberta (onshore conventional and shale); Brazil; United States Gulf of Mexico (US GoM); Middle East: Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and UAE; West Africa: Angola, Congo, Ghana, Nigeria; Other NW Europe: Denmark and Netherlands; United States Lower 48 (L-48): contiguous continental United States, thereby excluding Alaska and Hawaii.

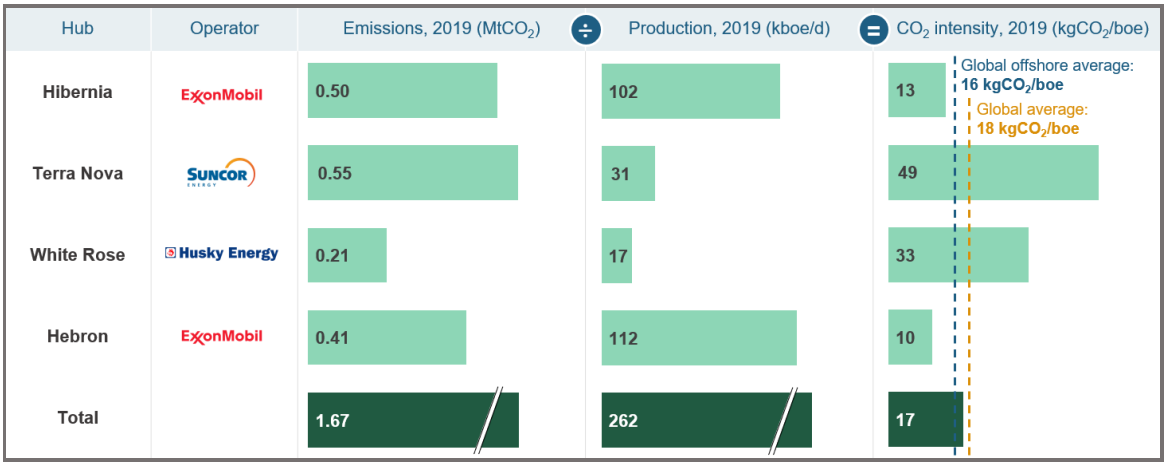



**FIGURE 13:** *Hub intensity in 2019*

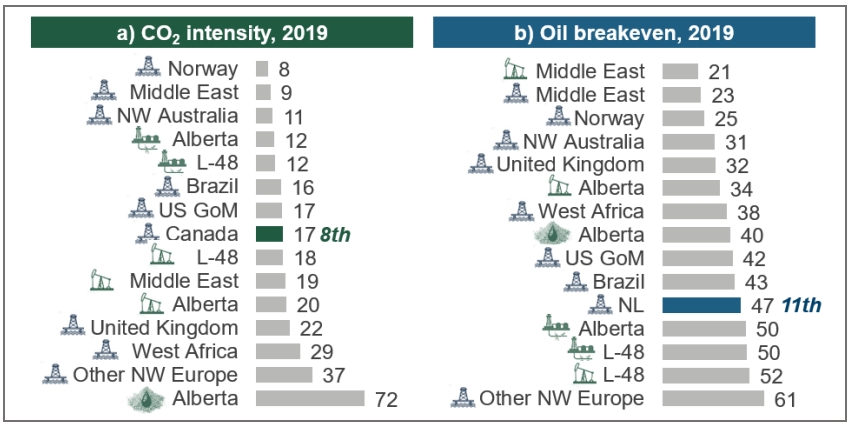



**FIGURE 14:** *a) 2019 upstream $CO_2$ intensity including extraction and flaring. b) 2019 oil breakeven for oil and gas-condensate fields sanctioned 2016-2020*

From a cost level perspective, offshore Canadian production faces significant competition from other regions. For greenfield assets sanctioned between 2016 to 2020, the average full-cycle breakeven cost of offshore Canada is 47 USD per barrel, which is at least 50 percent higher than assets in the Middle East, offshore Norway, and offshore UK (see Figure 14b). The average internal rate of return of projects in these regions is also higher than offshore Canada (21 percent). Looking to future developments, there is one large, planned project offshore Canada, namely the Bay du Nord project. The commerciality of the Bay du Nord project is under pressure. The project sits relatively high on the global cost curve and sanctioning is uncertain in low demand scenarios.

Looking forward, one of the key obstacles for operators to maintain a low intensity will be the declining output of their fields (see Figure 15). Based on production and emissions forecasts for currently sanctioned fields, the emission intensity for offshore Canada will continue to increase to 23 kilograms of $CO_2$ per barrel in 2030 then rapidly increase to over 40 kilograms per barrel by 2040. For this reason, the Bay du Nord project is critical for increasing produced volumes and to maintain a reduced emission intensity. Volumes from currently non-sanctioned discoveries, including Bay du Nord, will be able to suppress the intensity to between 14 and 19 kilograms per barrel, but this will increase to around 26 kilograms per barrels by 2040. New discoveries or emission reduction strategies will be required in order to maintain or even improve upon the currently observed emission intensity towards 2040. New fields with Combined-Cycle Gas Turbines that yields higher efficiency or electrification of existing facilities could bring emission intensities significantly down, well below the 10 kg CO2 per boe mark.

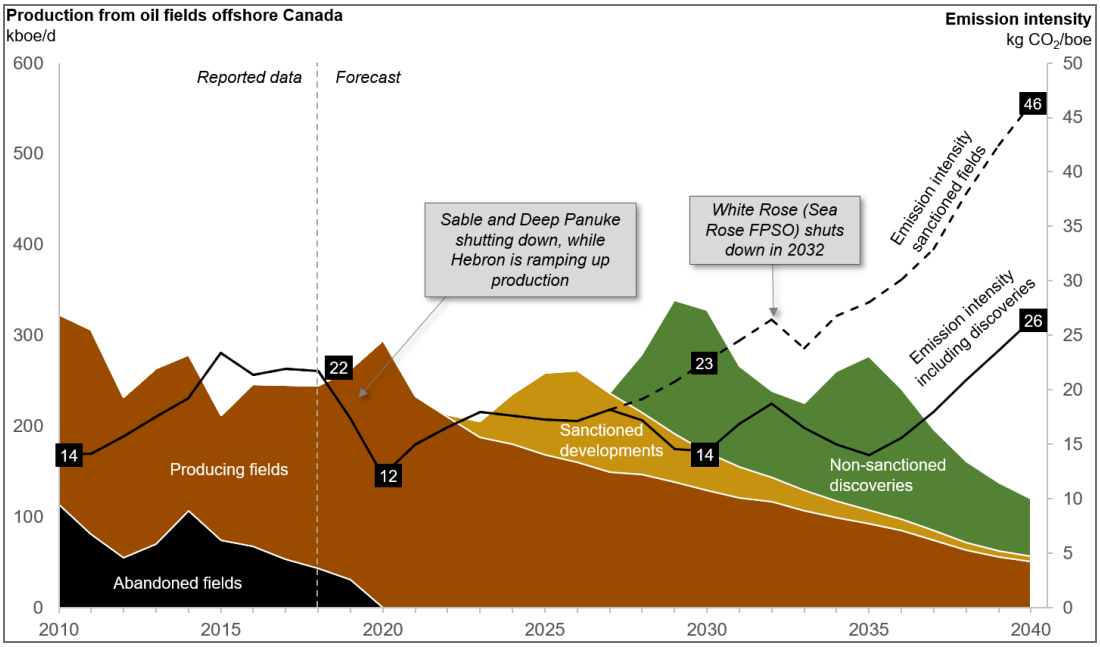



**FIGURE 15:** Historical and forecast production and emission intensity for offshore Canada split by sanctioned fields and unsanctioned discoveries.

The current lifting cost of producing fields is at a level of USD $9 (CAD $11.55) per barrel (see Figure 16). This is competitive compared to other regions and largely a result of having large production hubs. Once the lifting cost approaches the level of the oil price, the field will be at risk of shutting down. Even when looking only to producing and sanctioned fields we expect the levels to remain competitive and commercial. As such, the economics on these fields will likely be robust enough to apply brownfield cleantech technologies.

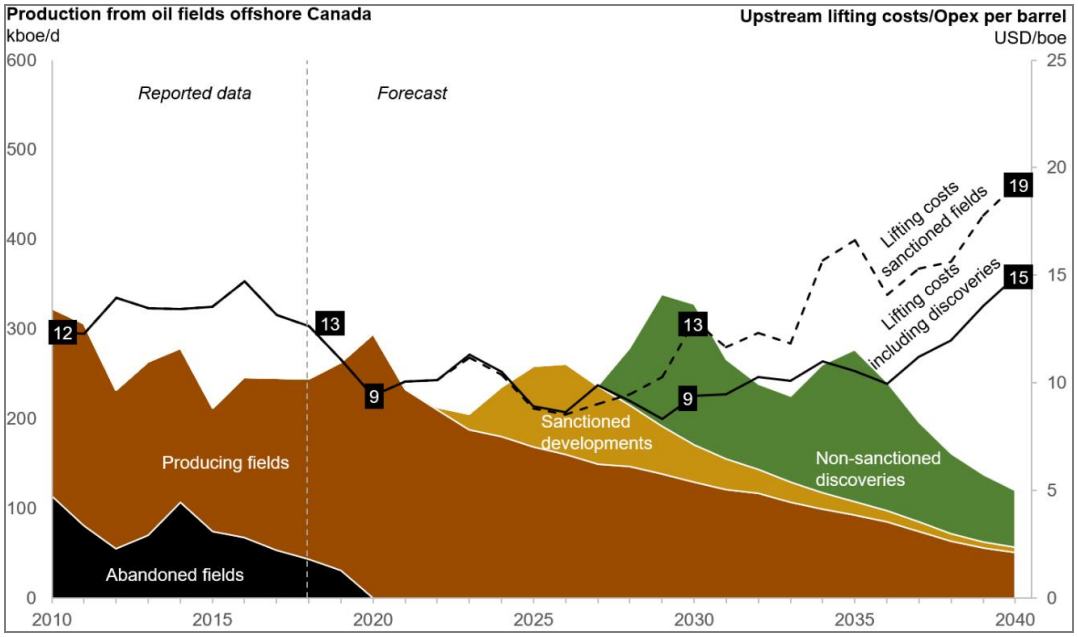



**FIGURE 16:** *Historical and forecast production and lifting costs for offshore Canada split by sanctioned fields and unsanctioned discoveries.*

Three of the four operators in offshore Canada have made commitments to reduce either their emission intensity or their gross emissions by at least 15 percent over the next decade, including Equinor, Husky Energy, and Suncor. Given the requirement for a reduced emissions intensity moving forward, in addition

to the high uncertainty relating to future oil demand, any successful cleantech development strategy will need to focus as much on cost reduction as it does on efficient, low emissions operations.

## THE SUPPLIER INDUSTRY CHALLENGE

There are more than 20 oil service companies that are headquartered in Newfoundland and Labrador, but most companies are small in terms of the number of employees and several are also delivering services to other sectors than oil and gas. These companies have delivered or are delivering services to all the major hubs offshore Canada that are currently producing, including Hibernia, Terra Nova, White Rose, and Hebron.

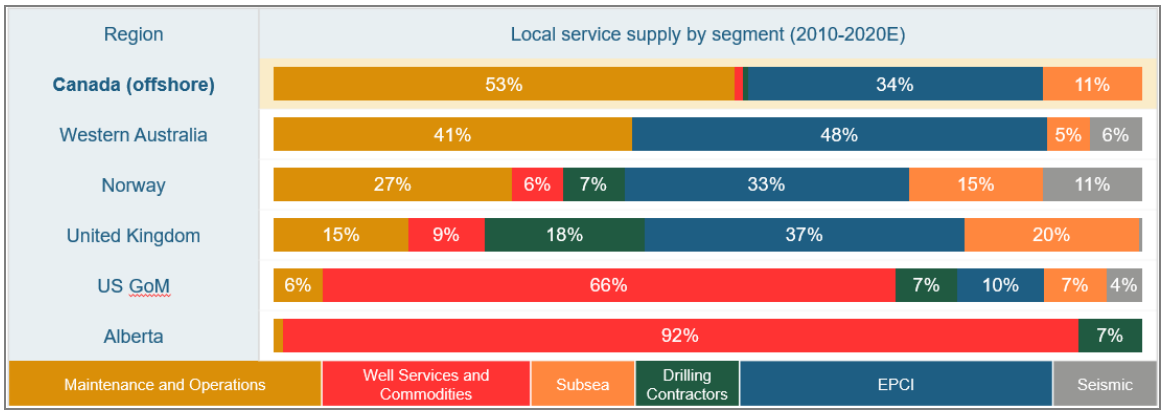



**FIGURE 17***: The supplier industry by service segment and jurisdiction, based on headquarters of supplier companies*

The key services that are supplied in Newfoundland and Labrador are maintenance and operations services- and EPCI-related services. This is similar to Western Australian service industry, which is also remotely located. The three other offshore regions have a broader oil service offering. The large share of well service and commodities in the US GoM is influenced by the nearby onshore market.

Approximately 53 percent of the service industry in Newfoundland and Labrador is related to maintenance and operations. Such services are needed throughout the life of a field, so it is therefore necessary that the service companies are based close to the basin in question. A piece of research conducted by Noia in 2019 revealed that the competitiveness of the supply chain in Newfoundland and Labrador is related to multiple factors including business capacity, operations, market experience and workforce skills. In the Noia research, several of the maintenance and operations-related segments came out best in the overall competitiveness ranking, with air travel, employment and workforce receiving the best scores. These findings support the strong position of maintenance and operations services in Newfoundland and Labrador.

There is also some capacity on EPCI services, and to a certain degree of subsea services, with companies that fabricate equipment needed for topside facilities and subsea production systems. Some companies are also involved more heavily in engineering and construction-related services.

Newfoundland and Labrador has less coverage on well and drilling services, as well as seismic services. These services are covered by large, international players, as they are typically needed for a shorter time span and international companies can provide these services at a lower cost. Based on Rystad Group's research, well- and drilling-related services are areas of the supply chain with the lowest competitiveness scores, both below average.

The oil service industry in Newfoundland and Labrador has a low competence base compared to the size of its offshore operations. One way to measure this is counting the number of engineers that are based in the region. When compared to its peers, it ranks 8$^{th}$ in terms of the number of engineers per boe (see Figure 18a) and engineers per spent BUSD (see Figure 18b), with the closest peer being Norway. Also similar to Norway, a high share of engineers work within the oil and gas industry.

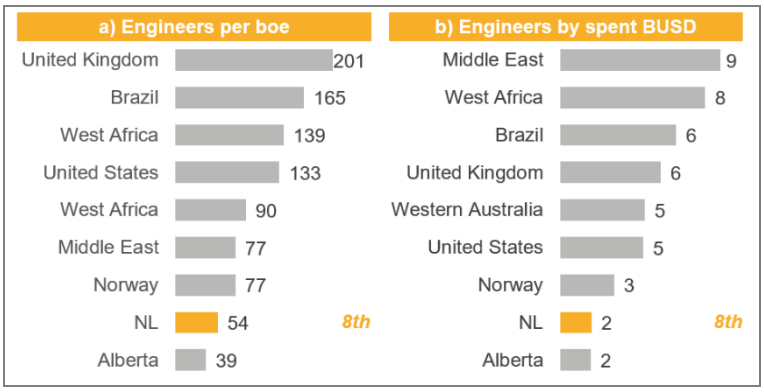



**FIGURE 18:** *The competence base of Newfoundland and Labrador relative to its peers*

In addition, the local supplier industry only covered 54 percent of the supply chain demand in 2015 in terms of number of jobs[15]. In 2015, Newfoundland and Labrador had 37 percent of its supply chain imports coming from international companies, primarily from South Korea, the UK, the US, and Norway. The same study found that the remainder of imports came from other Canadian states, with 27 percent from Ontario, 14 percent from Alberta, 11 percent from Quebec and the remainder from elsewhere in Canada.

[15] Jupia Consultants Inc. *Assessing potential: Newfoundland and Labrador's oil and gas supply chain.* August 2019.

## POLICY DRIVERS

Clean innovation and growing a clean technology sector depend on many categories of policies, including those that target different stages of technology readiness, economic sectors, technologies, and types of companies. According to Canada's Smart Prosperity Institute, accelerating clean innovation requires a mix of government interventions and policies that intervene at the right place across the innovation (TRL) lifecycle, as categorized in the following model:

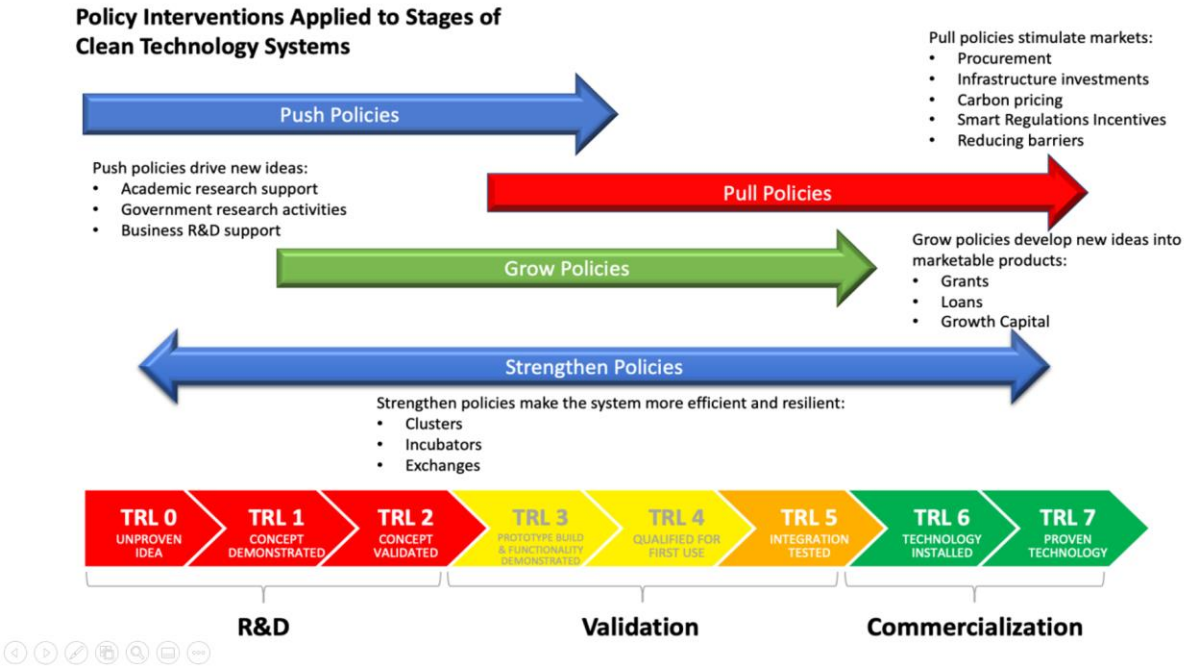



**FIGURE 19**: *Policy Interventions Applied to Stages of Clean Technology Systems*

**Pull Policies** seek to enhance the supply of technologies by providing incentives that reduce the costs of their development, such as direct financial incentives for low carbon energy supply and energy saving, regulation carbon pricing, and product and building standards and information campaigns. An example of pull policy is Australia incentivising voluntary emissions reductions through its Climate Solutions Fund, Safeguard Mechanism and ClimateActive carbon neutral certification framework.

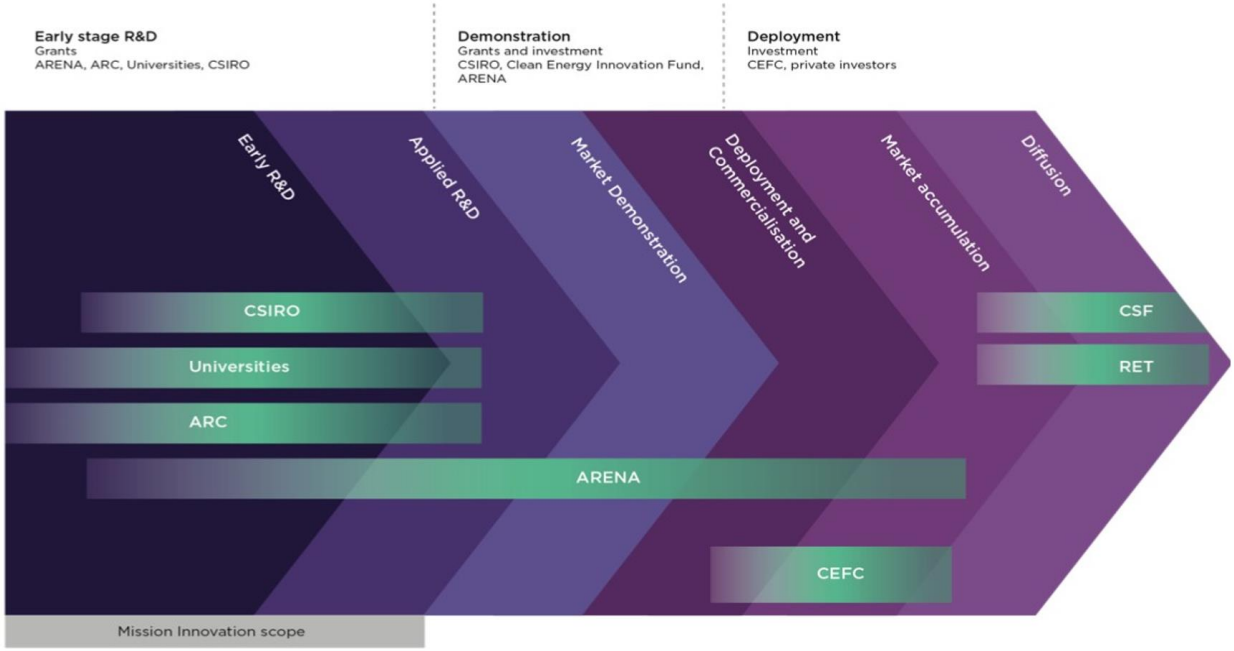
**Push policies** interventions foster technological change in technologies by stimulating their demand, where new ideas and inventions are generated through R&D (public and private), such as R&D tax credits, business incubation services, public grant programs, and through direct subsidies for research. For instance, Norway's Demo 2000 program aims to reduce costs and risks faced by the Norwegian supplier industry in developing new technologies by providing public funding to demonstration projects.

**Grow policies** help promising inventions move from the R&D stage to the point where they are ready for large scale market entry through what is called the "valley of death". It generally involves a proof of concept or an initial demonstration or pilot and then scales up through a series of larger and larger facilities. Norway, Australia, Scotland, and Alberta all have targeted programs, demonstration and innovation centres and tech parks to support this critical phase of the innovation lifecycle.

**Strengthen policies** support the ecosystem and magnify the impact of all other policies. These are generally in the form of skills, data/information, connections, accountability, and vision/strategy. The use of regional clusters in Norway is an example of a policy activity that is

supporting the whole innovation ecosystem. Another example is the UK making data openly and transparently available through a new National Data Repository and other digital platforms.

Jurisdictions with growing and maturing clean technology sectors use a mix of policy interventions such as funding and public institutions that support clean energy innovation from early-stage R&D to commercial deployment. Australia, for example, has Australian Research Council (ARC), CSIRO, ARENA, the CEFC, and cooperative research centres (CRCs). The following outlines how the Australian government is investing across the innovation chain.




Note: RET: Renewable Energy Target; CSF: Climate Solutions Fund.

**FIGURE 20**: *Policy Interventions for Clean Technology in Clean Technology*[16]

Some clean technologies require costly plants and equipment and longer time frames for testing and scaling up before they can get to market and realize a return on investment. This requires a combination of high capital needs and longer return periods, which makes financing extremely challenging as can be seen in Figure 21.

[16] Source: Australia Clean Tech Energy Review

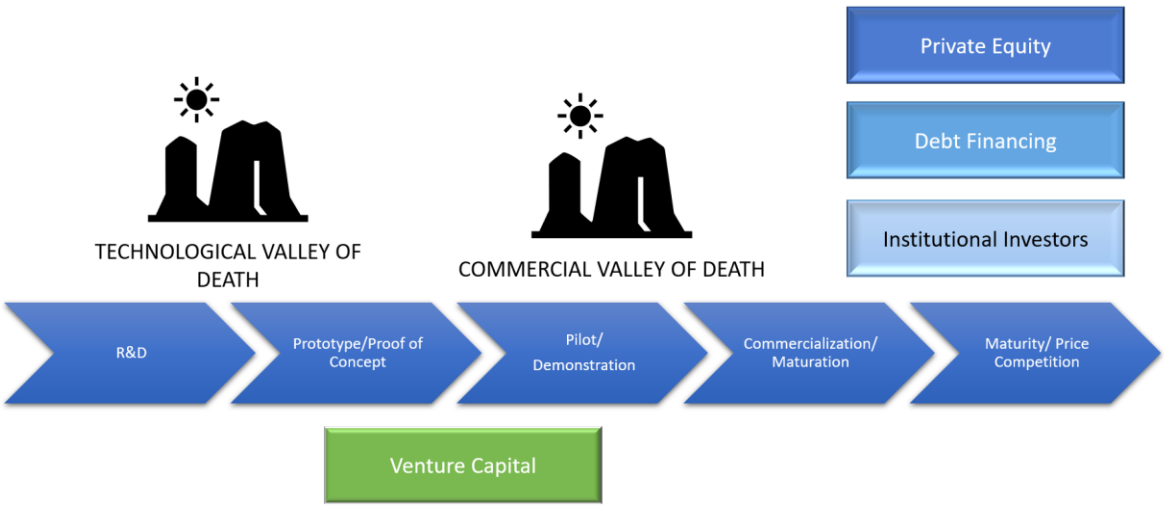



**FIGURE 21**: *Offshore Oil and Gas Clean Technology Innovation Lifecycle*

According to Norway's OG21 Technologies for Cost and Energy Efficiency, "technology demonstration is an especially challenging phase in the development of new technology. Technology demonstration requires both sufficient funding as well as access to suitable test facilities. Demonstration of new technologies at field level, especially offshore, could put large values at risk. This, in combination with decentralization and fragmented decision-making structures could introduce significant barriers towards demonstration of new technology." Moreover, there are challenges across the innovation lifecycle with gaps emerging as well as the importance of institutional supports, funding models as well as private sector interest to ensure the appropriate adoption of clean technology in the offshore oil and gas industry as can be seen in Figure 22.

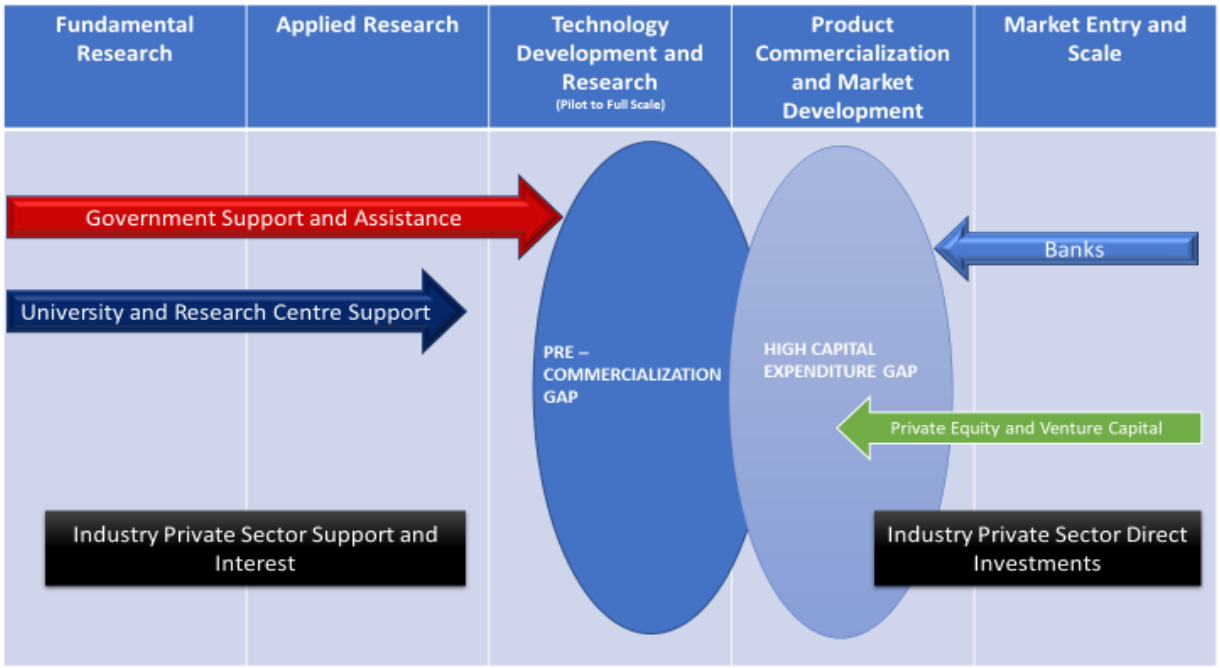



**FIGURE 22**: *Offshore Oil and Gas Innovation Gas and Mitigating Supports*

All of these policy drivers and innovation lifecycles help form the wider clean technology ecosystem.

## CLEAN TECHNOLOGY OVERVIEW

By technical definition, clean technology (also referred to as 'cleantech' or 'eco-innovation') reflects 'a diverse range of technologies, products, services and processes that measure, reduce, eliminate or remediate negative environmental impact, and/or improve the productive and responsible use of natural resources while returning a profit to the provider'.[17] However, more simply defined, a clean technology practice, product or industry is typically one that combines the three essential components of efficiency, environmental outcomes, and profitability.[18]

In Canada, clean technology is broadly defined as any process, product or service that reduces environmental impacts: through environmental protection activities, through the sustainable use of natural resources, or through the use of goods that have been specifically modified or adapted to be significantly less energy or resource intensive than the industry standard.[19]

## CLEAN TECH INDUSTRY INVESTMENT

The focus for clean technology development is usually about the simultaneous pursuit of increased profitability as well as environmental benefit. At the global level, clean technology is being embraced across all business and industry sectors. Indeed, 'cleantech' is now often considered as an industry in its own right. At the global scale, significant investment in cleantech is already occurring in both developing and developed economies; with the Americas, Asia and Europe dominating the market in terms of venture capital expenditure.

In 2019, the total new investment in renewable energy amounted to approximately USD $302 billion (CAD $388 billion) dollars worldwide. The amount of funding provided for clean energy worldwide has steadily increased over the last two decades. In 2004, clean energy investments totaled just under USD $37 billion (CAD $48) dollars and increased to a peak of USD $331 billion (CAD $425 billion) dollars in 2017.

The significant increase in investment funding indicates that the industry has matured greatly. Policy support for renewable sources, an accelerating industry, and the emergence of publicly listed companies that own renewable energy assets (also known as yieldcos) have driven the steady rise in clean energy investment.

Investment is highest for both solar and wind but there are many sources of renewable energy available, such as biomass and waste-to-energy, geothermal and marine. However, investment in solar and wind energy is by far the highest. Global investment in solar energy has soared since 2004, rising from just over USD $10 billion (CAD $ 13 billion) dollars to more than USD $140 billion (CAD 180) dollars.[20]

The countries with the highest investment in renewable energy are China and the United States, with investment in the former amounting to USD $90 billion (CAD $116 billion) dollars in 2019. However, this was a slight decrease from the previous year whilst investment in the United States experienced growth of 25 percent.

At the global level, energy efficiency, solar, biofuels and recycling are capturing large investment and interest. It is more than coincidental that it is these same industries who are leading the way in terms of transiting countries to a lower-carbon and more environmentally sustainable future: the ongoing policy and economic focus on this area means that 'cleantech' is likely to continue to experience strong growth. Consequently, it will be important that the risks and benefits of this sector be well understood and managed. These risks and benefits are of particular importance to emerging sectors such as what is seen in Newfoundland and Labrador.

Urging reduction in carbon emissions while counting the economic cost of switching to cleaner technology has been part of a long-standing policy debate. Moreover, this policy debate has coincided with significant investments funding research and development in renewable energies around the world to address

[17] DEEDI (Queensland Department of Employment, Economic Development, and Innovation), 2010, Queensland Cleantech Industry Development Strategy, Issues Paper: Growing Queensland's Cleantech Industry, April 2010.

[18] Kinnear, Susan & Bricknell, Lisa. (2012). Linkages Between Clean Technology Development and Environmental Health Outcomes in Regional Australia. 10.5772/29060.

[19] Source: https://www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/energy-and-economy/20062#L6

[20] Source: Statista – Clean Technology Dossier

elements of this debate and to prepare for a carbon-reduced future. For example, this is manifested in *Figure 23 – R&D Investment in 2019 in Clean Technology*[21], broken down by sector.

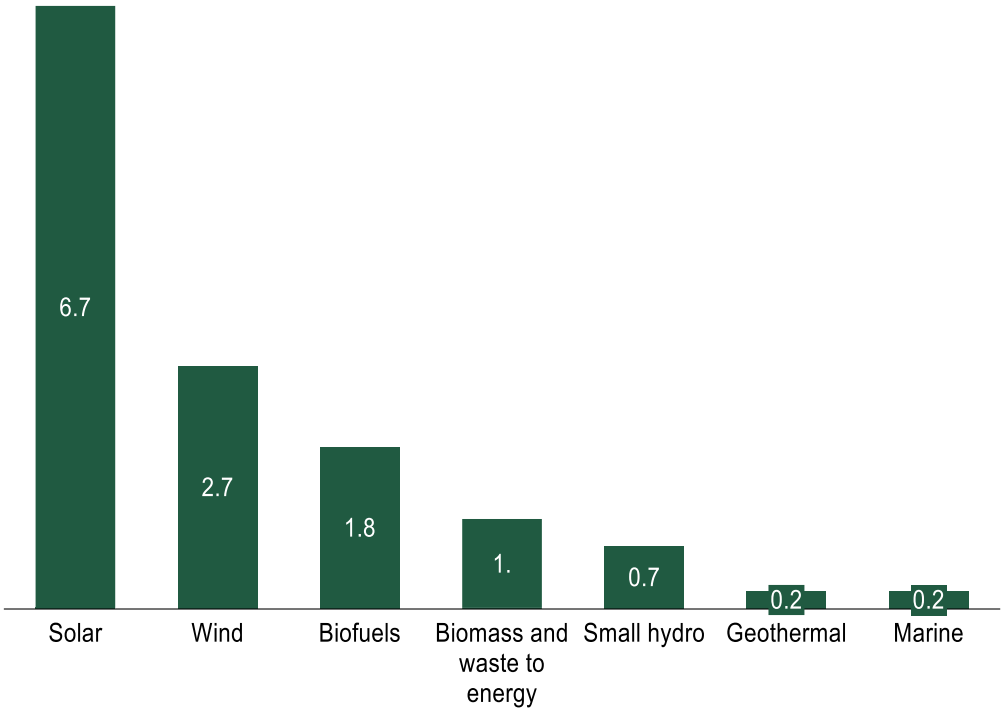



**FIGURE** 23: *R&D Investment in 2019*

The offshore oil and gas has obviously become an important component of global hydrocarbon production and emerging clean tech sector. However, most of the growth in the clean technology sector has come from Asia and specifically China – predominantly so that the country can lessen its dependence on coal burning as the main source of energy.

Chinese investment in clean energy is the highest worldwide. In 2019, China pumped some 83.4 billion U.S. dollars into clean energy research and development. The United States and Japan had the second and third highest clean energy investments that year, at USD $55.5 billion (CAD $70.6 billion) and USD $16.5 billion (CAD $21.2 billion), respectively. All countries combined had spent USD $219.2 billion (CAD $281.3 billion) in alternative energy technologies. China, the United States, and Japan accounted for roughly 71 percent of total investments. China`s wind and solar capacity as an economic and industrial powerhouse is impressive but the country is burdened with a huge daily power demand. Although the Chinese government is still heavily involved in broadening its coal-fired power plants, concerns over air pollution and its impact on the health of its most vulnerable citizens have resulted in greater awareness for renewable energy sources. As a result, in 2018, China`s cumulative wind power capacity amounted to 209.5 gigawatts. Solar PV is also common in the country, with 204.7 gigawatts of cumulative solar power capacity installed as of 2019. The United States is the most attractive market for renewable investment, according to an April 2020 score, which considers existing governmental policies and deployment opportunities within each country. It was the first time since 2016 that the U.S. ranked higher than China and largely the result of a production tax credit (PTC) extension and a greater focus on future offshore wind installations.[22]

Figure 24 displays the percent change in investment funding for renewable energies around the world from 2018 to 2019, broken down by key country. It is worth noting that Canada is not one of the major countries investing in clean energy on a global basis. About USD $302 billion (CAD $387.7 billion) was invested globally into clean energy in 2019.

[21] Source: Rystad Energy

[22] Source: Rystad Energy Research

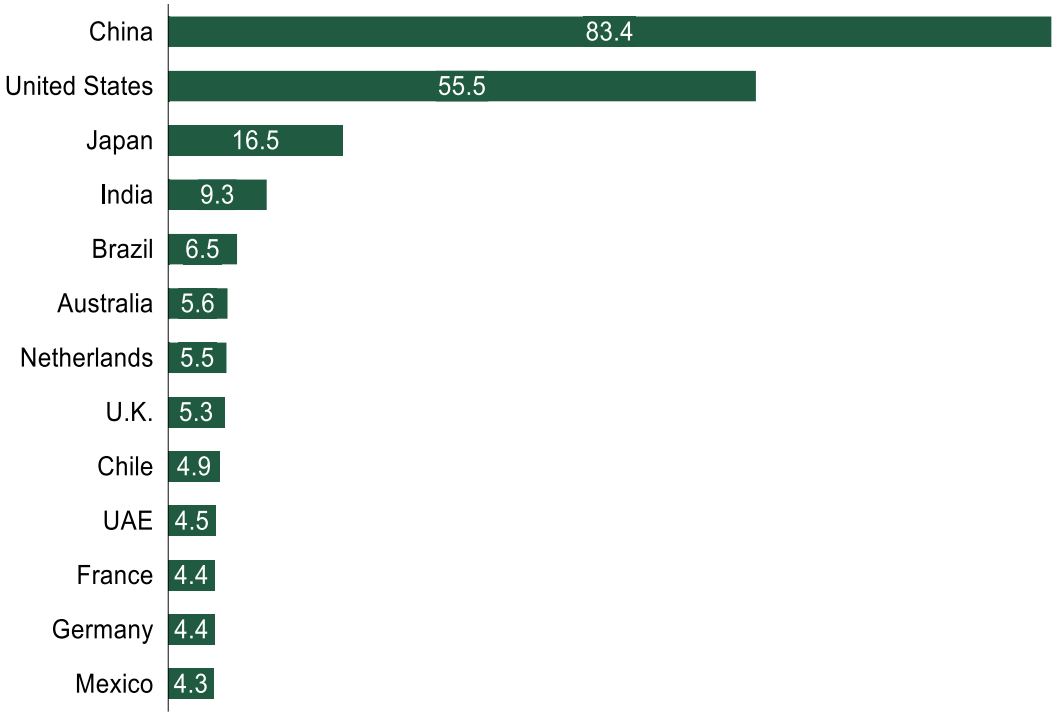



**FIGURE** 24: *Investment in Clean Energy Globally*[23]

## CANADIAN CLEAN TECHNOLOGY

In Canada, clean technology in the energy sector takes many forms which can be seen in *Figure 25 – Energy Sector, Clean Energy Technologies, and Clean Technology.*[24]

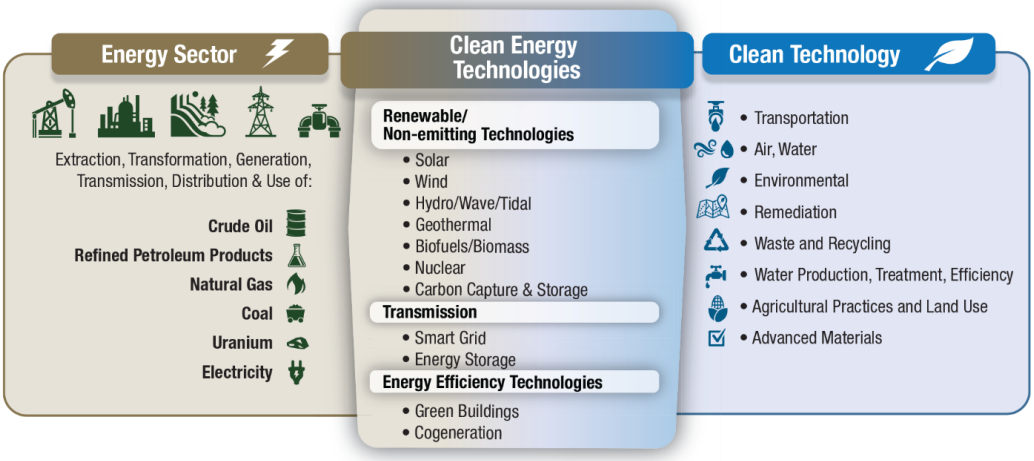



**FIGURE** *25: Energy Sector, Clean Energy Technologies, and Clean Technology*

The $10.6 billion Canadian Clean Technologies sector comprises renewable energy (bioenergy, geothermal, hydro, hydrogen and fuel cell, smart grid, and energy storage, solar, waste-to-energy, wave

[23] Source: Bloomberg NEF
[24] Source: NRCAN

and tidal, wind, and nuclear), and environmental sub-sectors (air pollution control, water and wastewater, solid waste management).[25]

Clean technology and the energy sector overlap with certain technologies, including renewable / non-emitting energy technologies like solar, wind, hydro, wave, tidal, geothermal, biofuels, biomass, nuclear, carbon capture and storage, transmission technologies like smart grids and energy storage, and energy efficiency technologies like green buildings and cogeneration.

Clean energy investments in Canada decreased from USD $3.2 billion (CAD $4.1 billion) in 2015 to USD $1.4 billion (CAD $1.8 billion) in 2019. Over half of annual investments go to onshore wind energy, with the majority of the rest going to solar photovoltaic projects. In 2017, the federal government invested in a Clean Technology Data Strategy to provide the foundation for measuring the economic, environmental, and social impacts of clean technology in Canada through data development. As part of this strategy, Statistics Canada has developed the Environmental and Clean Technology Products Economic Account (ECTPEA), which provides a comprehensive picture of the state of Canada's clean technology economy for years 2007 to 2018.

The ECTPEA includes processes, products, or services that reduce environmental impacts through environmental protection and resource management activities and the use of goods that have been adapted to be significantly less energy or resource intensive than the industry standard.

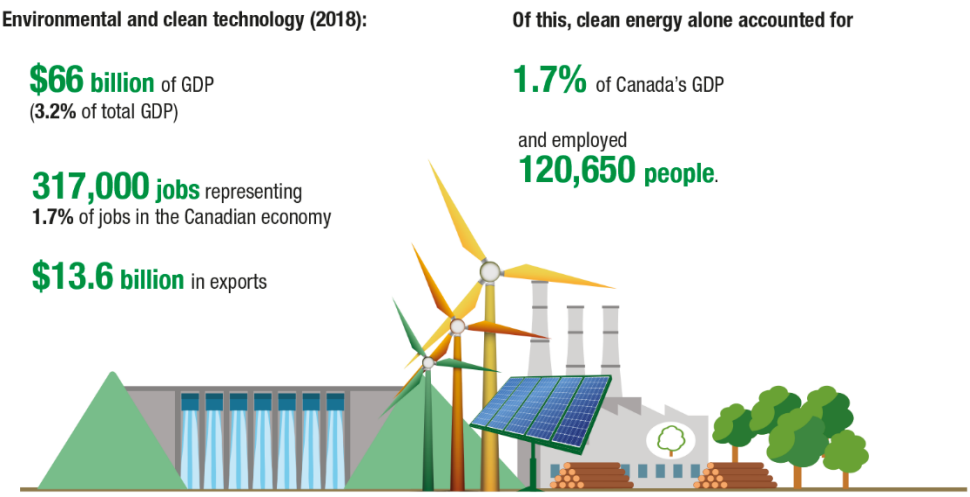



**Figure** *26: Environment and Technology Sector Impact*[26]

As can be seen in Figure 16 – *Environment and Technology Sector Impact* the industry is worth $66 billion in Canada with 317,000 jobs directly attributable to clean technology in clean technology. In clean energy there are over 120,650 people employed directly.

The TSX and TSX-Venture exchanges list 81 companies in the cleantech sector, with a total market capitalization of CAD $50.5 billion. This includes companies whose operations fall under:

- Energy Efficiency
- Low Impact Material and Products
- Renewable Energy Equipment Manufacturing and Technology
- Renewable Energy Production and Distribution
- Waste Reduction and Water Management

Seventy (70) of those companies are headquartered in Canada, with a total market cap of CAD $49.1 billion (as of April 30, 2020).[27]

[25] Source: https://www.tradecommissioner.gc.ca/sectors-secteurs/clean-technologies-technologies-propres.aspx?lang=eng
[26] Source: Statistics Canada
[27] Source: https://www.tradecommissioner.gc.ca/sectors-secteurs/clean-technologies-technologies-propres.aspx?lang=eng

The federal government of Canada has invested heavily in clean technology. Since 2017, the Government of Canada has invested over CAD $2.3 billion to support the innovation, commercialization, and adoption of clean technology.[28] The result is a diverse ecosystem of results-oriented programs and services to help Canada's most promising clean technology entrepreneurs and adopters.

For example, the Clean Growth Hub was established to help clean technology entrepreneurs and adopters navigate the federal ecosystem.[29] The Hub website lists programs and opportunities offered by the 16 federal departments and agencies that form the Hub. The Hub does not allocate funding, but it is a great place to find out about available programs and services.[30]

## CANADA OIL AND GAS CLEAN TECH INDUSTRY

There are a number of trends and opportunities emerging within the broader oil and has clean tech industry in Canada. Examples of two of the major trends are in Clean Fuel Technologies and Digitization.[31]

### Clean Fuel Technologies

According to the Clean Tech Alliance of Canada, Canada possesses the key ingredients to be a pioneer in production of cleaner fuels and clean fuel technologies.

The upcoming Clean Fuel Standard and related provincial policies will drive continued innovation in this sector. Canada's clean liquid fuels sector targets growth in production capacity from today's 3 million litres per year to 8.5 billion litres by 2030.

The Clean Fuel Standard aims to reduce Canada's greenhouse gas emissions by 30 million tonnes per year by 2030, making it an important contribution to the achievement of the country's target of reducing national emissions by 30% below 2005 levels by 2030. The standard complements other Canadian climate policies and investments under the Pan-Canadian Framework on Clean Growth and Climate Change, including carbon-pollution pricing. These policies work in concert to reduce emissions across the economy and to create incentives for innovation and clean growth.

The federal government has a number of clean-fuel fiscal programs to assist with the development, commercialization and use of clean fuels and clean-fuel technologies. These programs are driving new, world-leading examples of low-carbon and renewable-energy solutions. Federal funding examples include the CAD $1.2-billion Strategic Innovation Fund and the CAD $965 million Sustainable Development Technology Canada Tech Fund. The sector also has strong provincial support, with British Columbia's CAD $40 million Innovative Clean Energy Fund, Alberta's Bioenergy Producer Program and Quebec's refundable tax credit for biofuel production.[32]

### Digitalization

Canadian companies in the oil and gas industry are introducing significant cost savings and efficiencies into their operations by adopting customized digital tools and flexible solutions.

These solutions are driving Canada's sustainable energy future by establishing baselines on environmental performance, enhancing monitoring to improve maintenance and inspections, and developing predictive models to forecast environmental risks, operational issues, and equipment failures.

Canadian companies are also using digital technology to build immersive training environments in the oil and gas industry that capture data to inform critical, high-risk safety training scenarios, which enable privileged learning-by-doing outcomes.

Canadian digital technology is key to protecting employees, predicting equipment failures — and reducing environmental impacts of these failures — and reducing production upsets throughout operations.

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[28] Source: https://www.ic.gc.ca/eic/site/099.nsf/vwapj/Clean-Growth-Hub_Federal-ecosystem-of-support-for-clean-technology.pdf/$file/Clean-Growth-Hub_Federal-ecosystem-of-support-for-clean-technology.pdf

[29] Source: http://www.ic.gc.ca/eic/site/099.nsf/eng/home

[30] More information on federal government programs for clean technology funding can be found at - https://www.international.gc.ca/investors-investisseurs/assets/pdfs/download/vp-clean_technology.pdf.

[31] Source: https://www.canadaclean.tech/clean-technology-solutions

[32] Source: Government of Canada – Trade Commissioner Service

Digital companies work with data-rich oil and gas companies to transform complex data into custom-designed interactive visualizations and user interfaces to improve strategic planning, decision making and communication capabilities. Once these solutions are developed, they can be exported globally and used in other industrial markets that have similar data requirements. If a solution can succeed in Canada's extreme temperatures, it has a better chance of success in more moderate climates.

Other emerging trends in the Canadian clean technology sector focused on oil and gas include:

- Innovative water technologies
- Novel hydrocarbon extraction
- Reclamation technologies
- Low-emission value added solutions
- Methane technologies

Overall, both at a global and national level, the sector is growing spurred on by global targets such as the Paris Agreement as well as broader institutional and activist investors who are demanding change.

To better understand these policy and regulatory challenges, each jurisdiction identified at the beginning of the study examined the economic position, regulations and policies, R&D framework, innovation funding, supply chain, international competition as well as innovation ecosystem.

## ALBERTA

### OVERVIEW

| Economic Position* | Regulation and Policy | R&D Framework | Innovation Funding | Supply Chain | International Competitiveness | Innovation Ecosystem |
|---|---|---|---|---|---|---|
| • Substantial economic strength and opportunity<br>• Significant in terms of jobs and ability to attract funding for clean tech sector.<br>• Significant use of subsidies across full economy<br>• A hub for global companies and innovation | • Active, clear, and bold in policy and regulation including use of tax credits and incentives<br>• Ambitious climate targets on paper although some political risk in implementation<br>• Collaboration between different government regulators on economic priorities<br>• Same federal regulations as Newfoundland and Labrador | • Collaborative framework – CRIN and COSIA<br>• Strong mandate and oversight<br>• Significant funding through federal government with matched provincial government funds<br>• Industry -driven R&D priorities – focus on commercialization<br>• Tax incentives for operators | • Strong support for public funding into innovation<br>• Numerous funding opportunities<br>• Support across innovation lifecycle<br>• Regulatory focus on innovation funding and clean tech strategies – i.e., ERA, Innovate Alberta | • Burgeoning start-up and scale-up community around clean technology<br>• Collaborative engagement<br>• Numerous industry associations and networking<br>• Significant incentives to incorporate clean tech companies into the supply chain<br>• Novel incentives such as NRG COSIA Carbon XPRIZE competition | • United States is major export market – reflects nature of oil production and access to US market<br>• Early market movers<br>• Addressing global technology issues but local specific issues that are unique to Alberta – i.e., Oil Sands | • Numerous support institutions to help support innovation and projects<br>• National and regional cluster around clean technology in oil and gas – COSIA, CRIN<br>• Support for full TRL lifecycle – significant private sector investment<br>• Testing, piloting, and demonstration opportunities available |

Alberta's oil and gas industry has a long history of innovating and finding solutions to technical problems. Alberta's clean technology sector is distinct from Alberta's broader tech sector generally, and from clean technology sectors in other jurisdictions. Nearly two-thirds of the province's clean technology ventures identify their primary market as oil, gas, and mining.[33]

Direct Gross Domestic Product (GDP) for Alberta's cleantech in the oil and gas sector is estimated at more than CDN $1.4 billion in 2017. Roughly CAD $800 million is related to professional services, with the balance from machinery and equipment manufacturing and sales. Total direct, indirect, and induced GDP exceeds CAD $2.2 billion. Nearly 10,000 direct jobs and over 16,000 direct, indirect, and induced jobs exist because of cleantech activities associated with Alberta's oil and gas and downstream industries.[34]

A study by Delphi and the Clean Resource Innovation Network on the Alberta Clean Tech Sector, demonstrated the strength of Alberta's clean technology ecosystem especially since 2016. Over three quarters of companies seeking funding in 2017-18 were able to secure it. And each dollar of public funding that was reported generated $2.50 from private sources. Half of ventures in the Alberta Clean Tech sector are 'deep' innovation plays, developing solutions based on novel chemical processes or advanced materials, with longer commercialization cycles and higher capital costs than software-based start-ups. And over one in three has a female founder, whereas female participation in tech start-ups is about 13% nationally.[35]

Alberta's relative strength in clean tech is a product of both push and pull pressures. On the pull side, unprecedented demands and resource constraints on the energy sector have resulted in companies seeking out new and innovative processes, demonstrated through an increased focus on research and technology. In the heavy oil and oil sands industry, opportunities exist to reduce the use of water and natural gas and to decrease overall environmental impacts.

On the push side, regulation has extensively changed the industry. The establishment in 1974 of the Alberta Oilsands Technology Research Authority (AOSTRA) with CAD $1 billion of public funding delivered over CAD $217 billion in investment in oilsands development. Similarly, beginning in 2003, Alberta's government made CAD $45 million in strategic investments to support what has become the

[33] Source: Invest Alberta

[34] Source: Statista (2020). Oil Industry in Canada

[35] Source: https://cleanresourceinnovation.com/public/resources

Alberta Machine Intelligence Institute, now among the world's top five institutes for AI and machine learning.[36]

Overall, technology development and adoption, and process improvements are key components to increasing the competitiveness of Alberta's oil and gas industry clean tech industry.[37]

## GOVERNMENT – REGULATION AND POLICY

There are a number of government and non-government entities that help the oil and gas clean tech sector in Alberta. These including Emissions Reduction Alberta, Invest Alberta, Petroleum Technology Alliance Canada, and Canada's Oil Sands Innovation Alliance among many others.

For example, Emissions Reduction Alberta (ERA) was created in 2009 to help deliver on the province's environmental and economic goals. ERA's mandate includes climate change and supports economic growth by investing in the pilot, demonstration, and deployment of clean technology solutions that reduce GHGs, lower costs, attract investment, and create jobs in Alberta.[38]

Regulatory measures have also been typical incentives stimulating demand for clean technologies for industry adoption. Tax credits are available for investors in clean technology development. Both federal and provincial governments are supportive of lowering GHG emissions and reducing fugitive methane emissions from Canadian industry.

To support investment in small cleantech companies, for example, the now-expired Alberta Investor Tax Credit offered a 30% tax credit to investors providing capital to Alberta small businesses doing research, development or commercialization of new technology, new products, or new processes. This tax credit was phased out in March 2020.[39] The Federal Government' Scientific Research & Experimental Development ("SR&ED") tax credit encourages businesses to conduct research and development to create new or improve existing products, processes, principles, methodologies, or materials.[40] Policies in support of these initiatives kick-start development and demand for clean technologies for the oil and gas sector.[41]

Regulation and policy is also driven and influenced by the private sector in Alberta. One of the key themes emerging from both interviews and the research is the importance of collaboration in Alberta's clean tech sector. Canada's Clean Resource Innovation Network (CRIN) was formed to bring together organizations working independently and often duplicating efforts. CRIN was awarded a contribution from the government's Strategic Innovation Fund to drive cleantech development in Canada. Other organizations driving cleantech development are Canada's Oil Sands Innovation Alliance, an alliance of oil sands companies that have invested CAD $1.4 billion in technologies to improve environmental performance, and the Petroleum Technology Alliance Canada, a hydrocarbon industry association that also promotes the use of clean technology innovation.

## R&D FRAMEWORK

At the heart of clean technology is innovation. Strong research facilities and innovation resources exist in Alberta that clean technology companies can leverage to expand their business and commercialize their solutions.

Canada's oil and gas industry spends billions annually on research and development. In 2015, a single oil and gas company, Canadian Natural Resources Limited ("CNRL"), spent CAD $527 million towards research and technologies to enhance resource recovery, operating efficiencies, and environmental performance, ranking them 7th in Canada in overall R&D spending. Along with industry spending, a suite of additional non-dilutive funding opportunities from federal and provincial agencies exist to support clean tech innovators bringing their solutions to market.

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[36] Source: CRIN

[37] Source: https://investalberta.ca/industry-profiles/energy-and-cleantech/

[38] Source: https://eralberta.ca/about-era/

[39] Source: https://open.alberta.ca/dataset/e11d6fff-9194-4400-bfb1-9890933e0e5e/resource/747630f1-12bf-4081-b993-ac4a35a84d00/download/aitc-information-sheet-for-investors.pdf; https://www.alberta.ca/alberta-investor-tax-credit.aspx

[40] Source: https://www.canada.ca/en/revenue-agency/services/scientific-research-experimental-development-tax-incentive-program.html

[41] Source: https://calgaryeconomicdevelopment.com/assets/dmsdocument/Delphi-CED-Cleantech-in-Oil-and-Gas-Summary-Report-11-1-2017.pdf

Some of the programs that facilitate R&D in Alberta include the Federal Scientific Research and Experimental Development (SR&ED) and Industrial Research Assistance Program (IRAP), public project funders including Sustainable Development Technologies Canada (SDTC), Emissions Reduction Alberta (ERA) and Alberta Innovates (AI).

For example, Alberta Innovates develops and invests in applied research and innovation programs to sustain, grow, and diversify the energy, agriculture, food, and forestry industries; develop clean technology; reduce greenhouse gas emissions; increase productivity; add value to commodity products, and protect Alberta's environment.[42]

However, there are barriers to clean technology innovation in Alberta. In a study by the City of Calgary[43], three of the biggest barriers hindering research, innovation and investment in Alberta clean tech are:

a) risk aversion amongst oil and gas companies,

b) a lack of equity and capital funding for pilot and demonstration facilities;

c) lack of third-party sites to conduct pilot scale testing.

Overcoming these barriers have been a combination of government and private collaboration. In 2011 the Alberta Clean Technology Industry Alliance ("ACTIA") was founded to support Alberta companies working in cleantech. ACTIA's industry survey[44], which focused exclusively on companies participating in cleantech product development (or "pure play" companies), found that roughly three-quarters are focused on oil and gas and mining markets, and these companies are preparing for growth in the coming years with many expecting to hire new personnel. Cleantech wages on average are approaching CAD $100,000 per year, nearing the average salary in oil & gas ($106,0008) and above the Alberta average ($58,000). Cleantech providers in Alberta work across the industry spectrum focusing on chemicals, electricity, advanced materials, nanotechnology, internet of things ("IoT"), artificial intelligence ("AI"), advanced manufacturing, and smart grid applications. This broad range demonstrates that clean technology will impact all areas of the Alberta economy and daily life in the coming years and decades.

Overall, there is significant R&D activity in Alberta driven by both pull and push forces.

### FUNDING AND INCENTIVES

Alberta's clean technology sector is growing. In 2019, Alberta-based innovation clusters the Canadian Agri-Food Automation and Intelligence Network (CAAIN) and the Clean Resource Innovation Network (CRIN) secured over CAD $150 million in private sector matched Federal grant commitments to advance transformational technologies in agriculture and in oil and gas.[45] Over half of Alberta's clean technology ventures seek to sell to the oil, gas, and mining sectors; one in three to power and utilities; and one in five to the agriculture and food processing sectors.[46]

Regulatory measures have been typical incentives stimulating demand for clean technologies for industry adoption. As outlined above, tax credits are available for investors in clean technology development. Both federal and provincial governments are supportive of lowering GHG emissions and reducing fugitive methane emissions from Canadian industry.

Moreover, regulators are also heavily focused on R&D. For example, the Technology Roadmap Areas of Focus for ERA includes the following sectors:[47]

- **Cleaner Oil & Gas** - Transformative technologies and innovation to reduce the GHG footprint of Alberta's fossil fuel supply chain and explore alternative fuel and value-add opportunities that can help sustainability grow and diversify the province's energy economy.
- **Low Emitting Electricity System** - Technology and innovation to support a reliable, lower carbon electricity system, including reducing the GHG footprint of Alberta's electricity supply mix, increasing the deployment of renewable energy, and enabling a smarter electricity grid that can power Alberta's homes and businesses.

[42] Source: https://albertainnovates.ca/focus-areas/clean-resources/

[43] Source: https://calgaryeconomicdevelopment.com

[44] Source: https://actia.ca/ab-cleantech-sector-report-2019/

[45] Source: https://actia.ca/ab-cleantech-sector-report-2019/

[46] Source: CRIN

[47] Source: https://eralberta.ca/apply-for-funding/

- **Food, Fibre, & Bioindustries** - Innovation processes and technologies to advance Alberta's bioeconomy, and reduce GHG's, including novel agriculture and forestry practices; bioenergy and biomaterials; waste management and waste energy; and enhanced carbon retention.
- **Low-Carbon Industrial Processes & Products** - Technologies to deliver GHG reductions through energy efficiency, industrial process innovation, and low-GHG materials and chemicals.

Specific funding programs related to clean technology in Alberta include:

- Alberta Upstream Petroleum Research Funding (AUPRF) Industry sponsored research funding to address high priority environmental and social matters related to oil and gas in Alberta.
- Alberta Economic Development and Trade Tax Credits (AEDT)
- Capital Investment Tax Credit (CITC) and Investor Tax Credit (AITC)
- Alberta Innovates (AI) - Works with the private & public sectors to stimulate innovation, research & entrepreneurship in Alberta. Innovators can benefit from funding programs that focus on Advanced Hydrocarbons, Clean Technology and Environmental Innovation. Support for researchers and entrepreneurs through voucher and cross-sectoral programs.

Overall, there are a number of important funding and incentives programs for Alberta oil and gas clean technologies companies[48].

### INNOVATION ECOSYSTEM

Half of Alberta's clean technology ventures are 'deep' innovation plays, developing hardware solutions based on novel chemical processes or advanced materials. While deep innovation ventures may have the potential for greater environmental and economic benefit, this comes with longer commercialization cycles and higher capital costs than technology-based start-ups that have been preferred by private investors. Alberta's clean tech ventures cumulatively secured 614 patents or other forms of IP protection as of 2016 and added 48 more in 2017-18.[49]

Part of the innovation culture in Alberta comes from the push forces of regulation. For example, in 2015 the Government of Alberta announced it was is targeting a significant reduction of GHG emissions as part of its Climate Leadership Plan.[50] Oil sands related GHG emissions will be capped at 100 mega tonnes per year by 2030, and a methane emissions reduction target of 45% by 2025 has been mandated. Achieving these reductions required cleantech solutions and new operational processes that can reduce environmental impacts while maintaining sector productivity and profitability.

The Innovation Ecosystem in Alberta for clean technology firms is substantial. Some of the organizations that fund, grow, and connect clean technology organizations in Alberta include:

**Funding: Emissions Reduction Alberta (ERA)** - Invests in innovation to reduce greenhouse gas emissions in Alberta.

**Growth: ACAMP** - Product development centre for advanced technology provides engineers, tech experts and specialized equipment. Focus on autonomous systems for infrastructure and transportation.

**Connections: Petroleum Technology Alliance of Canada (PTAC)** - Facilitates collaborative R&D and technology development, and partners with industry stakeholders to transform challenges into opportunities.

The clean technology sector in Alberta is robust with significant activity across the value chain.

### SUPPLY CHAIN

As can be seen in other parts of this report, clean technology is applicable to most economic sectors making the term "clean technology" challenging to define – especially as it relates to supply chain. Invest Alberta contends that clean technology in the oil and gas sector, specifically in the supply chain, includes those activities that provide a net environmental benefit beyond "business-as-usual" by addressing

[48] A map of the clean technology ecosystem in Alberta can be found at https://actia.ca/alberta-ct-resource-map-2019/.

[49] Source: http://www2.jwnenergy.com/alberta-clean-technology-sector-2019; Alberta Clean Technology Sector 2019 – CRIN.

[50] Source: https://open.alberta.ca/publications/9781460140345

emissions (including greenhouse gases), water and wastewater, or land and biodiversity aspects across the hydrocarbon energy / oil and gas value chain, including upstream (exploration and production), midstream (gathering and transportation), and downstream (processing and refining) sectors.[51]

Alberta's oil and gas industry intersects with the environment at every phase of the value and supply chain, from exploration through to end-users. Opportunities exist at each junction of the value chain to reduce environmental impacts and use clean technologies to not only help reduce those impacts, but also help make oil and gas companies more sustainable, and profitable in the long run. Beyond using oil and gas for combustion there are other emerging ideas for utilizing hydrocarbons for non-combustible means. For example, some of these novel ideas are being tested as part of the NRG COSIA Carbon XPRIZE competition.[52] The strategy is that new hydrocarbon products put forth by clean technology developers in the overall supply chain will help deliver a cleaner hydrocarbon future.

## INTERNATIONAL COMPETITIVENESS

In the 2019 Alberta Clean Technology Sector Report by CRIN, Alberta's clean technology sector generated over $385 million in revenues in 2017/2018 with an average revenue growth of 37%. Over one third of companies reported revenue over $100,000 per annum, with 14% reporting more than $1 million annually. Only one fifth of the sector's total revenue was generated in Canada, with almost all remaining revenue coming from the US. Other markets accounted for less than 3% of the sector's revenue.

Emerging strengths in delivering innovation through clean technology in oil and gas, electricity and food and agriculture, improved the competitiveness of Alberta's leading economic sectors and companies while exporting solutions to the world. Alberta's largest export market for oil and gas clean technology is the United States. Nearly 80 percent of the over CAD $385 million in reported revenue in clean technology development came from sales in the United States, showing the importance of export-led growth.[53]

Clean technologies exported by Alberta-based companies are primarily established technologies in the areas of machinery and equipment, pumps, chemical agents, electric generating sets, transformers, sensors, instruments, and other oil and gas clean tech related electronic equipment.[54]

From an international competitiveness standpoint, the most significant barriers to growth according to Alberta's clean technology entrepreneurs are accessing investment capital, financing pilot projects, and finding domestic customers due to the lack of regulatory drivers for adoption.[55]

[51] Source: https://investalberta.ca/industry-profiles/energy-and-cleantech/
[52] Source: https://carbon.xprize.org/prizes/carbon
[53] Source: https://calgaryeconomicdevelopment.com/assets/dmsdocument/Delphi-CED-Cleantech-in-Oil-and-Gas-Summary-Report-11-1-2017.pdf
[54] Source: http://www2.jwnenergy.com/alberta-clean-technology-sector-2019; Alberta Clean Technology Sector 2019 – CRIN.
[55] Source: https://calgaryeconomicdevelopment.com/assets/dmsdocument/Delphi-CED-Cleantech-in-Oil-and-Gas-Summary-Report-11-1-2017.pdf

## AUSTRALIA

### OVERVIEW

| Economic Position* | Regulation and Policy | R&D Framework | Innovation Funding | Supply Chain | International Competitiveness | Innovation Ecosystem |
|---|---|---|---|---|---|---|
| • Substantial economic strength but losses have been reported in oil and gas sector in the near past<br>• Energy concerns are on the rise including energy security<br>• Power grid has reliability issues – major driver for innovation and investment<br>• Transition away from coal is a major economic driver both for domestic conception and global exports | • Significant regulatory support and practices<br>• Balanced carrot and stick policies<br>• Ambitious climate targets<br>• Previous regulations and policies have caused unintended consequences – i.e., solar power.<br>• Early movers on hydrogen<br>• Political risk for support of clean technology depending on governing political party | • Collaborative framework through NREA<br>• Strategy to grow collaboration and innovation to assist the energy resources industry manage cost structures and productivity,<br>• Identified need to support sector-wide transformation<br>• Estimated +$10 billion of new value for the Australian economy in R&D around clean technology | • Strong support for public funding into innovation through Australian Clean Energy Fund<br>• Numerous funding opportunities<br>• Support across innovation lifecycle especially by agencies such as ARC and CSIRO<br>• Issuing green bonds | • Driving energy transition through big projects such as Gorgon<br>• Collaborative engagement<br>• Maintenance, logistics and fabrication have composed most of the local supplier industry<br>• Suppliers – far from shore and limited population near development | • Fewer production hubs<br>• Addressing issues that have relevance not only to oil and gas but all sectors (mining, electricity, coal) make it more scalable and competitive<br>• Distance from major markets means local supply chain is focused on domestic industry – international competition not as big an issue as other jurisdictions | • National and regional clusters such as Western Australia<br>• Support for full TRL lifecycle<br>• Infrastructure is young – less interest in innovation unless driven by regulation – more interesting challenges in other sectors (such as coal)<br>• Have identified threats around innovation unless there is a continued emphasis on clean technology in the energy sector |

Australia holds abundant energy resources and is a leading exporter of coal, uranium, and LNG. However, the country's energy sector is undergoing a deep transformation with significantly increasing shares of wind and solar power. In a number of ways, it views coal, uranium, LNG as well as oil and gas as 'energy' from both a regulatory and innovation lens. This 'energy' lens has implications to how it views the transformation of clean technology in the oil and gas industry.

Despite its wealth of resources, energy security concerns in Australia are on the rise. As domestic oil production is dwindling, dependency on oil product imports and the oil supply chain are growing steadily. Natural gas supply in the east coast market has become tight, leading to higher prices in that market. For natural gas to play a role as a transition fuel to a low-carbon economy, resource development, additional pipeline capacity and market integration are critical.

Australia's power system finds itself exposed to concerns over reliability, particularly amid extreme weather events. It has a long and skinny power system with similar population dispersal to Newfoundland and Labrador.

Prompted by the South Australia system wide blackout of September 2016 and the Finkel Review, the Australian government implemented reforms to foster security of supply, including a retailer reliability obligation, adjustments to system operation, and planning for market design post-2025 at higher levels of variable renewables.[56] As of March 2019, Australia's oil and gas extraction industry had a gross value added (GVA) of around eleven billion Australian dollars. In recent years, the GVA of this industry has steadily increased across the country.[57] Moreover, in the financial year 2018, approximately 17.3 thousand people were employed in the oil and gas extraction industry in Australia. Since reaching a peak in 2014, employment in this industry has dropped by almost 25 percent.[58]

In financial year 2019, the operating profit before tax in the oil and gas extraction industry in Australia amounted to approximately AUD $20.33 billion (CAD $19.57 billion). This was a significant increase from the profit reported in the past five years, in which losses had been reported.

[56] Source: https://www.aemc.gov.au/markets-reviews-advice/review-of-the-system-black-event-in-south-australi
[57] Source: Statista – Energy Dossier
[58] Source: Statista – Energy Dossier

In 2019, the EBITDA of the oil and gas extraction industry in Australia was approximately AUD $45.65 billion (CAD $44.68 billion). This the highest EBITDA recorded over the reported period. At the end of 2019, Australia had 2.4 billion barrels worth of oil reserves as opposed to 3.8 billion barrels in 2010.This was the lowest worth of oil reserves in the nation since 2010.[59]

During 2019, approximately 490 thousand barrels of oil a day were produced in Australia. In 2009, around 507 thousand barrels of oil were produced each day.[60] The oil and gas industry in Australia is robust but, once again, it has to be seen in the wider context of *energy*.

## GOVERNMENT – REGULATION AND POLICY

In 2011, Australia introduced a Clean Energy Future Plan (Clean Energy Act, 2011). One element of the plan was a Clean Technology Investment Fund (code named CleanTech). This program, which ran from 2012 to 2014, offered financial grants to manufacturing facilities to switch to cleaner technologies. It was intended to allow facilities to retain their competitiveness relative to international competitors that might not be burdened by climate related regulations. The CleanTech program came with a price tag of almost half a billion dollars for the government. However, it gave Australia a competitive advantage in solar and wind power generation.

The Australian Clean Energy Regulator is the Government body responsible for administering legislation that will reduce carbon emissions and increase the use of clean energy. The role of the Clean Energy Regulator is determined by climate change law. The schemes it administers work together to reduce emissions while encouraging business competitiveness.[61]

The Clean Energy Regulator administers schemes legislated by the Australian Government for measuring, managing, reducing, or offsetting Australia's carbon emissions. The regulator's role is determined by climate change law. The regulator has administrative responsibilities for the:

National Greenhouse and Energy Reporting Scheme, under the *National Greenhouse and Energy Reporting Act 2007*

Emissions Reduction Fund, under the *Carbon Credits (Carbon Farming Initiative) Act 2011*

Renewable Energy Target, under the *Renewable Energy (Electricity) Act 2000*, and

Australian National Registry of Emissions Units, under the *Australian National Registry of Emissions Units Act 2011*.

As an economic regulator, the Clean Energy Regulator does not have any direct role or powers under legislation to enforce work health and safety, environmental protection, or planning laws. Responsibility for meeting obligations to undertake a project in accordance with the law always rests with the business or individual concerned. The responsibilities of the Clean Energy Regulator include:[62]

- providing education and information
- monitoring, facilitating, and enforcing compliance with each scheme
- collecting, analysing, assessing, providing, and publishing information and data
- accrediting auditors for the schemes administered, and
- working with other law enforcement and regulatory bodies.

The main regulations and legislation that drive clean technology in Australia include:

The **National Greenhouse and Energy Reporting** scheme provides a national framework for reporting and disseminating company information about greenhouse emissions, and energy production and consumption. This informs policy and program development nationally and reporting internationally. Corporations that meet a specified threshold must register under the framework and provide a report each year.

The **Emissions Reduction Fund** is designed to reduce Australia's emissions by providing an incentive for businesses, land owners, state and local governments, community organisations

[59] Statista: Statista – Oil and Gas

[60] Source: Statista – Energy Dossier

[61] Source: http://www.cleanenergyregulator.gov.au/About/Pages/default.aspx

[62] Source: http://www.cleanenergyregulator.gov.au/About/What-we-do

and individuals to adopt new practices and technologies which reduce emissions. The objective of the Emissions Reduction Fund is to help Australia to meet its emissions reduction target of five per cent below 2000 levels by 2020.

A number of activities are eligible under the scheme and individuals and organisations taking part can earn Australian carbon credit units. One Australian carbon credit unit is earned for each tonne of carbon dioxide equivalent (tCO2-e) stored or avoided by a project. Australian carbon credit units can be sold to generate income, either to the Government through a carbon abatement contract, or on the secondary market.

The **Renewable Energy Target** encourages investment in new large-scale renewable power stations and the installation of new small-scale systems, such as solar photovoltaic and hot water systems in households. The Renewable Energy Target is designed to reduce emissions of greenhouse gases in the electricity sector and encourage the additional generation of electricity from sustainable and renewable sources.

It has two core components: The Large-scale Renewable Energy Target and the Small-scale Renewable Energy Scheme. Together, these schemes create a financial incentive for investment in renewable energy.

The **Australian National Registry of Emissions Units (ANREU)** is a secure electronic system designed to accurately track the location and ownership of Australian carbon credit units (ACCUs) and emission units issued under the Kyoto Protocol.

**The Safeguard Mechanism** safeguard mechanism ensures that emissions reductions purchased through the Emissions Reduction Fund are not offset by significant increases in emissions above business-as-usual levels elsewhere in the economy. It does this by encouraging large businesses not to increase their emissions above historical levels.

The regulator also tracks the ownership and location of units or certificates issued under these schemes, and under the Kyoto Protocol, through the ANREU and the REC Registry.

There are other agencies and bodies that influence clean technology in the oil and gas industry in Australia. Part of this influence is also at the State side – the equivalent of provinces in Canada. Just recently the Environmental Protection Agency (EPA) commenced assessing projects against the Greenhouse Gas Ministerial Statement that was published in April 2020.[63] The Environmental Protection Act (1986) for Western Australia has just been amended (in November 2020) which now incorporates GHG accounting and the inclusion of cumulative impacts. Western Australia where most of offshore oil and gas activity is located is probably one of the more advanced jurisdictions in Australia with regard to the GHG regulatory framework and the Commonwealth is now working closely to ensure that both legislative and regulatory frameworks complement each other. The EPA provides independent advice to the Environmental Minister although it is closely aligned to the Department of Water and Environmental Regulation.

### R&D FRAMEWORK

There are a number of push elements into the R&D framework in Australia including the Renewable Energy Target (RET) scheme, which encourages the additional generation of electricity from renewable sources to reduce greenhouse gas emissions in the electricity sector. The Large-scale Renewable Energy Target (LRET) incentivises investment in renewable energy power stations, such as wind and solar farms, or hydro-electric power stations, by legislating demand for large-scale generation certificates (LGCs). One LGC can be created for each megawatt hour of eligible renewable electricity produced. LGCs can be sold to liable entities (mainly electricity retailers) who buy and surrender the LGCs to the Clean Energy Regulator to demonstrate their compliance with the scheme's annual targets. In turn, the LGCs provide the power station with a source of revenue additional to the sale of the electricity generated.[64]

[63] Source: Environmental Protection Authority, Environmental Factor Guidelines, Greenhouse Gas Emissions, April 16, 2020

[64] Source: https://www.industry.gov.au/funding-and-incentives/renewable-energy-target-scheme

The Regulator advised there are now sufficient projects approved to meet and exceed the 2020 target of 33,000 gigawatt hours of additional renewable electricity. The annual target will remain at 33,000 gigawatt hours until the scheme ends in 2030.

The Small-scale Renewable Energy Scheme (SRES) incentivises households, businesses, and the community to install eligible small-scale systems such as rooftop solar panels, solar water heaters, small-scale wind, or hydro systems by legislating demand for small-scale technology certificates (STCs). STCs are created at the time of installation according to the system's deeming period—the estimate of years the system will create renewable energy from installation until 2030. Liable entities have a legal requirement to buy and surrender STCs to the Regulator quarterly.

While it is possible for the system owner to create and sell the STCs themselves, installers of these systems usually offer a discount on the price of installation in return for the STCs.

The Emissions Reduction Fund (ERF)[65] incentivises Australian businesses to cut the amount of greenhouse gases they create and to undertake activities that store carbon. This can be through projects involving:

- new technology
- upgrading equipment
- changing business practices to improve productivity or energy use
- changing the way vegetation is managed to store more carbon

In the energy sector, the NERA (National Energy Resources Australia) is Australia's Industry Growth Centre for the energy resources sector. It was established by the Australia government to maximise the value to the Australian economy by having an energy resources industry that is globally competitive, sustainable, innovative, and diverse.

Through a national focus, NERA's role is to grow collaboration and innovation to assist the energy resources industry manage cost structures and productivity, direct research to industry needs, deliver the future work skills required and promote fit for purpose regulation. The organization contends it is uniquely positioned to support sector-wide transformation and unlock +$10 billion (CAD $9.8 billion) of new value for the Australian economy.

NERA is also an industry broker and the source of insight into challenges, solutions, skills, and regulation that will ensure Australia maximises its huge energy resources advantage and becomes a global energy powerhouse. Since its inception in 2016, NERA has worked to maximise the value to the Australian economy by developing an energy resources sector that is globally competitive, sustainable, innovative, and diverse.

NERA is engaged across the value chain to achieve significant industry efficiencies; identify and support digital, automation and other innovative technologies; develop future workforce skills; and ensure that there are regulatory frameworks that support future investment, innovation, productivity, and global trade.

The NERA has a Sector Competitiveness Plan (SCP) that provides a roadmap to unlock that value for the Australian economy, with a strategic focus that involves accelerating the development, commercialisation and deployment of technologies that strengthen Australia's position as a global hub for excellence in energy resources innovation and enhance the country's global competitive advantage by supporting the development of a world-class supply sector.

Over the next decade, the NERA contends that major sector challenges will transform the product and technology mix of successful energy and resource companies globally, particularly the need to invest in digital/data technologies, address climate change, reduce emissions and, increasingly, find competitive alternatives and renewable energy solutions. It has some interesting projects that are of interest to Newfoundland and Labrador including a National Decommissioning Research Initiative.[66] NERA has positioned itself to play a key role in creating the collaboration and innovation connections essential to ensure Australia successfully navigates this transformation.

[65] Source: https://www.industry.gov.au/funding-and-incentives/emissions-reduction-fund

[66] Source: https://www.nera.org.au/NDRI

## FUNDING AND INCENTIVES

The Australian Renewable Energy Agency (ARENA) was established by the Australian government in 2012. The agency's purpose is to improve the competitiveness of renewable energy technologies and increase the supply of renewable energy through innovation that benefits Australian consumers and businesses. In essence, it provides the R&D framework for clean technology in the country. Another agency that provides funding and incentives is the Commonwealth Scientific and Industrial Research Organisation (CSIRO), a government agency responsible for scientific research. CSIRO works with leading organisations around the world. From its headquarters in Canberra, CSIRO maintains more than 50 sites across Australia and in France, Chile, and the United States, employing about 5,500 people.[67] CSRIO would seem to be similar to NRCan in Canada.

The Australian Research Council (ARC) is one of Australia's two main agencies for competitively allocating research funding to academics and researchers at Australian universities. The other is the National Health and Medical Research Council (NHMRC). The ARC's mission is to deliver policy and programs that advance Australian research and innovation globally and benefit the community. It supports fundamental and applied research and research training through national competition.[68]

The Australian Clean Energy Innovation Fund is the largest dedicated cleantech investor in Australia, created to invest $200 million in early-stage clean technology companies. The Innovation Fund targets technologies and businesses that have passed beyond the research and development stage and which can benefit from early-stage seed or growth capital to help them progress to the next stage of their development. It draws on CEFC finance and expertise to provide primarily equity finance to innovative businesses which work in the areas of renewable energy, energy efficiency, and low emissions technologies[69].

Since 2012, ARENA has supported 566 projects with AUD $1.63 billion (CAD $1.6 billion) in grant funding, unlocking a total investment of almost $6.69 billion (CAD $6.5 billion) in Australia's renewable energy industry.

Early-stage R&D funding in clean technology in the oil and has sector is provided through grants and other financial incentives through ARENA, ARC, university involvement as well as CSRIO.

Market demonstration, deployment, and commercialisation is funded through CSRIO and Arena but primarily the Clean Innovation Fund. Similar to other jurisdictions, market accumulation and diffusion are funded through private sector funding and institutional investors in Australia.

## INNOVATION ECOSYSTEM

Australia's regional areas are vital in helping to deliver national goals in social, economic, and environmental issues, and they have strong drivers to be sustainable: regional communities represent an important and complex nexus between climate change, population growth, regionalisation, business and industry growth, natural resource management, liveability, and land use conflicts. However, many of Australia's regions are facing an important challenge: where economic growth relies solely on industries that consume finite natural resources, a region's economic position can only decline as those resources are extracted. Moreover, similar to Canada, there is guidance that comes specifically from the Australian states that influence the growth of clean technology, including a recent guidance on addressing greenhouse emissions in big development projects.[70]

In a study by Kinnear and Bricknell (2012)[71], ecological concerns and issues of resource depletion have been largely absent from the management of regional economic development in Australia. In Australia it is believed that there is now a need to change this trajectory and establish new regional economies around ecosystem services which enable regional areas to recapture value and create market and consumption niches. [72] Clearly, 'cleantech' is one way of exploring this. There are also many factors to

[67] Source: https://www.csiro.au/en/About/We-are-CSIRO
[68] Source: https://www.arc.gov.au/
[69] Source: https://www.cefc.com.au/where-we-invest/sustainable-economy/innovation-fund/
[70] Source: HTTPS://WWW.EPA.WA.GOV.AU/POLICIES-GUIDANCE/ENVIRONMENTAL-FACTOR-GUIDELINE-%E2%80%93-GREENHOUSE-GAS-EMISSIONS-0
[71] Source: Kinnear, S., & Bricknell, L. K. (2012). Linkages between clean technology development and environmental health outcomes in regional Australia. *Environmental Health: Emerging Issues and Practice*, 199.
[72] Source: Courvisanos, J. (2009). 14. Optimize versus satisfice: two approaches to an investment policy in sustainable development1. *Post Keynesian and Ecological Economics*, 279.

support the use of a regional approach to establish and grow Australian cleantech: these include the strong regional drivers for sustainability and the importance of regions in the national innovation agenda. Using a regional-level approach also brings cleaner production and environmental gains almost by default. For example, the recovery, reuse and/or substitution of raw input materials with locally sourced alternatives reduces transport emissions and encourages recycling.[73] (Furthermore, 'green' businesses and industries tend to be established in response to local markets for sustainable goods and services.[74] Perhaps one of the most important social elements of cleantech that is yet to be properly investigated and exploited is the possible effects on public and occupational environmental health outcomes, which Australia is engaging in both from a research and commercialization perspective.

Similar to Canada, Australia has a number of world-class universities doing work on clean technology. For example, at Edith Cowan University in Perth, there is The Centre for Sustainable Energy and Resources[75] that endeavours to decarbonise the energy supply chain, while simultaneously increasing the efficiency of hydrocarbon recovery and guaranteeing energy security. The Centre conducts leading edge research in the areas of improved natural gas and oil recovery, but also in carbon capture and storage and blue and green hydrogen production and hydrogen geo-storage.

## SUPPLY CHAIN

The rapid growth of Australia's oil and gas extraction industry has given rise to a large and dynamic supply chain. Thousands of domestic oil and gas suppliers have emerged in the past two decades to compete alongside larger, more mature global firms. This domestic supply chain has been an important source of value to complement oil and gas extraction, and according to NERA will be critical to the continued development of Australian oil and gas.

Australia's domestic oil and gas supply chain contributes AUD $38 billion (CAD $37.5 billion) to the economy. In 2016–17, Australia's oil and gas industry purchased $55 billion (CAD $53.6 billion) of goods and services to support its extraction of oil and gas, particularly conventional gas, and coal seam gas (CSG). Around 70 percent of the value of these goods and services was added in Australia, while the rest was imported. This makes the domestic supply chain a significant contributor to the Australian economy. At AUD $38 billion (CAD $37 billion), it is approximately 1.2 times the size of the building construction sector and generates almost 2 percent of the nation's gross domestic product (GDP).[76]

The size and composition of the domestic oil and gas supply chain is shaped by the phases of the production cycle. In 2013–14, in the middle of the construction boom, oil and gas operators spent AUD $99 billion (CAD $96.5 billion) in the supply chain, purchasing heavy equipment, engineering services and other goods and services. However, domestic suppliers captured less than half of this value. In the production phase that has followed, operators' overall expenditure on the supply chain is lower, but a greater share of value is captured by domestic suppliers, particularly in operations and maintenance services.

As in Newfoundland and Labrador, Australian suppliers tend to perform work that either must be conducted locally, or involves low levels of complexity: generic, non-specialised goods and services requiring low levels of technical expertise such as transport and logistics.

In regard to specific clean tech opportunities for suppliers, the NERA hosts a Technology Portal[77] that showcases Australian clean technology firms across the value chain. Some of the main focus points for companies who are involved in clean tech in the oil and gas industry in Australia include ones in the maintenance, digitization, and logistics fields.

## INTERNATIONAL COMPETITIVENESS

The key challenges for Australia, as envisioned by the NERA, to the success of the national low emissions technology roadmap and international competitiveness for the country are as follows:

[73] Source: Van Berkel, R. (2007). Eco-efficiency in the Australian minerals processing sector. *Journal of cleaner production*, *15*(8-9), 772-781.
[74] Source: Chapple, K., & Hutson, M. (2010). Innovating the green economy in California regions. *Center for Community Innovation, UC Berkeley*.
[75] Source: https://www.ecu.edu.au/schools/engineering/research-activity/centre-for-sustainable-energy-and-resources/about
[76] Source: NERA
[77] Source: https://www.nera.org.au/Tech-Catalogue -

- Australia's geography poses a unique set of challenges, similar to Newfoundland and Labrador, with much of the accessible natural gas basins located far away from population and manufacturing centres, making access to this energy source expensive and complex.
- Australia has an excellent record of research, but the commercialisation environment is challenged with significant barriers in the transfer of IP from universities and research institutes to the market. Once again, this is a similar situation to Newfoundland and Labrador.
- Falling oil and gas prices will place downward pressure on the economics of renewable sources in the short-term, and without policy support, some renewables as well as clean tech opportunities that have seen initiation or rapid deployment may be displaced to cheap hydrocarbons and fossil fuels.

For Australia, it is not just oil and gas, the focus is energy and the main driver for energy transformation is coal. The world is experiencing a global shift away from coal toward gas and ultimately renewable energy resources. Many nations are still heavily invested in coal fired power generation technology that is years away from retirement. New thermal generation is increasingly both high efficiency, low emission (HELE) coal and gas-based and as a leading supplier of both high-quality coal and natural gas, Australia has an advantage in the mid-term.

One of the biggest trends in Australia is the role of hydrogen. The Hydrogen Energy Supply Chain (HSEC) project between Australia and Japan eyes full commercial operations over the next decade and remains committed to delivering hydrogen from coal as the primary input. The HSEC is just one of a number of ongoing projects in Australia exploring hydrogen's production from alternative feedstock (coal). The HESC project aims to safely and efficiently produce and transport hydrogen from Victoria's Latrobe Valley to Japan, where hydrogen will be transported from a liquefaction and loading terminal at the Port of Hastings, Victoria to Kobe terminal in Japan.

The rationale of producing hydrogen from Latrobe Valley coal in Australia stems from three factors -- scale, urgency, and sustainability. The commercial phase of the HESC project will require a Carbon Capture and Storage (CCS) solution.

Coal gasification for hydrogen production is an off-the-shelf technology, which can be provided at scale with the use of a large-scale liquefied hydrogen tanker. There are 23 hydrogen specific demonstration projects and research facilities across Australia, mostly concentrated along the eastern coast of the country.

Natural gas continues to remain a significant feedstock for hydrogen production in Australia. The Australian Gas Infrastructure Group aims to reduce carbon dioxide emission through blending of biogas and hydrogen in gas networks and eventually convert the networks to carbon dioxide free biogas and hydrogen.

The NERA considers that renewables such as solar and wind coupled with the emergence of potential new uses of hydrogen may threaten this position in the long-term unless Australia acts now to integrate systems across the country. Moreover, Australia must leverage existing strengths and advantages and effectively utilise a diverse range of energy sources and solutions to achieve affordable, reliable, and clean energy.

There are a number of emergent low emissions technologies that align with Australia's historic strengths and offer considerable opportunities for its economy. Most significant among these are:

- The production of hydrogen for both domestic consumption and, eventually, export.
- SMEs to attract affordable growth capital to innovate and scale-up for technology deployment
- Growth of the country's capabilities in the utilisation and/or storage of CO2 produced in both the production and consumption of fossil fuels.
- Leveraging Australia's national leadership in the area of remote operations.
- Exploiting emerging areas in digitalization where solutions may be readily exported to other jurisdictions.

## GULF OF MEXICO

### OVERVIEW

| Economic Position* | Regulation and Policy | R&D Framework | Innovation Funding | Supply Chain | International Competitiveness | Innovation Ecosystem |
|---|---|---|---|---|---|---|
| • Substantial economic strength<br>• Most interest in clean technology in the US is not in the oil and gas sector – instead solar is the major driver<br>• A hub for global companies and innovation but little collaboration and no major institutional supports that are seen in other jurisdictions | • Confusing policy and regulation around clean technology<br>• Major focus on safety and environmental protection<br>• Political priorities and funding greatly influences policy development and regulation | • R&D would seem to be done at a company level, in conjunction with universities, but no central R&D framework or coordination<br>• Regulator operates under a Best Available and Safest Technologies (BAST) – is a major driver for R&D | • Significant private sector funding into clean tech in the offshore oil and gas but mostly around performance improvement not necessarily around developing technology that can be presented to a broader commercial market | • The supply chain in the Gulf of Mexico is complex and there is no central organization coordinating activity in the clean technology sector in the region | • Most of the clean technology activities that are emerging from the GOM are focused on domestic production and innovation. | • Innovation ecosystem is focused at company level with innovation activities at university, the National Research Labs, and individual companies. |

While the Gulf of Mexico is the area where offshore oil and gas operates in the United States, it is important to outline the overall importance of the sector to the country. Investment into renewable energy technologies has grown significantly in the United States over the last decades. In 2019, investments reached USD $59 billion (CAD $75.8 billion), in comparison to USD $11.3 billion (CAD $14.5 billion) in 2005. The United States` renewable market has also benefitted from green stimulus programs and uncertainties in renewable tax credits. As a result, the United States has also been a major market in terms of venture capital and private equity funding for green technology companies.[78]

The United States clean technology ecosystem has focused heavily on small-scale solar as well as utility-scale renewable technologies in comparison to other jurisdictions reviewed such as Norway and the United Kingdom.

With its shallow, warm waters, smaller average wave heights, and close proximity to existing offshore oil and gas infrastructure, the Gulf of Mexico presents many advantages for offshore wind and other renewable energy. However, unique conditions in the Gulf of Mexico introduce new technology challenges such as hurricane exposure, lower winds, and softer soils that will require offshore wind technology be adapted to not only survive these conditions, but also to demonstrate cost competitiveness in regional electric markets.

In our review of the Gulf of Mexico, it was hard to pinpoint any specific competitive advantage it has over other jurisdictions from a clean technology perspective in the offshore oil and gas industry when viewed from a government regulation and policy, R&D, or international competitiveness lens. There is certainly an ecosystem of companies engaged in clean technology either directly or indirectly, but this seems to have occurred either organically or emerged to address issues in the traditional offshore oil and gas industry.

### GOVERNMENT REGULATION AND POLICY

There are a number of regulators in the Gulf of Mexico and the Department of Energy (DOE), the Department of the Interior (DOI), and the Environmental Protection Agency (EPA) all have a role in advancing clean technology in the United States. For example, in 2012, these three agencies agreed to develop a multi-agency research plan to address the highest priority research questions associated with safely and prudently developing unconventional shale gas and tight oil reserves. The Steering Committee

[78] Source: Statista – US Oil and Gas

finalized the Federal Multiagency Collaboration on Unconventional Oil and Gas Research: A Strategy for Research and Development in 2014.[79]

The offshore oil and gas industry in the Gulf of Mexico is predominantly regulated by the Bureau of Safety and Environmental Enforcement (BSEE) which is under the United States Department of the Interior. Established in 2011, BSEE is the lead agency in charge of improving safety and ensuring environmental protection relating to the offshore energy industry, mainly natural gas, and oil, on the United States Outer Continental Shelf (OCS). The agency exercises the safety and environmental enforcement functions including the authority to inspect, investigate, summon witnesses, and produce evidence, levy penalties, cancel or suspend activities, and oversee safety, response, and removal preparedness.[80] BSEE is responsible for Offshore Regulatory Standards and in particular Emerging Technologies.[81]

The Emerging Technologies Branch (ETB) of the BSEE identifies, develops, and incorporates those new or emerging technologies with the potential to address and mitigate safety issues along America's Outer Continental Shelf (OCS). While assessing new technologies, the ETB considers how technologies may be applied and integrated into BSEE's regulatory programs to promote safety, conserve resources, and protect the environment. Technology reviews may be necessary because of the development of a new regulation, the modification of an existing requirement, the development and subsequent incorporation of a consensus-based standard, the issuance of a Notice to Lessees, or changes to permit conditions or approvals.

For the development of clean technology in offshore oil and gas, the ETB operates under a best available and safest technologies program. The Bureau's Best Available and Safest Technologies (BAST) Program within the Office of Offshore Regulatory Programs (OORP) fulfills specific provisions of the 1978 Outer Continental Shelf Lands Act (OCSLA) Amendments on behalf of, and in coordination with, the Director of BSEE.

Additionally, the regulations requires the best available and safest technology "[o]n all new drilling and production operations and, except as provided in paragraph (c)(3) of this section, on existing operations, you must use the best available and safest technologies (BAST) which the BSEE Director determines to be economically feasible and/or when the failure of that equipment would have a significant effect on safety, health, or the environment, except where the BSEE Director determines that the incremental benefits are clearly insufficient to justify the incremental costs of utilizing such technologies." Once evaluated, if approved, these technologies may be integrated into regulatory programs and initiatives and then used offshore.

### R&D FRAMEWORK

In the Gulf of Mexico, progress in technology development over the last five to ten years, both offshore and onshore, has been focused in several distinct areas:[82]

- Sophisticated data acquisition, processing, and visualization applied across the sector, from exploration to field maintenance and safe final plugging of wells.
- Water conservation and protection, chiefly through treatments enabling water reuse, as well as use of brines and non-potable water in oil and gas applications.
- Materials science, especially in cements and metals used for wellbore isolation and integrity.
- Technologies to increase reservoir recovery factors, in particular via stimulation.
- Combining increased oil and gas recovery with carbon sequestration in a technique known as CO2 Enhanced Oil Recovery (CO2 EOR), a nascent opportunity for building experience with carbon sequestration, but one with promise.
- Oil spill prevention technology for operations in deep- and ultra-deepwater.

Overall, the most profound technical developments have been in the field of drilling and completions, including horizontal drilling, extension, and hydraulic fracturing.

[79] Source: https://www.energy.gov/fe/multi-agency-collaboration-unconventional-oil-and-gas-research
[80] Source: https://www.bsee.gov/who-we-are/about-us
[81] Source: https://www.bsee.gov/what-we-do/offshore-regulatory-programs/emerging-technologies
[82] Source: https://www.energy.gov/sites/prod/files/2016/05/f32/Ch.7-SI-Oil-and-Gas-Technologies.pdf

The Office of Oil and Natural Gas' Division of Upstream Research promotes safety and environmental sustainability of oil and gas exploration and production. The Division provides early-stage research in upstream onshore and offshore.[83]

The Offshore Research is focused on increasing ultimate recovery of oil and gas resources in the Outer Continental Shelf while preventing oil spills through maintaining well control throughout the lifetime of the well. The research portfolio is comprised of a suite of projects that focuses on innovative solutions to solve the challenges associated with deepwater geohazard prediction, well control during drilling and over the lifetime of the well, surface systems and umbilicals including met-ocean effects, and subsea systems reliability and automation.

As well, the Office of Oil and Natural Gas' Division of Supply and Delivery identifies and operates in areas where there is an appropriate government role for the development of technologies that can increase energy and economic security. The Division provides early-stage research in natural gas infrastructure, gas hydrates and DOE research studies.

The Offshore Research Program sponsors research activities in two ways: Cost-Shared Research via public-private partnerships with industry, academia, and private labs; and, at the DOE's National' Laboratories, including the National Energy Technology Laboratory (NETL) Research.

The NETL partners with a wide range of entities including academia, private sector companies/institutes, and foreign governments to gain a full range of expertise and resources for targeted research and development areas. The Department of Energy National Laboratories and Technology Centers are a system of facilities and laboratories overseen by the United States Department of Energy (DOE) for the purpose of advancing science and technology to fulfill the DOE mission. Sixteen of the seventeen DOE national laboratories are federally funded research and development centers administered, managed, operated and staffed by private-sector organizations under management and operating (M&O) contract with DOE.

## FUNDING AND INCENTIVES

As a result of Covid-19, most Americans support an economic recovery that bolsters the clean energy industry: in recent surveys, 56% favor aid for renewable energy while 38% support aid for oil and gas.[84] However, there has been an absence of targeted funding in recent funding announcements specifically the Coronavirus Aid, Relief, and Economic Security (CARES) Act.[85]

The US government has provided tailored, targeted relief to oil and gas companies while largely dismissing the sector-specific requests of clean energy as part of its recent Covid-19 stimulus. Both clean energy and oil and gas are suffering from job losses related to COVID-19, but none of the actions taken to benefit the oil and gas industry are designed to assist fossil fuel workers who have lost their jobs. And according to the World Resources Institute, the government has failed to address the loss of clean energy jobs directly resulting from the coronavirus pandemic.[86]

Under CARES, changes to tax restrictions and rebates loosened rules on accounting for business losses, allowing businesses to carry back losses from 2018-2020 (both before and as a result of COVID-19) and decrease taxable profits for years prior to 2018.[87] This change is particularly helpful for the oil industry, given recent volatile profits.[88] The Treasury Department and IRS also provided tax relief for renewable energy projects by increasing flexibility around, extending, beginning of construction and placed in service deadlines for tax credits that financially underpin the industry.[89]

Funding and incentives have for clean technology development in the offshore oil and gas industry seem to have largely disappeared under the Trump Administration. In addition, COVID-19 has had a significant impact on the energy industry overall, particularly in terms of reduced demand, supply chain disruptions and lost jobs. Because many Americans have been in quarantine since the onset of the pandemic, there has been a drastic drop in demand for oil as airplanes, trains, cars, and trucks are largely unused.

[83] Source: https://www.energy.gov/fe/science-innovation/oil-gas-research
[84] Source: https://www.wri.org/blog/2020/06/coronavirus-stimulus-packages-clean-energy
[85] Source: https://home.treasury.gov/policy-issues/cares
[86] Source: https://www.wri.org/blog/2020/06/coronavirus-stimulus-packages-clean-energy
[87] https://www.taxpolicycenter.org/taxvox/who-benefits-cares-act-tax-cuts
[88] Source: https://www.bloomberg.com/news/articles/2020-05-15/-stealth-bailout-shovels-millions-of-dollars-to-oil-companies?sref=vdNmoUVL
[89] Source: https://www.irs.gov/newsroom/treasury-irs-provide-safe-harbor-for-taxpayers-that-develop-renewable-energy-projects

Recent forecasts from the U.S. Energy Information Administration suggest that the total U.S. electric power sector generation will decline by 5% in 2020 and motor gasoline consumption will fall by 11% compared to 2019.[90] The International Energy Association found that energy investment in the United States in 2020 is set to fall by 25%, a decline greater than some other countries, because of the U.S.'s exposure to oil and gas.[91]

The ability of wind, solar and hydropower developers to qualify for time-sensitive tax credits is impeded by supply chain disruptions, the shut-down of factories, or reduced production volumes and the inability to do installations when social-distancing is required. According to the industry, the existing tax credits for energy efficiency are insufficient to spur investment, particularly in this context, and at the scale currently needed to allow businesses to maintain staff or even consider rehiring.[92]

## INNOVATION ECOSYSTEM

Most of the innovation ecosystem around oil and gas in the United States is based on onshore drilling and/or fracking.[93] As well, there has been significant research around offshore wind development.[94] Where there is innovation ongoing, it would seem to be done in specific companies and/or universities instead of a coordinated and collaborative effort as seen in other jurisdictions.

Still, innovation in offshore oil and gas is occurring. For example, Shell has used 3D printers to prototype its Stones Oil and Gas station in the Gulf of Mexico. The team used a 3D printer to produce a scaled-down plastic version, including all components, in only four weeks. This version helped Shell understand how to improve components before building the real-life buoy in the construction yard, and even helped to work out the most efficient assembly sequence for the buoy. Shell saved USD $40 million (CAD $51.3 million) by highlighting design flaws at an early stage. The 3D-printed prototype also showed US authorities exactly how the finished design would function in a rough sea environment and helped Shell secure government approval.[95]

Offshore wind development is seen as the largest emerging trend in the Gulf of Mexico. Most of the interest in offshore wind would be that it seems to bring significant economic benefits to the region over the next decade. At the NREL there are a number of interesting studies looking at energy generation in the Gulf of Mexico. The first study, "Offshore Renewable Energy Technologies in the Gulf of Mexico," analyzed different offshore renewable energy technologies, including offshore wind, wave, tidal, ocean current, ocean-based solar, ocean thermal, deep water source cooling, and hydrogen conversion and transport, to determine which are best suited for electric utility-scale development in the Gulf. Offshore wind was found to offer a technically feasible resource potential of 508 gigawatts—the largest of any of the technologies analyzed, and twice the energy currently consumed in the Gulf states.

In addition to identifying offshore wind as the leading technology for Gulf of Mexico application, NREL further analyzed the economic feasibility of offshore wind both regionally and for selected sites. That analysis was the focus of the second study, "Offshore Wind in the U.S. Gulf of Mexico: Regional Economic Modeling & Site-Specific Analyses." In this study, NREL established selection criteria for hypothetical wind plant locations throughout the Gulf of Mexico and recommended to BOEM six viable study areas: Port Isabel, Galveston, and Port Arthur in Texas; Pensacola and Panama City in Florida; and New Orleans in Louisiana. The study projected that costs will decline steadily over the next decade with some sites reaching the threshold of economic viability (market potential without subsidies) by 2030; but the assessment assumed that new technology adaptations for hurricanes and lower wind speeds would also be in place.

The analysis also indicated that a single offshore wind project could support approximately 4,470 jobs with USD $445 million (CAD $571 million) in gross domestic product (GDP) during construction and an

[90] Source: https://www.eia.gov/outlooks/steo/
[91] Source: https://www.iea.org/reports/world-energy-investment-2020/key-findings#abstract
[92] Source: https://www.ase.org/tax-priorities-rebuilding-energy-efficiency-economy-and-workforce
[93] https://www.nrel.gov/docs/fy19osti/72151.pdf
[94] Source: Gernaat, D. E., Van Vuuren, D. P., Van Vliet, J., Sullivan, P., & Arent, D. J. (2014). Global long-term cost dynamics of offshore wind electricity generation. *Energy*, *76*, 663-672. Vieira, M., Maciel, G., Henriques, E., & Reis, L. (2019). A new proposal for an offshore wind foundation for transitional waters. *Marine Structures*, *68*, 102657. Haces-Fernandez, F., Li, H., & Ramirez, D. (2018). Assessment of the potential of energy extracted from waves and wind to supply offshore oil platforms operating in the Gulf of Mexico. *Energies*, *11*(5), 1084.
[95] Source: https://www.shell.com/inside-energy/how-3d-printing-is-changing-the-world.html

ongoing 150 jobs with $14 million GDP annually from operation and maintenance labor, materials, and services.

## SUPPLY CHAIN

In the Gulf of Mexico, the offshore petroleum industry evolved from the onshore industry and moved through wetlands and lakes and then across the OCS. The OCS defines a number of elements of the supply chain as a legal and political unit as it is under federal jurisdiction. The OCS generally extends from 3 to 200 nautical miles from the US coastline. In the offshore oil and gas industry within the Gulf of Mexico, the supply chain is a vast configuration of structures, vessels, companies, and people responsible for four primary activities: exploration, development (drilling), production, and decommissioning.[96]

Offshore oil and gas production is crucial to U.S. energy security. In addition, capital investment and purchases of intermediate inputs of the oil and natural gas industry stimulate its entire value chain and ripple through many sectors of the economy, creating jobs, contributing to GDP, and generating tax revenue at all levels of government.

Oil and natural gas industry activity supports employment across a wide swath of industries in manufacturing and services, including oil and natural gas machinery, air and marine transport, legal and insurance services.

The development of oil and natural gas resources in the offshore Gulf of Mexico is highly capital intensive. The Gulf Coast states, with the primary four being Texas, Louisiana, Mississippi, and Alabama, (including the federal waters of these states) are areas which produce oil and natural gas and receive the majority of the spending from the offshore oil and natural gas industry in the Gulf of Mexico.

These states are the location of most of the primary spending for capital equipment and purchases of intermediate inputs needed for the operational activities of the Gulf of Mexico oil and natural gas industry. Throughout the Gulf Coast, activities such as engineering and management, manufacturing of equipment, support of offshore activities, and fabrication of platforms and topsides are widespread.

Overall, the supply chain in the Gulf of Mexico is complex[97] and there is no central organization coordinating activity in the clean technology sector in the region.

## INTERNATIONAL COMPETITIVENESS

Overall, we did not find a particular area of the Gulf of Mexico that was good practice from an international competitiveness lens.

The United States will, for the foreseeable future, continue to rely heavily upon oil and natural gas to support its economy, national security, and energy security. Until recently, U.S. oil production was in decline. Oil imports contributed more than half of domestic oil consumption. Natural gas investment was moving towards expensive terminals to import natural gas. Today the situation has reversed—the United States is the world's largest producer of oil and natural gas, is exporting more refined products, including crude oil and liquified natural gas.[98]

Advances were generated in part by DOE technological investments in the early 1980s, and in part by industry's continued development and application of those technologies. Concurrent with these technological advances has been the drive to increase the effort to address environmental issues associated with oil and gas production. Public concerns over potential environmental impacts have been heightened by the BP Deepwater Horizon incident offshore, and by hydraulic fracturing onshore and the rapid development of shale oil and gas fields in many parts of the United States.

[96] Source: https://www.boem.gov/sites/default/files/boem-education/BOEM-Education-Images-and-Resources/TheOffshorePetroleumIndustryOrganizationalScheme.pdf
[97] Source: http://www.noia.org/wp-content/uploads/2015/12/QuestGoMEconomicAnalysis7-11-2011.pdf
[98] Source: https://www.energy.gov/sites/prod/files/2016/05/f32/Ch.7-SI-Oil-and-Gas-Technologies.pdf

## NORWAY

### OVERVIEW

| Economic Position* | Regulation and Policy | R&D Framework | Innovation Funding | Supply Chain | International Competitiveness | Innovation Ecosystem |
|---|---|---|---|---|---|---|
| • Substantial economic strength<br>• 50% of hydrocarbon resource produced. Decline is expected going forward.<br>• Significant use of subsidies across full economy<br>• A hub for global companies and innovation | • Active, clear, and bold in policy and regulation<br>• Balanced carrot and stick policies<br>• Ambitious climate targets<br>• Maximizing value of hydrocarbon resources<br>• Early movers on climate technologies, renewables, hydrogen and CCUS<br>• Collaboration on economic priorities | • Collaborative framework: OG21 /Energi 21<br>• Strong mandate and oversight<br>• Significant funding through Research Council of Norway<br>• State-driven R&D priorities – reported and monitored<br>• Tax incentives for operators | • Strong support for public funding into innovation<br>• Numerous funding opportunities<br>• Support across innovation lifecycle<br>• PETROMAKS 2 and DEMO2000<br>• Highest GDP/capita public expenditure on cleantech- R&D. | • Green transition package' of NOK 3.6 billion<br>• Growing start-up community<br>• Driving energy transition through big projects: Longship, Northern Lights<br>• Collaborative engagement<br>• Numerous industry associations and networking<br>• Prioritizing energy integration in transition | • Significant export support – Norwep and Innovation Norway<br>• Early market movers<br>• Addressing global technology issues | • Numerous innovation centres (including dedicated cleantech centre), science parks, incubators<br>• National and regional clusters<br>• Support for full TRL lifecycle<br>• Testing, piloting, and demonstration plants |

Norway has established a solid foundation to support the development and growth of a strong clean tech ecosystem. The depth and strength of these elements collectively have shaped Norway's strong clean technology sector.

Norway is a major energy nation in Europe based on its significant energy resources: hydropower, petroleum, and new renewable energy sources such as windpower and biomass. Norway has only one per cent of Europe's population, but 20 per cent of the hydropower resources, 40 per cent of the gas resources and 60 per cent of the oil resources.

It is the third largest exporter of natural gas in the world. Nearly all oil and gas produced on the Norwegian shelf is exported, and combined, oil and gas equals about half of the total value of Norwegian exports of goods. This makes oil and gas the most important export commodities in the Norwegian economy.

Norwegian power production is almost 100% renewable and emission free. 95 per cent of the power production stems from the 1600 hydropower plants which are spread all across the country, and some 3.5 percent stems from windpower. The latter is expected to grow significantly in the coming years.

A significant proportion of Norway is employed either directly or indirectly in the petroleum sector in Norway. In 2017, approximately 225,000 people were directly or indirectly employed in the Norwegian petroleum sector.

Norway has already used up roughly half of its oil and gas in the ground. Nonetheless, annual production is expected to increase substantially in the next few years. According to the Norwegian Petroleum Directorate (NPD) Norway's oil output will grow by 43% from 2019 to 2024 as new fields come on stream and older production facilities are upgraded.

The figures in each column show expected recoverable volumes and the uncertainty in the estimate is shown in the slanted line; low estimate on the left, high estimate on the right (Source: The Norwegian Petroleum Directorate)

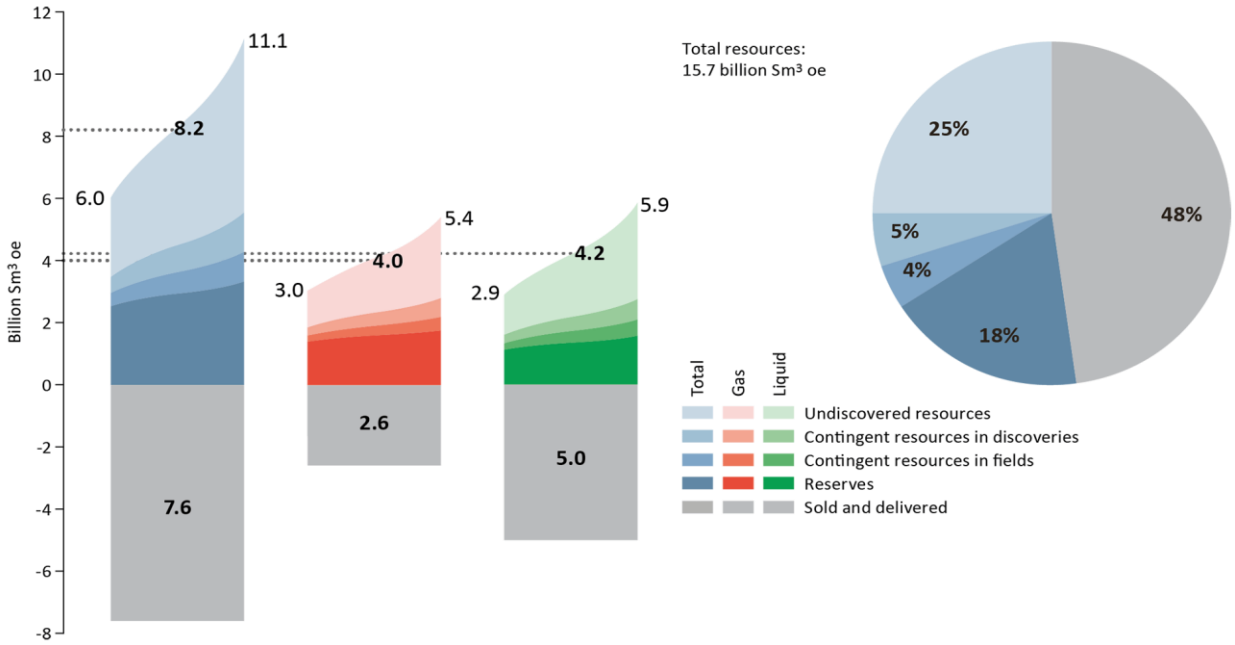


**FIGURE 27** – Value of Norway Crude Exports

Norway's energy transition activities are often referred to as globally leading. Norway signed the 2015 Paris climate agreement, have strong targets to sharply reduce its domestic carbon emissions in the coming decades and are making significant investments to diversify its economy into clean tech. Because Norway power production is based on hydroelectricity, it is already decarbonized. Nevertheless, it is challenged to meet its ambitious carbon reducing targets as its domestic emissions are rising due to increased emissions from oil and gas exploration and transport. Going forward, its plans are to aggressively produce and sell petroleum to others for as long as demand exists.

## GOVERNMENT – REGULATION AND POLICY

Norway's leading strength in clean tech is a product of significant push and pull pressures.

As a jurisdiction, Norway has always been considered an early mover when it comes to implementing measures to reduce carbon emissions. An example of strong push policy interventions occurred when Norway implemented a total ban on non-emergency flaring in the Norwegian continental shelf in 1971 in order to avoid wasting resources. Reduced gas flaring has advanced environmental protection policy while also driving the development of gas transportation infrastructure, which likely contributed to the development of many oil fields that became commercially viable thanks to the reduced gas utilization schemes.

Norwegian government is also an early mover in the development of strategic economic development policy. This is based on a framework of collaboration, alignment, funding innovation, a strong R&D and innovation ecosystem, as well as accountability. Examples are national strategies that have set priorities for a blue ocean economy, hydrogen, digitalization, carbon capture and storage and green shipping, offshore wind, etc. This has positioned Norway as leaders globally relating to these and other policy initiatives, which has opened doors to new markets, influenced technology maturation, fostered international collaboration, and attracted investment.

The polluter-pays-principle is a cornerstone of the Norwegian policy framework on climate change. Cross-sectoral economic policy instruments, such as CO2 tax are the basis for decentralised, cost-effective, and informed actions. Today, more than 80% of Norwegian GHG emissions are covered by taxes and/or the EU Emissions Trading Scheme (EU-ETS).

In addition to carbon-pricing instruments, the government supports research on and innovation in climate-friendly technologies to encourage developing emissions reduction solutions when the markets have not

provided them. In particular, Norway is a global leader in CCS research, development, demonstration, and deployment.

Although they are global leaders in the reduction of carbon, Norway has not turned its back on its strong hydrocarbon resources. With about 48 per cent of the estimated total recoverable resources on the Norwegian continental shelf already produced, its government is still looking to oil and gas production to generate substantial value creation. They are investing in significant funds into technologies that will improve the economics of projects and reduce the industry's environmental impact, such as wind developments, CCS, and electrification of offshore platforms.

From a regulatory perspective, Norwegian regulators, the Norwegian Petroleum Directorate (NPD), pride themselves in its predictable framework to support industry growth. Its mandate is to maximize value creation from the oil and gas sector. For instance, infrastructure lead exploration drives faster development times and more profitable per barrel with less emissions. Norway has clearly established regulations that foster third-party access to existing infrastructure, such as a producing platform, that has created substantial growth for the industry.

May 2020, the Norwegian government introduced a strong pull policy intervention with its 'Green transition package' of NOK 3.6 billion (CAD $.54 billion) to drive a green transition and use it to accelerate out of COVID-19 impacts on energy and industry. Solutions such as hydrogen, building renovation, batteries, offshore wind, circular economy, green shipping, and other forms of green energy are mentioned specifically. Funding is provided through public and public-private mechanisms. Most will focus on supporting medium to high technology readiness level (TRL) activities supporting industrial competitiveness in emerging solutions.

June 2020, Norway introduced a new hydrogen strategy, stating that hydrogen is an energy carrier with significant potential for reducing local, national, and global emissions, and for creating economic value for Norwegian businesses. It stated: "If hydrogen is to be a low or zero emission energy carrier, it must be produced with low or zero emissions, for example through natural gas reforming combined with CCS, or from electrolysis of water using renewable electricity. Hydrogen presents exciting opportunities for Norway, as an energy nation and a technology nation."

Culturally, Norway has been bold when it comes to the development and deployment for new technology. With a focus on value creation while reducing emissions, Norway has taken a leading position by heavily investing in the following industrial developments: clean hydrogen, CCS, offshore wind, power from shore. Its regulators, for example, have taken a basin-wide approach to identify fields that can be used for carbon storage to support industry growth into CCS.

### R&D FRAMEWORK

Technology and innovation has been essential in the economic development of Norway. Considerable emphasis has been placed by government to motivate and support innovation with research and technology expenditures expected to reach 2.4% of GDP by 2027. The result has been the creation of one of the world's cleanest petroleum industries and significant value creation.

Research and technology development are encouraged primarily through legislation or other forms of regulation. OG21 (Oil and gas for the 21st century) receives its mandate from the Ministries of Petroleum and Energy and Labor. Every five years it develops a national technology strategy for Norway to guide the technology and research efforts of the authorities and the industry. OG21 brings government, business, and research environments together to identify technology challenges and agree on strategies that set direction for publicly funded petroleum research in Norway, and it influences R&D plans and activities in the petroleum industry, in research institutes and in universities. The strategy is due for a new revision in 2021.

The current strategy has five strategic objectives, which has aligned the petroleum industry's drivers with the county's overarching socio-economic goals:

- Maximize resource utilization
- Minimize environmental impact
- Improve productivity and reduce costs
- Develop innovative technologies
- Attract, develop, and retain the best talents

While OG21 sets priorities, the Research Council of Norway funds and carries out the research in different areas including climate change and environment. Out of its four such research divisions, the Division for Energy, Resources, and the Environment is responsible for research and innovation targeting national and global challenges associated with the energy, petroleum, climate, polar, environmental, and marine resources sectors.

Energi21 establishes Norway's national strategy for the energy sector. Energi21 and OG21 both have a mandate by the Norwegian government to "boost value creation, facilitate development of new technology and cultivate internationally competitive expertise.

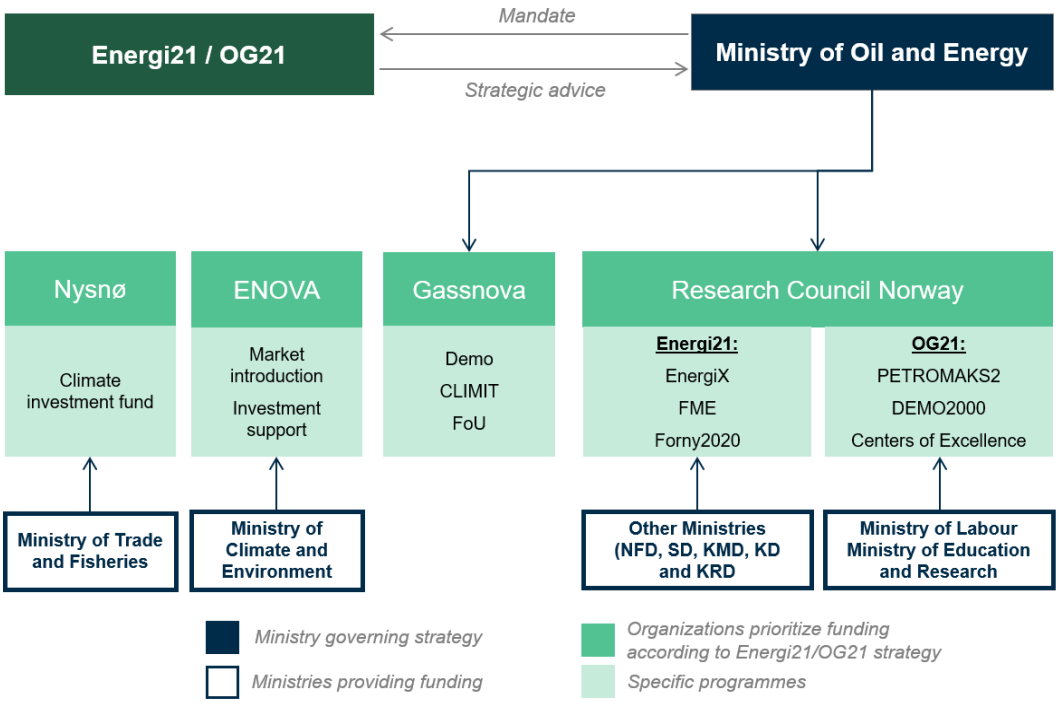


**FIGURE 28** – Norwegian R&D Clean Technology Ecosystem

Most R&D allocations go to the PETROMAKS 2 and DEMO2000 research programs and to research centres in Stavanger (IOR/EOR technologies), Tromsø (Arctic technologies) and Trondheim (Clean technologies).

- PETROMAKS 2 provides funding to a broad range of projects, from strategic basic research at universities and research institutes to innovation projects headed by the private sector. The programme has an overall responsibility for research that facilitates the best possible management of Norwegian petroleum resources and future-oriented business development in the sector.
- The DEMO2000 is a tool that lies further in the innovation chain testing new technology solutions in the petroleum industry. The goal is to reduce the industry's costs and risks by providing funding for pilot and demonstration projects.

The following are relevant factors to be considered to better understand OG21 and its role:

- While collaborative in nature, OG21 holds considerable influence across the oil and gas ecosystem: academia/researchers, industry, government, and the supply chain through the development of its strategy.
- Petroleum industry enterprises, universities and research institutes must update their R&D and technology strategies to reflect the guidance set out by OG21 strategy.
- There is significant ownership at the political level for OG21, which gives it influence and support. This, however, introduces political challenges as OG21 is still very much driven to support oil and gas technology and research; however, some opposition parties in Norway often have other ideas or agendas relating to the relationship oil and gas has in Norway's energy transition.
- Investments in R&D by the oil and gas industry is monitored, reported, and must reflect OG21 priority areas.
- Its mandate is evolving there is a strategic move to bring Energy21 and OG21 closer together as research is moved toward Norway's energy system. There will likely be stronger collaboration supporting R&D relating to Norway's energy and export system, involving hydrogen and ammonia value chains (both green and blue), either utilizing the clean energy from the Norwegian grid or natural gas where the CO2 is shipped and piped back to reservoirs offshore Norway for storage.
- Supporting innovation through the full TRL life cycle has been a challenge that OG21 has tried to address. To foster piloting and demonstration projects, which can be challenging on large offshore, mature assets, OG21 now allows piloting and demonstration projects on foreign assets, as long as the technology is relevant for the NCS.

## FUNDING AND INCENTIVES

It is a commonly held belief among Norwegian public officials that public funding of petroleum research offers high return to the society and the advancement of technology. Government funding has also been directed to support emerging cleantech innovations as well as significant industrial development projects that align with its petroleum industry.

The Norwegian government has recently proposed major funding to enable the large-scale implementation of carbon capture, transport, and storage (CCS) technologies in Norway. Named 'Longship', the funding package will see the implementation of the first full-scale CCS project in the world. Public funding of around NOK $1.8 billion (CAD $267 million) will contribute to the overall cost expected to be in the region of NOK $2.7 billion (CAD$401 million). Longship has the potential to open new trade routes to an entirely new economic model for Norway.

As part of this, it recently entered into a 3-year-old partnership called Northern Lights, which is a joint effort of the Norwegian government and energy firms Equinor, Shell and Total, and Microsoft. This partnership is seeking to standardize and scale carbon capture and storage, or CCS, across Europe.

It involves the implementation of the full-scale CCS chain with safe storage of the CO2 almost 10,000 feet under the ocean. Initially able to handle 1.5 million tons per year, the site will be able to receive, inject and store up to 5 million tons of CO2 per year when fully realized. This investment is believed to support a future hydrogen economy, something which can be accelerated by producing clean hydrogen from natural gas with CCS.

Two new offshore petroleum fields being developed will be powered by offshore wind with significant government subsidies. Government views this as a technology development project that will lower the cost of offshore wind and support the long-term commercial viability of the technology.

Over half of Norway' new projects are powered from shore. To build technology capacity to meet this demand the Government of Norway has funded the electrification of offshore fields.

Favourable framework conditions have also provided company incentives to carry out research and technology development in Norway. The following are examples of available funding:

- Investinor is investing in later expansion stages of a venture aiding its international growth
- ENERGIX is an applied energy research program aimed at restructuring the Norwegian energy system.

- CLIMIT is focused on Carbon Capture and Storage (CCS)
- Transnova funds pilot and demonstration projects concerning future-oriented sustainable mobility solutions
- Innovation loans finance up to 50% of a project and is targeted at the expansion phase.
- The Environmental Technology Scheme targets cleantech companies in the late start-up phase through co-financing.
- SkatteFUNN is a tax incentive scheme that allows companies to apply for tax deduction based on R&D project costs.
- The NOx Fund was established to finance measures that reduce nitrous oxide (NOx) pollution. Norwegian companies volunteer to pay into the NOx versus paying a NOx tax, the money then pays for NOx reduction measures implemented by the companies themselves. This fund has driven the development of carbon reduced shipping technologies and a new competitive advantage for Norway.
- A large part of the R&D funding is financed through the licenses. There is an attractive R&D scheme (the FoT setup) that allows operators to allocate a certain amount of their R&D spend (percentage of expex, capex and opex) to the oil and gas licenses they operate, where the owners will split the bill. The R&D work does not necessarily have to be relevant for that specific license, but for the NCS in general. For an operator with several licenses, large R&D projects can be financed through this setup.

## INNOVATION ECOSYSTEM

According to the Norwegian Minister of Research and Higher Education Henrik Asheim, “It is the Government’s ambition to make Norway one of the most innovative countries in Europe.” It has developed an expansive and focused innovation technology ecosystem that grew primarily from oil and gas but has diversified so Norway is a global leader in clean tech innovation. The ecosystem includes the following components, which have contributed to its growth and strength in clean technology:

- Norway’s Innovation Cluster Scheme has established strong regional cluster programs, including wind, smart grid and smart energy markets, clean water and maritime cleantech clusters. Involving businesses, universities and the public, this scheme is run by Innovation Norway, the Research Council of Norway and SIVA. It has two main programs: ARENA and the Norwegian Centres of Expertise (NCE). In ARENA, four of the regional clusters are in the cleantech sector (two wind energy, one bio energy, one material technology). The NCE program supports mature clusters and aims for international growth and increasing competitiveness. One of the 12 centres of expertise is in the cleantech sector and deals with smart energy markets.
- Siva is a governmental enterprise facilitating national infrastructure for innovation consisting of incubators, business gardens, catapult centres, innovation enterprises, innovation centres and industrial real estate. Through the Industrial Development Corporation of Norway (Siva SF), the Government grants funds for the establishment of catapult centres. The catapult scheme is to help businesses develop prototypes, test, simulate, and visualise, so that ideas are developed faster, better and with less risk.

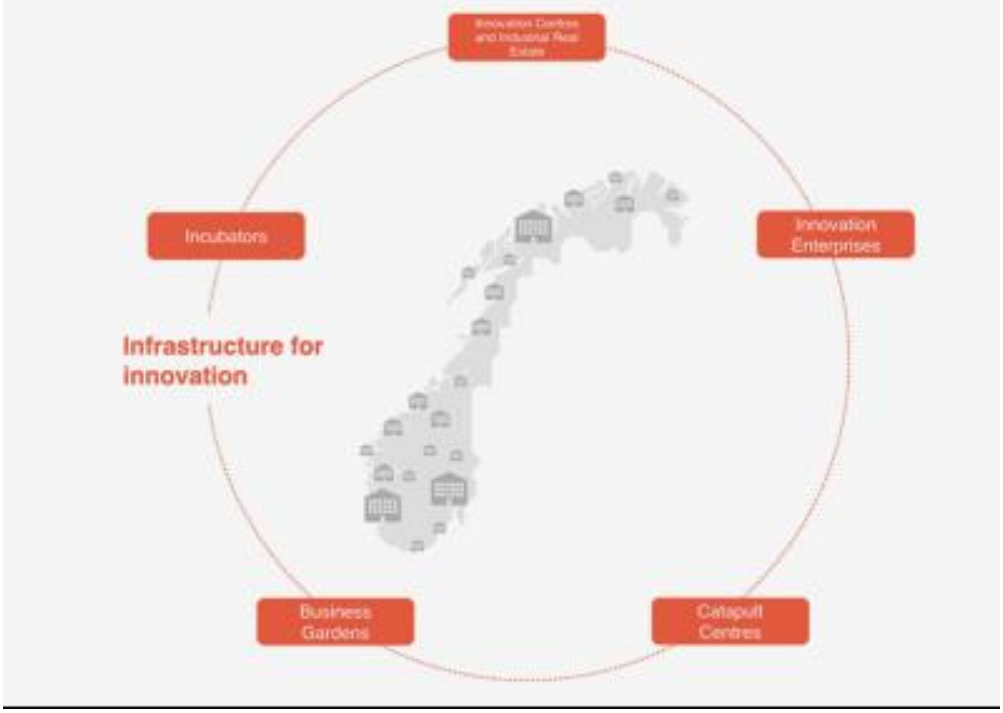


**FIGURE 29** – Infrastructure for Innovation in Norway

- Norway's start-up ecosystem has experienced recent growth supported by rapidly developing infrastructure and organizational supports. Numerous incubators and accelerators have emerged, such as Angel Challenge, The Factory, Katapult Accelerator, StartupLab, Siva, Kjeller Innovasjon and Venture Factory. Leading organizations, such as Startup Norway, have been established by founding entrepreneurs, proving a sense of community and cohesion.
- There is a new SINTEF research centre for low-emission technology for petroleum activity on the Norwegian shelf in Trondheim.
- June 2020, Norway's Research Council announced it is investing roughly NOK $2 billion (CAD $297 million) in new Centres for Research-based Innovation (SFI).
- The Centers for Environment-friendly Energy Research conduct focused long-term research involving industry, academia, and research institutions. There are currently 8 centres in cleantech which mainly deal with renewable energy and CCS.

## SUPPLY CHAIN

Close collaboration between oil companies, suppliers and research institutions has underpinned the successful development of new technology and solutions. Many seminars, programs and projects are organised for start-ups each year and it is estimated that about 15-25 % of Norwegian start-ups are related to the cleantech sector.

Industry associations, such as the Norwegian Hydrogen Association's (NHF), work actively to disseminate key achievements from hydrogen research and technology commercialisation, market trends, national and international policymaking by organizing conferences, seminars, and workshops, and connecting relevant international cooperation.

Innovation Norway supports innovative development of Norwegian enterprises to enhance their domestic and international competitiveness through financial and business support. They provide advisory, promotional and network services and promote industry-academia interactions.

The DEMO2000 program is aimed primarily towards Norwegian supplier companies and subcontractors that, in cooperation with petroleum companies and/or other petroleum service companies, have a need to carry out pilot projects and demonstrate new technology for use on the continental shelf and for sale in international markets.

## INTERNATIONAL COMPETITIVENESS

Norway has developed the know-how to plan and develop global mega projects. It is an early mover and is investing in research and development to create new sustainable innovations and solutions, such as hydrogen, battery technologies, ocean wind and low-emission shipping technologies.

The Norwegian-based service and supply industry had a total turnover of NOK $340 billion (CAD $50.5 billion) in 2017, of which 29% in international markets. Throughout more than 50 years of offshore petroleum activities, the industry has developed cutting-edge technologies and leading expertise, making it internationally competitive.

Supporting Norway's global expansion is Norwegian Energy Partners (NORWEP), an organisation that supports and assist in the internationalization of the Norwegian energy industry. Their main objective is to promote Norwegian energy industry, including renewable technologies, in overseas markets.

Technology developed at the Norwegian Continental Shelf has given the Norwegian service and supply industry a competitive advantage within international markets. The industry's competitiveness and innovation capacity have led to major positive spin-off effects and technological applications in other industries in Norway.

According to DNV GL's findings in Energy Transition Norway 2020, "Norway plays an important, global role in maritime transport and innovation. Norway has extensive experience and a lead in LNG, batteries, and hydrogen for domestic short-sea shipping. Extending this leadership into research and piloting and development of low- and zero-carbon fuels and related infrastructures for deep-sea shipping is a promising opportunity. Norway is also well positioned for a leading role in floating offshore wind power production. With its offshore gas and oil experience, Norway has competence in subsea, anchoring, floaters and much of what is needed to take part in developing and scaling floating offshore wind. Decarbonizing natural gas will be hugely important to secure the value of Norwegian gas and its industrial base."

## UNITED KINGDOM

### OVERVIEW

| Economic Position* | Regulation and Policy | R&D Framework | Innovation Funding | Supply Chain | International Competitiveness | Innovation Ecosystem |
|---|---|---|---|---|---|---|
| • Substantial economic strength<br>• Production is forecast to decline<br>• Significant use of subsidies across full economy<br>• A hub for global companies and innovation | • Centralized policy and regulation<br>• Balanced carrot and stick policies<br>• Ambitious climate targets<br>• Maximizing value of hydrocarbon resources<br>• Early movers on climate technologies, renewables, hydrogen and CCUS<br>• Collaboration on economic priorities | • Collaborative framework<br>• InnovateUK<br>• Strong mandate and oversight<br>• Significant funding through<br>• Strategic approach to R&D priorities<br>• Tax incentives for operators | • Gov funding encourages private/public partnerships<br>• Numerous funding opportunities<br>• Support across innovation lifecycle<br>• R&D expenditure to reach 2.4% of GDP by 2027<br>• Issuing green bonds | • Growing start-up community<br>• Driving energy tranisiton through big projects<br>• Collaborative engagement<br>• Numerous industry associations and networking | • Significant export support – OGA, OGUK, Scottish Enterprise<br>• Addressing global technology issues | • Numerous innovation centres (including dedicated cleantech centre), science parks, incubators<br>• Regional clusters<br>• Support for full TRL lifecycle<br>• Testing, piloting, and demonstration plants<br>• Catapult network |

The United Kingdom (UK) has established a solid foundation to support the development and growth of a strong clean tech ecosystem. The depth and strength of these elements collectively have shaped UK' strong clean technology sector.

The UK energy mix has evolved significantly over time. The offshore oil and gas industry meets 45 per cent of the UK's overall energy needs and will continue to provide energy security for decades to come. Energy demand met by oil and gas has increased since the early 1990s, from around 60 per cent to 75 per cent in 2018. As the use of coal decreases over time, gas has formed an increasingly important role to help meet peaks in electricity demand.

***Figure 1: UK Primary Energy Demand***

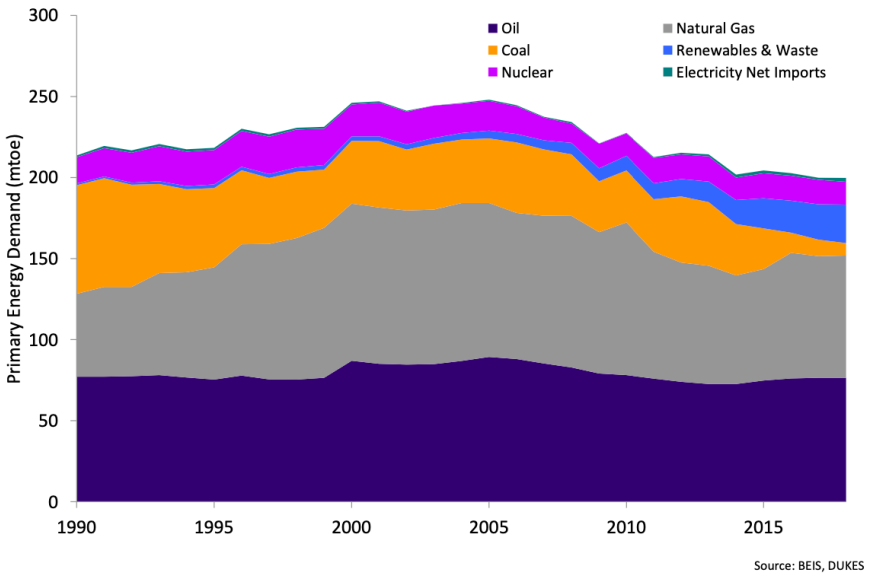


**FIGURE 30** – UK Primary Energy Demand

The oil and gas sector underpins the UK economy supporting more than 738,000 jobs. In 2019, the industry invested £13 billion (CAD $22.8 billion) and generated £95 billion (CAD $166.5 billion) in economic activity through its supply chain. Production of domestic oil and gas directly accounts for around 1.2 per cent of the UK's GDP and will continue to contribute billions of pounds of taxes in the future, as well as securing hundreds of thousands of skilled jobs.

The proved reserves of oil and natural gas is declining. At the end of 2019, the UK had approximately 2.7 billion barrels of proved reserves, down from 4.5 billion barrels twenty-four years earlier. Crude oil and natural gas liquids production both peaked in the first quarter of 2010, at 15.8 million and 1.4 million metric tons, respectively. By the first quarter of 2020, figures decreased by 3.6 million and 643 thousand metric tons, respectively. In that same quarter, the UK produced 12.2 million metric tons worth of crude oil and 738 thousand metric tons' worth of natural gas liquids.

The UK is under extreme pressure from the public and the international community to reduce its carbon emissions, which has increased scrutiny of its oil and gas producing industry. While offshore oil and gas production operations currently account for around 3 per cent of the UK's total greenhouse gas emissions, the majority of emissions from the wider economy are from the use of oil and gas products.

Although the Oil & Gas Authority (OGA) estimates that there are still around 10 to 20 billion barrels of oil equivalent remaining in the UK Continental Shelf, domestic production has more than halved since 2000. The Climate Change Committee (CCC) estimates that production of natural gas could drop by up to 80 per cent by 2050, compared to levels in 2017. However, the projections for demand for oil and gas, though much reduced, is forecast to continue for decades to come.

The offshore wind sector has proven to be one of the stand-out industrial successes of recent years, with the UK leading the world in the deployment of fixed-bottom offshore wind, pioneering floating wind and driving costs down further and faster than anyone thought possible just a few years ago.

The UK government's energy scenario (outlined prior to the adoption of the 2050 net-zero greenhouse gas emissions target) estimates that oil and gas will continue to provide around two-thirds of UK energy needs through to 2035. In a net-zero economy there will still be demand for oil and gas and the need for domestic production, albeit at a lower rate. The UK Committee on Climate Change (CCC) forecasts that the UK will still need to consume around 65 million tonnes of oil equivalent (mtoe) per year by 2050, or roughly 450 million boe, which is just under half of current demand.

## POLICY AND REGULATION

In May 2019, the CCC published its report 'Net Zero – The UK's contribution to stopping global warming'. It recommended the UK take a global lead and become a net-zero greenhouse gas emissions economy by 2050 (and by 2045 in Scotland). The adoption by the UK and Scottish governments of net-zero targets and the pathway set out in the CCC report has done much to catalyse the UK's energy sector.

November 2020, Prime Minister Boris Johnson announced a Ten Point Plan to get the UK closer to achieving net-zero emissions, investing £12 billion (CAD $21 billion) in government investment clean hydrogen, carbon capture and storage (CCS), zero-carbon transport and offshore wind to create 250,000 new green jobs. Highlights of the plan include:

- UK will host 40GW of offshore wind by 2030, enough to power every home and support up to 60,000 jobs.
- The UK will aim to generate 5GW of "low-carbon" hydrogen production capacity by 2030. Up to £500 million (CAD $876 million) will be invested to create a Hydrogen Neighbourhood in 2023, a Hydrogen Village by 2025, and to create the first town running entirely on hydrogen.
- UK will scale up large nuclear generation while also developing small and advanced reactor. This move will cost £525 million (CAD $920 million) and could support up to 10,000 jobs, according to the Government.
- Three regions will champion electric vehicle (EV) manufacturing. The UK will end the sale of new petrol and diesel cars and vans by 2030, but hybrid cars and vans will be given a 2035 deadline. A total of £1.3 billion (CAD $2.3 billion) will be used to accelerate the rollout of charge points, while £582m in grants will be made available to incentivise EV purchasing. Around £500 million (CAD $876 million) will be used for mass-scale production of EV batteries and a consultation on the phase out of new diesel will be introduced.

- Research projects for zero-emission planes and ships will be conducted to support airlines, airports, and shipping firms. Twenty million pounds (CAD $35 million) has been set aside for clean maritime innovations at sites including Orkney and Teesside.
- The UK wants to become a “world-leader” in CCS technology and will target the removal of 10MT of carbon dioxide by 2030. An additional £200 million (CAD $350.5 million) will create two carbon capture clusters by the mid-2020s, with another two set to be created by 2030. In total, £1 billion (CAD $1.8 billion) has been committed, which will support 50,000 jobs in the UK’s industrial clusters.
- The UK will make the City of London the global centre of green finance.

On December 14, 2020, the UK Government introduced an Energy White Paper focused on its transition to an innovative net zero economy. The Government plans to cut emissions from industry, transport, and buildings by 230 million metric tonnes – equivalent to taking 7.5 million petrol cars off the road permanently – while supporting hundreds of thousands of new green jobs.

The following are priorities established to support the oil and gas industry’s transition;

- Support up to 220,000 jobs in the next 10 years. This includes long-term jobs in major infrastructure projects for power generation, carbon capture storage and hydrogen, as well as a major programme of retrofitting homes for improved energy efficiency and clean heat.
- Supporting North Sea oil and gas transition for the people and communities most affected by the move away from oil and gas production, ensuring that the expertise of the oil and gas sector be drawn on in developing carbon capture and storage and hydrogen production to provide new green jobs.
- Investing £1 billion (CAD $1.8 billion) in state-of-the-art carbon capture storage in four industrial clusters by 2030 – sucking carbon out of industrial processes to stop emissions escaping to the air. Four low carbon clusters will be set up by 2030, and at least one fully net zero cluster by 2040, stimulating the market to attract new investors and manufacturers to reinvigorate our industrial heartlands.
- Kick-starting the hydrogen economy by working with industry to aim for 5GW of production by 2030, backed up by a new £240m net zero Hydrogen Fund for low carbon hydrogen production.

The oil and gas authority, the UK Oil and Gas Authority (OGA) was formed in 2016 as a fully independent regulator and a government-owned company. It is responsible for operational regulation of the UKCS, focused on supervising the licensing process and maximising economic recovery of the UK’s oil and gas reserves. They have a clear system of (private) informal and (public) formal warnings that can ultimately lead to the loss of operatorship and then license.

OGA works alongside the UK oil and gas industry and government to maximise the economic recovery (MER UK) of the UK’s oil and gas resources and to fully support the energy transition. Located in Aberdeen, it is strategically located in the UK oil and gas hub with most of the UK’s operators, supply chain and ecosystem. The OGA is largely funded by an industry levy.

The OGA’s primary role is to maximize value and supports the transition to a low carbon economy in the following ways:

- Asset stewardship and decommissioning strategies that encourage extending or reusing infrastructure assets
- Making UKCS data openly and transparently available through a new National Data Repository and other digital platforms
- Explore opportunities for hub or regional strategies and energy integration
- Eliminate unnecessary or wasteful flaring and venting of gas
- Approve and issue carbon dioxide storage permits
- Carbon Capture and Storage (CCS), including re-using existing infrastructure.
- Connect supply chain within oil and gas, requiring a SCAP (supply chain action plan) for all developments to be in place and approved by the OGA.
- Lead a cross-regulator project studying opportunities for deeper offshore energy integration with renewables, gas to wire, hydrogen, and offshore energy hubs.
- Support industry on export potential.

The MER UK Forum was set up to bring together government, industry and the OGA to deliver a program of work to maximise economic recovery from the UK Continental Shelf (UKCS) and maximise the UK value from the oil and gas industry as a whole. It operates to strike a balance with industry to incentivize investments and behaviours while exerting authority through a number of regulatory tools and penalties.

Every five years the OGA delivers its Corporate Plan, which establishes priorities and plans for the next five years. The most recent plan called "Vision 2035" establishes two specific ambitions: to add an additional three billion barrels of production by 2035, and to grow supply chain turnover by being a world leader in specific sub-sectors, doubling the UK's share of service sector exports.

Sir Ian Wood's industry reform report of 2014 identified collaboration as the fundamental behaviour needed in the oil and gas industry to secure a successful future from the UKCS. An UKCS Upstream Supply Chain Collaboration Survey is conducted annually. A Collaboration Index is determined based on the effectiveness of companies as partners in collaboration. This survey serves as a strong, public accountability tool.

In 2019, the UK government initiated the Energy Integration Project with a £900,000 (CAD $1.6 million) grant from the Better Regulation Executive's Regulators' Pioneer Fund. The project's purpose was to explore how different offshore energy systems (oil and gas, renewables, hydrogen and carbon capture and storage) could be co-ordinated across the UK Continental Shelf (UKCS) for environmental and efficiency gains, including identifying technical, regulatory, and economic hurdles.

Since the project began, the UK became the first major economy to set a target of net zero emissions by 2050; and the OGA began to refresh its core strategy to integrate net zero and develop benchmarking to track and monitor emissions performance. The focus of this project also progressed to include quantifying how energy integration could contribute to emission reductions.

It determined that energy integration could help reduce production emissions, as well as accelerate the progress of CCS and hydrogen in support of net zero. For offshore renewables, there are real opportunities for increased collaboration with oil and gas skills and supply chain for further expansion. There are over 30 energy integration projects underway across the UKCS.

The close co-ordination of these technologies are considered valuable in terms of energy production and cutting greenhouse gases. More importantly, this integration would help technologies become economically more attractive. The report states: "Integration has the potential to make a deep and meaningful impact, with a possible 30% contribution towards the country's overall net zero target, primarily through carbon capture and storage (CCS), and through CCS plus hydrogen. Adding offshore renewables (wind, wave and tidal) could take that up to 60% of the abatement required in 2050; demonstrating that the UKCS is a critical energy resource."

## R&D FRAMEWORK

The country's Industrial Strategy, which underpins its Clean Growth Strategy, has strategically connected R&D and innovation to the country's economic growth and future prosperity. The UK government hopes to leverage its expertise in technological innovation to create new high value jobs, industries, and companies. This has meant significant national and private sector R&D funding is being invested to drive a new, technologically innovative, high growth and high value 'low carbon' sector in the UK economy.

UK Research and Innovation (UKRI) is the national funding agency investing in science and research. Operating across the whole of the UK with a combined budget of more than £6 billion (CAD $10.5 billion), UKRI brings together the seven Research Councils, Innovate UK, and Research England.

InnovateUK calls itself UK's innovation agency. The organization works across UKRI and with partners to drive sustainable growth by investing in high-potential entrepreneurs and businesses across the UK, including working with spinouts and start-ups through to large businesses that can provide routes to market for the companies supporting them.

InnovateUK is also responsible for delivering the UK Industrial Strategy, including the commitment of UK R&D expenditure reaching 2.4% of GDP by 2027. It has invested over £1.5 billion (CAD $2.6 billion) in innovation, matched by a further £1.5 billion (CAD $2.6 billion) in partner and business funding. They have worked with more than 5,000 innovative companies in projects estimated to add £7.5 billion (CAD $13 billion) to the UK economy and create 35,000 extra new jobs. They have also provided up to £20 million to support a new clean technology early-stage investment fund

## FUNDING AND INCENTIVES

There are numerous funding organizations, incentives and financing options supporting carbon reduction innovations and the UK's economic energy transition. The government has been making substantial investments to cut greenhouse gases while revitalizing and diversifying its economy through massive industrial projects.

Tech entrepreneurship is strongly supported by the UK government with numerous entrepreneur and investor-friendly policies, including early-stage seed investment, a commitment to open data, corporate tax rates and overall tax simplification. The UK also has what is considered a business-friendly regulatory environment. Taken in their entirety, this range of policies and actions make the UK particularly attractive for entrepreneurs and investors, particularly at seed stage.

While the UK government is making its own direct investments to support business and innovation, they are also actively designing financing and investment schemes that engage the private and industrial sectors.

The UK government has prioritized economic growth in the financial services sector to support its net zero ambitions. The UK's Green Finance Strategy outlines how the government and the private sector can work together to make green finance an integral part of its financial services sector. It established its Green Finance Institute (GFI) to serve as the UK's principal forum for collaboration between the public and private sector and support delivery of its Green Finance Strategy.

In 2021, the UK will issue its first sovereign green bonds as part of its Covid-19 stimulus planning. This will be the first in a series of new issuances to help fund projects to help tackle climate change, finance much-needed infrastructure and investment and create green jobs.

Launched May 2020, the UK's Clean Growth Fund (CGF) invests in companies with products and services focused on driving clean growth in the low carbon economy. With £40 million (CAD $70 million), the fund is pooling public and private capital to invest in new, early-stage clean technology ventures and forms part of the UK Government's Clean Growth Strategy. With £20 million (CAD$35 million) of government investment matched pound for pound by one of the UK's largest charity fund managers (CCLA), the fund could reach £100 million (CAD $175 million) by Autumn 2021 through private sector fundraising. The fund will be managed by Clean Growth Investment Management LLP (CGIM).

There are cleantech and renewable investment funds like Zouk Capital, an independent London-based private equity fund manager with a focus on the European cleantech market. Zouk specifically invests in two areas of this growth market: clean technology companies and renewable and environmental infrastructure.

Innovate UK has established the Sustainable Innovation Fund, totalling £134 million (CAD $235 million) government investment to keep UK's greenest, most innovative businesses thriving during coronavirus pandemic and could help to secure and create new jobs across the country.

The Energy Technologies Institute (ETI) is a major consortium of public and private sector interests with major representation from government departments and multinationals, such as Shell and EDF Energy. It provides funding to high-potential innovative low-carbon technologies with a range of industrial applications.

Although the UK is commonly known as a centralised country among OECD countries, it has been decentralising national and local economic policies. While science and innovation policies are often regarded the responsibility of central national governments, local and regional governments across the UK are increasingly become important players in shaping these policy agendas as part of its innovation and entrepreneurship ecosystems.

The oil and gas industry and supply chain in north east Scotland is playing a central role to catalyse the transition of Aberdeen from a global oil and gas capital to a globally integrated energy cluster focusing on offshore wind (fixed and floating), hydrogen and CCUS. They plan to support and grow a broader energy supply chain, create, and secure high value jobs, drive export growth and deliver net zero.

The Oil & Gas Technology Centre (OGTC) was created as part of the Aberdeen City Region Deal with £180 million (CAD $315.6 million) of UK and Scottish government funding to maximise the potential of the North Sea. Since opening its doors in 2017, OGTC has co-invested more than £130 million with industry

in more than 200 projects. It has seven solution centres focused on the creation of an integrated offshore energy system, partnering with companies and R&D organisations.

## INNOVATION ECOSYSTEM

InnovateUK has established a network of world-leading technology and innovation centres supporting the UK's capability for innovation. There are currently over 180 business accelerators in the UK for start-ups and entrepreneurs. Technology and Innovation Centres (TICs) are organizations that deliver governmental and wider public sector programs, policies, and strategies to promote innovation.

There are 9 Catapults, spanning over 30 sites across the UK covering a range of different sectors, technology challenges and systems. Catapults have a national strategy to capture the economic benefit of the transition to a Net Zero economy. Since 2011, the Catapult Network has been responsible for directing over £2.5 billion (CAD $4.4 billion) of private and public sector investment into UK industrial research.

Offshore Renewable Energy Catapult is playing a leading international role operating the world's largest concentration of open-access offshore wind test and demonstration facilities, as well as one of the most advanced grid emulation systems in the world.

As the UK's oil and gas hub, Scotland has actively built a culture of innovation and has developed strong ecosystem infrastructure, including incubators, accelerators, and co-working spaces across the country; a network of eight Innovation Centres designed by industry for industry-led collaborations; numerous entrepreneurial support organizations supporting entrepreneurs with advice, competitions, funding and mentors, and networking events.

An Energy Transition Zone (ETZ) will be established in Aberdeen Harbour South to accelerate the delivery of net zero solutions and create an energy transition cluster built on offshore wind, hydrogen, and Carbon Capture Utilization Storage (CCUS) linked to with the new deep-water facilities. This is providing the physical infrastructure and collaborative environment to fast-track investment. CCUS "clusters" are expected to be developed where carbon capture will take place across a range of activities.

The OGTC recently established a Net Zero Solution Centre and published a Net Zero Technology Roadmap to accelerate technologies that help decarbonise operations and enable the industry to deliver the world's first net-zero hydrocarbon basin. Aligned to the industry's Roadmap 2035, this new centre is backed by the UK and Scottish Governments and companies including BP, Shell, Wood, Chrysaor, Aker Solutions, INEOS, CNOOC International, Total, Siemens and Equinor.

OGIC is a new Oil and Gas Innovation Centre set up to work with SMEs to deliver innovative solutions to the key challenges facing businesses operating in the UK Continental Shelf (UKCS). £10.6 million funding was approved by the Scottish Funding Council to create OGIC. Its role is to enable the development of new technologies which are needed to bring down operating costs, improve productivity in the UKCS and address innovation requirements in decommissioning. The OGIC partnership, was established to set up the Oil and Gas Innovation Centre for success, including universities, Interface, Scottish Enterprise, the Energy Technology Partnership (ETP), the Industry Technology Facilitator (ITF), Oil and Gas UK and industry representatives.

## SUPPLY CHAIN

The recent downturn in oil and gas, changing procurement models and a drive for reduced costs have all impacted the UK supply chain and will remain a significant challenge for years to come. COVID has also put exceptional pressure on its supply chain sustainability. It is predicted that job losses will be significant, particularly around 2035 when employment in oil and gas is expected to drop by around 60,000.

According to a November 2020 UK report called "Reimaging a Net-Zero North Sea", the UK supply chain must be encouraged to seize the opportunities from its energy transition, "guided by a clear roadmap for the North Sea that promotes capability-building while simultaneously ensuring that as much value, content and employment as possible remains in the UK."

It states: "Between 113,000 and 232,000 direct and indirect jobs could be supported in the UK energy sector by mid-century across all sectors, based on the current anticipation of 60% UK local content in offshore wind and hydrogen. Employment in offshore wind, for both power and production of hydrogen, could total nearly 160,000, CCS could support up to 28,000 posts, while blue and green hydrogen could potentially employ 35,000. Domestic oil and gas jobs are expected to be around 27,000 in 2050.

Industry, supported by government, is ready to invest in training, transferability, innovation and the supply chain; definitive action will ensure the true extent of future employment and wider economic benefit is realised while avoiding the potential negative impacts of the transition to the new North Sea."

According to a recent Energy Industries Council report called "Survive and Thrive", UK oil supply chain firms are diversifying into non-energy sectors due to Covid-19 and low commodity prices. Of the supply chain businesses surveyed, 72% moved into non-energy sectors such as infrastructure, industrial and pharmaceuticals. Nevertheless, 90% remain active in oil and gas and 26% have moved into renewables.

The oil and gas and clean tech supply chains in the UK are supported by numerous champions, organizations, industry associations as well as funding. The following is a snapshot of this sector:

- While the OGA does not regulate the service sector, it works collaboratively with the industry, governments, and trade associations to support and develop a stronger supply chain, which can compete globally. It has a supply chain team focused on developing a strong and competitive UK based oil and gas sector. Its supply chain strategy sets the framework for change to establish the UK offshore supply chain, by 2025, as a specialist engineering, manufacturing, services, and technology sector to support the energy transition and secure the UK as a global exporter of expertise in net zero activities, subsea, decommissioning & digital in addition to providing the resources and technologies. The supply chain will supply the technology and innovation that will enable operators and others to reduce greenhouse gas emissions, while still maximising economic recovery from the UKCS.
- The OGA requires that all new oil and gas projects require a SCAP (supply chain action plan) to be in place and approved by the OGA, setting out the contracting strategy to ensure maximum value is generated from each project.
- Scottish Enterprise is Scotland's primary economic development agency. It works with partners in both the public and private sectors, encouraging economic development, enterprise, innovation, and investment in business. It provides the funding for the full innovation life cycle and business education, facilitates partnerships, provides export assistance, helps companies access finance, and provides innovation and commercialisation supports.

Major industrial / clean growth projects are being initiated through private/public partnering to meet net-zero ambitions and diversify the economy. These are industry building projects that will foster innovation, promote supply chain sustainability, and create significant employment in clean technology. The following are examples:

- Aberdeen has been selected as the home for the "world's first" offshore floating facility to produce green hydrogen. The Dolphyn project will develop green hydrogen using floating wind turbines. This is projected to provide thousands of green energy jobs.
- Two of the UK's most promising carbon capture and storage (CCS) projects are based on new industry/government partnership to develop offshore $CO_2$ transport and storage infrastructure in the UK North Sea. A consortium of BP, Italy's Eni, Norway's Equinor, the UK's National Grid, Shell and Total have joined forces to form the Northern Endurance Partnership (NEP). With BP as operator, NEP will provide infrastructure for the developing Net Zero Teesside (NZT) and Zero Carbon Humber (ZCH) decarbonised industrial clusters, both based on the coast of Northeast England.
- Net Zero Teesside aims to decarbonise a cluster of carbon-intensive businesses and deliver the UK's first zero-carbon industrial cluster. Led by OGCI Climate Investments and with direct project support from global oil and gas operators, the project is working with the UK government to capture and store up to 6Mt of CO2 each year – the equivalent to the annual energy use of over 2 million UK homes and generate 1000s of new industrial jobs for workers who were destined for unemployment.
- In September 2019, OGUK, released 'Roadmap 2035: A Blueprint for Net Zero', highlighting the role the sector can play to help the UK achieve the energy transition needed to fully decarbonise its economy. To ensure industry was at the table and part of the solution, it committed to reduce its own emissions and help develop the technology essential to enable the UK to meet its wider aims. OGUK are working to form a transformational Sector Deal with the UK government to help the sector to decarbonise, including the electrification of assets, the development and deployment of carbon capture and storage (CCS) and hydrogen both on and offshore. They recognize the

need of these to be developed at scale to help other industries accelerate their own efforts to decarbonise.

## INTERNATIONAL COMPETITIVENESS

The UK has significant industrial capacity and is making substantial investments in research and development to create new sustainable innovations and solutions, such as hydrogen, CCUS and offshore wind, that is positioning it as a leading clean energy solutions provider.

The UK is betting on its potential as a location for the transport and storage of carbon dioxide, both for its own emissions and those from other countries. Storage sites have been identified with many decades' worth of storage at current emission levels. One recent study estimated 78GT of potential storage in the UK. Just 15% of this potential capacity would last the UK around 100 years. With recent changes to the London Protocol, UK storage locations are now allowed to be used for sequestering the emissions from other countries.

Supporting Scotland's global expansion is Scottish Development International, which is a part of Scottish Enterprise. This organisation supports and assists in the internationalization of the Scottish energy industry. Its main objective is to promote Scottish energy industry, including renewable technologies, in overseas markets. They provide market intelligence, funding, matchmaking, and other business programs to support Scotland's industry global competitiveness.

OGUK is the leading representative body for the UK offshore oil and gas industry and includes all companies active in the UK continental shelf, from super majors to large contractor businesses and from independent oil companies to SMEs working in the supply chain. It is the leading association within the UK energy industry, offering programs, studies, and support to ensure the UK North Sea remains an internationally attractive place to do business.

The OGA Supply Chain and Exports task force works collaboratively across trade associations, government, and regulators to highlight and strengthen the capability of the UK oil and gas service sector supporting its export competitiveness.

The MER UK Supply Chain & Exports Task Force works to support the service sector both domestically and in exporting to the world. Its recent 2020 report states the UK service sector has the potential to generate hundreds of billions of additional pounds in export revenue in the coming decades and sees increasing exports as a central part of the strategy to anchor the service sector in the UK. This will include supporting new initiatives such as building a comprehensive directory of the UK's energy supply chain capability and on matching potential exporters to experienced colleagues with in-country expertise.

## NEWFOUNDLAND AND LABRADOR: CLEAN TECH ANALYSIS

Below is a summary of Newfoundland and Labrador characteristics that are both contributing and challenging the province's ability to diversify its oil and gas industry and build a stronger clean tech sector.

| Economic Position* | Regulation and Policy | R&D Framework | Innovation Funding | Supply Chain | International Competitiveness | Innovation Ecosystem |
|---|---|---|---|---|---|---|
| • Weak economy<br>• Steep decline in production is forecasted<br>• Pace of exploration is historically slow. Forecasted to improve.<br>• It is a branch office for global organizations with limited corporate innovation and digitalization decision makers | • Highly political<br>• Regulations are old and very slow to change<br>• Carbon targets with an unknown implementation plan<br>• Low focus on maximizing value of hydrocarbon resources<br>• Late movers re: climate: hydrogen, CCS<br>• Few formal forums for collaboration | • Driven by operator priorities<br>• No collaboration<br>• No central leading organization to drive innovation for the province<br>• R&D priorities are not connected to a provincial or known industry strategy | • High revenue threshold for national funding is limiting access<br>• Limited financial support across innovation lifecycle (or known support)<br>• Low public or industry lead investment on cleantech - R&D | • Growing start-up community<br>• Big project expertise<br>• Limited collaboration across associations (improving)<br>• Some industry associations and networking supporting<br>• National clusters making significant investments - not regionalized (top down) | • Some export support<br>• Expertise in and export in ocean tech, remote sensing<br>• A global leader in cold-ocean and marine operations<br>• Support tends to be generic support versus focused on stronger opportunities (winners)<br>• Strong export network in marine/ocean tech sectors | • Arctic innovation hub with 40 research facilities<br>• No innovation centres, science parks, etc.<br>• No cross sector, or cluster collaboration<br>• Limited support for full TRL lifecycle<br>• Limited testing, piloting, and demonstration plants |

## REGULATIONS AND POLICY

- The law applicable to offshore Newfoundland (the Atlantic Accord) governs all oil and gas development offshore Newfoundland and Labrador. The goal is to ensure that oil and gas developments create a lasting economic legacy for the people of Newfoundland and Labrador.
- The Canada-Newfoundland Offshore Petroleum Board (C-NLOPB) is the regulating authority that is jointly managed by the Province of Newfoundland and Labrador and the Federal Government of Canada. Joint management means both levels must agree on regulatory revisions.
- Additional local content commitments are negotiated on a project-by-project basis by the provincial government. Previous projects' local content commitments and deliverables serve as benchmarks. It can take several years to negotiate these terms, which has slowed the pace and certainty for offshore developments.
- Newfoundland and Labrador has four producing offshore assets. When a field approaches tail-end production, as with offshore Newfoundland, both the OPEX per barrel and the $CO_2$-intensity increases. Three of the assets are over 20 years old so emissions are increasing. This makes the field vulnerable in a low demand scenario with lower oil prices and increased pressure to reduce $CO_2$-emissions. In today's marketplace, some assets may be targeted for early decommissioning versus increased investments in carbon reducing measures.
- The pace of new tie-in developments has been constrained in part by the inability of third parties to negotiate appropriate technical and commercial terms to achieve access to existing infrastructure. There are no policies or incentives to encourage third-party tie-ins. Developments are taking longer to implement and often end up being sub-optimal.
- Despite the natural gas resources already discovered, offshore NL does not produce or export gas. There are no regulatory levers, clear royalty guidelines, or incentives to support natural gas production.
- The pace of change to oil and gas regulations or policy development is extremely slow. It can take years to mature and implement change (Examples offshore OHS standards, FORRI, local content regulations, natural gas royalty, etc.). Benefits agreements can take years to negotiate.

## R&D FRAMEWORK

- Newfoundland performs comparatively well in the early stages of innovation. The performance drops off increasingly as potential innovation moves towards commercialization and market deployment – where the majority of jobs and wealth are created.
- There are specific requirements for R&D investment in the Atlantic Accord. The total R&D expenditure required during the development and production phases of a project is set as a percentage based on a Statistics Canada benchmark for R&D activity by oil and gas extraction companies. There are no requirements to invest in a prioritized area, such as clean tech.
- There is no mechanism for government to provide direction or a forum for industry collaboration to influence R&D investments that align with industry growth and resource maximization.
- R&D priorities are not established, communicated, or coordinated to build local understanding or engagement. It tends to be driven by operational matters and can also include training/education. There is limited piloting and demonstration activities on the province's offshore assets.
- Corporate R&D decisions makers are often not directly involved in location R&D. Projects are often regional versus corporately driven.
- Newfoundland and Labrador is not considered a global hub for R&D and innovation. R&D requirements force R&D take place locally activities, which is likely limiting access to global initiatives and collaborations.
- Emissions have not been considered a major concern for the industry, when compared to other jurisdictions, so R&D investments have not focused on carbon reduction.
- Oil and gas industry R&D projects have typically focused on operations, ocean tech and harsh environment projects.

## INNOVATION FINANCE

- Based on low participation rates, it seems local companies are not fully aware or are not availing of federal funding opportunities relating to clean tech.
- National thresholds for clean tech innovation funding tend to be too high for the small Newfoundland and Labrador SME's in the clean tech and innovation arena.
- There is a mix of provincial and federal funding to support innovation development. There is limited angel investment and venture capital support.
- Newfoundland and Labrador does not currently have a business support fund allocated for clean growth.
- Sometimes federal business funds require provincial matching; however, there are often no similar provincial programs to match the federal programs.
- R&D has been primarily funded by significant private sector oil and gas investments that are often focused on petroleum operations, ocean tech and some education and training.

## INNOVATION ECOSYSTEM

- NL is a global leader in cold-ocean and marine operations; an internationally renowned Arctic innovation hub with over 40 research facilities.
- Clean innovations relating to environmental management of the offshore oil and gas industry are typically branded for oil and gas versus clean solutions for other industries.
- Cross industry collaboration rarely occurs. This is improving with the growth of Canada's Ocean Supercluster.
- Oil and gas operators rarely collaborate with other operators within their basin to seek efficiencies or reduce emissions, such as sharing transportation.
- Approach to local content/industrial benefits have focused on employment and short-term fabrication. Little to no input is sought from the public or industry stakeholders when it comes to benefits agreements.
- Despite significant experience and expertise relating to ocean innovation, Newfoundland and Labrador is one of the only provinces in Canada without an innovation centre or tech park to support technology development and commercialization. A culture of silos coupled with a lack of long-term funding are contributing to the lack of progress to mature its innovation ecosystem.
- The oil and gas industry is experiencing a digital transformation globally, driven primarily by climate change and cost pressures. The province is lagging behind other oil and gas jurisdictions when it

comes to the digitalization of its oil and gas industry despite the fact that Newfoundland and Labrador has a growing technology sector. This is likely based on the fact that oil and gas operator decision makers dealing with new tech and digitalization are not located in Newfoundland and tend to be housed at a corporate head office. There is little opportunity for local companies to speak directly and develop relationships with these key stakeholders. Additionally, the local oil and gas and technology sectors have historically rarely collaborated, so there is a significant knowledge and awareness gap between the two sectors.

- While collaboration between the sectors is improving and has been identified as a priority at a local level, there is a lack of prioritization and accountability to deliver. This is likely based on limited funding resources and accountability.
- There have been a number of studies and strategies developed recommending advancement to the province's innovation ecosystem over the years. Follow up and implementation of these strategies is slow or has not occurred. For instance, the 2019 McKinsey report titled "Economic Growth Strategy for Newfoundland and Labrador" recommended that the province enhance its innovation infrastructure with an innovation center and position the province as a world-class ocean technology cluster through increased marketing and business development. It suggested targeted support services to grow high-potential ocean technology firms at different stages of commercialization, invest in digitalization of its economy, and implement an investment attraction program. Little has been advanced in these areas.

## SUPPLY CHAIN

- The supply chain offers experienced local and international contractors, which have delivered quality products to offshore projects, and are experienced working on world-class industrial projects.
- Based on a heavily reliance on oil and gas industry, the province does not have organizational capacity to support its energy transition, clean technology sector and cross sector collaboration to address climate change challenges.
- There are several active and engaged industry associations supporting local supply chain activities. Their funding tends to be inconsistent and their programing requirements are increasing so they have limited resources. Energy transition has not been a prioritized area of focus for many of these organizations.
- There is some provincial and federal export support for commercialization.
- Collaboration across sectors has historically not been strong. This has recently been improving.

## INTERNATIONAL COMPETITIVENESS

- The province is a global leader in cold-ocean and marine operations.
- There is limited availability to viable, long-term markets (both local and overseas) for clean tech innovations.
- There is little capital and support for the full innovation lifecycle, such as demonstration projects.
- Local content provisions in R&D have likely impeded international collaboration.
- The province does not have an active investment attraction program.

## CONCLUSION

When it comes to diversifying and building a stronger clean tech sector, Newfoundland and Labrador is encountering challenges that are difficult to manage and are somewhat out of the province's control, including the following:

- Newfoundland and Labrador is a province, not a nation so it is limited in its authority to set specific areas of policy.
- It is highly reliant on commodities that severely impact its economic stability, such as oil.
- It is a small province that often has limited influence on national energy initiatives.
- The province is a branch office not a head office for its oil and gas investors that tend to have head offices in international cities, such as in Houston, Calgary, and Oslo.
- The technology experts of the oil and gas industry are also located in these centres with supporting research and development institutions. This has negatively impacted the province's ability to access head office innovation and digitalization decision makers.
- As experienced in other jurisdictions, offshore platforms are rarely accessible to supporting demonstration projects or pilots. These factors, alone, significantly influence the province's ability to commercialize innovation and access end users and purchasers.

However, there are challenges within the province's mandate and capabilities that could be addressed, such as the following:

- The province is severely challenged when it comes to institutional accountability, policy implementation, establishing strategic priorities and does not support a strong culture of collaboration across sectors.
- Changes to regulations and policy move at a snail's pace. The province is lagging behind when it comes to climate change regulation and enforcement.
- There is chronic systemic inertia that appears to be directly connected to a lack of accountability, ownership, and inability to follow through on strategic initiatives.
- Currently, there are no forums or entities that are accountable to support the province's energy transition, foster collaboration and drive strategic innovations.
- Too few decision makers are involved in significant decisions relating to industry development, such as benefits agreements, policy priorities and strategic investments. This is coupled with little to no accountability or collaboration to support these important endeavours.
- Its innovation ecosystem could be much stronger, with stronger leadership driving strategy and investments such as innovation centres, incubators, and tech parks, etc. This would foster improved collaboration across sectors, which is greatly needed.
- The innovation ecosystem also needs stronger demonstration, piloting and proof of concept supports and access to facilities to support the full innovation life cycle. This could be supported by incentives, regulations, and improved collaboration.

Ultimately, Newfoundland and Labrador does offer strong elements to support its energy transition, such as its expertise and capacity in ocean technology, remote sensing, marine operations and harsh environments, its strong university and research institutions and its burgeoning start-up and technology community. It is strategically positioned between the US and European marketplaces with strong connectivity to international shipping lanes. Muskrat Fall has the potential to offer tremendous opportunities as the province will soon be the only jurisdiction in North America with 100% renewable energy.

Without doubt, technological competence, capacity, and financial investments from the oil and gas industry are needed to meet the nation's net-zero ambitions and deliver on the Paris agreement. By investigating and learning what is working and not working within oil and gas jurisdictions that are building a stronger clean tech sectors, Newfoundland and Labrador can potentially find its way, decouple its economic growth from hydrocarbon resource production and prioritize some of these jurisdictional learnings.

Newfoundland and Labrador offers a well-educated and industrious workforce. Newfoundlanders and Labradorians are known globally for its cold ocean expertise, harsh environment resilience and have established trade links globally. Newfoundland and Labrador's institutions and university are leading

advanced scientific research. The province is home to a cluster of companies, institutions and R&D facilities that are creating some of the world's most innovative cold ocean technologies, which are exported globally.

Newfoundland and Labrador should leverage its significant technical strengths and industrial capacity that have been built supporting the oil and gas industry, including engineering, maintenance and operations, development of innovation, big project management and fabrication as well as its supply chain, skills, and infrastructure. It must foster growth and diversification of its technology sector. Its marine and ocean technology competencies can should also play a pivotal role so the province can take advantage of the opportunities being driven by this energy transition and grow a stronger clean technology sector.

As with several of these jurisdictions, Newfoundland and Labrador must seek its own economic opportunities that go hand in hand with the planet's energy transition. As seen in other petroleum producing regions, it should not be viewed as renewable energy versus oil and gas. The opportunity lies in the continuous pursuit of sustainability within the energy sector at large.

## APPENDIX - APPROACH TO THE WORK

The following table outlines the approach to the study.

| | |
|---|---|
| Description of the emission challenge for offshore Canada | ● As an outset for the project, describe the emission challenge for oil and gas activities offshore Canada.<br>● Based on reported field emissions and activity forecasts from Rystad Energy proprietary databases forecast emission levels from oil and gas activities offshore Canada, distinguishing and quantifying emission types on platforms (flaring and power generation), drilling operations and look to the supply chain emissions (helicopters, OSVs).<br>● Describe the uniqueness of Canadian offshore operations with harsh conditions, long distances to shore and unique facility attributes that will influence the opportunity space for clean technologies for oil and gas.<br>● Examine the local supplier industry, size, and current areas of expertise. |
| Comparison with other offshore and onshore regions | ● Based on the above, benchmark offshore Canada with other offshore regions and onshore supply segments (tight oil, oil sands, conventional)<br>● To understand the need for increased adoption of clean tech, benchmark emission intensity for offshore Canada towards other regions, but also other metrics, (i.e., break-evens, lifting costs) evaluate the overall competitiveness of offshore Newfoundland and Labrador to other sources of supply.<br>● The unique attributes of the offshore oil and gas industry in Newfoundland and Labrador will potentially be a source of competitive advantage for the supplier industry when looking for export opportunities. We compared the nature of operations under these unique attributes (i.e., harshness, remoteness, facility types, water depth) with other offshore regions.<br>● We also evaluated the supplier industry in the other regions in terms of size and capabilities. |
| Selection of jurisdictions for comparison | ● Leading jurisdictions were identified, specifically targeting where progressive action has been taken with respect to regulations and supports in relation to both oil and gas and cleantech<br>● The jurisdictions chosen were limited to OECD countries only and leaned towards English speaking regions. The selection was informed by the comparison between regions from the phase above and regulatory similarity. Five jurisdictions were chosen: Norway, United Kingdom, Australia, Alberta, and Gulf of Mexico. |
| Programming and support structures | ● In the study, we identified the programming and/or support structures that were created (publicly, privately, or in partnership) in the selected jurisdictions to accelerate innovation (research, development, commercialization) of clean technologies within the oil and gas industry;<br>● We also identified and engaged with key stakeholders in selected jurisdictions to understand the critical success factors to accelerate innovation of clean technology in the oil and gas industry.<br>● An import success factor for technology adoption is aiding the technologies through the piloting phase. This is often capital intensive, and typically requires an offshore asset to apply the technology. As part of this phase, we assessed supporting structures along a Technology Readiness Level (TRL) value chain.<br>● In identifying the programming and/or support structures that were created (publicly, privately, or in partnership) in the selected jurisdictions to accelerate the adoption of existing and proven clean technologies within the oil and gas industry;<br>● Identifying and engaging with key stakeholders in selected jurisdictions to understand the critical success factors to accelerate the adoption of clean technology in the oil and gas industry. |

| | |
|---|---|
| Policies, regulations, incentives, and their effects | ● Identifying specific policies, regulations, and incentives that were put in place in these jurisdictions that stimulated clean technology development, application, and a more sustainability-focused industry;<br>● Identifying and engaging with key stakeholders in selected jurisdictions to understand the impact of specific policies, regulations, and incentives to stimulate clean technology development.<br>● Identifying challenges experienced in the implementation of these policies, regulations, and incentives in these jurisdictions<br>● Identifying and engaging with key stakeholders in selected jurisdictions to understand implementation challenges and tactics<br>● Identifying carbon offset programming to facilitate local industry participation and contributions towards jurisdictional-wide GHG emissions reductions pursuits (such as 'net zero');<br>● Identifying and engaging with key stakeholders in selected jurisdictions to understand carbon offset programming |
| Identifying and addressing local gaps | ● Based on the research acquired, compare the regulatory and support ecosystem related to cleantech to that of Newfoundland and Labrador and Atlantic Canada to identify key gaps (information on local ecosystem to be provided by the committee);<br>● Identifying and engaging with key stakeholders in Newfoundland and Labrador as well as Atlantic Canada to understand why there are key gaps in the ecosystem related to clean tech<br>● Key findings that can be summarized from each jurisdiction focused on how to address identified gaps |

## APPROACH - POLICIES ON CARBON PRICING – CONSIDERATIONS FOR POLICY MAKERS

Policies that directly target carbon emissions are becoming more common around the globe. In defining the role of a carbon policy system, policy makers should reflect on what the system is designed for and expected to do. For example, an emissions trading system could be intended to drive emissions reductions as its principal role or provide a backstop for other policies.

As can be seen from Figure 1 - *Carbon Taxes and Emissions Trading Systems* - the approach either Carbon Taxes or Emissions Trading Systems, function in different ways and possess different features.[99]

| INSTRUMENT | FUNCTIONING | FEATURES |
|---|---|---|
| Carbon Taxes | Direct taxation on emissions, e.g., a direct carbon dioxide tax; input or output charges | Creates a predictable carbon price<br>Difficult to estimate ex-ante the number of emissions that will be reduced |
| Emissions Trading Systems | Market-based instruments that create incentives to reduce emissions where these are most cost-effective, allowing the market to find the cheapest way to meet the overall target | Carbon price fluctuates<br>Allows control of the number of emissions in absolute or intensity terms, and therefore can provide certainty on an agreed-upon emissions reductions trajectory. |

*Figure 1 - Carbon Taxes and Emissions Trading Systems*

Throughout the process of defining the role of an emissions trading system, policy makers should also reflect on other expected outcomes of the system, such as changing business practices or shifting investment decisions. The other expected outcomes are especially important for Newfoundland and Labrador especially as they relate to promoting a more robust clean tech innovation ecosystem in the offshore oil and gas industry.

### POLICY LEVERS

The following are the primary approaches to carbon management policy directly impacting the oil and gas industry. Governments often combine these with both push and pull (or carrot and stick) policy levers.

- **Disincentives:** Policies that move away from policies that have historically supported hydrocarbon production by using disincentives, such as carbon taxes, which are considered an effective way to reduce GHG emissions. Other levers to inhibit emissions include Emission Trading Schemes, stricter permitting processes and restricting methane flaring.
- **Incentives:** Policies that encourage substitute technologies and fuel, such as renewable energy. An example is the Green New Deal, which is targeting for 100 percent renewables. These have involved significant subsidies for emerging technologies like hydrogen, offshore wind, electric vehicles and carbon capture and storage (CCS).
- **Sustainability behaviours**: These policies encourage oil and gas involvement in the circular economy. It encourages resources to remain in use for the longest period of time, rather than a linear economy, where products are produced used and then disposed. This means extracting the maximum value while in use, then recover and regenerate products and materials at the end of each product service life. For oil and gas, policies could focus on extending the lifetime of the facility, reducing gas flaring, or encouraging re-injection of produced water.

### NET-ZERO

Oil and gas producing jurisdictions that are successfully expanding into clean technology tend to support a policy based on net-zero emissions – a low carbon transition policy that views petroleum resources as part of the solution to the GHG reduction challenge.

[99] Source: IEA

There are numerous industry-wide initiatives focused on commercializing and scaling net-zero technologies, often referred to as the “decarbonizing” oil and gas. These include reducing oil and gas production, introducing new production efficiencies, and leveraging oil and gas competency to make the transition, such as investments into carbon capture and storage, hydrogen, and zero-emission electrification of upstream production.

Environmentalists are divided on the merits and viability of net zero. Some advocate for a complete halting of hydrocarbon operations as they believe there is not sufficient time to accept a transition away from oil and gas. Some question the cost-benefit of net zero technologies such as hydrogen and CCS.

### CARBON PRICING AND EMISSION TRADING SYSTEMS

Carbon pricing initiatives are spreading throughout the world. Over 60 countries, cities, states, and provinces have implemented or are planning to implement carbon pricing schemes, with a fairly balanced distribution between emissions trading systems and carbon taxes. Jurisdictions in Asia and the Americas are now the driving forces for new carbon pricing initiatives.[100]

Carbon pricing is a valuable instrument in the policy toolkit to help accelerate clean energy transitions. By providing a clear signal that GHG emissions entail a cost to society, carbon pricing can stimulate investments in low-carbon technological innovations, foster multilateral co-operation and create synergies between energy and climate policies. Carbon pricing is a policy instrument that we have seen in most of the jurisdictions reviewed.[101]

Carbon pricing instruments comprise carbon taxes and emissions trading systems. Carbon taxes place direct taxation or a fixed price on emissions but does not set an explicit limit on the emission levels. Emissions trading systems, on the other hand, are market-based instruments that cap emissions at a certain level but allow the price of the permits to fluctuate with demand.

Emissions trading systems expose emitters to the external costs of emissions in the most flexible and least costly way. The design of such a system needs to consider local contexts and regulations, as well as interlinkages with other policy priorities in each jurisdiction. Some of the elements to consider include the diversity and complexity of the interlinkages of energy policies, energy targets, and energy system structures.

[100] Source: IEA
[101] Source: International Energy Agency (IEA). Implementing Effective Emissions Trading Systems: Lessons from international experiences

## APPROACH - JURISDICTIONAL CARBON MANAGEMENT SCHEMES

In our review of the different jurisdictions, we found the following carbon management schemes.

| Newfoundland and Labrador | Alberta | Norway | United Kingdom | Australia | Gulf of Mexico |
|---|---|---|---|---|---|
| • Launched a provincial carbon tax for a number of sectors, along with a provincial performance standards system (PSS) in 2019. | • Emission offsets are generated by projects that have voluntarily reduced their greenhouse gas emissions. Emission offsets are quantified using Alberta-approved methodologies called quantification protocols and are verified by a third party in accordance with the Standard for Validation, Verification and Audit.<br>• Emission offset projects must meet the requirements in the Technology Innovation and Emissions Reduction (TIER) regulation, the Standard for Greenhouse Gas<br>• Emission Offset Project Developers, and a relevant Alberta-approved quantification protocol.<br>• Alberta emission offsets are registered and publicly listed on the Alberta Emission Offset Registry currently operated by CSA Group. | • Carbon price for oil and gas firms is one of the highest in the world<br>• Standard rate of carbon set at around 500 NOK/tonne and set to increase with 5% each year going forward<br>• About 50 per cent of Norwegian emissions is covered by the EU Emission Trading System (EU-ETS). About 90% of the oil and gas sector emissions are covered under the EU ETS.<br>• Supports Clean Development Mechanism of the UNFCCC and has a programme to procure some 60 million Certified Emission Reductions (CERs).<br>• 40% reduction target by 2030 compared to 2005 emissions, 70% by 2040 and near-zero by 2050 | • Industrial incentives to reduce emissions due to increased EU ETS compliance costs.<br>• It is expected that CO2 prices will increase to incentivise decarbonisation of operations.<br>• Established a UK Emissions Trading Scheme (UK ETS) January 2021 to replace the current EU ETS at the end of the Transition Period. Provides continuation of emissions trading for UK businesses and certainty on how they operate. | • The Climate Change Authority, a statutory agency, was created to advise the government on the setting of carbon pollution caps, to conduct periodic reviews of the carbon pricing process, and to report on progress towards meeting national targets.<br>• Australia operates an Emissions Reduction Fund that is designed to reduce Australia's emissions by providing incentives. | • The United States has proposed approaches to a carbon tax and an ETS regime. The regime differs as to whether it is federal or state. The proposals are as follows:<br>• Energy Innovation and Carbon Dividend Act (introduced 01/24/2019) – Carbon Tax<br>• There is nothing specific to the Gulf of Mexico States.<br>• The most prominent ETS is the California model - Global Warming Solutions Act, 2006; Regulation for the California Cap on Greenhouse Gas; Emissions and Market-Based Compliance Mechanisms, 2010 |

*Figure 2- Different Jurisdictional Carbon Management Schemes*

As can be seen from the Figure above, most carbon management systems, the government sets an emissions cap in one or more sectors, and the entities that are covered are allowed to trade emissions permits.

In the review, carbon taxes were seen in most jurisdictions and ETS were seen in all jurisdictions except for Newfoundland and Labrador.[102] However, it would seem that ETS are the most effective mechanism to address carbon. British Columbia's carbon levy and Alberta's former output-based pricing system failed to stimulate GHG abatement over their respective histories compared to the success of the EU ETS and the linked California-Quebec WCI cap-and-trade programme a 2020 analysis has found.[103]

The 2020 analysis, by the Canadian Energy Research Institute, found that, overall, the emissions trading (ETS) policy was found to be more effective at reducing greenhouse gas (GHG) emissions than the carbon tax policy or a hybrid policy. Evidence from the same study suggests that while gross domestic product (GDP) is also negatively impacted in the EU case, the magnitude of the effect on GDP is smaller than the effect on overall emissions; in other words, the impact of the ETS is larger on emissions than on the economic growth.

The European Union Emission Trading System reduced cumulative emissions of about 1.2 billion tonnes over the period 2008–2016, or approximately half of what EU governments promised in the Kyoto Protocol. Australia's emissions trading scheme generated more than $2.5 billion in emission-reduction actions by private sector companies, including large mining companies that recognized carbon pricing is both a solution and a financial opportunity if the right market environment is created.

California-Quebec Cap-and-Trade analysis suggests that the system is effective at reducing emissions and thus increasing emissions efficiency without negatively impacting the economic growth.

British Columbia carbon tax policy boosted economic activity but had no effect on emissions. Since the objective of regulatory policy is to reduce emissions, the carbon tax policy in British Columbia failed to achieve its goal. In fact, oil prices have been found to have a bigger effect on emissions in BC than

[102] Australia has changed their system from a carbon tax to an ETS.
[103] Source: https://carbon-pulse.com/106669/

carbon tax. Alberta SGER policy did not reduce GHG emissions as well. In fact, the SGER policy had a statistically significant positive impact on GHG emissions.

## CARBON MANAGEMENT SCHEME SETUP

### CHOOSING THE EMISSIONS CAP

Policy makers can set the cap of an emissions trading system in different ways, and this choice affects the predictability of emissions reductions. The most common ways to set a cap are through an absolute emissions reduction target (or "mass-based" cap) or an emissions target set relative to output ("intensity-based" target). Mass-based caps provide certainty on emissions reduction performance. Intensity-based targets can increase absolute emissions under certain conditions, but they allow more flexibility in adjusting to changes in economic conditions.

### THE LONG-TERM PERSPECTIVE: POLICY PREDICTABILITY

When designing an emissions trading system, policy makers may want to consider what role the system would play in the jurisdiction's long-term strategy, as well as how to ensure long-term policy predictability for the emissions trading system. For the private sector, long-term policy predictability is important for guiding investment decisions as it enables management of carbon price expectations. This is especially true for attracting new investment into jurisdictions such as Newfoundland and Labrador. Guiding questions for policy makers on the role and function of a new emissions trading system:[104]

- What is the intended role of the emissions trading system?
- What is the emissions cap design most suited to the trading system's role and function?
- How could the emissions trading system evolve to expand greenhouse gas and sectoral coverage, and strengthen incentives and emission cap stringency?
- What role will the trading system play in the jurisdiction's long-term emissions reduction strategy?
- What is the best way to best ensure long-term policy predictability for the emissions trading system?

### POLICY COMBINATIONS

In larger jurisdictions such as Norway, carbon pricing policies are implemented alongside a wide mix of other policies that promote clean energy transitions, such as air pollution control, renewable energy deployment, energy conservation, economic restructuring, and energy sector and power market reforms. It is important to understand the interaction of an emissions trading system with these other policies because it can accelerate or hinder clean energy transitions especially in Newfoundland and Labrador.

Mechanisms that promote both flexibility and certainty of a carbon price are fundamental to ensure that emissions trading systems can respond to unexpected or unintended impacts of domestic companion policies and other external factors, such as an economic crisis as we are experiencing with the global pandemic.

## ALIGNING EMISSIONS TRADING SYSTEMS WITH FEDERAL MITIGATION OBJECTIVES

An emissions trading system is generally embedded within higher-level greenhouse gas mitigation objectives, including those expressed within a country's nationally determined contribution (NDC) to the Paris Agreement on climate change and long-term mitigation strategies. Some jurisdictions have worked to align the emissions reductions trajectory and cap off their emissions trading system with these mitigation objectives, though in different ways. Setting the emissions trading systems cap with a top-down approach can help better align the trading system with the national or provincial mitigation objectives rather than being too collaborative in setting goals. Guiding questions for policy makers on the interactions of emissions trading systems and other policies:

- How will the emissions trading system interact with other national/provincial companion policies?
- What mechanisms can be used to promote emissions trading system flexibility and certainty over time?
- What is the best way to align the emissions trading system with national mitigation objectives?
- Tailoring emissions trading systems to energy market structures

[104] Source: IEA

In theory, the cost of an emissions trading system allowances creates various levels of incentives for the energy sector to reduce emissions, for example by investing in less carbon-intensive supply, reducing electricity demand, or changing the merit order of electricity dispatch in favour of low-carbon energy supply.

In practice, however, energy markets are often fully or partially regulated, and some power market structures can weaken the carbon pricing signal, reducing the emissions trading system's effectiveness. This raises questions about the compatibility of trading systems with energy market regulation constraints. It is essential for the design of an emissions trading system to match local circumstances such as what we see in Newfoundland and Labrador to generate the most effective carbon price signals.

### ADAPTING THE DESIGN OF EMISSIONS TRADING SYSTEMS TO POWER MARKET STRUCTURES

Several methods can be used to better reflect the system's carbon price signal while taking into consideration existing power market regulations. These methods include consignment auctions, covering indirect emissions, consumption charges, climate-oriented dispatch rules, carbon investment boards and pricing committees. Further research and experience will improve understanding of the effectiveness of these options.

### COST AND BENEFIT OF A CARBON MANAGEMENT SCHEME IN SPECIFIC SECTORS

How the Newfoundland and Labrador offshore oil and gas sector is included in an emissions trading system needs careful consideration. Policy makers should estimate the potential greenhouse gas mitigation potential available in industry and more generally reflect on the role of industry as a functional sector for the wider decarbonization of the economy. At the same time, it is important to estimate the potential economic impact that an emissions trading system would have on the various players in the oil and gas sector especially here in Newfoundland and Labrador.

### COMPETITIVENESS AND CARBON LEAKAGE CONCERNS

Introducing an emissions trading system in the offshore oil and gas sector could in theory affect economic competitiveness, leading for example to lower investments in industry and job losses. It could also affect the economic competitiveness of internationally traded goods. Offshore oil and gas production (and associated pollution) might also move to jurisdictions with less stringent environmental controls or emissions reductions requirements, a phenomenon known as "carbon leakage". All current emissions trading systems address these concerns by including features aimed at reducing the extra costs imposed on the offshore oil and gas sector.

It is therefore important to have a transparent means of identifying parts of the Newfoundland and Labrador offshore oil and gas industry with the highest risks of carbon leakage and competitiveness concerns, estimating the associated costs. Free allocation of allowances has been widely used by various emissions trading systems as a way to address competitiveness and carbon leakage concerns. There exist different design methodologies to allow free allocation of allowances, which require varying degrees of inputs. The choice of the allocation method is important, as this would determine the number of allowances that the offshore oil and gas sector would receive and would impact its emissions trading system obligations. Gradually phasing down free allocation in favour of auctioning can help correct potential market distributional distortions, generate revenue, and increase the mitigation effectiveness of trading systems. Guiding questions for policy makers on emissions trading systems and industry

- How can competitiveness concerns and the risks of carbon leakage be accurately identified for the offshore oil and gas industry?
- How can allocation decisions balance near-term competitiveness concerns with ensuring cost efficiency and distributional equity over time?
- Is there sufficient data to develop benchmarks?

## SUMMARY

Overall, we found that the implementation of a carbon price or emissions trading systems in certain jurisdictions may also have supported the application of internal carbon pricing for corporate investment decisions. An ETS system would seem to be the most effective mechanism for Newfoundland and Labrador based on worldwide trends and good practice.

The private sector is increasingly using carbon pricing as an indicator to quantify the financial implications relating to energy transition risks, as part of their climate risk management strategies.

In particular, the Task Force on Climate-related Financial Disclosures (TCFD) recommends that organizations provide their internal carbon prices as part of the metrics used to assess climate-related risks and opportunities, in line with their strategy and risk management processes. Private companies, organizations and investors are also using internal carbon pricing more and more as a planning tool to help identify revenue opportunities and risks, as an incentive to reduce costs through energy efficiency, and as guidance for capital investment decisions.

The level, distribution, variation, and trends of internal carbon prices could become key drivers for companies to change development plans, investment philosophies and climate governance.

## APPROACH - GREEN BONDS AND FINANCING

Rapid transformation to meet the Paris climate target requires greater attention to be given to the role of innovative low carbon early-stage businesses and the public sector's role in addressing finance gaps for longer horizon investment requirements. As entrepreneurs require different forms of finance as their businesses grow and move up the 'finance escalator', there is a role of public sector support for grant, equity, debt, and new forms of finance such as green bonds. These funds can enable individual sustainability focused businesses, such as offshore oil and gas clean technology firms, to access finance and encourage investment into new areas through having a demonstration effect. Overall, to ensure a successful innovative ecosystem for clean technology in the oil and gas industry in Newfoundland and Labrador requires an understanding and addressing a finance ecosystem approach that ensures complementary forms of finance for low carbon investment are connected at provincial, national and international scales, alongside support to build entrepreneurial skills and investment readiness. There is also a need for better evidence of the role of public sector support where there is greatest impact on clean tech in the offshore oil and gas sector.

## BACKGROUND

Last decade's clean-tech gold rush ended in disaster, wiping out billions in investments and scaring venture capitalists away for years.

Green bonds and financing, a major driver to the sector, came during the Obama Era. In addition to private money, President Obama committed over USD $90 billion (CAD $115 billion) to green innovation and renewable energy project development as part of the USD $1 trillion (CAD $1.28 trillion) emergency financial stimulus during the global financial crisis.

The US federal government money drove down the cost of renewables, batteries, and other technologies such that many of them are now cost competitive with incumbent sources of power generation, such as combined cycle natural gas.

Unfortunately, that first wave of investment petered out because it did not achieve cost-competitiveness in time to reward investors. Research by MIT shows that venture capital funds lost significant money in the clean tech space between 2006 and 2012. Firms spent over USD $25 billion (CAD $32 billion) funding clean energy technology, and generally lost over half their money, with some losing much more.

Collectively, these prior investments helped fund the learning curve such that the economics of these technologies are now compelling. Bloomberg reports that over USD $300 billion (CAD $383 billion) was invested in the renewable energy and clean technology in 2018, for the fifth year in a row. Trend-setting investor, Warren Buffett, has made some big investments, including in Chinese electric car maker BYD and in renewable energy, including with Alberta wind power investment in 2019. Clean tech is going mainstream.

A new investment boom is building again, this time around a broader set of climate-related technologies. This trend was confirmed in our interviews where multiple jurisdictions have pointed to the rise of investor interest in clean technology especially in the oil and gas sector as a driver to industry growth and change. Funding in clean technology has soared more than 3,750% since 2013, as numerous climate-focused venture firms emerge, and established players return to the field (including some that got scorched the last time). Investments are poised to rise further as market, policy, and technological forces align to make venture capitalists and entrepreneurs more confident.

Capital is being raised partially through the issuance of green bonds. In 2019, the green bond issuance in the United States equaled USD $51.5 billion (CAD $66 billion) and China's green bonds totaled USD $31.5 billion (CAD $40.4 billion). Green bonds are fixed-income instruments which are specifically designed to raise money for climate and environmental projects.

In Canada, the Canadian Pension Plan Investments (CPP) has issued USD $500 million (CAD $642 million) which is the fund's first U.S. dollar-denominated green bond, a Floating Rate Note linked to the new Secured Overnight Financing Rate. CPP have issued four green bonds to date.

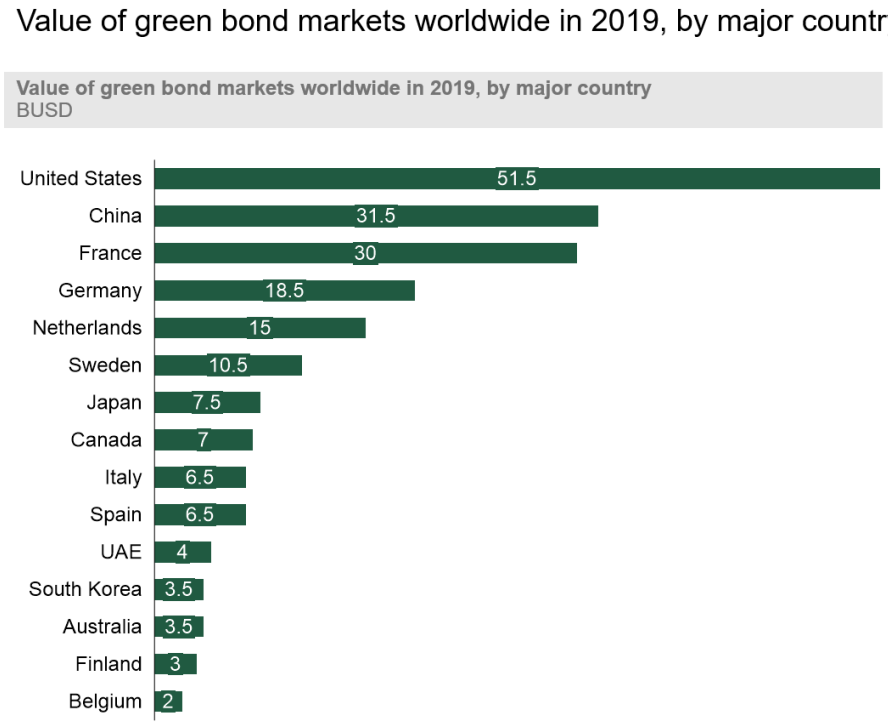


**FIGURE 1**- Value of Green Bond Markets Worldwide in 2019[105]

In 2019, Fannie Mae was the global leader in green bond issuance and issued USD $22.9 billion (CAD $29 billion) in such bonds. The German state-owned development bank, KfW, followed behind with USD $9 billion (CAD $11.5 billion) in green bonds.

In Canada, CPP Investments was the world's first pension fund manager to issue a green bond to help support the fund's investments in such opportunities as pursued by Power & Renewables and other groups. Green bonds provide CPP Investments with additional funding as the fund pursues acquisitions of eligible assets including renewable energy producers and LEED Platinum-certified buildings. The four green bonds issued to date includes $1.5 billion Canadian dollar-denominated green bond sale, and two sales of euro-denominated issuance worth €1 billion (CAD $1.75 billion) each. CPP also issued a green USD $500 million (CAD $642 million) floating rate note. CPP financing green bond financing as a strategy is intended to expand the fund's investor base as it invests in assets that are resilient to the energy transition.

CPP Investments' Energy & Resources (E&R) group operates an Innovation, Technology and Services strategy. This strategy capitalizes on opportunities created by the global energy transition, such as networks to charge electric vehicles. E&R carefully considers the transition when investing in traditional energy and natural resource assets. CPP Investments has also launched a new climate change opportunities investment strategy.

[105] Source: Climate Bonds initiative; Statista estimates

Value of green bond markets worldwide in 2019, by major country

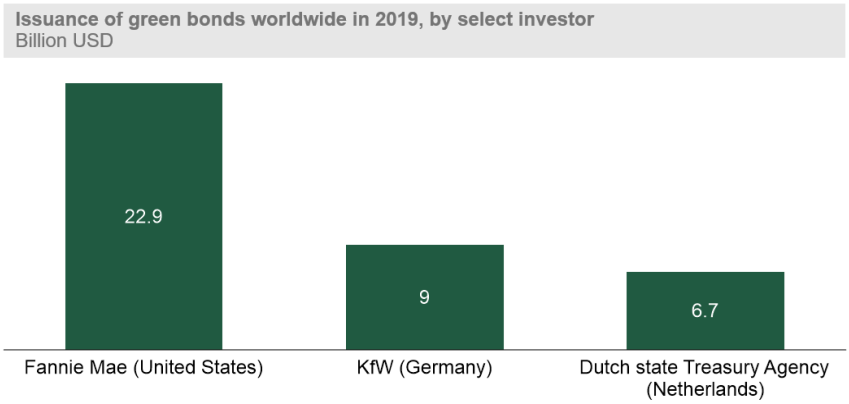


**FIGURE** 2- Issuance of Green Bonds Worldwide in 2019[106]

In 2019, 31 percent of proceeds from green bonds were used to fund the energy sector globally. Moreover, the use of green bonds and financing is being driven by institutional investors, such as CPP Investments and Allianz, one of the world's largest insurance companies. The Allianz Group is significantly expanding its climate strategy and has announced commitments to actively support the global change to a low-carbon economy over the coming decades. Allianz is one of the first insurance companies to set itself long-term climate goals which are linked to the two-degree target of the Paris Climate Agreement.

By 2040, in a step-by-step process, Allianz is proposing to have phased out both its proprietary investments in coal-based business and its insurance coverage of such risks. In addition, the company will reduce the carbon footprint of its business operations by 2040, for example through a higher proportion of renewable energies in electricity purchase.

Moreover, for the investment of the premiums of its insurance customers, Allianz defines one of its long-term objectives as structuring its tradable investments in all carbon intensive sectors to be climate neutral. Companies that do not succeed in adjusting their greenhouse gas emissions to the two-degree target over the coming decades will be gradually removed from the portfolio. This will be implemented for example by active dialogue with the companies and by requests for long-term climate protection targets, similar to the ESG scoring approach, which is already applied to companies with high ESG risks. Investment in green bonds is one method to mitigate this higher ESG risk.

Allianz is not unique in this strategy to divest from fossil fuels and invest more in clean technology and energy. Blackrock, the world's largest asset manager, stated in April 2020 that it is believes that there will be a fundamental reshaping of finance.

[106] Source: Climate Bonds Initiative

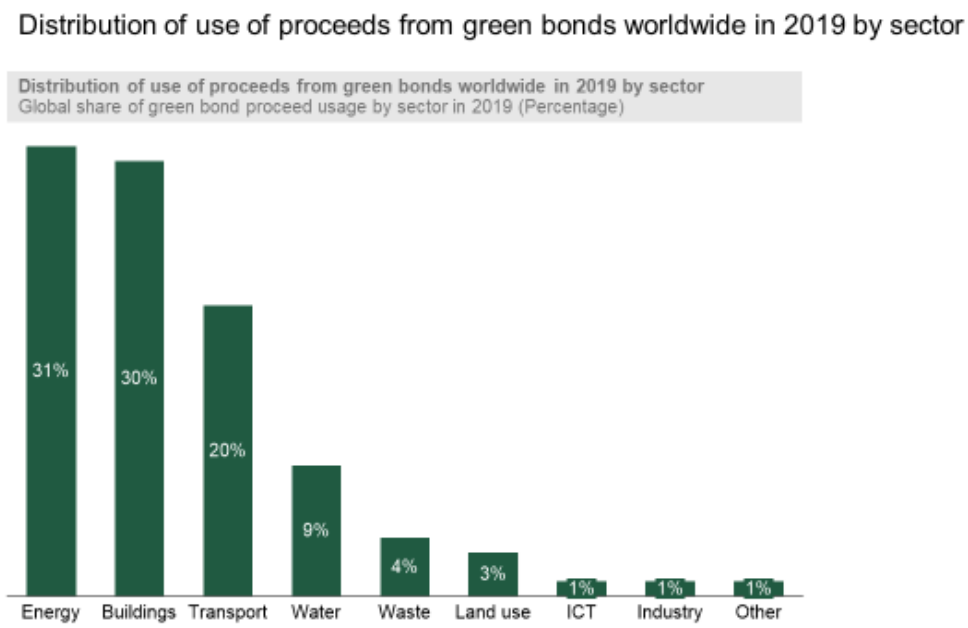


**FIGURE** 3- Distribution of use of Proceeds from Green Bonds[107]

The need to reshape finance is demonstrated in the distribution of the use of green bonds worldwide. Figure 3 displays the number of climate-aligned bonds worldwide in 2018, broken down by sector. For example, in 2018, over 1,360 green bonds had been used to finance the transportation sector. Green bonds were largely directed towards rail infrastructure.

Furthermore, the need to reshape financing is driving significant investments into the clean tech sector. Blackrock, for example, plans to lead an intensified focus on sustainable stewardship and climate change, launch new investment products that screen for fossil fuels, and start voting against boards and managements that do not disclose their sustainability procedures and their sustainability goals. BlackRock's shift in position for the nine out of ten American companies it owns stock in appears to not be entirely motivated by fiduciary considerations and, is instead, being driven by shareholder activists.

## SUMMARY

Investor participation in climate tech is fundamentally different to the early 2000s clean tech era. Climate tech funding seems to be coming from every corner of the market. More traditional venture capital firms are today at the table, growth stage investors including government backed asset managers such as Blackrock and private equity players are getting involved in earlier stage deals to get exposure, and corporate players from oil majors and global consumer goods companies to big tech are playing important roles as strategic investors to scale approaches.

The COVID-19 pandemic has not slowed investment activity. Since the crisis hit, major firms have pledged billions of dollars into this including Amazon's $2 billion (CAD $2.57 billion) 'Climate Pledge' venture fund, Microsoft's USD $1 billion (CAD $1.28 billion) Climate Innovation Fund, and Unilever's GBP €1 billion (CAD 1.75 billion) climate funds.

In addition, close to 300 companies now have a commitment to achieve net zero emissions before 2050. Every commitment represents a demand signal—a new customer—in the market for a solution, such as clean technology in the offshore oil and gas sector, that helps them achieve that call. In many cases, the solutions are not yet available, and will need to be delivered by technologists and start-ups over the coming decades.

Still, despite the substantial growth rates this market as a whole, it is a nascent sector. Capital, for example, remains thin rather than bountiful. While policy and regulatory environment is moving in the right

[107] Source: Climate Bonds Initiative

direction, companies pioneering the high-risk capital-intensive breakthrough technologies still struggle to get through the valley-of-death and be market competitive without policy incentives.

The bottom line is that demand for climate tech is only going to accelerate. With global corporations, investors, and governments pledging to transition to net zero value chains, portfolios, and jurisdictions, they are all betting on climate technology breakthroughs to be found, scaled and to transform the offshore oil and gas sector as well as broader society.

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