CANADA-NEWFOUNDLAND & LABRADOR

C-NLOPB

OFFSHORE PETROLEUM BOARD

2022

ANNUAL EMISSIONS REDUCTION INITIATIVES REPORT

January 31, 2023

The Honourable Jonathan Wilkinson, P.C., M.P.
Minister of Natural Resources
Government of Canada
21st Floor, 580 Booth Street, Room C 7-1
Ottawa, ON K1A 0E4

The Honourable Andrew Parsons, Q.C., MHA
Minister of Industry, Energy and Technology
Government of Newfoundland and Labrador
7th Floor – Natural Resources Building
50 Elizabeth Avenue
St. John's, NL A1B 4J6

Dear Ministers:

We are pleased to present the first Annual Emissions Reduction Initiatives Report for the Canada-Newfoundland and Labrador Offshore Area, as requested.

This report describes work that has been undertaken by the oil and gas industry in the Canada-Newfoundland and Labrador Offshore Area towards Greenhouse Gas emissions reduction and achieving Net Zero.

We thank those who have provided the information compiled herein.

Respectfully submitted,

Roger Grimes

Chair

TABLE OF CONTENTS

INTRODUCTION

The Government of Canada and the Government of Newfoundland and Labrador are committed to achieving net-zero emissions by 2050 in order to do their part to avoid the impacts of climate change. The Federal Government has set an interim target of reducing greenhouse gas (GHG) emissions by 40-45% from 2005 levels by 2030.[1] The Newfoundland and Labrador government has committed to interim targets to achieve a reduction of 10% from 1990 GHG emission levels by 2020 and a 30% reduction from 2005 levels, by 2030.[2]

Canada's total emissions in 2020 were 672 Megatonnes of Carbon Dioxide Equivalent (Mt CO_2e), with 150 Mt CO_2e or 22% coming from the oil and gas sector. This included natural gas, conventional oil and oil sands production but excluded midstream and downstream emissions.[3] In 2020, Newfoundland and Labrador offshore upstream oil and gas production accounted for 1.5 Mt CO_2e, 0.22% of Canada's total and 16% of the province's 9.5 Mt CO_2e total.[4]

In 2020, oil and gas production in the Newfoundland and Labrador Offshore Area accounted for 1% of Canada's upstream oil and gas sector emissions.

In 2022, the Newfoundland and Labrador Minister of Industry, Energy and Technology and the Minister of Natural Resources Canada requested that the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) compile an annual report describing work that has been undertaken by the oil and gas industry in the Canada-Newfoundland and Labrador Offshore Area to reduce GHG emissions and reach Net Zero. The information in this inaugural Annual Emissions Reduction Initiatives Report was provided by local operators, industry associations and research entities in the Fall of 2022 in response to a request made by the C-NLOPB. The report outlines their commitments and goals to reduce emissions, highlights progress made to date and describes ongoing Research and Development (R&D) projects that may further reduce emissions from the Canada-Newfoundland and Labrador Offshore Area. That information and the text contained herein has been compiled and edited by C-NLOPB staff for clarity and consistency of scope.

For more information about the C-NLOPB, please visit www.cnlopb.ca, email information@cnlopb.ca, follow the C-NLOPB on Twitter @CNLOPB, or phone (709) 778-1400.

[1] Net-Zero Emissions by 2050 - Canada.ca
[2] ClimateChangeActionPlan_MidtermUpdate.pdf (gov.nl.ca)
[3] Greenhouse gas emissions - Canada.ca
[4] CER – Provincial and Territorial Energy Profiles – Newfoundland and Labrador (cer-rec.gc.ca)

MESSAGE FROM THE CHIEF EXECUTIVE OFFICER

Climate change is among the greatest global challenges of our generation and is a top priority of the public interest in which we regulate, on behalf of the Governments and the people of Canada and Newfoundland and Labrador.

This report describes measures undertaken by the local oil and gas sector and related private-sector and academic organizations that will contribute to reduced emissions from the Canada-Newfoundland and Labrador Offshore Area.

Thank you to everyone who has contributed to this report and to our staff who have compiled it. The initiatives described reflect an understanding by all of the above-noted organizations and entities -- shared by all of us at the C-NLOPB -- that climate change is real, caused by human activity, and must be urgently addressed.

Scott Tessier
Chief Executive Officer

CENOVUS ENERGY INC.

Cenovus Energy Inc. (Cenovus) operates the *SeaRose* Floating, Production, Storage and Offloading (FPSO) vessel producing from the White Rose and North Amethyst Fields. These fields are located 350 kilometers (km) east of St. John's, Newfoundland and Labrador. After the White Rose Field discovery in 1984, production began in 2005. Cumulative production from the *SeaRose* FPSO has reached 318.56 million barrels (MMbbl) of oil and 437.19 billion standard cubic feet (Bscf) of natural gas as of March 31, 2022. The cumulative gas disposition to March 31, 2022 for this facility includes 44.99 Bscf flared, 58.18 Bscf used as fuel, 328.72 Bscf injected, and 218.83 Bscf used for gas lift. The annual emissions from the *SeaRose* FPSO from 2018-2021 are outlined in Table 1 and include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

Table 1: *SeaRose* FPSO Annual Emissions

YEAR	GREENHOUSE GAS TONNES OF CARBON DIOXIDE EQUIVALENT (t CO_2e)			
	CO_2	CH_4	N_2O	TOTAL
2018	332 733	21 639	2 185	**356 556**
2019	242 550	14 846	2 049	**259 445**
2020	343 084	17 047	2 232	**362 362**
2021	311 297	18 223	1 965	**331 484**

Source: NL-Industrial-Facilities-Provincial-GHG-Data-for-Website-2016-2021.pdf (gov.nl.ca) as of January 12, 2023

Cenovus has set a corporate target to reduce absolute Scope 1[5] and 2[6] GHG emissions on a net-equity basis by 35% from 2019 levels by year-end 2035, and to build toward their ambition to achieve net zero emissions by 2050. Cenovus reports absolute emissions to regulators and works to manage GHG emissions on site. From 2007-2021, absolute emissions from the *SeaRose* FPSO were reduced by approximately half (from 640 kilotonnes (kt) CO_2e in 2007 to 331.5 kt CO_2e in 2021).

Throughout the operating life of the *SeaRose* FPSO, Cenovus has worked to identify and implement means for continuous improvement. In 2020, the maintenance department developed and implemented a Fugitive Emissions Management Program (FEMP) in alignment with the corporate FEMP. The FEMP is based on the systematic detection and repair of leaks and malfunctioning equipment. Systematic detection relies on regular surveys for fugitive emissions using specialized equipment and techniques. Data collected during surveys and repair details are stored in a centralized corporate data management system to complete reporting, and to inform decisions on affected components and preventative maintenance practices.

[5] **Scope 1** emissions are *direct* GHG emissions that occur from sources that are controlled or owned by an organization or government. These emissions are associated with natural gas and fuel, refrigerants and emissions from combustion in boilers, furnaces or vehicles. They also include process emissions that are released during industrial processes and on-site manufacturing.

[6] **Scope 2** emissions are *indirect* GHG emissions from purchased or acquired energy (such as electricity steam, heat or cooling) generated offsite and consumed by a company or government. These emissions account for roughly one third of all GHG emissions.

Since 2019, a major focus has been on the reduction of flaring. In 2016-2018, flaring accounted for an average of 35% of total emissions, reduced to 25% in 2019-2021. Significant effort was undertaken in 2021 to reduce emissions to as low as reasonably practicable. The baseline emissions level for 2020-2022 was 387,189 t CO_2e. The 2021 reduction target (or "limit") was set at 10% below the baseline emissions level at 348,471 t CO_2e. Actual emissions, excluding venting and fugitive sources for 2021, were 324,843 t CO_2e (23,628 t CO_2e below the limit). Quarterly reporting of air emissions, which began in 2020, has provided the operations team with the opportunity to identify the relative contributions of each of the main sources of emissions: flares, main power generators, boilers, fugitives and diesel consumers.

In 2022, to provide more timely visibility into emissions and in keeping with the corporate core values of Protecting What Matters and Making It Better, the Atlantic Region of Cenovus developed a GHG Dashboard for the *SeaRose* FPSO. The dashboard provides valuable near real-time information about all of the *SeaRose* FPSO's CO_2e emissions. This level of visibility provides the operations team with an opportunity to be systematic and in control by understanding how operational changes and decisions impact performance and in turn, emissions. The Atlantic Region also implemented a product called *emissions.AI* that monitors energy consumers and emissions generation and uses artificial intelligence (AI) to identify operational inefficiencies. This information provides insights for future improvements and emissions reductions.

In addition, the Atlantic Region of Husky Oil Operations Ltd., now Cenovus, has worked on other scopes since 2018 with the objective of reducing emissions. The first was the conduct of continuous reviews of operating strategies with the objective of improving performance, resulting in the following reductions:

- 2 vs. 3 Main Power Generator operating philosophy, resulting in an average reduction of 75-100 t CO_2e/day or an 8% reduction in fuel usage average per year for 2020, 2021 and 2022; and
- Turnaround planning: a greater focus has been given to ramp-down and ramp-up plans to consider emissions reductions.

Consistent and reliable operation of the *SeaRose* FPSO is another key factor in reducing emissions, as process upsets can lead to increased emissions. A second scope area was to put a greater focus on equipment reliability and included the use and continuous improvement of tools to ensure uptime and equipment availability are top quartile. A "trip report" provides a review of all trips and the associated impacts, focused on preventing repeat occurrences and implementing improvements.

Cenovus participated in two studies as a part of the Government of Canada's Emissions Reduction Fund (ERF) Offshore Research, Development and Demonstration (RD&D) Program. These studies focused on the ways to potentially reduce emissions through modifications to the existing facility during future planned maintenance programs. This research centered on the two areas with the greatest opportunity to reduce emissions: the main power generation system, and the flare system.

***SeaRose* Main Power Generation Optimization**

This study assessed the feasibility of operating the *SeaRose* FPSO on two power generators instead of three through the remaining life of field and taking into consideration the anticipated increased power requirements for West White Rose production. It was found there was the potential to upgrade power

turbine sections to increase the power output of each main power generator, while providing a more efficient running engine. The project can be completed in stages, as part of scheduled maintenance and upgrades for the power generation system. If approved, the project has the potential to reduce emissions by 25,000 t CO_2e/year from 2025 to 2038.

***SeaRose* Flare Gas Optimization**

This research examined modification options to capture all normalized flaring from separators, reduce venting and flaring from sources such as flash gas compression, cargo tank blanketing and background flaring. The study also assessed the feasibility of a closed flare system, which would be used for safety purging and flare ignition, and a flare tip upgrade and replacement. The flare tip replacement would look at a more efficient flare tip with the potential to provide a greater destruction efficiency while the flare is burning, leading to reduced unburned methane emitted during flaring instances. The combined benefit of these flare gas initiatives is a potential reduction of 50,000 t CO_2e/year from 2025 to 2038.

In addition to the studies completed under the federal government's Offshore ERF RD&D, Cenovus worked with OPEX Group to develop and implement a Machine Learning/AI technology dashboard that reviews current and historical operations, searching for deltas in the total emissions generated for similar operations. The system then highlights the opportunities to reduce emissions. The technology went live in September 2022.

Although a brownfield environment provides greater challenges to large scale changes, Cenovus is committed to continuous improvement and identifying ways to further reduce the facility's carbon footprint. They also participate in ongoing initiatives through Energy Research and Innovation Newfoundland and Labrador (ERINL), such as the Ocean Supercluster (Digital Offshore Canada), which focuses on digitalization opportunities that may also provide GHG reductions and the ERINL-sponsored Net Zero Project, supporting Carbon Capture and Storage (CCS) and other projects leading towards net-zero.

EXXONMOBIL CANADA PROPERTIES

ExxonMobil Canada Properties (EMCP) operates the *Hebron* Platform producing from the Hebron Field, and is located approximately 240 km southeast of St. John's, Newfoundland and Labrador. This Field was discovered in 1980 with production starting in 2017. Cumulative production from the *Hebron* Platform has reached 178.16 MMbbl oil and 76.08 Bscf of natural gas as of March 31, 2022. The cumulative gas disposition to March 31, 2022 for this facility includes 10.17 Bscf flared, 22.35 Bscf used as fuel, 43.58 Bscf injected, and 57.53 Bscf used for gas lift. The annual emissions from the *Hebron* Platform from 2018-2021 are outlined in Table 2 and include CO_2, CH_4 and N_2O.

Table 2: *Hebron* Platform Annual Emissions

YEAR	GREENHOUSE GAS (t CO_2e)			
	CO_2	CH_4	N_2O	TOTAL
2018	400 088	78 210	3 151	**481 449**
2019	517 219	85 621	2 805	**605 645**
2020	481 622	26 099	3 032	**510 753**
2021	437 227	14 113	3 302	**454 643**

Source: NL-Industrial-Facilities-Provincial-GHG-Data-for-Website-2016-2021.pdf (gov.nl.ca) as of January 12, 2023

EMCP is an indirect, wholly-owned subsidiary of Exxon Mobil Corporation (EMC). With advances in technology and the support of clear and consistent government policies, EMC aims to achieve net-zero operated Scope 1 and 2 GHG emissions by 2050. In addition, EMC has announced 2030 emission-reduction plans which are intensity based, focused on driving industry-leading performance while still meeting the needs of society, and which include a:

- 20-30% reduction in corporate-wide GHG intensity,
- 40-50% reduction in upstream GHG intensity,
- 70-80% reduction in corporate-wide methane intensity, and
- 60-70% reduction in corporate-wide flaring intensity.

EMC's 2030 emission-reduction plans cover Scope 1 and 2 emissions from assets EMC operates, compared to 2016 levels. For non-operated assets, EMC works with its equity partners to advance GHG reductions.[7]

In Newfoundland and Labrador, EMCP has focused on reducing emissions on the *Hebron* Platform by operating reliably and efficiently. EMCP, a subsidiary of EMC, is able to leverage core capabilities and strategies of advantages in scale, integration, technology, functional excellence and people to build globally competitive businesses to meet society's need for products essential to modern life, while addressing the challenge of climate change. EMCP is also able to leverage the experience and expertise

[7] Information contained in this section is sourced from ExxonMobil's Advancing Climate Solutions (ACS), and is subject to important terms and conditions found in said publication (e.g., cautionary statements). The ACS supersedes any information contained in this document. Exxon Mobil Corporation has numerous affiliates, many with names that include ExxonMobil, ExxonMobil Canada, and XTO. Nothing contained herein is intended to override the corporate separateness of affiliated companies. Exxon Mobil Corporation's goals do not guarantee any action or future performance by its affiliates or Exxon Mobil Corporation's responsibility for those affiliates' actions and future performance, each affiliate of which manages its own affairs. This material is not to be reproduced or distributed for other purposes.

of the other Hebron owners in evaluating potential emissions reduction opportunities for the Hebron Project.

Hebron has implemented changes to its operations to reduce GHG emissions, including improvements in Gas Injection Compressor reliability, updates to gas injection strategies, and refinements in operational practices. This has resulted in an estimated 77% reduction of GHG emissions from flaring between 2019 and 2021. Hebron has an optical imaging Leak Detection and Repair (LDAR) program to identify and mitigate fugitive emissions.

EMCP is continuously evaluating opportunities for R&D including for emissions reduction opportunities. Two of these key early-stage potential initiatives are:

- **Wind Power Generation**
  - EMCP is conducting a R&D project to assess the potential wind resource and the feasibility of using wind generated power to supplement current power.

- **Carbon Capture and Storage**
  - EMCP is conducting a R&D project to assess the potential for a brownfield design and installation of an amine-based carbon capture process unit. The study will assess feasibility of adapting technologies suited for onshore generation systems for installation and operation on the *Hebron* Platform.

HIBERNIA MANAGEMENT AND DEVELOPMENT COMPANY LTD.

Hibernia Management and Development Company Ltd. (HMDC) operates the *Hibernia* Platform producing from the Hibernia Field. The Hibernia Field was discovered in 1979 and is located approximately 300 km east-southeast of St. John's, Newfoundland and Labrador. HMDC declared first oil in 1997 and has produced 1,220.38 million barrels (MMbbl) of oil and 2,119.03 billion standard cubic feet (Bscf) of natural gas as of March 31, 2022. The cumulative gas disposition to March 31, 2022 for this facility includes 103.39 Bscf flared, 129.01 Bscf used as fuel, 1,886.55 Bscf injected and 42.83 Bscf used for gas lift. The annual emissions from the *Hibernia* Platform from 2018-2021 are outlined in Table 3 below and include CO_2, CH_4 and N_2O.

Table 3: *Hibernia* Platform Annual Emissions

YEAR	GREENHOUSE GAS (t CO_2e)			
	CO_2	CH_4	N_2O	TOTAL
2018	494 123	54 777	3 067	**551 968**
2019	456 146	44 239	3 137	**503 522**
2020	546 920	16 797	3 014	**566 731**
2021	509 770	15 701	2 907	**528 379**

Source: NL-Industrial-Facilities-Provincial-GHG-Data-for-Website-2016-2021.pdf (gov.nl.ca) as of January 12, 2023

HMDC has committed to continuing to make progress on reducing GHG emissions. HMDC is focused on reducing Scope 1 GHG emissions directly from their operations and has been successful in doing so by operating reliably and efficiently. Prevention, control and mitigation of environmental risks have been emphasized from the beginning of the Hibernia Project, starting with the Environmental Impact Statement, continuing through production facilities design and development of operating procedures and inspections or audits of environmental performance. The key factors to ensure compliance have been HMDC environmental staff working alongside the planning and design teams, participating in the specification and procurement of major equipment. Sound operating procedures and good housekeeping practices improve effective prevention, control and mitigation of effects on the surrounding environment.

The Hibernia Project has implemented several initiatives and operational improvements to reduce GHG emissions. From 2005 to 2021 the Hibernia Project has achieved GHG emission reductions of approximately 29% (746 to 528 kt CO_2e). An overview of some of the specific initiatives to achieve this reduction are:

- **Flare management – estimated 50% reduction in GHG emissions from flaring (2005 to 2021)**
  - Operational efficiencies through time, including optimization of flare purge gas rates and work to improve gas compression reliability, has led to a reduction in flaring emissions by approximately half since 2005.

- **Fugitive emissions management**
  - Establishing an optical imaging LDAR program resulted in a decrease of fugitive methane emissions.

- **Pervasive WiFi system installation**
    - Funding from the Newfoundland and Labrador Provincial Government Industry Recovery Assistance Fund enabled installation of a pervasive WiFi system in the *Hibernia* Platform production areas. Data enabled by this digital technology allows for real-time analytics and remote execution leading to logistics and equipment fuel consumption efficiencies.

- **Diesel cranes replacement to electric**
    - In 2020, the two original diesel-powered *Hibernia* Platform pedestal cranes were replaced with electrically powered units. This will result in an approximate reduction in emissions of up to 265 tCO_2e per year.

HMDC is also pursuing R&D in technologies that can further reduce emissions and is investing in innovative solutions that may have broad impacts in the industry. Three of these key early-stage potential initiatives are:

- **Hibernia Power Generation System Digital Prototype**
    - HMDC has built a power generation optimization system prototype for the *Hibernia* Platform. This digital prototype provides the ability to simulate various power generation scenarios with accompanying GHG emission estimates. The digital prototype was developed based on historical power generation data and further research is required for the technology to monitor real-time data, in order to provide insight into GHG emissions reduction opportunities on the *Hibernia* Platform.

- **Wind Power Generation**
    - HMDC is conducting a R&D project to assess the potential wind resource and the feasibility of using wind generated power to supplement current power generation.

- **Flare Reduction Technology Feasibility Study**
    - EMCP, as participating interest/shareholder of the Hibernia Project, investigated the feasibility of using a proprietary technology to convert light-end gas into liquid products, thereby reducing the amount of flare gas to be flared. This research was supported by the Federal ERF, with coordination and support from ERINL.

SUNCOR ENERGY INC.

Suncor Energy Inc. (Suncor) is the operator of the *Terra Nova* FPSO vessel producing from the Terra Nova Field, discovered in 1984. This Field is located 350 km east-southeast of St. John's, Newfoundland and Labrador. Production began on the *Terra Nova* FPSO in 2002 and produced 425.03 MMbbl oil and 842.35 Bscf of natural gas as of March 31, 2022. The cumulative gas disposition to March 31, 2022 for this facility includes 64.65 Bscf flared, 75.27 Bscf used as fuel, 702.43 Bscf injected, and 144.52 Bscf used for gas lift. The annual emissions from the *Terra Nova* FPSO from 2018-2021 are outlined in Table 4, below and include CO_2, CH_4, N_2O, HFCs (Hydrofluorocarbons), PFCs (Perfluorochemicals) and SF6 (Sulfur Hexafluoride). Please note, the *Terra Nova* FPSO was off-site for the majority of 2020 and all of 2021 while undergoing upgrades to the facility, which resulted in lower than normal emissions reported for those years.

Table 4: *Terra Nova* FPSO Annual Emissions

YEAR	GREENHOUSE GAS (t CO_2e)				
	CO_2	CH_4	N_2O	HFCs, PFCS, SF_6	TOTAL
2018	559 216	28 917	3 849	22	**592 005**
2019	468 435	21 619	3 776	162	**493 993**
2020	59 768	121	2 671	0	**62 560**
2021	0	0	0	0	**0**

Source: NL-Industrial-Facilities-Provincial-GHG-Data-for-Website-2016-2021.pdf (gov.nl.ca) as of January 12, 2023

Suncor has a corporate GHG emissions goal of reducing their emissions by 10 Mt CO_2e by 2030 across the value chain. This would be a step towards the longer-term objective of net zero by 2050. Suncor's strategy is to grow their business in low GHG fuels, electricity and hydrogen, while sustaining and optimizing existing hydrocarbon businesses and transforming their GHG footprint. To achieve this, Suncor is focusing on:

- Reducing Scope 1 and 2 emissions through base business improvements;
- Growing low-emissions energy businesses in renewable fuels, electricity, and hydrogen to address Scope 2 and 3[8] emissions; and
- Working with others to reduce value chain emissions, including Scope 3.

In 2021, the *Terra Nova* FPSO left Canada to undergo improvements to the facility, called the project's Asset Life Extension (ALE). The scope of the project's ALE includes making improvements aimed at reducing GHG emissions through increased reliability, mitigation for corrosion and reductions in process upsets, losses of containment and flaring when the *Terra Nova* FPSO is back in production.

Specifically, the ALE project includes the following work:

- An upgrade to the gas compression units, resulting in possible annual GHG reductions of up to 1% of CO_2e;

[8] **Scope 3** emissions include all indirect emissions that are not produced by an organization or government and are not the result from their owned or controlled assets. These include all emissions not within the Scope 1 and 2 margins.

- The replacement of pipe spools; upgrading of metallurgy; renewal of pipe coatings; and replacement or refurbishment of passing valves, resulting in possible annual GHG reductions of up to 1% of CO_2e.

Suncor currently has a subsea digital twin project underway on the *Terra Nova* asset. This project will be a single source of truth for all subsea assets, including the generation of consistent anomaly data to provide a basis for automated inspection activities. The goal is to optimize vessel movements and time-on-station to reduce CO_2 emissions. This has the potential to reduce emissions by 720 t CO_2e annually. Through the ERF process, Suncor submitted two proposals to investigate two discrete offshore emissions reduction opportunities, both of which were successful in receiving funding. These proposals were the *Terra Nova* FPSO Flare Reduction Study, and the Sustainable Emissions Reduction by Digital Integrity Management (SERDIM), or Copsys Intelligent Digital Skin (CIDS), which are outlined below. Suncor has led and managed those projects over 2021 and 2022.

Flare Reduction Study

The Flare Reduction Study assessed the technical feasibility of installing a closed flare system on the *Terra Nova* FPSO and reducing gas compression train related flaring. With regards to the closed flare system, the study showed that implementing a closed flare system is not feasible on the *Terra Nova* FPSO. However, the other portion of the study focused on the current protocol for routine testing of Terra Nova's well barrier elements. Barrier testing is a regulatory task performed in accordance with Suncor's well intervention and integrity management strategy and currently requires the gas compression train to be taken offline and to flare or burn all produced gas. Developing a method to keep the gas compression train online during testing will allow gas to be processed by the facility without flaring. By changing the barrier test procedure to utilize the annulus bleed system to bleed off tubing pressure above the downhole safety valves, there would be no need to shut down gas injection during the test.

The Flare Reduction Study confirmed it is possible to modestly increase the flow through the annulus bleed with a larger restriction orifice, improving the chance for successful gas injection well barrier testing. Detailed engineering and risk assessment is required in accordance with Suncor's Business Process for Management of Change before making a final recommendation to increase the orifice size and proceeding with modifications. Therefore, Suncor intends to conduct a trial in 2023, utilizing the annulus bleed testing philosophy with the existing orifice. If the trial is successful and allows gas compression to stay running while barrier tests are completed, annual GHG reductions of 4000 t CO_2e are possible.

Sustainable Emissions Reduction by Digital Integrity Management

Copsys Intelligent Digital Skin (CIDS) is a new coating-based (paint) digital sensor technology that could transform existing corrosion and integrity management systems. Developed by Copsys Industries Inc. and led by Suncor, this project aims to further test and advance CIDS technology and its ability to replace predominantly labor-intensive piping inspection processes to detect and manage corrosion under insulation, with a persistent digital presence that will be able to detect corrosion hotspots before they occur and provide ongoing protection. This could improve process safety, facility integrity, reliability, and environmental performance. CIDS has the potential to reduce GHG emissions by reducing the frequency of production upsets, which could result in a decrease in flaring and a

significant reduction in the likelihood of fugitive emissions caused by corrosion. This technology could be used in oil and gas production and transportation, as well as other process industries. This project targets taking the CIDS technology from a technical readiness level (TRL) of four (validated in a test environment) to a TRL of eight (qualified for use). Once this technology is commercial, the expected resulting decrease in emissions is estimated to be between 4-7%.

Suncor is also participating in the following projects through ERINL that may have some emissions reduction potential for the Canada-Newfoundland and Labrador Offshore Area:

- Digital Offshore Canada Project – Canada's Ocean Supercluster Technology Leadership Project
- OceanVision™ – Canada's Ocean Supercluster Technology Leadership Project
- The Open Offshore Program - Government of Newfoundland and Labrador Oil & Gas Industry Recovery Assistance Fund and Atlantic Canada Opportunities Agency Jobs and Growth in Communities Recovery Fund Project

Suncor is actively working to identify and assess GHG emissions reduction opportunities in its base business assets, including Terra Nova and within its supply chain. Suncor will continue to monitor technology enhancements, and support R&D opportunities, that could potentially reduce GHG emissions in the Canada-Newfoundland and Labrador Offshore Area.

BP CANADA ENERGY GROUP ULC

bp Canada Energy Group ULC (bp) is planning to conduct an exploration drilling program in the Canada-Newfoundland and Labrador Offshore Area beginning in 2023.

bp's strategy includes delivery of resilient hydrocarbons, convenience and mobility solutions to consumers and low carbon energy. Resilient hydrocarbons will be delivered by a high-graded portfolio, lowering emissions and driving returns. bp's ambition is to become a net zero company by 2050 or sooner and to help the world get to net zero. They have set several aims to enable their net zero ambition and relevant items are detailed below.

Net Zero Operations

bp aims to be net zero across the entire operations on an absolute basis by 2050 or sooner. This aim relates to Scope 1 (from running the assets within our operational control boundary) and Scope 2 (associated with producing the electricity, heating and cooling that is bought in to run those operations) GHG emissions. bp has established interim global targets of 20% by 2025 and 50% by 2030 from a 2019 baseline. By the end of 2021, bp had achieved a cumulative reduction of 35%.

Reducing Methane

This aim is to install methane measurement at all existing major oil and gas processing sites by 2023, publish the data and then drive a 50% reduction in methane intensity of operations by 2030. bp will work to influence joint ventures to set their own methane intensity targets of 0.2%.

More Money for New Energies

This aim is to increase the proportion of investment made into non-oil and gas businesses. Over time, as investment goes up in low and zero carbon, it will likely go down in oil and gas.

bp does not currently have operating assets in the Canada-Newfoundland and Labrador Offshore Area, however any potential future developments will, in addition to delivering regulatory requirements, follow all bp requirements including assessment of environmental and social impacts to allow for the implementation of appropriate mitigations and deliver on the above mentioned aims[9]. Any potential future developments would assess emissions and seek to mitigate during design based on available technologies at the time. Further work would occur through the life-cycle of the asset to manage emissions.

bp conducts R&D within company operations and through partnerships with industry (e.g., Oil and Gas Climate Initiative), technology developers, and academic institutions around the world. Research into new technologies that improve operational efficiency or that focus directly on emission abatement may be applied to future developments.

[9] Our sustainability aims - bp.com

EQUINOR CANADA LTD.

Equinor Canada Ltd. (Equinor) has completed several exploration drilling campaigns in the Canada-Newfoundland and Labrador Offshore Area, most recently resulting in an interest in developing the Bay du Nord Field. This field is located 450 km east-northeast of St. John's, Newfoundland and Labrador.

Equinor aims to be a leader in the energy transition. It has set a clear ambition to become a net zero company by 2050, including emissions from production and final consumption. Equinor's Energy Transition Plan combines carbon-efficient oil and gas production with accelerated, value-driven expansion in renewables and low carbon technologies. The strategy includes clear and measurable portfolio-level targets to ensure absolute reductions in global GHG emissions.

For example, by 2030, Equinor has set corporate targets that include:

- 50% reduction in their operated GHG emissions (2015 baseline);
- 12-16 gigawatts (GW) of installed renewable energy capacity globally; and
- 5-10 million t CO_2 transport and storage capacity >50% of annual gross capital expenditure allocated to renewables and low carbon solutions.

A key priority of Equinor's corporate Energy Transition Plan is an optimized oil and gas portfolio with industry-leading emission efficiency. If sanctioned and once operational, Bay du Nord would continue to assess new technologies and innovations to further reduce emissions and incorporate those deemed viable. Continuous improvement is intrinsic to Equinor's culture and critical to meet Bay du Nord's commitment to net zero GHG emissions by 2050.

Corporately, Equinor has stated that only the most robust upstream projects will be developed and that carbon considerations will continue to influence all portfolio decisions. Equinor believes that a Bay du Nord development has the potential to be the lowest carbon intensity project of its scale in Canada. Equinor has prioritized carbon efficiency at Bay du Nord from the earliest phase of planning and design. Working closely within Equinor's global competence, wherever possible, the latest innovative practices and technological advances will be integrated to safely avoid carbon emissions.

Bay du Nord remains an early-phase development in Equinor's portfolio. As the project design matures, Equinor will continue to explore new technology integrations including technology such as a closed loop gas recovery flare system to ensure no routine flaring – the first use of this technology in offshore Canada – as well as combined cycle technology to harvest waste heat created during production and turn it into a source of energy – another first-use technology in Canada's offshore. Both technologies would significantly reduce the project carbon footprint.

Bay du Nord operations would also leverage digitalization related to robotics, drones, artificial intelligence, and machine learning to increase efficiency, strengthen safety, and reduce emissions. For example, the use of seafloor-resident drones, tasked for subsea inspection, has the potential to reduce the requirement for remote operated vehicles support vessels, thus reducing emissions from vessel operations.

Equinor actively invests in the local and Canadian R&D community. The company conducts its own R&D activities and is also a partner in ERINL and Canada's Ocean Supercluster joint industry programs. Equinor's investment in strengthening additive manufacturing in Newfoundland and Labrador to create local capacity and a digital warehouse of parts able to be made locally, is an example of technology investment with emissions reduction benefits. Building capacity in the local economy to supply parts to Bay du Nord would also reduce emissions associated with shipping parts from around the world, while also boosting the local economy. Equinor's R&D investment in Newfoundland and Labrador would increase substantially should Bay du Nord be sanctioned, activating a commitment to material and ongoing investments in local R&D and Education and Training (E&T).

Equinor is one of the most CO_2-efficient producers of oil and gas in the world. Its 2021 upstream CO_2 intensity was less than half the global average.[10] Its methane intensity for operated assets (upstream and midstream) is roughly 10% of the industry average.[11]

Equinor works collaboratively across a network of industry associations and partnerships to advance innovation and best practices to further reduce global emissions and accelerate the energy transition. Some of these partnerships include:

- Oil and Gas Climate Initiative;[12]
- Global CCS Institute;[13]
- Global Gas Flaring Reduction Partnership;[14]
- Methane Partnership; and[15]
- The Environmental Partnership.[16]

As the world transitions towards a net zero future, the need for fossil fuel continues to grow, and it's important we meet that need with the lowest carbon intensity resources available. Bay du Nord is an important opportunity to help secure the global energy demand with the potential to be the lowest carbon intensity project of its scale in Canada.

[10] Equinor 2022 Energy Transition Plan, pg. 14
[11] Ibid
[12] CEO-led organization bringing together 12 of the largest oil and gas companies worldwide to accelerate action towards a net zero emissions future consistent with the Paris Agreement
[13] An international think tank aimed at accelerating the deployment of CCS
[14] A World Bank multi-donor trust fund composed of governments, oil companies, and multilateral organizations committed to ending routine gas flaring at oil production sites across the globe
[15] A voluntary initiative created by the Climate and Clean Air Coalition (CCAC) and the United Nations Environmental Programme to help companies reduce methane emissions in the oil and gas sector
[16] Comprised of companies in the U.S. oil and natural gas industry committed to continuously improving the industry's environmental performance

CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

The Canadian Association of Petroleum Producers (CAPP) is an industry association representing companies that explore for, develop and produce oil and natural gas in Canada. CAPP has developed a set of eight climate principles which represent commitments by Canada's upstream natural gas and oil industry to enable it to be a key, effective solution provider through innovation, collaboration and globally competitive strategies designed to meet the challenge to mitigate climate change. The climate principles can be found on CAPP's website[17].

CAPP has published a plan titled *Collaborating for Safety & Sustainability: A Continuous Improvement Plan*[18] that highlights the collaborative work operators are doing. This plan, launched in February 2020 and updated in 2021 and 2022, outlines a vision: Atlantic Canada as the safest and most environmentally responsible offshore oil and natural gas operating region in the world. The plan also outlines a joint purpose statement: To enhance collaboration and information sharing across the offshore oil and natural gas industry, and facilitate continuous improvement in support of safe, responsible and reliable operations.

A key objective outlined in the plan is to support efforts to reduce GHG emissions. CAPP's role in this regard is to provide a forum for information sharing and collaboration between CAPP members, and more broadly with other stakeholders. Specific initiatives completed in support of this objective include; mapping cumulative absolute GHG emissions for producing assets, as well as for basin logistics and transportation to identify potential collective improvement opportunities and working with members to develop a list of broad potential efficiency projects that could result in emissions reduction. This list was shared with Natural Resources Canada to help inform planning for the ERF. CAPP also led the planning of the 2022 Offshore Environmental Forum to provide a venue for sharing emissions reduction progress and opportunities. CAPP also has a role to play in communicating the work underway by the industry in reducing emissions. CAPP recently developed a video series in conjunction with ERINL to highlight projects completed through the ERF administered by Natural Resources Canada. These videos can be found on CAPP's website.

CAPP is currently developing its 2023 update to *Collaborating for Safety & Sustainability*, which will include an objective related to emissions reduction/climate. Although specific research is taking place through ERINL, individual members and other groups, CAPP members believe in the importance of reinforcing the collective commitment to reducing emissions in the Canada-Newfoundland and Labrador Offshore Area through the plan.

CAPP also hosted the 2022 Newfoundland and Labrador Offshore Environmental Forum, a virtual event, on March 8th and 9th, alongside the Canada-Newfoundland and Labrador Offshore Petroleum Board and One Ocean. The next Offshore Environmental Forum is planned for November, 2023. Further information can be found on CAPP's website[19].

[17] Industry's Climate Commitment - capp.ca
[18] Continuous Improvement Plan - atlanticcanadaoffshore.ca
[19] 2022 Offshore Environmental Forum - atlanticcanadaoffshore.ca

ENERGY RESEARCH AND INNOVATION NEWFOUNDLAND AND LABRADOR

ERINL is a not-for-profit organization that identifies collaborative RD&D opportunities and facilitates projects on behalf of Newfoundland and Labrador's oil and gas industry. The Government of Canada provided funding for the ERF to discover more ways to reduce GHG emissions in the oil and gas industry. ERINL is delivering the offshore component of the ERF and has worked on 18 projects that investigated offshore emissions reduction opportunities.

Seven of these projects were outlined by operators in previous sections. The remaining projects are described here. It is important to note that the estimates of potential reduction assumed in some cases are modeled on a full deployment in the Newfoundland and Labrador Offshore Area (e.g. all assets/vessels), and that implementation of some solutions would reduce the CO_2 available to be reduced by other measures (e.g. full scale electrification from one solution would reduce power generation emissions targeted by other technologies). Other projects not addressed previously are as follows:

- **Atlantic Towing Ltd.**
    - Atlantic Towing Ltd. delivered the Novel Battery Hybrid Retrofit of a Multi-Purpose Platform Supply Vessel project. This project is a first-in-kind integration of multiple battery technologies combining spinning reserve and all-electric transit on a platform supply vessel. Battery technology has enabled carbon-free, all-electric operation of smaller vessels for short transits when power demand is low. Battery-hybrid drive train technology has also been used on North Sea supply vessels. This project combined these technologies under a single power management system and was demonstrated on the Atlantic Shrike platform supply vessel. The estimated GHG emission reduction is approximately 800 t CO_2e per year.

- **Cnergreen**

    A project completed by Cnergreen tested the ability to reduce GHG emissions offshore using Novel Nanoparticle-based Foam Technology. Cnergreen investigated the performance of its patent-pending ArmorFoam™ technology in laboratory-simulated offshore reservoir conditions. The studies showed that the innovative nanoparticle-based foam reduces the short-circuiting of injected gas/water and can potentially reduce fluid circulation and associated emissions. Reducing gas/water re-circulation reduces the power required for gas separation, compression and injection, thereby reducing GHG emissions. A prototype equipment skid for a future field trial was also developed. If technology is successful and fully adopted across the region, the estimated GHG emission reduction could be 180,000 t CO_2e per year.

- **Design By Analysis**
    - Design By Analysis developed LUMENATE Wellbore Operations Monitoring System, a novel downhole monitoring system that provides measurements during phases of offshore drilling not covered by existing telemetry. Offshore operators will have the live downhole information needed to optimize wellbore operations, remove uncertainty, and reduce well construction and workover time. This will shorten the time required to produce a field, reducing their GHG emissions accordingly. Extending reach has the

potential to increase production from existing facilities lowering emissions intensity. If technology is successful and adopted as defined during the project, the estimated GHG emission reduction could be 34,000 t CO_2e per year.

- **Duxion**
  - Duxion developed Express Hybrid Electric Retrofit Solution for Offshore Vessels, the world's first 500 kilowatt (kW) hybrid diesel-electric propulsion system that can be retrofitted to the existing propulsion systems of in-service vessels without the need for costly dry docking or significant drive shaft modification. This offers traditionally-configured vessels a greener propulsion system with significant emissions reductions. This project investigated design challenges, manufacturing optimization, prototyping and testing, and will deliver a physical prototype for future demonstration. If the technology is successful and fully adopted on applicable offshore supply vessels in the region, the estimated GHG emission reduction could be up to 43,000 t CO_2e per year.

- **Growler Energy**
  - Growler Energy investigated the feasibility of supplying renewable electrical energy as a source of energy for power generation for Newfoundland and Labrador's offshore oil and gas facilities. Looking at multiple options, including electrification from shore, hydrogen and wind energy, the study adopted a risk-based approach that identified barriers, opportunities and knowledge gaps associated with using renewable energy to power offshore oil and gas platforms. If the projects outlined in this study were to be implemented, this could result in an emissions reduction of 270,000 t CO_2e per year.

- **M.A. Procense**
  - M.A. Procense is developing a compact carbon capture system to remove CO_2 from the exhaust gas of offshore facilities' power generation systems, including Fdual fueled gas turbines, diesel generators, and steam generation systems. The system pressurizes the exhaust gas from turbines and routes it through an expansion cooling system composed of specialized nozzles. The separated CO_2 can be further pressurized and made ready for storage. If the technology is successful and fully implemented across the region, this could result in emissions reductions in the range of 250,000-400,000 t CO_2e per year.

- **Memorial University of Newfoundland**
  - Memorial University of Newfoundland worked on a proof-of-concept project called Separation First Technology which involved the development and demonstration of porous materials for the reduction of CO_2 in offshore oil production. Specifically, this project is exploring using Metal-Organic Frameworks (MOFs) to separate CO_2 from offshore oil and gas exhaust streams. MOFs are porous materials that can be designed at the atomic level for different applications. Having developed and pilot tested a potential MOF porous material, this project focused on developing a small-scale filtration system to separate CO_2 from a simulated exhaust stream.

- **Planetary Technologies**
    - Planetary Technologies investigated the ability to use a novel electrochemical process using alkalinity generated from mine waste to capture carbon from the exhaust of offshore production facilities. The resulting bicarbonate is stored within seawater, helping to reduce ocean acidification. The project determined that the mild alkalinity proposed would not be optimal for a space constrained offshore oil and gas platform, although direct ocean air capture has significant potential.

- **Intecsea**
    - Intecsea performed a life-cycle study to look at the suitability of using offshore floating wind to power offshore facilities. The study examined the benefits to Canada through reduced emissions, and the contribution to the development of a workforce associated with floating wind concepts fabricated and assembled in Canada and safely operated offshore. The results of the study indicated the use of floating wind turbines offshore Newfoundland and Labrador is technically feasible, and that major components could be constructed in Atlantic Canada. If the scenarios defined in this project were to be implemented, this could have the potential to reduce almost 40% of baseline emissions for offshore platforms.

- **Waterford Energy Services Inc.**
    - Globally, floating wind technology has advanced and prototypes tested, however, research regarding its applicability to the unique conditions in the Canada-Newfoundland and Labrador Offshore Area is in the early stages. Therefore, Waterford Energy Services Inc. (WESI) performed a conceptual study applying floating wind as an alternate energy source for Mobile Offshore Drilling Units (MODU) installations in the Canada-Newfoundland and Labrador Offshore Area and examined mooring analysis, power cables, wind resource assessment, battery systems, ice effects, power modelling, and electrical cable disconnection. The study concluded that Floating Offshore Wind Turbines are feasible in this region and WESI is planning further studies to progress field trials in the future. The outcomes of this study estimated that, with the addition of hybrid wind power, 33,000 t CO_2e could be avoided annually per MODU.

- **St. Francis Xavier University**
    - St. Francis Xavier University's project measured methane emissions from oil and gas platforms in the Canada-Newfoundland and Labrador Offshore Area, by collecting aircraft-based measurements of methane around oil production facilities to quantify and verify methane emission levels. Results were compared to measured values of other offshore platforms in the North Sea and Gulf of Mexico, and to Canadian onshore environments which are thought to have higher methane intensity. The study provided comparisons between offshore operations, and confirmed Canada's offshore production is among the least methane-intensive in Canada and the United States.

Outside of the ERF, ERINL is also involved in the following emissions reductions projects:

- **Digital Oceans Canada**
    - Digital Oceans Canada (DOC) is a project involving Ocean Supercluster, ERINL, Virtual Marine and GRi Simulations. This is a multi-phase project that will see the development of a shared platform that will enable the creation and commercialization of digital twins and other digital products and services for a range of ocean industries. DOC will be built by developing a set of tangible, high-value digital twin use cases in the offshore sector that will demonstrate benefits and deliver an initial viable platform. Future work will scale up and expand initial twins and applications, add new twins (including from other ocean sectors), and continually add to data and analytical tools in the platform. At the end of the project, DOC will feature a proven development platform environment and a set of digital twins that can be accessed by multiple stakeholders to benefit from the interfaces, numerical and visual models, and data that is available in the platform. Future phases could expand the functionality and broaden the application of initial twins, create new twins (including for direct application in other sectors), expand ocean environmental data sets accessible to users, continue to improve and build the analytical toolset within the platform, and expand access to the platform, including through potential immersive simulators in relevant regional innovation hubs (such as the proposed “digital ocean innovation centre” in St. John’s and the Centre for Ocean Ventures and Entrepreneurship in Dartmouth). Analysis by Accenture, in collaboration with the World Economic Forum, shows that digital technologies, if scaled across industries, could deliver up to 20% of the 2050 reduction needed to hit the International Energy Agency net-zero trajectories in the energy, materials and mobility industries.

- **Advancement of Environmental Genomics and Ednatec**
    - Advancement of Environmental Genomics and Ednatec are developing a set of methodologies and technologies that will facilitate the mainstream application of novel genomics-based technologies in environmental assessment and monitoring most relevant to the oil and gas industry. If implemented this will require less ship time to complete the work compared to current methods and therefore reduce emissions from shipping. It is estimated that this methodology has potential to be approximately seven-10 times more efficient than traditional “catch and look” environmental assessment technologies.

MEMORIAL UNIVERSITY OF NEWFOUNDLAND

Uniquely positioned in the harsh maritime environment of Newfoundland and Labrador, Memorial University boasts nationally and internationally leading research expertise in a range of areas including ocean engineering and science; technology; natural resources; health; innovation and entrepreneurship; and climate change. More than 40 per cent of Memorial's current research is ocean-related. That work is supported by world-class research facilities and strong public partnerships with industry and organizations.

Memorial University researchers have been active in the understanding and reduction of GHGs across multiple sectors. Directly or indirectly related to offshore oil and gas, there have been several projects looking at flare reduction, methane emissions monitoring, CO_2 capture techniques, renewable energy, and utilization/storage. A listing of these projects is outlined below:

- **Department of Process Engineering, Faculty of Engineering and Applied Science**
    - Dr. Majid Abdi has been working on the use of compact process technology and Process Intensification for carbon capture technology including use of dual membrane contactors, centrifugal contactor systems, and use of advance nozzle technology.
    - Dr. Lesley James and team at the Hibernia Research Group have been studying how captured CO_2 at offshore locations can be utilized for enhanced oil recovery. The focus has been on constrained CO_2 volumes possibly captured from existing facilities, the effect of less selective CO_2 capture techniques resulting in impurities in CO_2 and their impact on recovery efficiency, the effectiveness of injecting CO_2 in Water Alternating Gas (WAG), mixed CO_2-natural gas WAG, carbonated water injection and combinations including rates of CO_2 recycle/volume injected. The work has included the effect of different reservoir fluid and rock characteristics, along with their interactions, on oil recovery efficiency. These interactions are important to CO_2 storage with CO_2 storage evaluation a focus of future work.
    - Drs. Lesley James, Salim Ahmed and Kelly Hawboldt and students have helped evaluate a flare reduction strategy resulting in economic potential if there is a green source of energy.
    - Drs. Lesley James, Kelly Hawboldt and Yahui Zhang are working on the feasibility of offshore blue/turquoise hydrogen production, which is a form of renewable energy using natural gas.
    - Dr. Kelly Hawboldt and team study how adsorbents sourced from forestry and fishery waste can be used to capture CO_2. Work to date (TRL3) has shown the treated bioadasorbents have the capacity to adsorb CO_2 on par with existing commercial CO_2 adsorbents. Based on this proof of concept, Dr. Hawboldt, Dr. Kris Podsuka (Physics), and Dr. Stephanie MacQuarrie (Chemistry) are building on this work using a multidisciplinary approach to further develop bioadsorbents in carbon capture processes from material development to process design and scaling up.

- **Department of Mechanical Engineering**
    - Drs. Kevin Pope, Greg Naterer and others of Mechanical Engineering are studying offshore wind.
    - Drs. Kevin Pope, Greg Naterer and teams are working on green hydrogen, a form of renewable energy using water and wind.

- **Faculty of Business Administration**
    - Dr. Cooper's team completed a report which highlighted business processes and social enterprise models that could be deployed to reduce GHGs in the Canada-Newfoundland and Labrador Offshore Area whilst still supporting economic growth and reduced reliance on government/public donations/support.
    - Dr. Tom Cooper along with Caron Hawco Group Inc. and Rystad Energy did a jurisdictional analysis of the Clean Tech Sector funded by econext and EnergyNL.

THE NET ZERO PROJECT

The Net Zero Project is a collaborative partnership of EnergyNL, econext and Oil and Gas Corporation of Newfoundland and Labrador (OilCo) with goals of driving economic growth, diversification, investment, and awareness through the lens of sustainability and the pursuit of net zero in Newfoundland and Labrador's energy sector.

This organization is focused on the energy industry in the Canada-Newfoundland and Labrador Offshore Area, with the understanding that many onshore industries in supply and service chains support, and are linked to, the offshore environment. It is The Net Zero Project's mission to provide independent analysis on technologies that will reduce GHG emissions in the Canada-Newfoundland and Labrador Offshore Area, identify the technical and economic challenges that may exist, and identify policies that can enable the implementation of these technologies within the context of achieving net zero emissions by 2050, while growing oil and gas production in the Canada-Newfoundland and Labrador Offshore Area. To support that mission, it is The Net Zero Project's vision to develop and steward a collaborative, centralized framework – involving industry, regulators, and government – that defines targets, R&D priorities, develops strategy, contributes to the sustainability of industry, and achieves alignment with respect to the pursuit of emissions reductions pathways within the offshore energy industry.

The Net Zero Project has developed a series of pathways for pursuing these environmental milestones through the delivery of the report *Net Zero Pathways for Canada's Offshore Oil Industry,* being released in 2023. This report will help to define how the offshore energy industry in the Canada-Newfoundland and Labrador Offshore Area can achieve a reduction (or offsetting) of GHG emissions by 2050. The Net Zero Project has also been involved in the publication of several other reports outlining opportunities for emissions reductions in the Canada-Newfoundland and Labrador Offshore Area. Findings from these reports found that Canada's offshore oil carbon intensity is 30% below the global average. This fact, combined with investing in transformational clean technologies implies that it is possible to grow the offshore industry while maintaining net zero by 2050 standards. The Net Zero Project has conducted in-depth research and determined that technologies such as Carbon Capture Utilization and Storage (CCUS), electrification of offshore operations from shore or from floating wind turbines, and hydrogen production can be attractive solutions for the Canada-Newfoundland and Labrador Offshore Area.

The Net Zero Project conducted a CCUS Workshop in September 2022, since it became clear that CCUS is becoming a technology that is going to play an important role in the future of the offshore oil and gas industry. This was confirmed by engagement activities undertaken by project staff. While prevalent in Western Canada, CCUS is a relative unknown within Newfoundland and Labrador. Moreover, it has never been applied before – anywhere in the world - in an offshore oil and gas context. Thus, there were many questions and many unknowns which needed to be explored. Collaboration is key to any success in CCUS, the size of projects may be beyond the purview of one single proponent. Newfoundland and Labrador has an opportunity to be an early front runner in offshore CCUS technology with proper planning and collaboration amongst stakeholders.

The Net Zero Project has also provided guidance reports to its project partners regarding carbon offsets. These reports clearly define the regulatory system as-is, demonstrate the need for the

implementation of new frameworks, and provide options on what form these frameworks could take. Enabling the purchase of carbon offsets within Newfoundland and Labrador could open the door to investment and operational revenues for Newfoundland and Labrador-based carbon offset projects. The development of a carbon offset 'roadmap' articulating actions required is planned and will help Newfoundland and Labrador to realize potential related to carbon offsets. A carbon offset framework can help to enable net zero, present opportunities for economic development, and mitigate economic leakage.

The ERF has released reports on electrifying the offshore. Analyzing the results of these reports, The Net Zero Project will focus on bridging information gaps by following through on recommendations made by these reports and pursing any next steps identified within these valuable pieces of work.

Incorporating the results stemming from the previous focus areas, The Net Zero Project will continuously refine the analysis of technologies and processes that appear (or should appear) in net zero pathways for the offshore oil and gas industry. This would include, for example, but not be limited to: the use of hydrogen as a fuel in offshore operations; shared logistics; closed flare systems; etc. This continuous refinement of net zero pathways was a key finding stemming from the research undertaken through the ERF – as circumstances are changing regularly and decision-makers require information that can be relied upon as being current.

Outside of the above noted work, The Net Zero Project has yielded a number of important benefits and related work/efforts towards emission reductions in the oil and gas industry in the Canada-Newfoundland and Labrador Offshore Area. These include:

- Helping stakeholders to understand the feasibility of GHG emissions reduction opportunities;
- Providing a net zero framework for the offshore from which further analysis can be undertaken;
- Identifying enabling conditions and barriers for each net zero opportunity;
- Focusing research, development, and investment towards net zero in the Canada-Newfoundland and Labrador Offshore Area;
- Increasing collaboration within the industry;
- Building capacity within the industry to pursue net zero by 2050; and
- Communicating information through the life of the project, and beyond.

APPENDIX: LIST OF ABBREVIATIONS, CHEMICAL ABBREVIATIONS AND UNITS

ABBREVIATIONS

ALE (Asset Life Extension)
CAPP (Canadian Association of Petroleum Producers)
CCS (Carbon Capture and Storage)
CCUS (Carbon Capture, Utilization and Storage)
CIDS (Copsys Intelligent Digital Skin)
C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board)
DOC (Digital Oceans Canada)
E&T (Education and Training)
EMCP (ExxonMobil Canada Properties)
ERINL (Energy Research and Innovation Newfoundland and Labrador)
ERF (Emissions Reduction Fund)
FEMP (Fugitive Emissions Management Program)
FPSO (Floating, Production, Storage and Offloading)
GHG (Greenhouse Gas)
HMDC (Hibernia Management and Development Company)
LDAR (Leak Detection and Repair)
MOF (Metal-Organic Framework)
R&D (Research and Development)
RD&D (Research, Development and Demonstration)
TRL (Technical Readiness Level)
WAG (Water Alternating Gas)
WESI (Waterford Energy Services Inc.)

UNITS

bbl (Barrels)
Bscf (Billions of Standard Cubic Feet)
GW (Gigawatts)
km (Kilometers)
kt (kilotonnes)
kW (kilowatt)
MMbbl (Million Barrels)
Mt CO_2e (Megatonnes of Carbon Dioxide Equivalent)
PFCs (Perfluorochemicals)
t CO_2e (tonnes of Carbon Dioxide Equivalent)

CHEMICAL ABBREVIATIONS

CH_4 (Methane)
CO_2 (Carbon Dioxide)
CO_2e (Carbon Dioxide Equivalent)
HFCs (Hydrofluorocarbons)
N_2O (Nitrous Oxide)
SF6 (Sulfur Hexafluoride)

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