Petroleum Planning & Analysis Cell
Ministry of Petroleum & Natural Gas, Government of India

PPAC JOURNAL

Volume 2023-34 | Edition 2 | August 2024

Special Issue on

NET ZERO

plans of oil and gas companies

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We acknowledge the support of HPCL in designing this issue of PPAC Journal

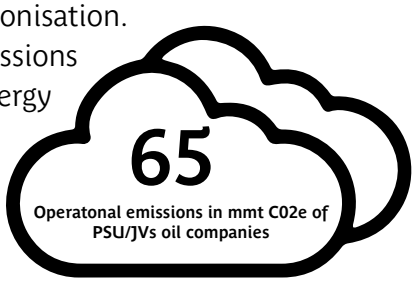
EDITORIAL

Dear Readers

We are thankful for appreciation received for the first edition of PPAC Journal which was released during the India Energy Week 2024. During the release, Director General PPAC announced "Net Zero Plans of India`s Oil & Gas organisations" as the theme of the next issue.

India has set target of 2070 for achieving Net Zero target. India has also submitted its long-term low-carbon development strategy with reaffirmation of the goal of reaching net-zero by 2070. India's long-term low-carbon development strategy is based on the principles of equity and climate justice and the principle of Common but Differentiated Responsibilities and Respective Capabilities.

India is going through dual transition, first towards becoming a developed nation and the other towards decarbonisation. This poses a challenge as Greenhouse Gas emissions are set to increase on account of larger energy consumption for its development and poverty eradication goals apart of energy equity.



Oil & Gas along with Coal are considered responsible for the status of the carbon emission of the world and hence are at the centre of decarbonisation debate. The Oil & Gas industry's operations are estimated to add 5.1 billion tonnes (Gt) CO2-eq in 2022. These "scope 1 and 2" emissions from oil and gas activities are responsible for just under 15% of total energy-related greenhouse gas (GHG) emissions. The use of the oil and gas results in another 40% of emissions (source of emissions). This puts large responsibility on the industry for reducing emissions. India`s PSU / JV Oil & Gas sector have emission ~ 65 million tonnes CO2e and have Energy Transition spending Plans of over 6 Lakh crores.

In this backdrop of critical role Oil & Gas industry, PPAC thought it opportune to bring out a special issue of its Journal on their plans to decarbonise. From the articles submitted by Oil & Gas majors of the country, it is noted that these organisations are very proactively and enthusiastically pursuing decarbonisation goal. Very interestingly, while these companies are prioritising actions on scope 1 and 2 emissions, they are also focussed on reducing scope 3 emissions through products and offerings which help in lowering the emissions. All these companies are today experimenting and offering biofuels (as such and through blending), Gas (which is emerging as bridge fuel in transition efforts), renewables and new fuels like hydrogen. These companies are committing large investments for transition and empowering their human resources through reskilling for the changed scenario.

We are happy that second issue of the PPAC Journal is now before you. This issue has articles from Oil & Gas companies, eminent energy experts and organisations on net zero initiatives. This issue is coming in the month of Independence Day and presents a knowledge bank for companies for learning from each other to achieve larger goal of energy independence and decarbonisation.

We are thankful for overwhelming response from the companies and experts. We acknowledge the sincere support of Executive Director- PRCC HPCL for assisting PPAC in bringing out this issue of the journal in the form and shape it is before you. We also acknowledge the services of Mr Sandeep Gawde for designing this issue of the journal.

We would like to add that views expressed in the articles are those of the writers in their personal capacities or organisations they represent and PPAC has only provided a platform for knowledge sharing. PPAC/MoPNG will not be responsible for any errors, omissions, discrepancies, and disputes arising out of these articles.

Suggestions and Feedback from the readers are invited for improvement of the Journal. Next issue of PPAC Journal on the theme of LiFE & Biofuels will be released at the time of IEW 2025 We invite articles for the same.

Warm Regards,

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Additional Director, PPAC
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Message from Director General

सम्-गच्छ-ध्वम्, सम्-व-दद्वम्, सम् वो मानसि जानताम्।

(Let's move together, let's all interact together & Everyone's minds should also be one) said Hon'ble Prime Minister of India during COP26 Summit in Glasgow.

Petroleum Planning & Analysis Cell (PPAC) as an attached office of the Ministry of Petroleum & Natural Gas (MoPNG), Government of India, has set high standards of collecting, analysing and disseminating data and its reports in the Oil and Gas Sector, which are a comprehensive databank for Oil & Gas industry for the country. The global energy landscape is undergoing a transformative shift, with sustainability and carbon neutrality becoming core objectives. The energy transition is not merely a necessity but an opportunity to innovate and lead in a sustainable future. PPAC as a responsible arm of the Government has been closely working with all stakeholders in the Oil and Gas Sector and in its efforts towards the twin goal of becoming developed country by 2047 and achieving Net Zero by 2070.

The current edition of PPAC Journal encapsulates detailed Net zero plans of major Oil & Gas players in India and provides a platform for various domain experts to share their knowledge and thoughts with stakeholders and the best practices including the invent of state-of-the-art technologies in the sector. India's long-term low-carbon development strategy is based on the principles of equity and climate justice and the principle of Common but Differentiated Responsibilities and Respective Capabilities.

According to the GHG Protocol corporate standard, greenhouse gas emissions are classified into three scopes. Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the process, including both upstream and downstream emissions.

India's long-term low-carbon development strategy rests on seven key transitions to low-carbon development pathways. These include:

- low-carbon development of electricity systems consistent with enhanced development benefits.
- develop an integrated, efficient and inclusive transport system.
- promote adaptation in urban design, energy and material efficiency in buildings, and sustainable urbanisation.
- promoting economy-wide decoupling of growth from emissions and development of an efficient, innovative low emission industrial system.

- development of carbon dioxide removal and related engineering solutions.
- enhancing forest and vegetative cover consistent with socioeconomic and ecological considerations.
- economic and financial needs of low-carbon development.

For India, achieving net-zero emissions is especially vital as it harmonizes economic development with environmental sustainability. Owing to steps taken by the country, India is emerging as a global leader in climate action by aggressively expanding renewable energy, implementing robust environmental policies, and fostering international climate cooperation.

I am confident that this edition will provide valuable insights into the Net Zero initiatives of Oil and Gas companies and inspire further innovation and collaboration in this vital sector.

I extend my sincere gratitude to all contributors and the editorial board at PPAC for their hard work in bringing this edition to fruition.

Reflecting on the ethos of our culture, the ancient Sanskrit quote "प्रकृतिं यान्ति भूतानि" (Prakrtim Yaṅti Bhuťaṅi) meaning "All beings follow their nature," reminds us of our intrinsic connection to nature and the importance of aligning our industrial practices with natural laws for the well-being of all.

P. Manoj Kumar
Director General
Petroleum Planning & Analysis Cell (PPAC)
(Ministry of Petroleum & Natural Gas)

CONTENT

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NET ZERO 2038

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ONGC: Pioneering India's Path to Net Zero Emissions

Shri Deepak Tandon,
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Ms Chandrali Mukherjee,
PRO, ONGC

India's commitment to combat climate change is underscored by its ambitious pledge to achieve Net Zero emissions by 2070. This commitment includes interim targets such as a 45% reduction in the emissions intensity of GDP by 2030 from 2005 level and ensuring that 50% of its cumulative electric power capacity comes from non-fossil fuel sources. Recent global accords, including the COP 28 summit in Dubai, have emphasized the urgent need for decisive action, highlighting the critical transition away from fossil fuels to achieve net-zero emissions by 2050. This global shift necessitates significant investments in carbon reduction technologies, renewable energy capacity, and carbon capture initiatives.

ONGC's Strategic Role in India's Climate Action

The oil and gas industry, a cornerstone of India's economy, plays a crucial role in this transition. Recognizing the urgency of climate action, Oil and Natural Gas Corporation (ONGC), a major player in the Indian oil and gas sector, has set an ambitious goal to achieve Net Zero Emissions for Scope 1 and Scope 2 categories by 2038. This commitment was further evidenced by ONGC's participation in initiatives like the Oil and Gas Climate Declaration at COP28. By signing Oil and Gas Decarbonisation Charter (OGDC), ONGC has committed to initiate steps to achieve Net-Zero operations by 2050 at the latest and ending routine flaring by 2030, near-zero upstream methane emissions.

Advanced Technologies for Emissions Reduction

In pursuit of its emissions reduction goals, ONGC leverages advanced technologies to detect and mitigate methane emissions. Utilizing TROPOMI satellite data and AUSEA drone surveys, ONGC identifies methane hotspots and conducts ground surveys to address fugitive emissions sources. Since 2007, these efforts have prevented approximately 20.48 million Standard Cubic Meters (MMSCM) of methane gas leakages, resulting in an emission reduction of approximately 306,250 tons of CO2 equivalent (tCO2e).

Moreover, ONGC is actively engaged in various carbon reduction projects, including waste heat recovery, flare gas recovery, and the development of energy-efficient green buildings. These initiatives have collectively resulted in a reduction of approximately 22.05 million tCO2 equivalent. The company also prioritizes water conservation and waste management, with advanced technologies developed in collaboration with the Bhabha Atomic Research Centre (BARC) to treat oil-contaminated effluent to potable grade.

Embracing Renewable Energy and Carbon Capture

ONGC's commitment to sustainability extends beyond emissions reduction to include significant advancements in renewable energy and energy efficiency. The company is advancing hydrogen production technologies and expanding its renewable energy capacity through wind and solar installations. Additionally, ONGC is exploring carbon capture, utilization, and storage

(CCUS) initiatives, including a collaboration with Indian Oil Corporation Limited (IOCL) to capture and sequester CO2 emissions.

Comprehensive Sustainability Initiatives

In alignment with its dedication to sustainability, ONGC is launching initiatives focused on supplier emission disclosures and greening its entire supply chain. These collective efforts underscore ONGC's comprehensive and ambitious approach towards achieving its Net Zero goal and contributing to global climate change mitigation efforts through the adoption of state-of-the-art technologies and sustainable practices.

ONGC: A Legacy of Energy Leadership and Innovation

Since its establishment in 1956, ONGC has played a pivotal role in shaping India's energy landscape, from the discovery of oil in Gujarat's Ankleshwar field to major finds like Mumbai High, bolstering India's energy self-sufficiency. Committed to sustainability, ONGC has made significant strides in emission reduction and aims for Net Zero Emissions by 2038. The company plans substantial investments in green initiatives, including renewable energy, offshore wind, and green ammonia production.

In 2023, ONGC witnessed significant growth, with a 37% increase in stock price and a 32% rise in oil production by its subsidiary, ONGC Videsh Limited. The company is dedicated to achieving zero flaring and methane emissions by 2030, emphasizing robust corporate governance and talent management. Globally recognized, ONGC consistently ranks high in prestigious lists like S&P Global Commodity Insights and Fortune Global 500, showcasing its commitment to excellence and sustainability in the energy sector.

Leading the Charge for a Sustainable Future

ONGC Chairman and CEO Arun Kumar Singh encapsulates the company's forward-looking vision: "We have done our internal workings and are now confident that we can achieve Net-Zero for Scope-1 and Scope-2 emissions by 2038. We are focused on the round-the-clock (RTC) issue. A team is working on it. 5 GW of solar power, green ammonia, and wind energy, everything is on the table."


upstream

Energy Transition

India's ONGC outlines $24.2 billion investment to meet net-zero emissions target

State-controlled company aims to scale up its renewable portfolio to 10 gigawatts by 2030

Through its comprehensive strategy and unwavering commitment to innovation and sustainability, ONGC is not just aligning with India's climate goals but is also setting a benchmark in the global energy sector. The company's initiatives highlight the critical role of the oil and gas industry in driving the transition to a sustainable and resilient future.

Baseline Emissions

ONGC has adopted the Absolute Contraction Approach established by the Science Based Targets initiative (SBTi) to set its scope 1 and scope 2 emission reduction targets. For the fiscal year 2021-2022, baseline emissions have been meticulously calculated, revealing a total of 9.00 million tonnes of carbon dioxide equivalent (tCO2e) from operational activities. This includes 8.81 million tCO2e from Scope 1 emissions, with significant contributors being captive power generation (49%), gas flaring (14%), and fugitive emissions (4%). Scope 2 emissions amount to 0.19 million tCO2e, predominantly from grid electricity purchases, underscoring ONGC's commitment to recognizing indirect emissions from energy use. Additionally, the Scope 3 emissions are substantial at 24.30 million tCO2e (17.9 milliontCO2 eq. is attributable to processing of Sold products), bringing the grand total to 33.30 million tCO2e. This comprehensive breakdown of emission sources, including contributions from fuel combustion, diesel, and aviation turbine fuel (ATF), provides stakeholders with a detailed perspective on ONGC's environmental impact.

S No.	Particulars (Baseline FY 21-22)	(Million tCO2e)	
Operational emissions			
1	Scope 1 emissions (Million tCO2e)	8.81	
2	Scope 2 emissions (Million tCO2e)	0.19	
3	Total Emissions (Scope 1 + 2 in Million tCO2e)	9.00	
Supply Chain Emissions - (Baseline FY 21-22)			
4	Scope 3 emissions (Million tCO2e)	24.30	
5	Grand Total (Scope 1 + 2 + 3 in Million tCO2e)	33.30	
S No.	**Emission Sources (Scope 1)**	**(Million tCO2e)**	**%**
1	Captive Power Generation	4.40	49%
2	Gas Flaring	1.22	14%
3	Acid Gas Venting	0.54	6%
4	Fugitive	0.36	4%
5	Fuel Combustion- Heating and CHP	1.32	15%
6	Diesel	0.94	10%
7	ATF	0.02	0%
Emission Sources (Scope 2)			
8	Grid Electricity Purchase	0.19	2%
Total		**9.00**	**100 %**

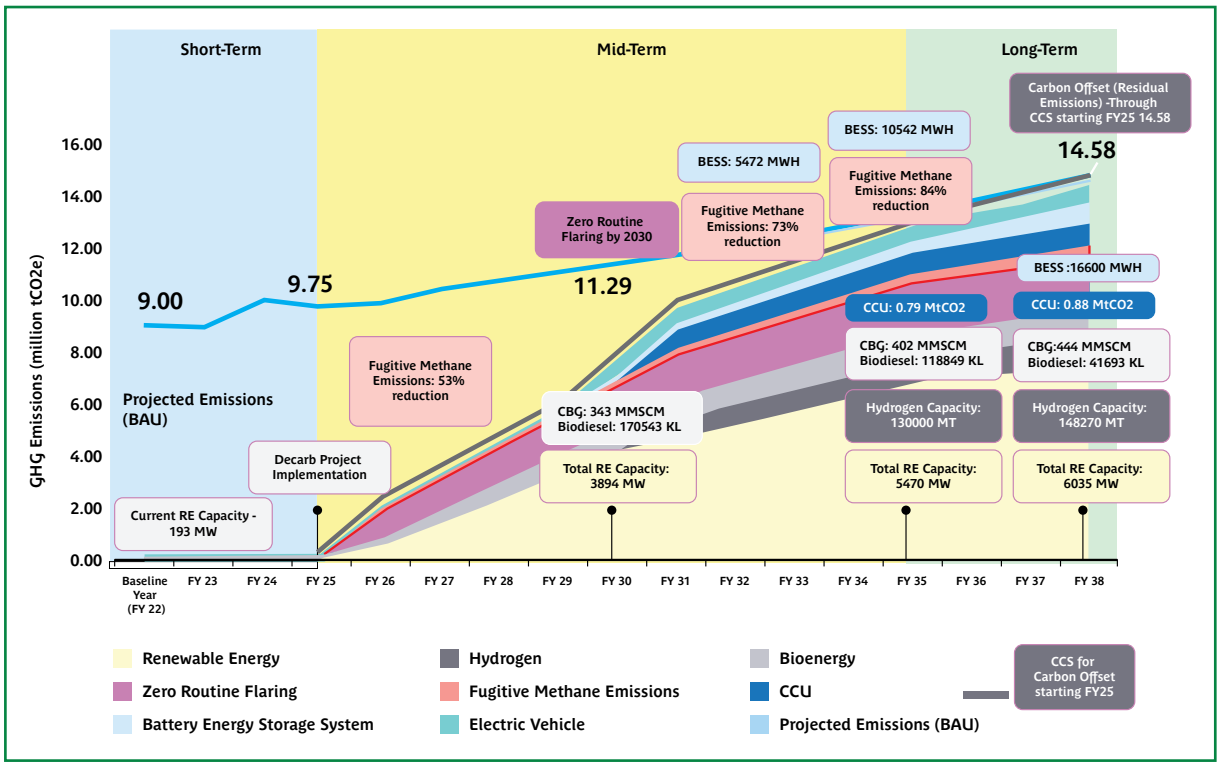
ONGC Operations Emissions

ONGC's greenhouse gas (GHG) emissions from its operations are categorized into three primary sectors: Plants, Offshore, and Onshore. Plants account for approximately 2.65 million tonnes of carbon dioxide equivalent (tCO2e), while Offshore operations are the largest contributors at 4.95 million tCO2e, and Onshore activities add 1.20 million tCO2e. This results in a combined total of 8.80 million tCO2e for Scope 1 emissions across these categories. Specifically, within these classifications, Plants contribute 1.77 million tCO2e (30%), Offshore operations contribute 4.96 million tCO2e (56%), and Onshore operations contribute 1.20 million tCO2e (14%). Additionally, emissions from Basin operations and Services account for 0.0002 million tCO2e and 0.87 million tCO2e, respectively. Scope 2 emissions, mainly from grid electricity purchases, add an additional 0.19 million tCO2e, highlighting ONGC's comprehensive approach to accounting for both direct and indirect emissions in its environmental footprint.

Classification	tCO2e
Plants	1.77 million tCO2e – 30%
Basin	0.0002 million tCO2e
Services	0.87 million tCO2e
Offshore	4.96 million tCO2e – 56%
Onshore	1.20 million tCO2e – 14%
Total	**8.81 million tCO2e**

Net-Zero Roadmap for ONGC

On the basis of baseline emission and anticipated business growth an emission profile has been developed which predicts that by 2038, business as usual emission of ONGC operations



will be 14.58 million tCO2e. Through a systematic deployment of various decarbonization measures, ONGC's pathway showcases a decline in emissions, affirming the pledge for net zero by 2038.

Key Initiatives Planned to Be Taken by ONGC

Renewable Energy as a De-carbonization Lever

ONGC is spearheading large-scale renewable hybrid energy projects with a combined capacity of 5,465.8 MW. These projects, which integrate both solar and wind energy, are expected to reduce emissions by 6.88 million tCO2e, significantly contributing to the company's sustainability goals.

Offshore Wind Project in Maharashtra

In addition to onshore initiatives, ONGC is developing offshore wind projects with a capacity of 720 MW. With a CAPEX of 69,912 million INR and OPEX of 577 million INR, this project will cut emissions by 0.85 million tCO2e, showcasing ONGC's commitment to harnessing the full potential of renewable energy sources.

Small Hydro Projects

ONGC is also investing in small hydro projects, which will add 156.1 MW of clean energy capacity and reduce emissions by 0.13 million tCO2e. These projects highlight the company's diverse approach to renewable energy generation.

State-specific initiatives in renewable energy underline ONGC's strategic approach. Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh, and Assam are key states where ONGC plans to significantly expand its renewable energy capacity, particularly focusing on hybrid solar and wind power, as well as small hydro projects. The total projected capacity across these states is 5,465.8 MW, with a combined CAPEX of approximately 556,203.4 million INR, OPEX of 5,689.36 million INR, and an overall emission reduction of 6.88 million tCO2e. This comprehensive plan is expected to generate substantial annual savings and achieve payback periods ranging from 8 to 12 years.

The deployment of renewable hybrid energy (combining solar and wind) is a key component of ONGC's strategy. This includes a blend of 30% solar and 70% wind capacity, ensuring round-the-clock energy availability and reducing dependency on fossil fuels. Offshore wind projects, particularly in Maharashtra and Andhra Pradesh, further bolster ONGC's renewable portfolio.

In Gujarat, ONGC is developing extensive solar and wind projects, with capacities of 268 MW and 1,247 MW respectively. These projects, with a combined CAPEX of 115,313 million INR and OPEX of 1,233 million INR, are expected to reduce emissions by 1.46 million tCO2e. These efforts demonstrate ONGC's strategic focus on leveraging India's renewable energy potential.

Land Requirements

Land requirements for these renewable energy installations are meticulously planned. For instance, Gujarat will require approximately 2,008 acres for its solar and wind projects combined. Similarly, Maharashtra will need around 8,299 acres for its extensive renewable hybrid and offshore wind projects.

Investment in Green Hydrogen and Carbon Capture

Carbon Capture Utilization and Storage (CCUS)

ONGC is advancing in the field of carbon capture, utilization, and storage with a capacity to sequester 2.21 million MT of CO2 emissions. This technology is vital for reducing the carbon intensity of industrial processes and achieving long-term sustainability targets.

Green Hydrogen Projects

The development of green hydrogen capacity is another cornerstone of ONGC's strategy. Collaboration with potential players, start-ups, and strategic investments will enable the establishment of green hydrogen projects, aimed at achieving a capacity of 0.15 million MT by FY 38, resulting in a significant reduction in emissions.

Additional De-carbonization Levers

ONGC is amplifying its commitment to reducing greenhouse gas emissions through a range of additional decarbonization strategies. The expansion of capacities for compressed biogas and biodiesel is a significant focus, aiming to harness these sustainable energy sources to substantially cut emissions. This initiative not only supports a cleaner environment but also promotes energy diversification.

Achieving zero routine flaring by FY 2030 is another critical objective. ONGC is implementing advanced technologies to capture and utilize flare gas, thereby minimizing waste and reducing the environmental footprint of its operations. This effort aligns with global best practices and reinforces ONGC's dedication to sustainable operations.

Reducing fugitive methane emissions is also a priority. By establishing robust monitoring systems, ONGC aims to detect and mitigate leaks, thereby preventing this potent greenhouse gas from entering the atmosphere. These systems are crucial for enhancing operational efficiency and achieving significant emission reductions.

Investing in Battery Energy Storage Systems (BESS) is essential to support the integration of renewable energy initiatives. ONGC is committed to building substantial BESS capacity to ensure a stable and reliable energy supply, even when renewable sources are intermittent. With a capacity of 1,300 MW, these systems will help reduce emissions by 1.02 million tCO2e, ensuring that renewable energy can be effectively integrated into the grid. This investment is pivotal for transitioning to a sustainable energy future.

The transition to electric vehicles (EVs) for logistics operations represents another key initiative. By replacing conventional fuel-powered vehicles with EVs, ONGC aims to further reduce its carbon footprint. This shift not only contributes to emission reductions but also supports the broader adoption of clean transportation technologies.

Compressed Biogas and Biodiesel

Expanding capacities for compressed biogas and biodiesel to 0.48 million MT will lead to an emission reduction of 0.48 million tCO2e. These initiatives not only support sustainable energy but also contribute to waste management and rural development.

Innovative Initiatives

ONGC has participated in the Clean Development Mechanism (CDM) to generate Certified Emissions Reductions (CERs). ONGC has already submitted application with UNFCCC for transition of 6 CDM projects under Article 6.4 of Paris Declaration, 2015.

ONGC also monitors the wastewater usage and maintains the quality of effluent discharged conforming to statutory requirements. Treatment and disposal of produced water from operations, produced water is re-used and recycled, wherever feasible. The Company has 41 number of Effluent Treatment Plants across work centres to treat approx. 104,000 m3/day of wastewater produced during E&P operations. Recently, ONGC Energy Centre in Collaboration with BARC has developed a technology for treating oil-contaminated effluent to Potable grade in Mehsana. The first phase of the geothermal project has begun in Puga, Ladakh but has faced challenges related to logistics and extreme temperatures. The second phase of this project entails drilling two wells, including a 1000-meter well, and installing a steam turbine with a capacity of 1 MW.

ONGC is also exploring the possibility of entering partnership with major players (Engie, Santos Energy Solutions etc.) in carbon neutral E-Methane production technology to offset emissions. By investing in renewable energy sources for hydrogen production and utilizing carbon capture technologies, ONGC can produce E-methane as a clean alternative to traditional natural gas. This shift positions ONGC as a leader in sustainable energy solutions, opening new markets and revenue streams. Moreover, the production of E-methane aligns with global decarbonization efforts, ensuring ONGC's resilience in an industry transitioning towards cleaner energy. Investing in E-methane technology allows ONGC to diversify its energy portfolio, reducing dependency on conventional fossil fuels. This strategic shift not only mitigates environmental impact but also future-proofs ONGC against evolving market trends and regulatory changes.

ONGC's comprehensive and ambitious strategy to achieve Net Zero emissions by 2038 demonstrates it dedication & commitment to environmental sustainability. By leveraging cutting-edge technologies, expanding renewable energy capacities, and investing in carbon capture and green hydrogen projects, ONGC is not only aligning with India's climate goals but is also setting a benchmark in the global energy sector. These initiatives highlight ONGC's pivotal role in driving the transition to a sustainable and resilient future.

NET ZERO 2040

2

Oil India Limited's Roadmap to achieve Net Zero

Ms. Swagata Baruah
Deputy Chief Engineer, OIL

Preamble

India's commitment to combat climate change is underscored by its ambitious pledge to achieve Net Zero emissions by 2070. This commitment includes interim targets such as a 45% reduction in the emissions intensity of GDP by 2030 from 2005 level and ensuring that 50% of its cumulative electric power capacity comes from non-fossil fuel sources. Recent global accords, including the COP 28 summit in Dubai, have emphasized the urgent need for decisive action, highlighting the critical transition away from fossil fuels to achieve net-zero emissions by 2050. This global shift necessitates significant investments in carbon reduction technologies, renewable energy capacity, and carbon capture initiatives.

OIL's Approach

Paving its way along with India's ambitious goal of reaching a non-fossil fuel energy capacity of 500 GW by 2030, OIL is also taking proactive stance to increase the share of non-fossil fuel-based energy to 12-15% in its portfolio by 2040. Being a CPSE engaged in the business of exploration, development and production of crude oil and natural gas, OIL is primarily dependent on fossil fuel. As such, OIL's journey to align with India's target to reduce CO2 emissions by 1 billion tons and reduction of Carbon intensity below 45% by 2030 will be challenging. Notwithstanding this, the organization is leveraging its resources with tailored strategies to embark into the journey to achieve Net Zero (emissions) target with alacrity by 2040.

OIL is on the cusp of major energy transition and in the process of incorporation of wholly owned subsidiary (WOS) company dedicated to managing Alternate energy business of the company. Some of the initiatives for clean energy pathways are detailed below:

Renewable Energy Portfolio: OIL is committed to deploying 5-5.5 gigawatts of renewable energy capacity by 2040, emphasizing wind, solar, and other sustainable energy sources.

- ***Installed Renewable Energy Capacity (188.1 MW)***

  OIL has manoeuvred into the domain of Wind and Solar energy in the years 2012 & 2014 respectively in the state of Rajasthan. OIL is also aligning with the 'One Sun-One World-One Grid' Initiative floated by the Prime Minister to harness tremendous potential of solar energy in India. The company has remained steadfast in its transition towards Renewables by successfully commissioning wind energy projects with a total capacity of 174.1 MW and solar energy projects with a capacity of 14 MW across different regions in India. Additionally, the company operates solar plants with a capacity of 0.906 MW for captive utilization.

- Furthermore, OIL's commitment extends to augmenting solar potential through the integration of rooftop solar plants in newly constructed buildings and captive plants dedicated to various processes.

- ***Collaboration with Assam Government (645) MW Solar Projects***

  OIL's collaboration with the Assam Government has yielded substantial progress in the renewable energy sector. OIL has established a JV "Green Power Limited" with APDCL for green energy projects with a combined capacity of 645 MW beginning with 25 MW solar project at Namrup, Assam adding more values in the tapestry of OIL's renewable energy portfolio. These projects signify a major step forward in utilizing Assam's abundant sunlight to generate clean energy and contribute to the state's sustainable development.

- ***Partnership with Himachal Pradesh State Government (150 MW Solar Project)***

  OIL's collaboration with the Himachal Pradesh State Government has been articulated to deliver a 150 MW solar project. This initiative demonstrates OIL's commitment to extend the reach of renewable energy infrastructure beyond company's conventional cocoon of operation, furthering our contributions to India's clean energy goals.

- ***Partnership with CPSEs***

  OIL has inked an MoU with NTPC to explore collaboration in the areas of Renewable energy, Green Hydrogen and its derivatives, Geothermal and other decarbonisation initiatives. The MoU shall facilitate knowledge and experience sharing on the upcoming Decarbonisation technologies like Carbon Sequestration.

Emphasis on Natural Gas

Recognizing Natural Gas as a cleaner energy source, OIL is also bolstering to explore new gas fields, enhancing the infrastructure, and becoming a fellow traveller in nation's journey to create a gas-based economy from current 6% to 15% by 2030. OIL is transcending the natural gas production from its current level of 3 BCM to 5BCM (67% increase) in two years for which pipeline facilities/infrastructure are under construction. OIL's natural gas production has reached all time high of 3.182 BCM during FY 2023-24 setting a benchmark in OIL's growth paradigm.

Biofuels

Aligning with the GOI's Millennium Development Goals (MDGs) of India turning Net Zero by 2070, OIL has also plunged into Biofuels along with subsidiary NRL and has commenced its journey towards widespread adoption of biofuels such as CBG (Compressed Biogas) and Bioethanol.

- ***Compressed Biogas (CBG) Plants***

  In support of the Government of India's mission to provide affordable and sustainable energy, OIL has been mandated to establish 25 CBG(2-5 Tonnes Per Day O/P capacity) Plants strategically located in diverse regions of India such as Himachal Pradesh, Assam, Odisha, Haryana, Sikkim, Meghalaya, Tripura, Arunachal Pradesh etc, guided by the Ministry of Petroleum & Natural Gas (MoP&NG) under SATAT scheme .This green initiative aims to convert waste into energy while addressing the increasing waste management challenges in towns and cities across the North-eastern region.

- ***Bioethanol Plant***

  To achieve its ambitious goal to produce bioethanol to the tune of 100-120 crore Liters per year, OIL's subsidiary NRL in collaboration with two other foreign investors viz M/s Fortum and M/s Chempolis, has formed the Joint Venture Company - "Assam Bio- refinery Private Limited (ABRPL)' which is setting up a second-generation bio-refinery at Numaligarh, Assam to produce ethanol from non-food grade feed stock bamboo. The 2G Bioethanol plant is at advanced stage of commissioning with expected ethanol production to commence from July 2024. The Bio-Refinery plant will produce around 50TMT Ethanol together with two platform chemicals viz. Furfural & Acetic Acid from 300TMT Bamboo (Bone dry) feedstock. Ethanol produced will be used to blend with Motor Spirit in line with GOI's aim of achieving 20% Ethanol Blending by the year 2025. The Bio refinery projects aims to reduce greenhouse gas emissions creating a Carbon sink with mass plantation of bamboo. 500 TMT raw bamboo will be sourced annually as feed for the Bio refinery which in turn is expected to improve household income of large number of rural households in the region. A component of the project is development of more than 35 small scale chipping units along with local level entrepreneurs for storage and chipping of bamboo, before being supplied at the refinery.

- One more pre-feasibility study for setting up a 2G Ethanol Bio-Refinery in Northeast is also in progress.

City Gas Distribution

Spanning over an expansive Geographical Areas (GAs) through 9 CGD Projects, OIL is also taking significant effort to promote responsible energy practices and addressing the rising demand for cleaner and more sustainable fuels through JVs as below.

- ***HPOIL (JV of HPCL and OIL)***

  Established CGD Networks in Ambala-Kurukshetra and Kolhapur and is under operation.

- Purba Bharati Gas Private Limited (PBGPL) (JV of AGCL, OIL and GAIL Gas) focusing on CGD network development in Kamrup-Kamrup Metropolitan Districts and Cachar, Hailakandi, and Karimganj Districts of Assam.

- ***Northeast Gas Distribution Company***

  JV with Assam Gas Company Ltd. for City Gas Distribution in FY 2022-23, encompassing 3 GA's. These GAs involve developing a CGD network in the North bank of Brahmaputra in Assam and in North Tripura & South Tripura in Tripura.

- In the 12th CGD bidding round, Consortium of OIL & BPCL has won the bid for Geographical areas (GA's) of Arunachal Pradesh, while HPOIL, has won the bid for GA's of Nagaland.

Green Hydrogen Initiatives

OIL is taking quintessential steps within a short span of time for driving a successful energy transition by establishing a 100kw pilot plant for Green Hydrogen which has the capacity of 30 kg per day at PS#3 Jorhat drawing its power from the 500KWp Solar plant. OIL has also taken a pioneering lead in green mobility and has developed a Hydrogen Fuel Cell e-Bus through its funded start-up initiative "SNEH" which was flagged off by Hon'ble Prime Minister of India during the India Energy Week 2023 in Bangalore. Its trial run was initiated in Jorhat in Assam in August '2023. OIL is also taking trailblazing initiatives in blending 2% Hydrogen with Natural gas and supplying it to Jorhat town through PNG network. The company has embarked on a journey to produce 20 TMT per annum (KTPA) of Green Hydrogen through its subsidiary NRL.

Moreover, feasibility studies for setting up a 1 MW capacity green hydrogen plant at Himachal Pradesh and for Green Hydrogen/Ammonia plant is in progress.

Zero Flare

OIL is strategically planning to be a zero-flare company by March 2025 by emphasizing on upgradation of the installations and pipeline networks.

Some of the key measures to support OIL's commitment to achieve Zero Flare in the operations are:

- In Arunachal Pradesh, Kumchai flaring has been reduced by commissioning of Kumchai (in Arunachal Pradesh)-Kusijan (in Assam) Pipeline to reduce flare of 0.05 MMSCMD.
- Construction of Nadua-Dikom pipeline reducing 0.02 MMSCMD flare and reducing 53 ton of Carbon emission.
- Commissioning of Lakwagaon gas evacuation pipeline for reducing 0.02 MMSCMD flare and reducing 53 ton of Carbon emission.
- Installing Makum compressor facility leading to a flare reduction of 0.06 MMSCMD with 158 Ton of Carbon emission reduction per day.
- Providing connectivity with AGCL pipeline in Mechaki area which will lead to a reduction of 0.01 MMSCMD flare with 26 ton of Carbon emission reduction per day.
- Further, installations/compressors at Baghjan, Hapjan, Bhekulajan, Bhogpara are lined up for flare reduction in the current Financial Year.

Geothermal Energy

Not restraining the business possibilities within the comfort nest, OIL has also collaborated with ISOR, Iceland Geo-survey, GSI, Center of Earth Sciences & Himalayan studies and National Centre for Seismology, IIT Bombay and Govt of HP for looking into the possibility of Geothermal energy in the probable geographical locations of North-East and Himachal Pradesh.

Carbon Capture Utilization and Storage (CCUS) initiatives

OIL's CCUS initiatives exemplify our dedication to reducing our carbon footprint while exploring innovative methods to enhance our production. The initiatives taken in this regard is detailed below:

- ***CCUS in Assam***

  Based on the initial study conducted in collaboration with the University of Houston, USA, OIL has paved the way for the planned implementation of CCUS technology in the Naharkatiya Field. The preliminary step of injecting water for Reservoir Pressure has been kickstarted and the next step of CO2 injection phase is scheduled to commence in September 2027 which will be a key component of OIL's CCUS strategy. This phase involves injecting captured carbon dioxide into the reservoir, facilitating resource recovery and simultaneously sequestering carbon emissions.

- ***Carbon Capture and Storage in Rajasthan Field***

  A prefeasibility study for establishing CO2 storage in saline aquifer of Jaisalmer basin of Rajasthan fields is also in progress which is a testament to OIL's approach towards curbing emission.

- OIL's afforestation efforts directly align with the GoI's mission to enhance India's green cover in the country. Under Project Vasundhara, OIL has planted 2,50,000 indigenous saplings across a total area of 100 hectares in Digboi, Assam focused on carbon sequestration and restoration of degraded forest land in the Upper Dihing Reserved Forest (west block) under Digboi Forest Division.
- Moreover, OIL has also successfully planted 78,000 saplings across eight abandoned well sites. This substantial initiative is estimated to sequester approximately 507 tons of CO2, further demonstrating our proactive approach to carbon reduction.
- Under Green Credit Program (GCP) of MoEF&CC, OIL intends to carryout voluntary plantation in 1250 Ha of land in Assam, Rajasthan, and Odisha cumulatively. Accordingly, OIL has registered land parcels in the GCP portal in 3 states thereby becoming the First OIL CPSE to do so and intends to facilitate increase of green cover in the country.

Conclusion

Contributing towards attaining the net zero emissions goal, an investment of INR 25,000 Crores by 2040 has been planned by taking a wide spectrum of initiatives which aims to reduce emissions. Embarking on a path intricately woven with Hon'ble PM's appeal to follow a sustainable lifestyle emphasising on the idea of making 'Lifestyle for Environment' (LiFE) a global mission through bolder steps by the global clean energy fraternity, OIL has launched "SEED" (Social, Environmental and Economic Development) to edify the human resources of the company to a culture of sustainability and responsibility within the organization. In the relentless pursuit to achieve Net zero-2040 echoes, OIL is resolutely pursuing comprehensive strategies making the journey as an evolving manuscript of endeavours.

NET ZERO

3 IndianOil's NET ZERO Commitment

Alternative Energy & Sustainable Development, IOCL

> *IndianOil has resolved to achieve Net-zero operational emissions by the year 2046. This will be a landmark year with India completing 99 years of independence and the celebration of its 100th Independence Day*
>
> - Chairman, IndianOil

Environmental and Energy Aspirations

India is leading the way in sustainability and environmental conservation with Mission LiFE (Lifestyle for Environment). This India-led global mass movement aims to inspire individual and community action to protect and preserve the environment. Earlier, during the 26th session of the United Nations Framework Convention on Climate Change (COP 26) in November 2021, India had also announced its target to achieve Net Zero by 2070. The country is clearly demonstrating its efforts to reduce import dependence and transition to cleaner, more affordable energy sources. As a Maharatna public sector enterprise in the energy sector, IndianOil too is dedicated to promoting sustainability and achieving Net Zero. The company supports the country's development by making energy affordable, accessible, and clean while fostering an inclusive, ecologically balanced, and prosperous world.

IndianOil aims to expand its influence by becoming a leading energy player in India, with a goal of increasing its share of the energy market from the current 9% to 12.5% by 2050. As a responsible oil major, IndianOil is pioneering innovative low-carbon energy solutions for all. As a first step, the corporation has also incorporated a wholly owned subsidiary "Terra Clean" on 31.5.2024 for its green ventures.

Pledging Towards Net Zero

IndianOil has committed to achieving net-zero operational emissions by the year 2046. As on 31st March 2024, IndianOil's standalone greenhouse gas emissions stand at approximately 22.7 million metric tonnes of carbon dioxide equivalent. With the planned brownfield/ greenfield

expansions necessitated to fulfill the growing oil demand, this would go up to ~40 MMTCO2e by 2030. IndianOil's mitigation strategy encompasses broad spectrum of levers, including Energy efficiency, cleaner/ greener fuels such as green hydrogen, biofuels, and renewables, nature-based solutions, Carbon Capture Utilization and Storage, Carbon markets etc. for which investment of ~ Rs 2.4 lakh crore would be required. IndianOil has already commenced the journey in right earnestness with ~ 4.5 MMTCO2e as emission avoidance/mitigation in 2023-24.

Decarbonization pathways adopted by IndianOil.

In its endeavour to decarbonize its operation and achieve Net Zero goals, IndianOil is exploring multiple pathways to mitigate carbon emissions and offsetting of any residual emissions, as enumerated below.

Energy Conservation (ENCON) initiatives

IndianOil is implementing a comprehensive range of measures to enhance efficiency, reduce emissions, and promote sustainability across its operations. By adopting advanced technologies and implementing best practices, IndianOil aims to maximize energy efficiency, thereby reducing fuel consumption and lowering emissions associated with heating processes. Various schemes such as use of residual heat in spent gases / steam, boiler furnace efficiency / electrification of heater, use of technology, loss minimization have been adopted to support energy conservation.

Natural Gas

Another significant aspect of IndianOil's pathways to Net Zero involves transitioning away from traditional fuel sources such as fuel oil, gas oil, and naphtha towards cleaner intermediate fuels like natural gas. Natural gas is not only a more environmentally friendly option but also offers greater efficiency and lower emissions, aligning with IndianOil's commitment to sustainability. IndianOil plans to triple its Natural Gas portfolio by 2030 and continue the journey of growth for which entire supply chain and sourcing is being strengthened.Maximizing renewable Grid Power

IndianOil is actively working towards maximizing the import of power through grid. By leveraging grid power, IndianOil is reducing its reliance on fossil fuels for electricity generation. All major Refineries of IndianOil have been connected to the grid. As the grid becomes greener, it would lead to lowering of carbon footprints and contributing to India's renewable energy goals.

Green Hydrogen

Green Hydrogen holds the potential to provide a clean and reliable source of energy that can be used in a wide range of applications, including the transport sector. Besides ensuring energy security to the nation, the environmental benefits of using hydrogen in a fuel cell vehicle could be significant.

IndianOil has collaborated with ReNew Power and L&T to venture into green hydrogen space in the country. The company has also signed a binding agreement with L&T to enhance domestic electrolyzer production capacity. The company is planning to set up a 10kTPA green hydrogen plant at Panipat. It is also working and conceptualizing capacities at other potential refinery locations for other such projects.

Towards advancing green hydrogen mobility in the country, IndianOil, in September 2023,

introduced green hydrogen fuel cell buses in Delhi, which are fueled by green hydrogen generated at its R&D center in Faridabad. IndianOil was incidentally the first corporation to set up a hydrogen fuel cell dispensing facility in Baroda, Gujarat. Presently, fifteen fuel cell buses are operational in the NCR and Gujarat region Collaborating with the Indian Army, IndianOil is delving into hydrogen mobility for defense transport as well. Furthermore, partnerships with Italy's Snam SpA are being explored to repurpose existing natural gas pipelines for hydrogen transportation, showcasing a commitment to sustainable energy solutions. IndianOil is also exploring multiple hydrogen production pathways, including solar electrolysis, biomass gasification and bio-methanation.

Hydrogen powered Fuel Cell Bus of IndianOil being showcased at the India Energy Week, 2024

Carbon Capture Utilization & Storage

Carbon capture, utilization, and storage (CCUS) is another important aspect of IndianOil's Pathways to Net Zero. IndianOil is actively engaged in the pursuit of Carbon Capture, Utilization, and Storage (CCUS) technologies through collaborative efforts. A 128 KLPD capacity 3G ethanol plant (using refinery off-gas to produce ethanol using Lanzatech technology) has been commissioned at Panipat Refinery. Two carbon capture plants of 460 kTPA capacity each from Mono Ethylene Glycol (MEG) units to Acetic Acid are being evaluated at petrochemical units at Panipat & Paradip.

Renewable Energy

In line with its commitment to renewable energy, IndianOil is investing in solar, wind, and other renewable energy projects to diversify its energy portfolio. IndianOil's current renewable energy capacity stands at approximately 249 MW, comprising 168 MW

5 MW Rawra Solar Power Project

21 MW Kutch Wind Power Project

from wind sources and 81 MW from solar installations. IndianOil aims to significantly increase this capacity by an additional 1 GW through its wholly owned subsidiary (WoS). IndianOil has formed a JV with NTPC to source 650 MW round-the-clock renewable-based power to meet the energy requirement for its refinery expansion projects.

As part of the net zero objectives, IndianOil plans to scale up and have a significant portfolio of renewables by 2046. As of date, IndianOil has successfully integrated solar power across 32,000+ retail outlets with cumulative installed capacity of 166.7 MW.

Compressed Biogas

In its endeavor towards promoting green and sustainable mobility solutions, IndianOil is playing pivotal role in enabling CBG plants across the country under the SATAT initiative. CBG produced from organic waste sources, offers a renewable and low-emission fuel option for transportation and other applications. Further to augment the CBG production capacity in the country, IndianOil has targeted setting up of 30 CBG plants through Joint Venture Companies (JVCs).

As of date, production from 32 CBG plants is being dispensed through 88 IndianOil retail outlets under the brand name of IndiGreen. Given the green credentials of CBG, Indian Oil also aims to explore CBG based hydrogen production as part of its Net Zero Plans.

CBG plant at Namakkal & Indigreen at retail outlet

Biofuels

The Ethanol Blended Petrol Programme (EBP) is aimed at addressing environmental concerns, reducing import dependency, and providing a boost to the agriculture sector. IndianOil has plans in place to step up and meet the Government of India's mandate for increasing ethanol blending to 20 per cent by 2025. IndianOil has started dispensing E-20 fuels from 4792 of its retail outlets. Further, E-100 standalone ethanol fuel has been introduced at 401 retail outlets.

IndianOil has established a 100 KL/day 2G ethanol production plant at Panipat (Haryana), utilizing paddy straw as feedstock. This plant is envisaged to play a pivotal role in North India's fight against stubble burning.

Bio-based, Sustainable Aviation Fuel (SAF) is seen as the most promising solution to decarbonize the hard to abate aviation sector. As part of this approach, the Company is collaborating with technology players like LanzaJet, and Praj for setting up Sustainable Aviation Fuel (SAF) plants in India.

Tree Plantation and Purchase of Carbon Credits

In addition to these initiatives, IndianOil is actively involved in tree plantation efforts/ ecosystem restoration to offset carbon emissions and promote biodiversity conservation. Furthermore, IndianOil is planning for the purchase of carbon credits, supporting projects that reduce greenhouse gas emissions and contribute to global climate change mitigation efforts.

Electric Mobility Solutions

Electric vehicle adoption is gathering momentum in India with the policy focus at both the center and the state levels. With the entry of global and domestic auto players, sales are picking up, especially in the two-wheeler segment. IndianOil has plans to provide electric mobility solutions through its vast network of retail outlets. The company has set up over 9,200 EV charging stations and 85 battery swapping stations to bolster electric mobility systems across the country. In the domain of battery technology, IndianOil has a joint venture 'IOC Phinergy Private Limited' (IOP) which is working on aluminium-air batteries—an upcoming battery technology which has the potential to revolutionize the space, especially in Indian conditions. IndianOil and Panasonic Energy are collaborating to form a joint venture for setting up advanced cell manufacturing for lithium-ion batteries, including battery subsystems. It also intends to explore the potential of establishing an ecosystem for the availability of critical minerals in India to explore suitable alliances in this domain.

Focusing on New age efficient fuels

IndianOil, serving millions of customers daily, acknowledges its pivotal role in meeting India's fuel demands. With energy consumption contributing significantly to global emissions,

IndianOil proactively offers greener, more efficient cleaner fuel/ products options like SERVO Raftaar, Xtra Tej, XP95, XP100, Xtragreen, and IndiGreen.

Leveraging in-house R&D's innovation and guidance in adopting new age technologies: Over the past years, R&D centre of IndianOil has made remarkable developments in pursuit of innovation, driven by a team of skilled professionals and the constant development and adoption of advanced technology. Research focused on fuels and lubricants, refining, petrochemicals, pipeline transportation technology and polymers, as well as emerging fields like Nano Tech, Solar, Bioenergy, Hydrogen, and Fuel Cell technologies. The second campus of the R&D Centre focusing on Alternate energy research is also slated to be commissioned. The R&D Centre also spearheads the Company's StartUp scheme which has seen incubation of start-ups. R&D has also been instrumental in offering higher efficiency solutions in refining & petrochemical processes, catalysts, and pipeline research.

Establishing leadership in environmental sustainability

As a leader in the energy sector, IndianOil views sustainable practices as vital for maintaining competitiveness and societal as well as business standing. Recognizing the need for business transformation, IndianOil is investing in employee training, technology exposure, and cross-functional team building to mobilize resources effectively towards achieving net zero emissions. IndianOil is building competencies and experience in environmental sustainability to sustain its leadership position amidst changing business landscapes.

Looking Forward

IndianOil's net zero ambitions knit together a wide range of technologies, stakeholders and ecosystems, which remain dynamic. Through its willingness to undertake a task of this magnitude, IndianOil is demonstrating its commitment to sustainability, environmental stewardship and social wellbeing. The company is sure that its efforts would play a vital role in energizing India's net-zero journey.

NET ZERO इंडियनऑयल

4 Achieving Net Zero: BPCL's pathbreaking roadmap

Shri G. Krishnakumar,
CMD, BPCL

Sustainability has become a pivotal topic in boardrooms across the oil and gas industry. The United Nations (UN) emphasizes the urgency of limiting global temperature increase to 1.5°C above pre-industrial levels to avert the most severe impacts of climate change. Currently, the Earth is approximately 1.1°C warmer than in the late 1800s, with emissions continuing to rise. The Paris Agreement, established in 2015, calls for a reduction in emissions by 45% by 2030 and reaching net zero by 2050 to maintain a livable planet. In this context, Net Zero concept continues to gain importance globally and it recognizes the economic and operational realities to allow for minimum viable emissions while aiming to reach as close to zero emissions as possible with remainder being re-absorbed from the atmosphere. Increasing focus is seen from tight regulations, increased shareholder and investor push on climate activism, and growing commitment amongst the wider audience at an individual as well as corporate level.

This global mandate has intensified the focus on net-zero commitments, necessitating significant transformations across industries, particularly in oil and gas due to its substantial carbon footprint. Oil and Gas players have a differentiated approach and intensity, based on geography (emerging vs developed markets), ownership (public vs private) and position in the value chain.

Globally Oil & Gas companies have announced net zero targets in line with the Paris Agreement by 2050. Oil & Gas majors such as BP, Shell, Equinor and Total Energies have set scope 1,2 and 3 absolute net zero targets by 2050, with strategies centered on transitioning from traditional fossil fuels to renewable energy sources. These companies are investing heavily in renewable energy projects such as wind, solar, and hydrogen, as well as in carbon capture and storage (CCS) technologies to mitigate emissions from ongoing oil and gas operations. E.g., Total Energies aims to produce approximately 400 GW of renewable energy capacity, and 500 TWh/year of energy storage by 2050. These companies are also enhancing energy efficiency within their processes, reducing methane leaks, and adopting digital technologies to optimize energy use and lower carbon footprints. Additionally, many are setting ambitious interim targets for emission reductions and engaging in carbon offset programs to balance out remaining emissions. Collaborations with governments, industry partners, and environmental organizations are also pivotal to their plans, ensuring a cohesive approach to tackling climate change and achieving sustainable energy transitions. E.g., Collaborations like the Northern Lights Project Longship, involving Shell, Equinor, and Total Energies with the support of the Norwegian government, are developing the world's first open-source CO2 transport and storage infrastructure, with a capacity of 1.5 MTPA CO2e per annum.

The Indian context is unique and needs to be seen from the perspective of its economic development. The growth in the Indian economy and the associated increase in the country's energy requirements will necessitate further investments in Oil and Gas & allied sectors in the foreseeable future. India is expected to be the single largest source of global oil demand growth until 2030, ahead of China. Underpinned by strong economic and demographic growth, the country is on track to post an increase in oil demand of almost 1.2 mb/d from 2023 to 2030. National Oil Companies are committed to support India's requirement to ensure energy security for its citizens and further the cause of affordability, accessibility and availability of energy, vital for the nation's growth.

Bharat Petroleum Corporation Limited (BPCL), a prominent leader in this industry, is committed to reducing its environmental impact by setting an ambitious target of achieving net-zero emissions by 2040 for its operations, well ahead of India's national goal of 2070. BPCL has developed a comprehensive roadmap to reach this objective. This article delves into BPCL's net-zero strategy, highlighting the key components and initiatives driving this monumental transition.

The cornerstone of BPCL's net-zero strategy is a comprehensive Emissions Baseline Analysis, adhering to the Greenhouse Gas (GHG) protocol's standards for establishing and disclosing emissions. By adopting the Intergovernmental Panel on Climate Change (IPCC) emission factors, BPCL ensures alignment with global best practices, providing a robust foundation for its emissions reduction efforts. This baseline analysis enables BPCL to accurately quantify its current emissions, facilitating effective tracking and management of progress. In the baseline year FY19-20, BPCL's emissions were approximately 10,300 TMT CO2e, with over 97% stemming from its refineries.

To enhance its emissions monitoring capabilities, BPCL has implemented a dynamic dashboard, an interactive tool offering real-time oversight of GHG emissions across BPCL's refineries and business units, providing a streamlined interface for emissions footprint analysis and historical trend evaluations. The dashboard empowers BPCL to make data-driven decisions and adjustments, ensuring the company remains on track to meet its net-zero targets.

Central to BPCL's roadmap are six critical Net-Zero Levers: renewable power (RE power), Green Hydrogen (Green H2), Bio-Compressed Natural Gas (Bio-CNG), Carbon Capture, Utilization, and Storage (CCUS), efficiency improvement, and offsets procurement. These levers represent a multifaceted approach to reducing emissions and promoting sustainability.

Efficiency

Efficiency improvements in refineries involve initiatives that reduce energy consumption while maintaining or enhancing productivity. These include enhancing furnace efficiency, managing steam traps to minimize steam loss, and implementing waste heat recovery systems. These measures are expected to contribute approximately 10% of total emissions abatement for refineries, assuming successful implementation and realization of the Energy Intensity Index (EII) as per the Solomon index. Marketing BUs will also see emissions reductions through structural changes like end-of-life replacement of pumps and machinery, and operational changes such as installing occupancy sensors and reducing power usage in non-operational areas.

Renewable Energy

Replacing brown power procurement from the grid and captive power plants with renewable energy (RE) is expected to contribute around 25% of total emissions abatement. Renewable energy is also essential for other abatement levers such as electric boilers, green hydrogen, and CCUS, all of which have significant electricity requirements. For refineries, an Inter-State Transmission System (ISTS) hybrid solution with 1.3 MW solar and 2.2 MW wind capacity per MW of power requirement has been devised to achieve 80-85% capacity utilization.

Green Hydrogen

Green Hydrogen, produced through the electrolysis of water using renewable electricity, has been devised to replace existing steam reforming units (SMR) in Mumbai and Bina refineries. This is expected to contribute around 15% of total emissions abatement. Necessary electrolyser or biomass-based hydrogen facilities will be set up in all three refineries to meet this target. Excess hydrogen produced during peak power availability can be stored for later use.

Solar Plant At Anik Nala Mumbai

Wind Power Plant in Hanumantappa

Bio-CNG

Bio-CNG, derived from biogenic feedstocks like agricultural residue and municipal solid waste, has been developed as a replacement for fuel oil and natural gas used across refineries and diesel in generators at marketing locations in tier-1 cities. Bio-CNG is expected to comprise approximately 30% of the total abatement pathway. BPCL plans to establish mid-sized plants to abate emissions, aiming to inject Bio-CNG annually into the City Gas Distribution (CGD) network by 2040. Advocacy for policy reforms and economic incentives are crucial for achieving the required scale.

CCUS

CCUS technologies will capture, transport, utilize, and store CO2 emissions, targeting hard-to-abate emissions from hydrocarbons generated as by-products within refineries or from steam reforming units (blue hydrogen). CCUS is expected to contribute around 25% of total emissions abatement. The cost of carbon capture varies based on CO2 concentration in refinery streams, with utilization options including storage, enhanced oil recovery, and urea manufacture being prioritized based on market attractiveness and technical feasibility.

2G Bio-Ethanol Refinery Project at District Bargarh, Odisha

Offsets

Carbon offsets, which reduce or remove CO2/GHG emissions to compensate for emissions generated elsewhere, will mitigate hard-to-abate last-mile emissions. BPCL can procure offsets from Indian registries or generate them through projects such as afforestation, renewable energy, community initiatives, and waste-to-energy programs. The decision to generate versus procure offsets will depend on operational challenges and the evolution of carbon markets.

Emissions from refineries can be broadly divided into three major areas – Power & Steam procurement / generation, Hydrogen procurement / generation and Processing units within refineries that burn fuel for heating. The emission profile of refineries across these three sources varies significantly based on refinery configuration, fuel type and processes. Taking into consideration these refinery specific nuances, tailored solutions have been devised for emission abatement of each refinery. Abatement of emissions from power procured / generated through grid / CPP has been devised through replacement with Renewable energy along with

Alkaline Electrolyser Green Hydrogen Stall at IEW developed by BPCL in Collaboration with BARC

deployment of power storage solutions and purchase of RECs (Renewable Energy Certificates) in the long term. Emissions from Steam Methane Reformer (SMR) can be abated through adoption of Green or Blue Hydrogen. Green Hydrogen refers to Electrolyzer-based generation of Hydrogen powered through renewable energy. Blue Hydrogen refers to deployment of CCUS on existing SMR set-up for capture and abatement of emissions. Further, refineries burn multiple fuels (FO, LNG, FG, Coke etc.) across furnaces for heating applications. Replacement of FO and LNG consumed with Bio-CNG and CCUS deployment are key abatement levers. Based on technology advancement, deployment of electric furnace is also planned.

Emissions for marketing Business units are largely from electricity procurement from the grid and abatement of these emissions shall be done through replacement with renewable energy and purchase of RECs. Further, efficiency measures such as replacement of outdated and less efficient machinery and installation of occupancy sensors shall be undertaken.

Achieving BPCL's net-zero ambition will require significant capital expenditure totaling to over INR 100,000 Crores. To ensure cost-effectiveness, BPCL has conducted a detailed business case assessment across initiatives, creating a Marginal Abatement Cost Curve (MACC). This provides a consolidated view of all potential levers for emissions abatement, indicating the materiality of each lever in emissions abatement and the associated cost of abatement, measured in $/tCO2e.

Going forward, BPCL is undertaking detailed feasibility studies and creating project charters for each initiative devised as part of the Net Zero study. Detailed roadmap is created for each of the initiatives. These roadmaps outline well-defined steps for next 2-3 years.

BPCL is already putting into effect replacement of brown grid power with green power, detailed efficiency improvement studies, strategic studies and pilots on Renewable Energy projects, green hydrogen generation and advocacy agenda on Bio CNG. BPCL has also created a Renewable Business Unit as Organization structure modification to initiate implementable levers like (RE, CCUS, Green Hydrogen etc.), governance model in order to review and track progress, build internal processes to incentivize net zero outcomes and capability building programs etc. (personnel, digital tools, market intelligence, technology mapping)

Bharat Petroleum Corporation Limited stands at the forefront of the oil and gas industry's efforts to combat climate change. By focusing on renewable energy, green technologies, and efficiency improvements, BPCL's strategy exemplifies a proactive and responsible approach to sustainability. As the company continues to implement its net-zero levers and track its progress, it serves to create a compelling model in the sector in the global fight against climate change. The journey towards net zero is complex and capital-intensive, however, BPCL's strategic initiatives and planning demonstrates its leadership in the oil and gas industry's transition to a sustainable future.

NET ZERO 2040

5 HPCL's plans for Net Zero

Energy Transition Department,HPCL

Net-Zero – A global perspective

Net zero is a state where the amount of greenhouse gases (GHGs) released into the earth's atmosphere is balanced by the amount of GHGs removed. These emissions are the primary cause of global warming resulting in temperature rise and natural calamities.

To holistically and urgently tackle global warming and its impact, the United Nations (UN) in 2015 introduced the Paris Agreement, a legally binding international treaty on climate change. As per the agreement, the goal is to limit the increase in the rise of temperature to 2 degrees Celsius while pursuing efforts to limit the increase even further to 1.5 degrees Celsius by the year 2100.

To limit the global warming to 1.5°C above preindustrial levels, limiting the generation of greenhouse gases will be necessary to prevent permanent warming of the planet and the catastrophic consequences. Those efforts are referred to as decarbonization.

Many countries through their governments and business organizations have pledged to decarbonize, or to make the net-zero transition, in the coming years. Power, oil and gas, and transport industries are frequently cited as the biggest emitters, but all industries need to work towards decarbonization to achieve net zero. Decarbonization efforts are needed to reach net zero.

Net-Zero – Indian perspective

India is the world's third-largest consumer of oil as well as emitter of CO2. Still India's per-capita energy consumption is only a third of the global average and is expected to grow at 2.7% till 2050 as compared to World's average of 0.6%. India's economy saw rapid growth in 2023, expanding by 6.7%. India being an emerging economy, Greenhouse Gas emissions are set to increase, albeit from a low base, in pursuit of its development and poverty eradication goals. Hence, it is critical that India takes steps to combat global warming while taking care of aspirations of its citizens.

India has also submitted its Intended Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015 and updated in the year 2022. At COP 26 held in Glasgow, U.K in 2022, India presented the five nectar elements (Panchamrit) of India's climate action. One of the elements is achieving net zero emission target by the year 2070.

HPCL and its Net-Zero journey

HPCL is a Central Public Sector Undertaking, having diversified business interests in the entire hydrocarbon value chain from refining to marketing, alternative energy sources such as Solar, Wind, Biofuels including Bio-Ethanol, Bio-Diesel, Compressed Bio Gas (CBG), Green Hydrogen with state-of-the-art technologies and cutting-edge R&D. In line with the country's Net-Zero ambition, HPCL is also committed to reduce its carbon footprint. Various initiatives are being undertaken in that direction. HPCL has undertaken the following measures and developed an action plan for reaching its Net-Zero by 2040 for Scope 1 and 2 emissions:

Development of a roadmap

HPCL has completed its Environmental Strategy with the help of renowned consultant. HPCL is the first OMC to engage this consultant to develop the strategy, roadmap & implementation plan. This roadmap has a strong focus on transitioning towards a multi-energy green and low carbon Corporation. HPCL, through its customer-oriented approach, is also committed to provide accessible and affordable clean energy to its customers.

To accelerate its energy transformation journey HPCL has incorporated a wholly owned subsidiary HPCL Renewable & Green Energy (HPRGE) Limited consolidating all green and emerging business opportunities under one umbrella. The subsidiary has commenced supply of renewable energy. HPCL has also set up 'Energy Transition Cell', which acts as a think tank on various energy transition pathways and provides inputs on policy matters to various stake holders.

Key levers for attaining Net Zero in HPCL

HPCL has identified following key levers for achieving net zero by 2040 under Scope 1 and 2

- Use of renewable power in refineries and other operating locations

- Replacing hydrogen with green hydrogen at refineries
- Enhancing energy efficiencies in its own operations at refineries and other operating locations
- Fuel substitution with biogas.
- Abatement with carbon capture, utilization and storage.

Significant achievements

HPCL is seizing green and emerging opportunities by expanding footprints in advanced/ alternative fuels. For expanding footprints in biofuels, various biofuels projects are under execution by HPCL. Expansion in renewables is being done for switching over to renewable power at refineries and marketing locations.

Following are the key achievements

- The first electrolyser in a refinery in India having a production capacity 370 TPA (2.6 MW) has been set up at Visakh Refinery which is under final stages of commissioning after successful trial. HPCL is planning to source Green Hydrogen to the extent of 50 MW (7 KTPA) by 2026-27. This will be further scaled up reach to a capacity of 200 MW (29KTPA) by 2030 which is approximately 10% of total hydrogen requirement of HPCL's refineries. These will pave way for complete switchover to green hydrogen for its captive requirement by 2040. These quantities may be revised under SIGHT-2B allocation.
- HPCL has put up various Captive Solar Projects across SBUs totaling 97 MW, in addition to 100 MW of Wind Energy Portfolio. HPCL is also in process of setting up more projects including a Mega Solar Project of 100 MW in Andhra Pradesh and for Mumbai Refinery Greening. Plans are in place for further capacity enhancement in the current year. HPCL is planning for 10 GW RE portfolio by 2030.

Following initiatives will fall under Scope 3 emission reduction over and above Scope 1 and 2.

- In the Electric Vehicle (EV) ecosystem, battery swapping and energy storage solutions, are being explored in collaboration with various technology start-ups and OEMs. The vast network of over 22,000 retail outlets of HPCL is being leveraged while foraying into emerging opportunities. Electric Vehicle (EV) charging facilities are available at more than 3,600 retail outlets of HPCL as of May 2024.
- Solarization of over 80% of the retail outlets have been completed.
- In consonance with its long-term vision to reduce carbon intensity of its products, HPCL has increased its Ethanol blending ratio to 15.02 % as of May 2024.
- HPCL is also actively participating in the Government of India's SATAT (Sustainable Alternative Towards Affordable Transportation) initiative for the promotion of Compressed Bio Gas (CBG) and so far, 9 Biogas plants have been commissioned. In addition, there are 109 active Letter of Intents (LOIs) for the setting up CBG plants with a total plant capacity of 227.6 TMTPA.
- HPCL has commissioned a compressed biogas plant (CBG) with a 100 TPD biomass processing capacity at Budaun, UP.
- A cow dung based CBG plant having capacity of 1.6 TPD CBG at Pathmeda, Rajasthan, has been commissioned.
- HPCL is constructing a second-generation ethanol biorefinery at Bathinda, Punjab, with a production capacity of 100 kiloliters per day of ethanol from biomass.
- There are plans for additional Ethanol/CBG plants to expand the capacities further.

CBG plants over a period of time will be scaled up to replace natural gas requirement at the refineries, thereby reducing Scope 1 emissions.

Role of R&D in Net-Zero

HPCL has developed HP Green Research & Development Centre (HPGRDC) in Bengaluru with state-of-the-art infrastructure facilities, comprising energy-efficient green buildings with a built-up area of about 6 lakh square feet on a sprawling campus of 104 acres. The strength of HPGRDC is being leveraged to provide advanced technical support to various strategic business units and for the conceptualization, development and commercialization of products and technologies in emerging areas.

HPGRDC has developed inhouse technologies related to net zero. Examples are technologies for the production of Ethanol (HP-ASAP), production of Compressed Bio Gas (HP-RAMP), Sustainable Aviation Fuel (HP-Trijet), producing hydrogen enriched CNG (H-CNG) technology without emission of CO2 and requirement of any water (H-CNG) and Carbon Capture (HP-HiGas) which are at different stages of pilot and commercial implementation. HPGRDC has developed and commercialized H2PSA technology along with Adsorbents and Programmable Logic Controller (PLC).

Research in area of battery and electrolyzer technology (for producing green hydrogen) is also taken up. HPGRDC has successfully commissioned India's first Solid Oxide based Electrolyser (SOE) for Green H2 Generation in May 2024. This highly efficient pilot-scale electrolyzer can generate Green Hydrogen with 99.99% purity and marks a significant step in evaluating this technology for generation of hydrogen and its derivatives. Catalysts have been developed for synthesis of DME, methanol, etc. from Carbon Dioxide.

HPGRDC is an IGBC Platinum rated facility. The Administration Block of the R&D Centre facility which is approx. 60,000 sqft has been awarded with Net Zero energy rating which showcases HPCL R&D's continuous efforts towards sustainable research and development. The center has a 2330 kW capacity solar PV to reduce demand on conventional energy. Ten Vertical Axis Wind Turbines of capacity 1 kW each have been commissioned in the center. Biodiesel is

being used in generators. HPGRDC has also installed Electrolysers which produce Hydrogen through solar power. The green Hydrogen produced from this unit is utilized for the operation of R&D pilot plants.

The R&D center is recognized by Department of Scientific and Industrial Research (DSIR) and has collaborations with international institutes, technology and energy companies to collaborate in various fields including those related to Net-Zero. These include sea water electrolysis, photo catalytic reduction of CO2 to methanol, development of sodium/sulfur battery, anode less battery, electrolyte catalytic hydrodeoxygenation of bio-oil produced from co-pyrolysis of agricultural residue and plastic waste.

Competency & skill development for Net-Zero

As a part of Capability Building to meet Net-Zero challenges, HPCL is sensitizing its workforce on challenges and mitigation measures related to Net-Zero. It has developed training modules tailored for different levels of its workforce. It also includes participation of workforce in various related national and international seminars and workshops. As a part of the development of Environmental Strategy, extensive training was provided to the employees on Climate and Sustainability in Business. Construction, commissioning and operation of various new green-energy plants are helping the workforce to get on-the-job experience and making them future ready for HPCL to expand its green footprints while striving for achieving its Net-Zero commitments.

Net Zero – the road ahead

India needs a balanced and orderly energy transition from fossil to renewable fuels while maintaining energy security, sustainability and affordability for its citizens. Energy companies play a pivotal role in nation-building due to their fundamental contribution to economic development, social progress, energy security, energy affordability and environmental sustainability. HPCL as an integrated energy company is committed to a balanced and orderly energy transition by offering clean, green and differentiated products and services while adopting environmental and social stewardship in its businesses and supply chains

NET ZERO HP

NET ZERO 2035

6 NET ZERO ROADMAP OF GAIL

Shri Sameer Virmani,
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Shri Vikash Kumar,
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Abstract

India is undergoing a significant energy transition, aiming to increase the share of natural gas in its primary energy mix from 6.7% to 15% by the year 2030. This shift is crucial for enhancing energy security and supporting the country's commitment to achieving Net Zero emissions. As a leading player in the natural gas sector, GAIL (India) Limited is at the forefront of this transition, playing a pivotal role in the development of India's Natural Gas Grid (NGG). The concept of Net Zero involves balancing greenhouse gas emissions with their removal from the atmosphere. GAIL has undertaken an ambitious target for 100% reduction in Scope 1 and 2 emissions by 2035 and a 35% reduction in Scope 3 emissions by 2040.

To achieve these targets, GAIL has outlined a strategic roadmap divided into multiple phases. The roadmap emphasizes the importance of new projects being 'Net Zero by Design,' ensuring that future expansions do not increase baseline emissions. The decarbonization pathway includes several abatement levers such as electrification of equipment, adoption of renewable energy, development of green hydrogen, implementation of CBG, CO2 valorization, and Battery Energy Storage Systems (BESS). Additional strategies include energy efficiency improvements, afforestation and offsetting.

While the journey towards Net Zero is fraught with challenges, GAIL's commitment to low carbon future and achieving sustainability is unwavering. The company's strategic initiatives, combined with necessary policy support and stakeholder collaboration, underscore

its determination to become a Net Zero organization by 2040. This roadmap not only supports India's climate goals but also sets a precedent for other players in the energy sector to follow.

Introduction

India, being a new energy economy is under an energy transition. The government aims to increase natural gas share from 6.7% to 15% in primary energy mix by the next decade. This would mean, that gas demand would get more than tripled to reach 500 MMSCMD by 2035. Increased usage of Natural gas being a cleaner fuel, will also help India in its commitment to Net zero. The Government recognizes the need to augment the natural gas transmission infrastructure in the country and has been driving the development of natural gas pipelines connecting all regions of the country which is shaping-up into Natural Gas Grid (NGG).

GAIL (India) Limited is India's leading Natural Gas (NG) company with diversified interests across the NG value chain of Marketing, Transmission & Distribution, LPG production & transmission, LNG re-gasification, Petrochemicals, City Gas Distribution (CGD), E&P, Renewable Energy etc. GAIL is furthering the Government's vision of low-carbon energy access and security at the pan-India level in the form of natural gas and is operating around 16,240 km of natural gas pipeline spread across the country. GAIL is also working on execution of multiple pipeline projects to further expand the National Gas Grid. This shall help to cater to India's increased gas demand.

Natural Gas is a cleaner fuel vis-a-vis other fossil fuels and therefore results in lower GHG emissions. Nevertheless, the Transportation and Processing of Natural Gas requires consumption of a part of it as fuel which results in CO2 emissions.

Understanding Net Zero

Net zero refers to the balance between the amount of greenhouse gas emissions produced and the amount removed from the atmosphere. Achieving net zero emissions is crucial in mitigating the devastating effects of climate change and transitioning to a sustainable future.

Study of Greenhouse gas (GHG) emission under different scopes and categories is essential for understanding and categorizing the sources of emissions contributing to climate change and companies' carbon footprint.

Scope-1

Emissions are direct Green House Gas (GHG) emissions that occur from sources which are directly owned and/or controlled by GAIL. These include fuel combustion in boilers, furnaces and other equipment installed at GAIL's plants.

Scope-2

Emissions are indirect GHG emissions associated with the purchase of electricity (generated from non-renewable sources) for use at the facilities of GAIL. While these emissions occur at the generation source, they are accounted in the organization's GHG inventory because they are a result of energy use for plant-related operations.

Scope-3

Emissions arise from assets not directly owned or controlled by GAIL but are part of our value chain. Emissions from upstream and downstream value chain from GAIL's activity are included within its ambit.

Being a responsible energy company and to further accelerate our decarbonization goals, GAIL developed a science-based Net-Zero action plan in FY 2022-23 to achieve 100% reduction in Scope 1 and Scope 2 emissions and 35% reduction in Scope 3 emissions by 2040. Recently during FY 2024-25, GAIL has advanced its Net Zero target and aims for 100% reduction in Scope-1 & 2 emissions by 2035 itself.

Strategic Roadmap to Achieve Net Zero

Projected Emission Scenario

For estimation of projected emissions, an analysis of the baseline emissions was required. This has been conducted based on the maximum of emissions observed in the last 03 years. In addition to these baseline numbers, projects planned by GAIL to be commissioned in the coming years were also mapped.

The projections for Scope-1 & 2 were divided into three scenarios as detailed below:

- In the **Business-as-usual (BAU) Scenario**, projections have been made considering no interventions by GAIL to curb Scope-1 & 2 emissions.
- In the **Avoidance Scenario**, it is considered that the new Expansion Projects should preferably be "Net Zero by Design" so that the Baseline emission do not increase further. This 'Avoidance Scenario' shall help to limit the emission to a large extent.
- In the **Net Zero Scenario**, which is the desired scenario, the impact of all the decarbonization levers in emission reduction have been accounted to reflect a gradual reduction in emissions to "Zero".

GAIL Decarbonisation Pathway

As a first step towards achieving Net Zero target, GAIL has decided that all the new Projects to be implemented in future, shall be 'Net Zero by Design'. This shall help to substantially reduce the overall emissions. Further, to achieve the Net Zero Targets, GAIL has identified the following Abatement Levers:

- Electrification of existing NG based equipment
- Renewable Energy (RE)
- Green Hydrogen
- Compressed Bio Gas (CBG)
- Battery Energy Storage System (BESS)
- CO2 Valorization - Direct Sale and Value-added Products
- Energy Efficiency Improvement
- Afforestation
- Offsetting

The specific Projects under these Abatement Levers were identified and deliberated in detail. It emerged that most of the Projects can be carried out concurrently at different sites. Therefore,

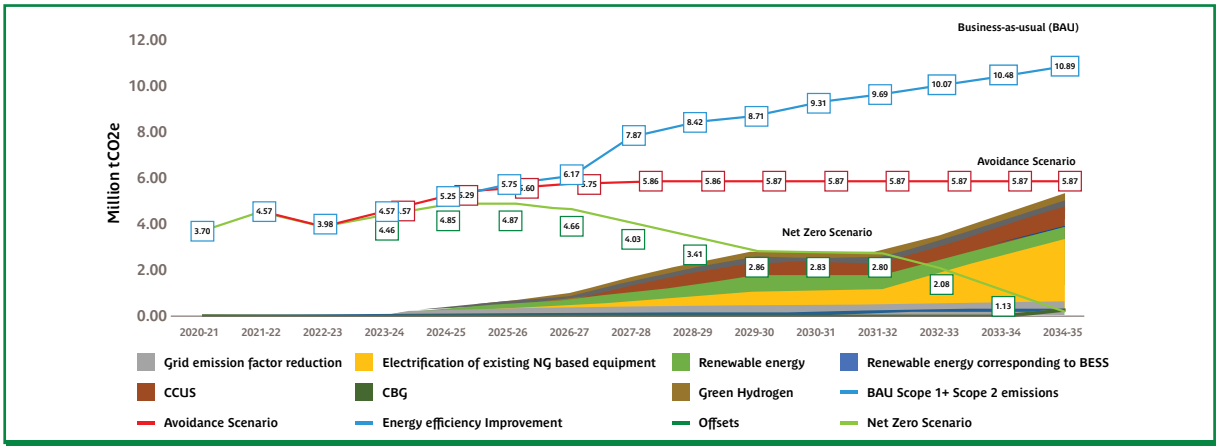


Figure: Decarbonization Pathway (Scope-1 & 2)

it was realized that the Net Zero target for achieving 100% reduction in Scope- 1 & 2 emissions can be further advanced to 2035.

Accordingly, the contribution of different Decarbonisation Levers to achieve Net Zero for Scope-1 & 2 is depicted as below:

Implementation Roadmap

The roadmap for implementing the Net Zero projects has been divided into 4 phases as given below:

SN	Phase	Timeline	Emission Category	Abatement levers considered
1	Phase-1	FY2024-25 to FY2027-28	Scope-1 & 2	Electrification of Pipeline Compressor Drives, RE, CO2 Valorization - Direct Sale, CBG, Green H2, Energy Efficiency Projects, Afforestation.
2	Phase-2	FY 2028-29 to FY 2031-32	Scope-1 & 2	Electrification of Pipeline Compressor Drives, RE, CO2 Valorization - Direct Sale, CBG, Green H2, Energy Efficiency Projects, Afforestation.
3	Phase-3	FY 2032-33 to FY 2034-35	Scope-1 & 2	Electrification of Process Plants machines, RE, BESS, CO2 Valorization – Value added Products, Energy Efficiency Projects, Afforestation.
4	Phase-4	FY 2035-36 to FY 2039-40	Scope-3	RE, BESS, Green Hydrogen, CBG, CO2 Valorization-Value added Products.

Challenges on the Road to Net Zero

- ### *Technological Limitations*

  The development and deployment of new technologies like CCUS and green hydrogen production are still in their nascent stages and require significant investment and innovation.

- ### *Financial Constraints*

  Transitioning to a Net Zero framework necessitates substantial capital expenditure. Balancing profitability with sustainability goals can be challenging.

- ### *Regulatory and Policy Environment*

  Navigating the complex regulatory landscape and ensuring compliance with both national and international environmental standards can be demanding.

- ### *Supply Chain Transformation*

  Decarbonizing the entire supply chain, from extraction to distribution, requires coordinated efforts and collaboration with suppliers and contractors.

7 Powering a new era of Sustainability in India's Energy Sector

Nayara Energy Limited

Energising the aspirations of a developing nation are inherently linked to the development of its, infrastructure and skill-building. One cannot ignore the role of energy sector that is crucial towards fulfilling the dreams of a nation and its people. India, as one of the world's fastest-growing major economies, has been heavily reliant on fossil fuels to drive its growth. This dependence has made the country a major contributor to global greenhouse gas emissions. While demand for refined petroleum products in India is expected to grow in the coming decades, fuelled by economic growth which in turn is driven by increasing urbanization, industrialization, and population growth. This rising demand presents a paradox for refineries: who are cognizant of the fact that there is a need to reduce emissions, while meeting production of domestic energy needs.

Embracing sustainability is indeed the need of the hour thereby ushering a transformative shift to minimise the impact on climate change. The Indian oil and gas industry is at the cusp of a generational shift towards achieving net-zero emissions. The industry has been a cornerstone of the nation's economic development. India is the

world's third-largest consumer of oil, and its refineries have traditionally operated on a model that prioritizes efficiency and output with significant carbon footprints being an inevitable byproduct of refining processes.

India's Sustainability goals and Evolving Supporting Regulations

The shift towards sustainability in the Indian oil sector began gaining momentum in the early 21st century, driven by international climate commitments, such as the Paris Agreement, and domestic policy initiatives aimed at reducing emissions. The government's push for cleaner energy, coupled with rising environmental consciousness among the public and stakeholders, has set the stage for a green transformation within the industry. India's regulations are also evolving to support and achieve the sustainability goals.

- Some of these regulations, some of which are in draft stage, drive decarbonization, clean energy adoption within the country and aim to educate and change consumer behaviour. For example, as we go forward, Perform, Achieve and Trade (PAT) and Renewable Purchase Obligations (RPO) will likely be subsumed into Principal scheme Carbon Credit Trading Scheme - CCTS which will have yearly GHG emission intensity reduction targets in place of specific energy targets.
- Another key regulation which is expected to significantly drive decarbonization is the Green Hydrogen Consumption obligation.
- Government has also issued mandate for bio-fuel usage. For example, currently, 5% of the power generation is required to be done by bio-mass co-firing. Additionally, there is a mandate to achieve 20% ethanol blending in Motor Spirit by 2025 – a target which was advanced by 5 years.

Nayara Energy Overview

Nayara Energy is a new-age downstream energy and petrochemicals company with a formidable presence spanning across the entire hydrocarbon value chain, from Refining to Retail. At the heart of its operations lies the Vadinar refinery in Gujarat, India's second-largest single-site refinery with a capacity of 20MMTPA. With over 6,500 Retail Outlets, Nayara Energy caters to the need for reliable and safe mobility across the length and breadth of the country. It is also in the process of commissioning a 450 KTPA polypropylene project as part of its maiden into petrochemicals journey. As a testament to India's broader climate ambitions, Nayara Energy has also prepared its sustainability roadmap as path towards reducing its carbon footprint. The core objective of the company is to serve the Indian customer with affordable, secure and sustainable energy.

Headwinds in the Decarbonization Journey

- Nayara Energy's intensity is structurally influenced by the coal-based captive power plant, which contributes significantly to scope 1 and combustion emissions. In view of its higher Nelson Complexity Index, Nayara Energy is neither leading nor lagging as compared to its peers with similar complexity across the region.
- ***Technological Constraints***

  Existing technologies are primarily designed for efficiency rather than controlled emissions, necessitating substantial upgrades.

- ***Financial Investment***

  Transitioning to greener technologies requires substantial capital investment, posing a financial challenge. Furthermore, even today many of the greener technologies are not economically viable.

- ***Evolving Regulatory Landscape***

  Government of India has introduced various schemes for different sectors including the Green Hydrogen Mission, PAT Scheme, mandatory EBMS, biodiesel etc. However, in many cases, the technology is not mature enough or not commercially viable, to address the energy trilemma of affordability, availability and sustainability.

Nayara Energy's Strategic Decarbonization Roadmap

Nayara Energy has developed a comprehensive roadmap outlining key strategies and milestones to achieve reduction in its carbon Intensity footprint. The approach is multi-faceted, focusing on operational efficiency, renewable energy integration, Bioethanol, green hydrogen, compressed biogas (CBG), sustainable aviation fuel (SAF), digitalization etc and stakeholder engagement.

Broadly, there are 7 different abatement strategies used for decarbonization – Operational Efficiency, Low Carbon Usage, Biofuels, Hydrogen, Electrification, CCUs and Circularity. If the current Indian regulations applicable to oil and gas players are mapped, various regulations impact one or the other abatement measure. Nayara Energy has drafted and selected specific Sustainability Strategies from above areas which would help the organisation to grow sustainably. These initiatives are shortlisted based on their potential emission intensity reduction impact, technology maturity and financial viability.

Decarbonization strategy for Nayara Energy can be viewed from short term and medium-term perspective. It considered emission reduction regulations and respective targets as a guide to the emission intensity target, setting the theme for action plans for these initiatives under different timeframes.

Solar panels at more than 1,000 Nyara Energy Retail Outlet across the country

- In short term, the targets for emission intensity are not mandated by government. However, Nayara Energy targets and plans to maintain an emission intensity similar to the baseline beyond the expansion projects are commissioned. It has also planned various operational efficiency initiatives and target to execute cost-effective projects with matured technology to maintain and reduce by 2-5% its emission intensity over the next 5-8 years period.
- In medium term, (beyond 2030- 2035), Nayara Energy aims to take up several additional initiatives to meet the emission intensity target subject to commercial business feasibility.

Short-term projects being evaluated by Nayara Energy -

- ***Enhancing Operational Efficiency***

  Improving operational efficiency is the first step towards reducing emissions. It plans to undertake the following measures:

  - **Energy Audits**: Conducting regular energy audits to identify areas of inefficiency and implement corrective actions.
  - **Process Optimization**: Utilizing advanced process control systems to optimize refining operations and reduce energy consumption.
  - Heat Integration: Implementing heat integration techniques to recover waste heat and use it within the refinery processes, thereby reducing fuel consumption.

- ***Small-scale Renewable Energy***

  Transitioning to renewable energy sources is crucial for reducing reliance on fossil fuels:

  - **Solar Power**: Installation of photovoltaic panels for our retail outlet and depot operations
  - **Biofuels**: Nayara Energy has already acquired land parcels in Andhra Pradesh and Madhya Pradesh to set up ethanol plans with 200 KLPD capacities each. It eventually will expand to five plants across the country.

- ***Digital Transformation***

  Leveraging digital technologies, such as artificial intelligence (AI) and the Internet of Things (IoT), to enhance monitoring, predictive maintenance, and efficiency in operations.

- ***Stakeholder Engagement***

  Engaging stakeholders, including management, shareholders, employees, and communities, is essential to drive the sustainability agenda:

  - **Sustainability Workshops**: Ideating on sustainable practices and providing training programs to employees on the importance of reducing emissions.
  - **Transparent Reporting**: Even though not regulatorily mandated, as a good Corporate Citizen and the largest unlisted Company in the country, the Company plans to publish annual sustainability report beginning FY 2026 to communicate progress and maintain transparency with all stakeholders.
  - **Government and Community Outreach**: Policy advocacy with governmental agencies and conducting awareness campaigns and community development programs to foster local support for the Company's green initiatives.
  - Collaboration with the ecosystem partners including vendors, suppliers, dealers and off-takers.

- ***Skilled-Manpower***

  The energy transition also requires a skilled workforce equipped with knowledge of advanced technologies and sustainable practices. The Company plans to invest in capacity building and skill development to train personnel in areas such as renewable energy, energy efficiency, and carbon management.

In its journey of accelerating the decarbonization strategy, Nayara Energy will undertake feasibility studies to implement the following projects:

Green belt with mango plantations within Nayara Energy Refinery

- ***Enhanced Renewable Energy***

  Scale up adoption of Renewable Energy which would help is to reduce emissions Intensity by 15-18%.

- ***CBG Blending***

  While the plants are economically viable, the individual capacity constraints and feedstock – grid alignment shall require plants to be spread across the country and entail significant investments.

- ***Circular Economy Practices***

  Embracing circular economy principles may help minimize waste and maximize resource utilization. This includes recycling and reusing by-products, recovering energy from waste streams, and implementing closed-loop processes. Such practices shall help not only reduce emissions but also enhance the sustainability of refinery operations.

Nayara Energy's decarbonization journey shall be emblematic of the broader transformation within India's oil industry. Achieving a reduced carbon footprint is not only a moral imperative in the fight against climate change but also a strategic move that will peg Indian refineries as leaders in sustainable practices. The combined efforts of regulatory compliances, technological innovation, strategic investment, commercially feasible and stakeholder engagement underscore the Company's commitment to a sustainable future.

NET ZERO

NET ZERO 2046

8 Net Zero Goals of CPCL

Shri H. Shankar,
Managing Director I/c & Director (Technical), CPCL

Net-zero goals are becoming a pressing priority for refiners, both to remain compliant with regulations and also to meet stakeholder expectations by managing risks & fostering innovation in a carbon-conscious world. As global energy markets evolve and low-carbon alternatives gain traction, refiners that adopt net zero goals early may be positioned better for sustainable growth. Transitioning to net zero emissions is not only critical for addressing climate change and its associated risks but also presents opportunities for businesses to enhance their reputation, reduce costs, and build resilience for a more sustainable future.

The Challenge of Net Zero

The journey to net zero can be complex and requires substantial investment in new technologies and infrastructure. Long-term targets and understanding the best available journey for the benefit of our business and making it a reality can be challenging. It is a sequential process starting with understanding the current

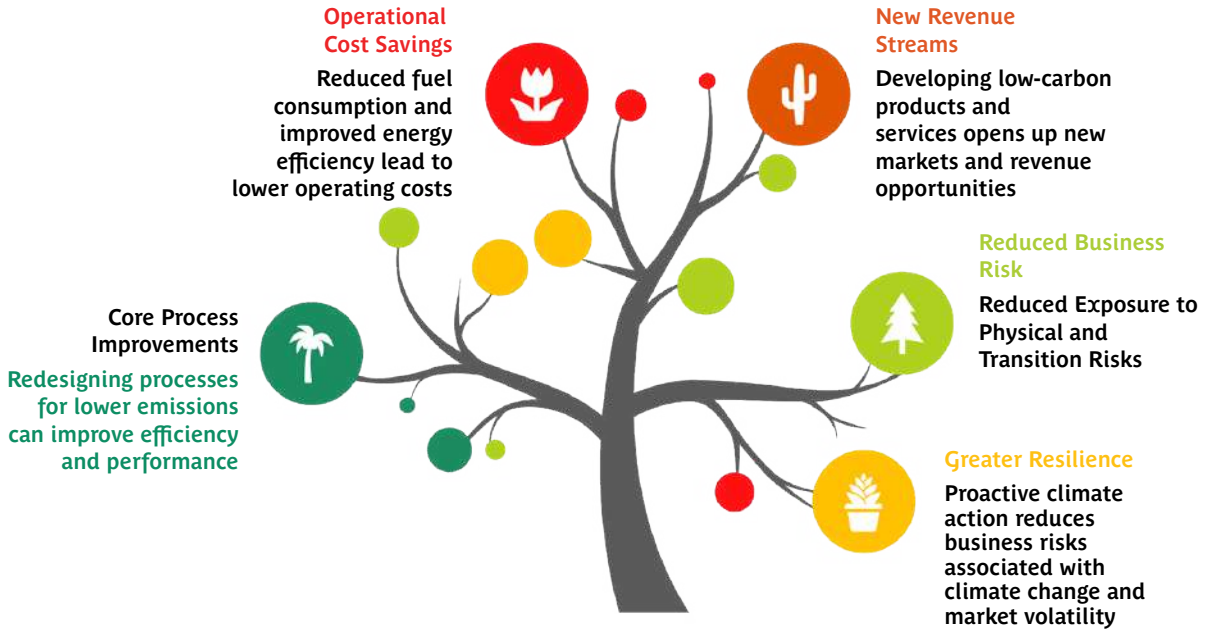
levels of GHG emissions at a granular level, setting targets in line with the business vision and mission, Identifying the right projects coupled with benefit analysis and technologies to apply during the journey for carbon reduction at an optimum cost. Furthermore, finding the most beneficial projects for strong business cases, sourcing investment and implementing projects with business benefits remains as a great challenge even today.

Challenges in the Transformation

What can Net Zero deliver?

While these challenges may seem daunting at first, the benefits of achieving net-zero emissions can be transformative. This includes a wide range of benefits right from profitability in terms of operational cost savings, core process improvements, and developing new revenue streams that may support diversification. As we move towards sustainability, it contributes to future planning, enabling greater resilience and reduced business risk.

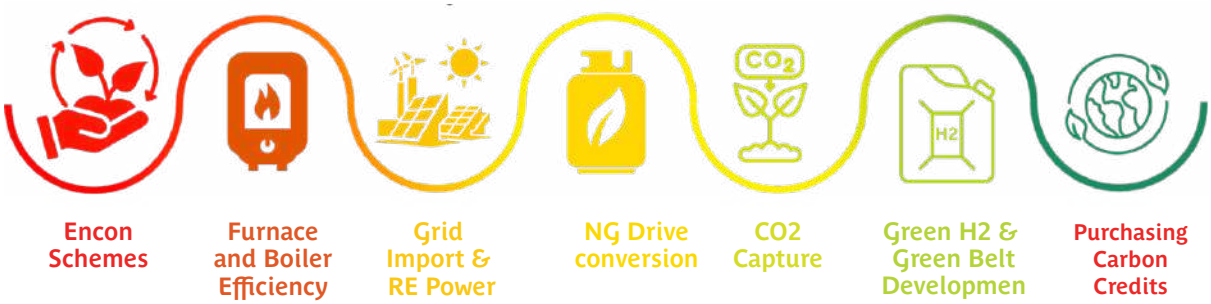
Benefits of Transformation



Achieving Net Zero in a Phased Manner

To achieve a net-zero economy, CPCL is investing in the energy systems of the future. This necessitates innovation and adaption of more new technologies in the existing solutions like renewable energy sources, biogas, low-carbon fuels such as biofuels, green hydrogen, carbon capture & storage, and innovative carbon removal technologies like direct air capture. Setting near-term milestones to achieve long-term targets involves breaking down the larger goal into manageable and measurable steps. CPCL considers phased implementation of net zero goals as the same is crucial for managing risks, controlling costs, ensuring user adaptation, and improving overall progress. By breaking down the Net zero implementation roadmap into manageable stages, CPCL plans to achieve a more successful and sustainable net zero goal by 2046.

Components of Transformation



Early Adoption (2024-2030)

CPCL has set near-term milestones to get on track for long-term targets. This initial phase focuses on cutting down the present level of emissions by around 30 %. The main strategies would involve the implementation of energy conservation measures, increasing the use of cleaner fuels like RLNG, Carbon capture and utilisation, and implementing green hydrogen projects coupled with renewable energy projects like solar power projects and windmill farms. CPCL, in line with the government's Renewable Purchase Obligations (RPOs), is set to install solar and wind power units equivalent to 200MW capacity, and will also fulfil the requirement through Power Purchase Agreements (PPAs) and Renewable Energy Certificates (REC). This strategic move aligns with the principles of Energy Efficiency and Renewable Energy Integration, ensuring CPCL meets its energy demands and targets while contributing to a sustainable energy future. CPCL is also planning to set up a Green Hydrogen plant of 2 KTPA capacity by 2027 and will subsequently scale up the same to 10 KTPA by 2030 as per allocation provided by MoPNG. These early actions are projected to have a substantial cut in the emission levels, laying the groundwork for more ambitious targets in later phases.

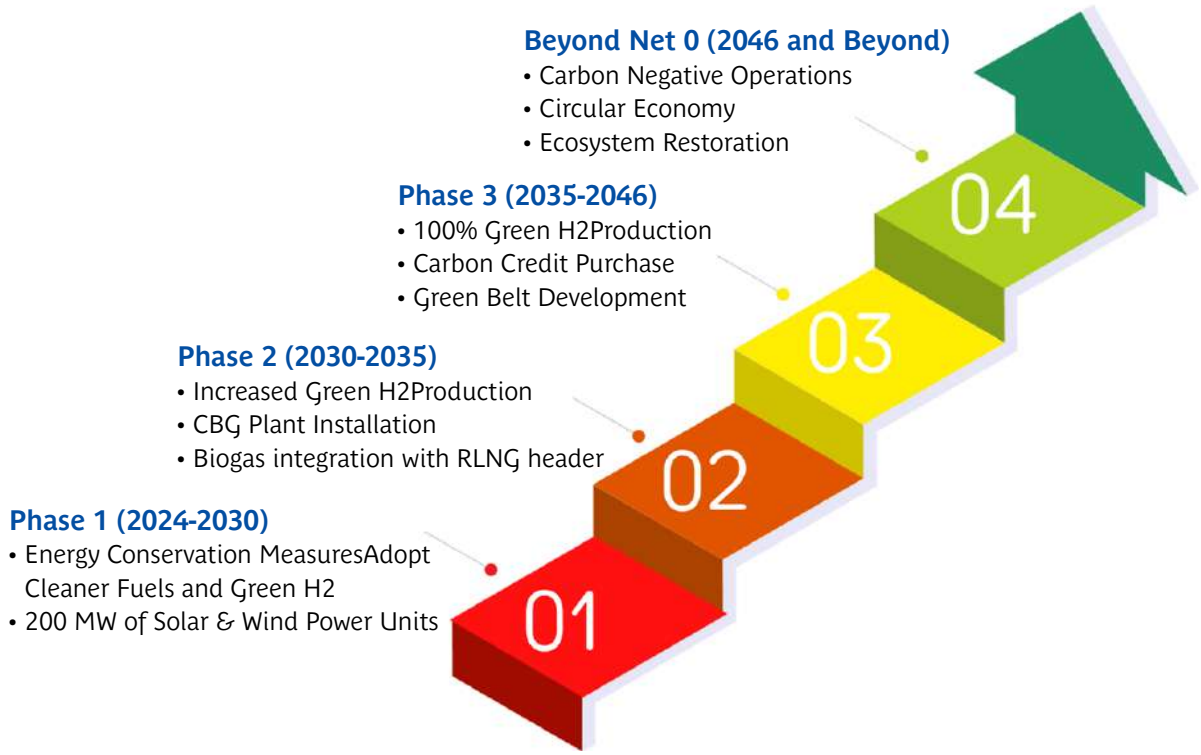
Scaling Up and Transition (2030-2035)

This phase builds upon the initial green hydrogen plant established in Phase I, with an estimated increase of 30 % in Green hydrogen production capacity, further reducing reliance on fossil fuels. Adding to this, feasibility for production of Compressed Biogas (CBG) is being explored through collaboration with existing CBG operators and it is targeted to commence CBG production and the subsequent integration of the biogas header with the existing refinery's RLNG header, operational by 2035. These efforts are expected to yield a further 24% reduction in emissions, demonstrating the company's commitment to accelerating its decarbonisation efforts.

Full Decarbonisation (2035 Onwards)

This phase involves phasing out the use of grey hydrogen (produced from fossil fuels) and completely transitioning to green hydrogen by 2045. Another initiative involves installing Carbon Capture, Utilization, and Storage (CCUS) technology in the Fluid Catalytic Cracking (FCC) unit, a major source of emissions in refineries. This phase also includes the installation of a stage-wise separation system for removing impurities like sulphur dioxide and carbon dioxide to add on to the emission cut. For emissions that are hard to abate, CPCL plans to purchase carbon credits and invest in developing Green belt areas to offset the emissions. The final phase represents CPCL's most ambitious target, aiming for a massive cut of around 46 % emission reduction.

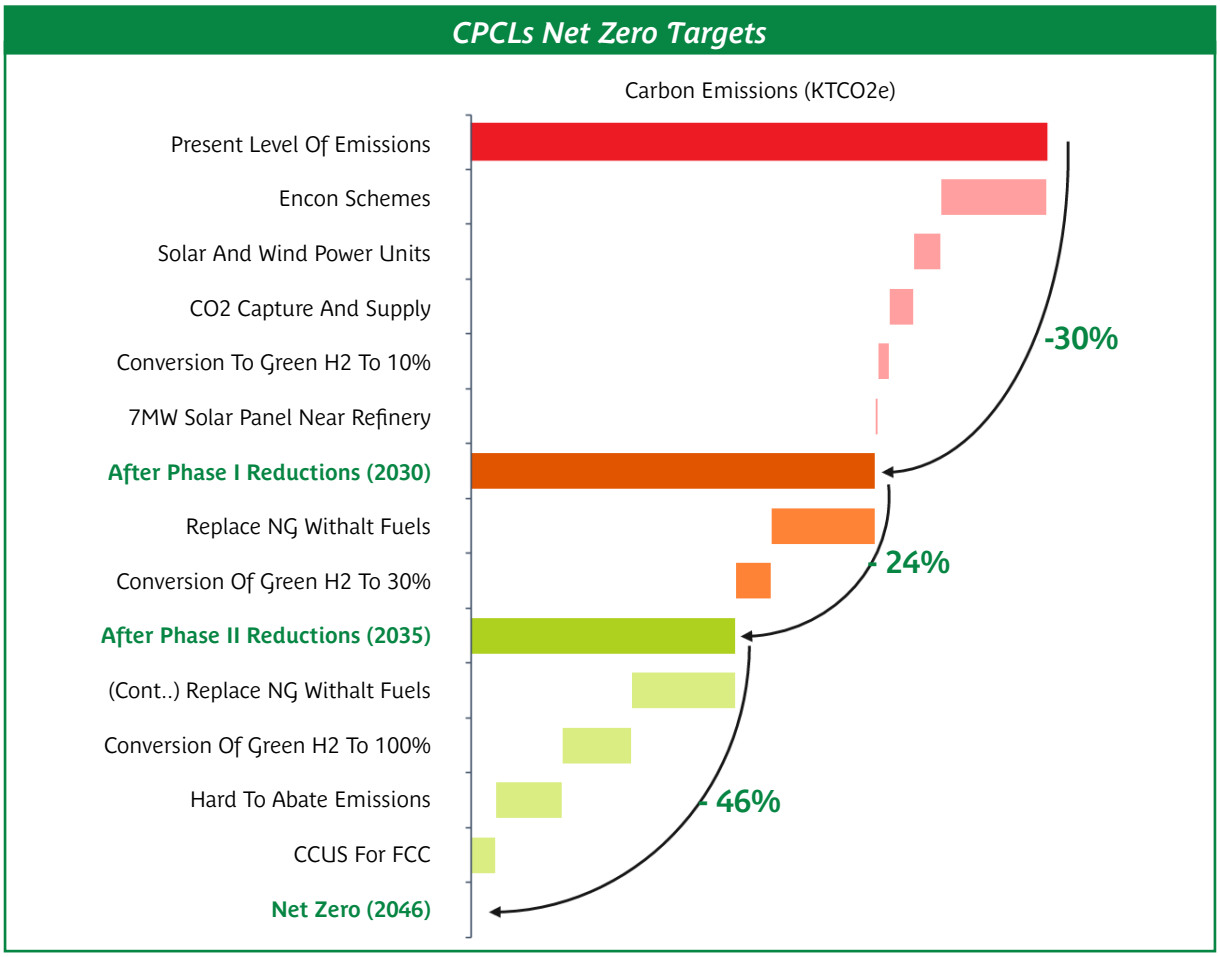
Phases of Transformation



How can refiners take a proactive stance in the race to Net Zero?

Refiners who take the lead in decarbonisation can position themselves as leaders in the fight against climate change and secure their long-term viability in a carbon-constrained world. While CPCL has primarily focused on reducing Scope 1 and 2 emissions through a balanced energy transition, achieving net zero necessitates addressing Scope 3 emissions also across our entire value chain. This means working with suppliers to adopt cleaner production

methods, optimising transportation and distribution networks, and even influencing consumer behaviour to promote the use of lower-carbon fuels. By taking a holistic approach to emissions reduction, refiners can create a ripple effect throughout the energy ecosystem, accelerating the global transition to net zero.



A little more than a quarter of a century is a very short period for this scale of technological change. As such, we must take the next step, evaluate and develop the processes that ensure we reach net-zero targets as soon as possible and in the most effective way possible. Instead of passively waiting for changes in the energy landscape, we should develop proactive strategies for transitioning into a balanced energy landscape that addresses not only the climate risk but also the associated business risk due to volatility in the oil market.

In summary, refiners adopting net-zero goals can better align with the expectations of a wide range of stakeholders, including investors, customers, employees, supply chain partners, and the broader community. This alignment not only supports regulatory compliance but also drives business growth, enhances reputation, and ensures long-term economic viability in an increasingly sustainability-focused world.

NET ZERO CPCL

NET ZERO 2050

9 Shell's Journey to a Net-Zero World

Ms Mansi Madan Tripathy,
Chairperson Shell Group of Companies India and VP, Shell Lubricants APAC

Global Context and Shell's approach to Energy Transition

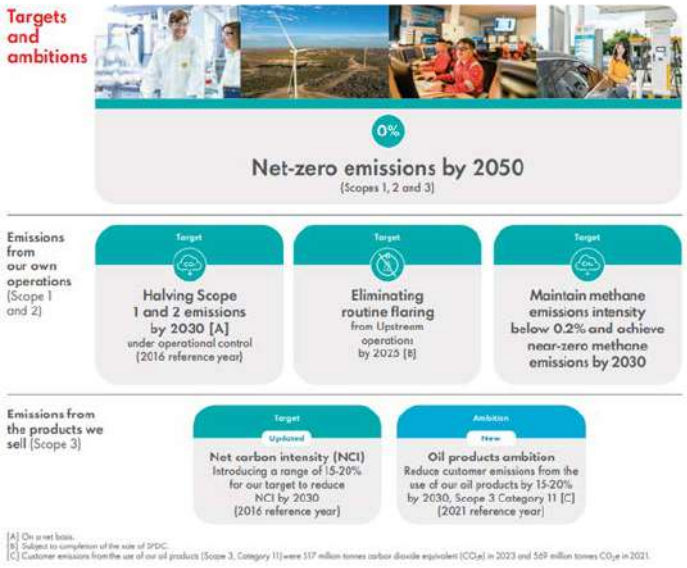
In a world where fossil fuels still command an overwhelming 80% of global primary energy consumption, the need for a transition to sustainable energy solutions is more pressing than ever. The global demand for energy exceeds 300 million barrels of oil equivalent per day. Notably around 250 million barrels of this consumption are derived from fossil fuels, underscoring the significant dependency, particularly in developing countries that rely on them for stable energy supply and pricing.

As global populations rise and prosperity increases, the demand for energy continues to grow. This necessitates a transition from fossil fuels to low carbon energy sources to mitigate climate impacts, while ensuring that energy supplies remain secure and affordable. As the energy transition progresses at varying rates across different countries, each adopting unique approaches, the global oil demand is expected to slow this decade and decline in the following decade.

Reflecting on the diverse energy landscapes across the globe one might ask, how can we effectively balance the necessity for economic growth with the imperative to reduce carbon emissions? In developing countries, where reliable energy access can transform economic opportunities, we need to tread energy trilemma – comprising security, equity and sustainability, in a balanced manner.Shell is committed to addressing these challenges and leading the way towards a sustainable energy future. We have set our target to become a net zero emissions energy business

by 2050 including scope 1, 2 and 3 emissions, transforming our operations and energy products. We believe this target supports the more ambitious goal of the Paris Agreement, to limit the rise in the global average temperature to 1.5°C above pre-industrial levels.

As we work towards net-zero, we are reducing emissions from our operations and energy products and helping our customers move to cost-competitive and clean energy.



Our energy transition plan covers all our businesses

- ***Integrated Gas***

  We plan to grow LNG business with lower carbon intensity by using renewable power and carbon abatement technology in the form of carbon capture and storage. LNG provides both energy security and flexibility because it can easily be transported to places where it is needed most. It will also be a critical fuel in the energy transition, offering flexibility in power generation to support renewable energy and potential decarbonization pathways for heavy industries.

- ***Upstream***

  We continue to focus on more value and less emissions, cutting emissions from oil and gas productions. Electrification of our offshore oil facilities and carbon capture and storage will be core to reduce and capture emissions from our facilities, respectively.

- ***Downstream, Renewables and Energy Solutions***

  We are transforming our business to offer more low-carbon solutions. Between now and 2030, we are focusing on three areas where we have the potential to positively impact the energy transition-electric vehicles charging, biofuels and integrated power. For example, we aim to increase the number of public charge points we operate to around 200,000 by 2030, from around 54,000 today. Additionally, the focus on producing premium biofuels such as sustainable aviation fuel, renewable diesel, and renewable natural gas (RNG) will help to reduce emissions in commercial road transport. Beyond 2030, Shell is focusing on developing integrated energy hubs, select carbon capture and removal pathways and fuels of the future, such as hydrogen, to prepare to meet our customers needs.

India Energy System: Our beliefs

India's economy is poised for significant growth. By 2035, it is expected to more than double in size, making India a major energy market and industrial hub. India's energy system is characterized by very low per capita consumption and very high share of coal in the energy mix. The key challenge is decarbonizing while supplying massively increasing energy demand being generated from top six sectors - power, transport, steel, cement, buildings and agriculture[1]. While each of these sectors continue to grow, the set of solutions in terms of energy mix and infrastructure required needs to undergo a significant change.

Power is the most rapidly decarbonising part of the energy system. More than 25% of electricity now generated from renewables, and India ranks 3rd globally in installed renewables capacity[2].

There has been rapid growth in wind and solar generation in the last 10 years, increasing significantly from 9% in 2011-12 to 26% as of Mar'23[3]. We think this trend is accelerating, aided by the adoption of electric vehicles.

The transport sector accounts for nearly 20% of final energy use. Oil products meet over 90% of transport energy demand, with the rest supplied by compressed natural gas and biofuels. India through its progressive policy blending mandates, integrates alternative fuels like ethanol to reduce reliance on oil imports. Electric vehicles (EVs) are rapidly growing in passenger road transport and would need robust public charging infrastructure for growth. Biofuels, LNG and renewable natural gas can play a role in reducing emissions from commercial road transport. Long-term decarbonization paths include electricity and hydrogen, depending on technological advancements and policies.

Heavy industry, including steel and cement production, relies on energy-intensive processes that are challenging and costly to electrify. These sectors predominantly use coal, gas, and electricity. Gas and LNG play a crucial role in supporting their decarbonization efforts by providing the necessary energy intensity and reliability that renewables currently lack.

Building sector made significant improvements in energy efficiency to reduce energy consumption, and emissions. India has made substantial progress though programmes such as energy-efficient lighting and benchmarking energy-efficient household appliances. As the demand for cooling is expected to surge in the sector, constructing energy efficient buildings becomes crucial.

In agriculture, energy consumption is highest during land preparation and irrigation. To improve efficiency and reduce emissions, transitioning to more efficient machinery (such as pumps and tractors) and adopting low-carbon energy sources like distributed solar power and renewable electricity is essential.

While fossil fuels will remain important, India's growing energy demand requires gradual shift to cleaner alternatives. India has been taking climate and energy policy action is areas such as energy access, energy efficiency, renewable electrification, enhancing the role of bioenergy, and accelerating the decarbonization of mobility. The country now needs to sustain that effort and ramp up actions in other areas. As India targets to achieve net-zero emissions by 2070, achieving this goal requires strategic choices and focus on few key areas:

- **Electrification**: Increase electrification across industry, transport, buildings, and agriculture. Electricity production should double, or triple compared to the previous decade.
- **Non-Fossil Sources**: Meet electricity demand from non-fossil sources, with low-carbon electricity generation accelerating 5-15 times faster than before.
- **Low-Carbon Alternatives**: Develop commercially viable alternatives like hydrogen and biofuels for hard-to-electrify sectors.
- **Natural Gas as a transition fuel**: Use natural gas as a lower-carbon alternative to coal.
- **Energy Efficiency**: Intensify efforts to improve energy efficiency in industry and buildings, aiming for a 10-30% reduction in emissions.
- **Circular Economy**: Promote circular economy models for efficient resource use, especially in the industrial sector.
- **Carbon Removal**: Plan for carbon removals to address challenging residual emissions.

In India's journey to Net-Zero, we must tread carefully—avoid dismantling the current energy

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1 *McKinsey India Decarbonisation Scenario Explorer. Oct 2022*

2 *India ranks 3rd globally for total renewable additions in 2021: Report | IBEF*

3 *Report on Optimal Generation Mix 2030 Version 2.0, CEA*

infrastructure faster than we construct the clean energy system of tomorrow. The pace of this transition hinges on factors like affordability, technological advancements, and evolving consumer preferences shaped by government policies. Moreover, securing substantial low-cost financing from both public and private sources is essential. Creating carbon markets, with international links, will enable- attracting investment, fostering innovation, and driving widespread adoption of low-carbon technologies. Collaboration between the government and industry is paramount, together to catalyse demand aggregation, establish shared supply chain infrastructure, raise societal awareness, and ensure favorable economic outcomes.

Shell Partnering in India's Decarbonization

In India, our purpose is to power progress together with the nation, aligning with the country's objectives of self-reliance, energy security, achieving net-zero emissions, and fostering sustainable economic development.

As a multi-faceted global energy company, Shell aspires to become an integral part of India's expanding energy ecosystem. We intend to achieve this by offering a comprehensive portfolio of conventional and innovative energy solutions.

Natural Gas

Natural Gas has a critical role to play in India's energy future as a transition fuel. With increasing energy requirements of the country, it can serve both energy security and the energy transition. India's demand for LNG is expected to triple by 2040, driven by industrial growth, power and infrastructure build-out. We expect Natural Gas to continue to provide a secure supply of energy for fertilizer sector, and in CGD network expansion for households. We believe, LNG will be the low-carbon energy source for heavy-duty transport replacing diesel, and for industries such as cement and steel. As the share of renewable energy increases in India's energy mix, using gas-fired generation during the transition will help in meeting the net load and maintaining grid security and stability. Hazira LNG regasification terminal supports this shift, aligning with the Indian government's vision to increase the share of natural gas in the country's energy mix from 6% to 15%. From Hazira, we deliver natural gas via trucks to customers nationwide, including those in off-grid areas.

Investment in renewables

With increased electricity demand across sectors, we believe renewable energy will be a crucial lever in decarbonization of the power sector. In 2022, through our strategic acquisition of one of India's leading renewable energy platforms Sprng Energy, Shell invested USD 1.55 billion in India, positioning ourselves as pioneers in creating an integrated energy transition business within the country. By synergizing Sprng's capabilities with Shell India's robust customer-oriented gas and downstream operations, Shell is poised to unlock substantial growth opportunities.

This acquisition enables us to accelerate and expand onshore wind and solar projects, contributing significantly to India's carbon reduction efforts and facilitating its transition to a low-carbon economy. With a contracted portfolio of 4.3 GW (including 2.3 GW of operating capacity), this investment represents Shell's largest commitment to renewable power generation worldwide.

Enabling EV growth with Shell Mobility

India Mobility sector is still nascent with dual challenges of existing demand shifting -mainly from urban 2W owners to alternatives in electric 2W while new gasoline/diesel consumers are added too.

As the demand for electric vehicles increase, it'll be critical to set-up support infrastructure, which is safe, reliable and convenient. With India's potential growth in this area, Shell now operates EV recharge points at our stations to support India's decarbonization journey, with possibility of integration with our capabilities in renewable energy and 350 retail stations offering fuels, lubricants, and convenience stores.

Innovation and digitalisation to adopt technology efficient energy systems

Shell's unwavering commitment to innovation and sustainability in the energy sector is deeply rooted in its extensive research and development (R&D) initiatives. The Shell Technology Centre in Bangalore stands as one of the three state-of-the-art innovation and technology hubs globally, serving as a Center of Excellence for essential technical advancements and digitalization across our worldwide operations. At this forefront of innovation, we lead cutting-edge research across various domains, including biofuels, hydrogen, GenAI, and material circularity.

Our strategic partnerships with esteemed academic institutions like the Indian Institute of Science (IISc) and the Indian Institute of Technology Madras (IITM) underscore our commitment to fostering innovation and driving decarbonization in India. The newly established Shell IITM Centre for Energy Research (SICER) serves as a hub for collaborative R&D projects, startup incubation, and knowledge exchange, contributing to a thriving innovation ecosystem. Additionally, the Shell E4 Program provides a platform for collaboration and conversation around valuable energy transitions, offering startups an opportunity to bring their ideas to life with Shell's guidance and support. Aligned with our global vision, the Shell E4 program actively contributes to the evolution of the energy sector's start-up ecosystem.

Powering India's progress

India has an opportunity to deliver economic growth that is environmentally sustainable and socially inclusive. The country can take a different development path, relying on lower-carbon sources of energy to deliver economic growth, energy self-reliance and improved standards of living. With the right policies, the energy transition can provide opportunities for balanced and sustainable economic development that delivers a better livelihood for all.

Shell in India has the largest employee base globally, with over 13,000 employees. Our presence spans Integrated Gas, Downstream, Power, Renewable, and Upstream. Shell's strategic approach ensures a balanced transition aligned with our 'Powering Progress' strategy. We deliver the oil and gas required today while actively contributing to the development of a cleaner energy system for the future. This approach harmonizes with India's decarbonization trajectory, ensuring secure and affordable energy supplies. We remain optimistic about the progress made in India, reinforcing our unwavering commitment to catalyze India's net-zero journey while participating in its growth story.

NET ZERO 2038

10

Net Zero Plans and roadmap for Numaligarh Refinery

Ms Geetali Kalita,
Head-ESG, Numaligarh Refinery Limited

Background

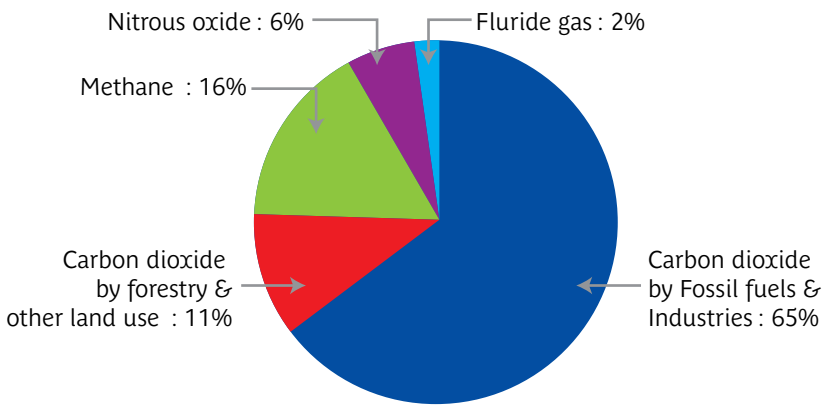
Numaligarh Refinery Limited being a mini-ratna, schedule-A company is presently having operating capacity at 3 MMTPA. The refinery processes crude oil and Natural gas received from OIL & ONGC to produce a wide range of products including LPG, Naphtha, MS, ATF, SKO, HSD, RPC, CPC, Sulphur, Wax, Nitrogen, MTO, SBPS. Refinery is underway with its capacity expansion project up to 9 MMTPA by FY 2025-26.

ABRPL is its joint venture company located adjacent to Refinery which is going to commission a 50 TMTPA bamboo-based Bioethanol project wef 2024-25.

Present energy transition scenario

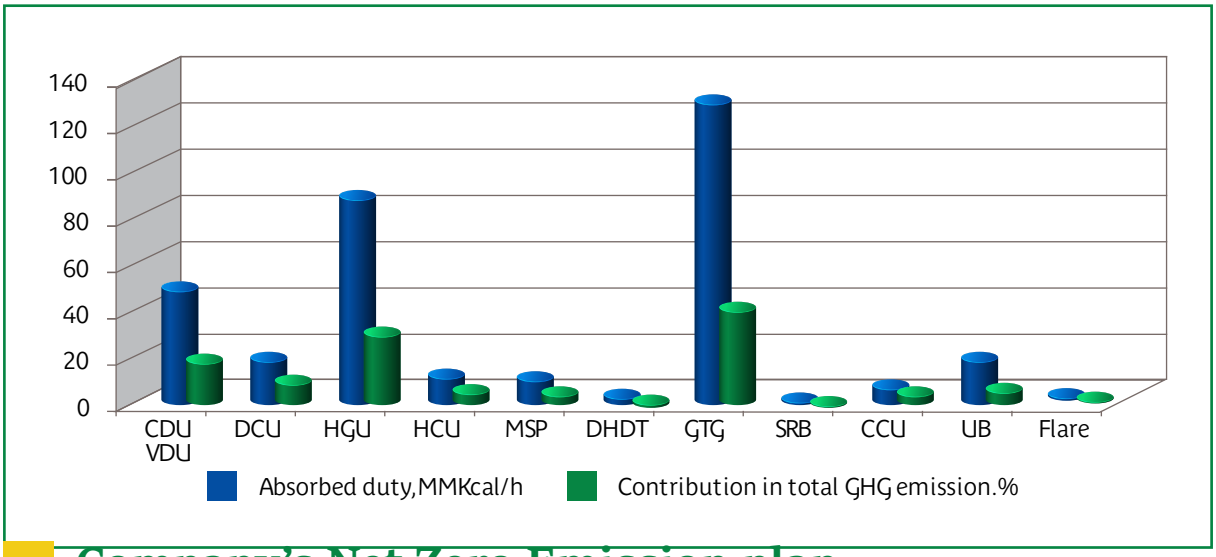
Anthropogenic climate change is mainly driven by emissions of CO2 but other greenhouse gases (GHGs) also play a part. Here contribution from fossil fuel combustion alone is about half of the total from all GHGs. Greatly reducing man-made CO2 emissions is central to meeting the global challenge to limit the temperature rise at 1.5 °C wherein efforts required from every economic sector—power, industry, fuel transformation, transport, and buildings—in both industrialized, transitional, and developing economies

Global Green House Gas emissions



The GHG emissions (Scope 1 & scope 2) of Numaligarh refinery is around 0.84Mt CO2e. With the addition of another twofold capacity crude train, there would be increase of 2.58 Mt CO2e resulting in 3.4 Million ton CO2e by the year 2026-27.

Graphical representation of Refinery Process units: Absorbed duty and GHG emissions contribution.



Company's Net Zero Emission plan

Reflecting on what NRL MD says- "In this ever-changing energy landscape of our planet, sustainability is at the core and decarbonisation is though small but significant subset of it. We prioritize our actions oriented towards achieving NZE for future sustenance".

- In company level transition strategies, reducing emissions, scope 1 & 2 from the NRLs own operations is pivotal. This would help forge a pragmatic and viable pathway for NRL's energy transition.
- With ambitious business expansion plans, while striking balance for sustainability of the organisation, a roadmap to NZE is being formulated with constructive ideas that could help NRL fully capitalize on the opportunity to make itself a more efficient, clean, sustainable economy, and achieve Net Zero emissions by 2038, while contributing towards achieving energy independence by 2047 for overall growth of the Nation.

Strategy to achieve NZE

- NRL shall reduce 45% of its GHG emission by year 2030 from 2005 level on basis of energy intensity reduction being one of the five nectar elements announced by GOI in COP26 on climate change action plan.
- Develop a short-term plan aiming to achieve the 45% emission reduction by 2030.
- Develop a long-term roadmap to achieve Net-zero GHG emission by year 2038.
- Many different measures are necessary to reduce GHG emissions. These measures include increasing energy efficiency in the plant; using renewable energy sources such as wind, biomass, geothermal and solar energy as per applicability; switching to low- or no-carbon fuels; alternative fuels; waste to value addition; and implementing carbon dioxide capture and storage. It is also necessary to reduce other GHG emissions like methane and nitrous oxide and to enhance natural carbon sinks for CO2 absorption.

Approach

- In case of refinery, total fuel and incidental Loss(F&L) incurred to process crude oil and NG are responsible to GHG emissions. To convert F&L to Ton of Oil (TOE) equivalent we apply net heating value of 1 TOE=10000 Kcal/kg. The carbon content of the TOE is considered 70% and oxidation factor (OF) as 100%. By multiplying the TOE with the C content % and OF, the GHG emissions is converted to Ton of CO2e.
- Plotting GHG emission nos. since 2005 upto 2023 and extrapolate the numbers beyond 2023 considering 2% CAGR on F&L.

Estimation

- At 2005, GHG emission had been 0.7 MMTCO2e. So, 45% of carbon footprint reduction would be 0.306. By 2030 GHG inventory would drop from 3.4 MtCO2 to 2.7 MtCO2e.
- NRL has been focussed with its environmental vulnerabilities since inception and have been carrying out carbon footprint assessment in the past two decades. Also, there is practice of engaging external experts for verification and validation since 2010 as per ISO14064, API Compendium 2009 and GHG Protocol.

Roadmap crafted by NRL to achieve NZE with following considerations

For the duration of transition, clean energy and fossil fuels systems are both required to deliver energy services and assessing and managing the co-existence of both systems is crucial. Several clean energy technologies have a close affinity with existing skills and resources in the O&G industry. They include technologies that can make use of the industry's know-how in handling liquids and gases, financial resources, extensive research and development expertise, technical and operational knowledge, and proficiency in executing and managing high value projects. Scale up clean energy to scale back fossil fuel use with investment in NZE scenario is crucial.

Some of the identified technology /initiatives considered in the NZE roadmap

Green Hydrogen initiative and future capacity ramp up

- The production of hydrogen is one of the major sources of emissions from refineries. Globally around 42 Mt of hydrogen is used to refine and upgrade oil resulting in around 380 Mt CO2 annually. So, hydrogen from low-emissions electrolysis to replace hydrogen from unabated fossil fuels would contribute significantly in pathways to carbon emission reduction.
- Hydrogen produced through water electrolysis by using renewable power is called as Green Hydrogen.
- Hydrogen from SMR with integrated carbon capture facility is called blue H2.
- There are primarily four types of electrolyser technology currently available, namely- Alkaline water Electrolysers (AEL), Proton Exchange Membrane (PEM), Solid Electrolyser Cell (SOEC) and Anion Exchange Membrane (AEM).
- Going by the spirit of National Green Hydrogen mission, the NZE roadmap shall adopt GH2 production and replace 10% and 50% of total Grey H2 with GH2 by 2030 and 2038. This step would substantially contribute to reduce carbon emission over prevailing SMR process with fossil sources for generation of Hydrogen.

- Refinery is underway with a 2.4 KTPA GH2 project to replace 5% of Grey H2 by the end of FY 2025.
- Refinery shall utilise green power with availability as matured over time and add value to green economy of the nation.

CCS and CCU (Carbon Capture, Storage and Utilisation)

- CCS provides suite of technologies that can effectively capture CO2 from refinery emission sources. Out of the options for carbon capture and storage most optimal solution may be explored. CCS technology like physical, chemical solvent absorption viz Amine solution absorption/ rectisol based absorption, cryogenic method, adsorption and membrane & biological/microbial separation and then sequester in deep geological strata etc. Implementation of CCS shall require detail techno-economic feasibility study.
- CCU : Utilising recovered CO2 into EOR (Enhanced Oil recovery), CO2 based synthetic fuels, chemicals, urea and other fertilisers, and building aggregates (concrete or plastic materials), Graphene production as they are gaining momentum.CO2 to fuels & chemicals pathways are being explored extensively by NRL.

Sustainable Aviation Fuel (SAF)

- SAF is a drop-in fuel up to 50 vol% with traditional aviation turbine fuel. This will provide opportunity for reduction in carbon footprint from the complex together with valorisation of waste stream of CO2.
- Various routes and feedstock for production of SAF evaluated: -
- SAF production utilising green (or blue) hydrogen and captured CO2 is being considered for evaluation.
- Source of CO2 may be considered from PSA Off-Gas ex SMR of Hydrogen Generation Unit since the CO2 content is typically > 50 vol% compared to refinery fire heater flue gas having CO2< 15 vol%. Other option for source of CO2 may be from Bio refinery flue gas emissions at 50TPH CO2. The recovery of CO2 from PSA Off-gas/Biorefinery whichever is economical shall be prioritised.
- Two alternate sources of H2 for SAF production may be evaluated for economic feasibility viz. low emission electrolytic hydrogen and Blue hydrogen from SMR integrated with CO2 capture.
- SAF production process steps explored viz.
- Syngas generation via reverse water gas shift reaction; Fischer Tropes synthesis; product fractionation /treatment.
- SAF from Ethanol (Alcohol) to Jet (ATJ) route from Bioethanol ex Bamboo based biorefinery
- SAF from Biogenic feedstock (preferably Palm oil) is being evaluated.
- However, production of SAF is Hydrogen intensive. So NRL need to check for Green/Blue H2 option for feasibility in the CO2 abatement journey.

Renewable Energy- Round -The-Clock (RERTC)

- The replacement of Fossil fuel-based grid power to renewable power shall impart a major boost toward reducing GHG emission tending to achieve net zero target. The source of Renewable power is either Solar, wind or hydro (small and large). However, getting RE power on round the clock (RTC) basis is challenging due to high intermittence in power supply,

low predictability for multiple scheduling, low CUF (solar 24%-27% & wind 30-35%) makes it necessary to accommodate storage (battery, pump hydro storage) facility for sustaining RERTC.

- Presently NRL pursing to avail green power@20MW for production of GH2 from grid entering per se agreement. Also, NRL shall operate the NREP fully on import power 220MW. Here opportunity lies to convert it into power from renewable sources. Options are being evaluated to have agreement undergoing PPA etc.

CO recovery and Acetic acid production

CO recovery from Hydrogen Generation Unit for production of Acetic acid at 400TPD capacity is being pursued by refinery.

Compressed Bio-Gas (CBG)

NRL in collaboration with OIL is planning to set up 2-5 TPD CBG plant (30KTPA from 25 CBG units) .Main feedstock would be MSW, rice straw, cow dung, pine needle. CBG would be injected in network of NG to qualify as feed to GH2 production releasing CO2 less than 2kg/kg of H2

Carbon sink

Through various afforestation measures and extensive bamboo farming, green sink shall be populated & expanded phase-wise to offset the carbon emissions.

The pathway to NZE

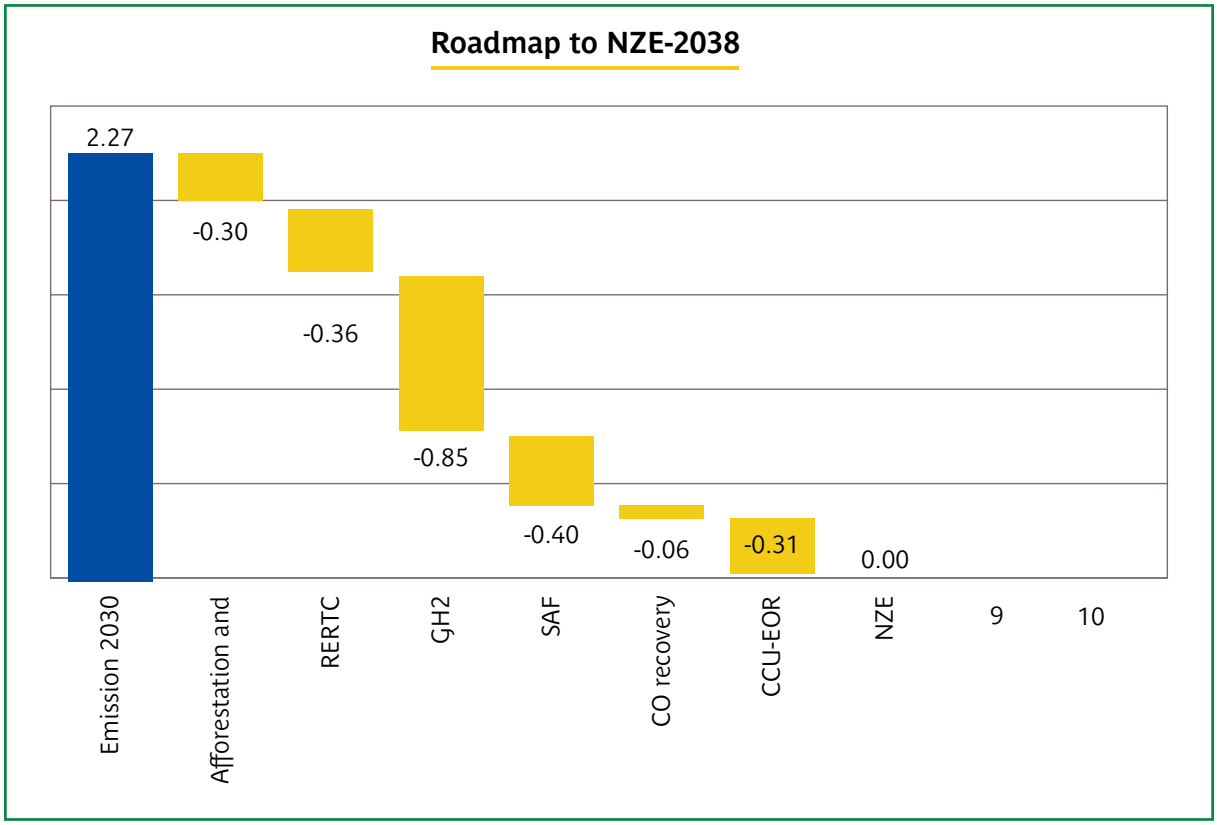
Term	FY	S.l.	Abatement levers	CO2 reduction	CO2 abatement	Net CO2 emission	Capex
				MMTPA			Rs in Crore
Short Term	2024-30		**Present GHG Emission**	**0.84**			
		1	15000 Ha bamboo farming	0.255	1.129	2.271	9
		2	1 lakh tree plantation in Nagkati	0.001			2
		3	65 thousand tree plantations in Kondoli	0			1.1
		4	3.5 lakh tree plantation in Dibrugarh	0.002			1.6
		5	30 KTPA CBG production	0.14			600
		6	2.4 KTPA Green H2 plant-I	0.024			145
		7	80 MW RE power in Refinery power mix	0.358			4
		8	12 lakh tree plantations in Assam& Orissa	0.008			8
		9	10 KTPA SAF production through PSA off gas	0.04			696

Term	FY	S.l.	Abatement levers	CO2 reduction	CO2 abatement	Net CO2 emission	Capex
				MMTPA			Rs in Crore
		10	Installation of CO recovery plant (270 TPD)	0.14			240
		11	Installation of CO2 recovery plant (CCUS) for EOR	0.06			20
		12	10 KTPA Green H2 plant -II	0.1			240
Total	**2024-30**			**1.129**			**1967**
	2026-27		**CO2 emission post refinery expansion project**	**2.58**			
Total GHG emission from refinery wef. 2026				**0.84+ 2.58=3.4**			
Mid Term	2030-35	1	40 MW RE power in Refinery power mix	0.179	1.016	1.26	240
		2	23 TPH SAF through Biorefinery flue gas	0.4			2700
		3	35 KTPA Green H2 plant-III	0.35			2250
		4	Installation of CO recovery plant (116 TPD)	0.06			120
		5	Installation of CO2 recovery plant (CCUS)-EOR	0.027			10
Total	**2030-35**			**1.016**			**5320**
Long Term	2035-38	1	15000 Ha bamboo farming	0.255	1.26	0	9
		2	50 KTPA Green H2 plant	0.5			3750
		3	3.5 lakh tree plantation in Assam	0.002			4
		4	40 MW RE power in Refinery power mix	0.179			120
		5	CCUS (CO2 from flue gas)	0.324			176
Total	**2035-38**			**1.26**			**4059**
	By 2038			**-3.4**		**0.00**	**11346**
Carbon abatement during short & long term					**Net Zero Carbon Emission**		

Capital investment

The pathways to NZE would invite economic opportunity of around Rs 11346 Cr (~1.5 billion USD)

A NZE waterfall diagram



Conclusion

The envisaged roadmap is planned based on present context and knowledge of technology prevailing and developing in near future scenario utilizing all viable policy options to lead NRL to achieve net zero emissions by 2038.

In total, the use of electrolytic hydrogen and CCUS – alongside other emission reduction measures taken by refinery, including the use of green electricity and bioenergy for heat, carbon sink the scope 1 and scope 2 emissions of refining would fall from 2.27 MtCO2e to Net zero by 2030 and 2038 respectively.

NET ZERO 2035

11 Engineers India Limited (EIL) Catalysing Energy Transition for the Oil and Gas Industry to Net Zero

Ms Vartika Shukla,
CMD, EIL

India has emerged as the frontrunner in global economic growth and the role of Oil & Gas sector has been immense contributing around 7-8% to the country's GDP and energy security. This sector has a pivotal role in the growth of industrial sectors including inter alia transportation, manufacturing, and agriculture.

It is worth noting that India registered a robust GDP growth rate of more than 8% in the third quarter of fiscal year 2024 with a projected growth rate ranging from 6-7% in the upcoming fiscal years. The country also surpassed China to become the most populous country in the world growing roughly around 1% indicating the continued growth of the consumer market in the country during 2023-2030 and the country's Crude oil consumption is anticipated to rally with an upward slope vis-à-vis the GDP growth rate during this period making India the largest source of global oil demand growth in this decade as per the Indian Oil Market Outlook 2030 published by IEA.

It is to note that in the year 2023-24, the country's crude oil processing stood at 256 Million Metric Ton (MMT) to become the fourth largest refiner in the world which is expected to reach around 450 MMTPA by the year 2030. Most of the new capacity additions in the state-owned refineries are slated to be commissioned by the year 2027. The major green-field expansion projects include the implementation of hydro processing units leading to enhanced light and middle distillate outputs.

Further, in the recent year, India became the fourth largest exporter of middle distillates playing an instrumental role in meeting Europe's energy requirements, one of the ramifications of the Russia-Ukraine conflict. However, the planned additional growth in the refining industry warrants caution owing to the dynamics of the global geopolitical scenarios as India imports almost 90% of its refinery intake heavily denting the Government exchequer.

Oil & Gas Sector vis-à-vis the Global Energy Transition

The oil and gas sector faces increasing pressure to decarbonize and contribute to global efforts to achieve net zero emissions by mid of this century. Transitioning to a net zero future requires a comprehensive strategy that integrates technological innovation, operational efficiency, investment in renewable energy, and sustainable business practices. Burning fossil fuels is responsible for most of the Green House Gas (GHG) emissions. It is interesting to note that Oil & Gas contribute around 30% of India's energy mix emitting around 700 million tons of CO2eq GHG emissions in the atmosphere.

In the recent past, the Oil & Gas industry has adopted a multipronged approach to accelerate the pace of decarbonization. Setting the carbon reduction target has been a critical step undertaken by almost all companies based on their assessment of carbon footprints. EIL is leading the industry by example and has declared to become a net zero carbon emitting corporation by the year 2035.

The company has prioritized enhancing energy efficiency across its assets including application of Building Management Systems (BMS) to automate and optimize HVAC operations. Furthermore, EIL is expanding its solar power installation at various office complexes across the country towards the reduction of scope-2 emissions in addition to transforming the systems through various digital interventions. It is worth noting that EIL has reduced its total scope-1 and scope-2 emissions in the previous fiscal year by around 6% compared to the FY 2022-23 and is committed to assisting its clients in achieving their decarbonization journey using the organizational vast experience and capabilities.

EIL has played a crucial role in shaping the development of the Oil & Gas sector in India and has contributed significantly to implementing mega projects across the hydrocarbon value chain in its journey of six decades. EIL has a strong footprint in 20 out of 23 refineries in India and has also implemented 10 out of 11 mega petrochemical projects in the country. In the changing global energy landscape, EIL has aligned its business strategy to the emerging needs of the industry.

Hence, EIL's role is not only significant in this sector's growth but also immense in assisting the industry in its energy transition journey to achieve net zero carbon emissions within the projected timeline.

Key Drivers of Energy Transition for the Oil & Gas Industry

Energy efficiency

Energy efficiency improvement has been considered a key pillar and a stepping stone in the energy transition journey of the industry. Energy conservation and energy efficiency improvement of existing industrial infrastructure are quintessential for realizing the low-hanging fruits in the decarbonization endeavours. There has been a global focus to double the average annual rate of global energy efficiency improvements in the ongoing decade that has the potential to achieve around 7 Giga tons (Gt) Carbon emission savings in 2030. The approach also includes a shift in human behaviour in their daily lives.

For instance, the Bureau of Energy Efficiency (BEE), Govt. of India has been instrumental in launching various policies ranging from enhancing the energy efficiency of appliances to the Carbon Credit Trading Scheme (CCTS). The compliance mechanism of CCTS shall push the Oil & Gas sector as well to take innovative measures to enhance the energy efficiency of their existing equipment. In the previous decade, India has witnessed phenomenal growth

in renewable energy contribution to the country's installed power generation capacity resulting in a significant reduction of carbon intensity of power generation to around 700g/KWh. However, it is still way above the global average of around 450g/ KWh.

The Oil & Gas sector has already been increasing the share of grid power in its operations and eyeing opportunities for integrating renewable power in the refinery process units. For instance, as per EIL's estimate, around a 10% reduction in the crude heater duty can be achieved by integrating Concentrated Solar Technology (CST) in the crude preheating train showcasing its potential to reduce the GHG emissions in the fossil fuel firing in refinery processes. EIL is offering these services in collaboration with M/s Sunrise CSP Group, Australia.

In addition, this sector will also attract more investment in clean technologies and infrastructures across the globe in the years to come which has recently reached about USD 2 trillion as per the estimate published in the IEA World Energy Investment 2024 report.

Big Dish to harness concentrated solar power

EIL has multidisciplinary experience in the Design & Detailed Engineering of large and critical assets and has a pool of BEE Certified Energy managers and Auditors to assess and implement energy conservation initiatives.

The company has performed energy efficiency improvement studies of Refineries and Petrochemical complexes for both Indian and International clients and recommended short, medium, and long-term measures to save energy. Refiners in India have already been implementing EIL-recommended measures to improve their Energy Intensity Index (EII) to achieve the Quartile 1 (Q1) target fully aligned with the Govt. of India's target to reduce carbon intensity by 45% over 2005 level by the year 2030.

Natural Gas as a Transition Fuel

Natural Gas has been considered a bridge fuel in industrial decarbonization owing to its low carbon content in comparison to the high carbon content of fossil fuels like coal and crude oil. The Govt. of India has also set an ambitious target to increase the share of natural gas in the energy mix to 15% by the year 2030 which presently stands at 6%.

Recently, the GoI has come out with CBG Blending Obligation (CBO) with the key objectives to stimulate demand for CBG in the CGD sector, import substitution for Liquefied Natural Gas (LNG), saving in Forex, promoting circular economy and to assist in achieving the target of net zero emission. It will encourage investment of around Rs. 37500 crores and facilitate the establishment of 750 CBG projects by 2028-29. This would boost the availability of the non-fossil natural gas in the market for various applications very similar to the E20 mandate for the Ethanol blending in Gasoline. It will also help refineries to provision for Biogas as part of their fuel switching philosophy which as per EIL's estimate, a substantial CO2 abatement (~30-35%) can be achieved by substituting refinery fuels with Biomethane indicating its relevance in the Oil & Gas sector's decarbonisation journey ahead. Further, GoI has been taking several policy measures towards increased natural gas availability in the country including development of LNG import and regasification facilities.

On the distribution front, GoI envisages to develop around 14239 Km of natural gas pipeline in the nation as part of the National Gas Grid which currently has approx. 16788 Km in operation.

The development of the City Gas Distribution (CGD) network is anticipated to ensure the accessibility of clean fuel for the household, industrial, and transportation sectors at an affordable price.

EIL's role has been critical in implementing various pipeline projects and LNG terminals in the country to enhance the availability of natural gas for various applications across the nation.

Digitalisation and Automation for Energy Asset Optimization

Energy Asset Integrity Management has become increasingly vital in the current energy transition, as industries worldwide strive to achieve their decarbonization goals. The old assets offer opportunities to improve energy efficiency through better heat integration, improving heater efficiency, adding air preheater systems, low-level heat recovery, optimization of fractionators and distillation columns, and steam & power system optimization. Besides this, refineries have room for better maintenance practices using predictive maintenance strategies, IIoT application through Digital Twins, and real-time optimization in view of varying feeds, varying climatic conditions, and varying fuels in heaters.

EIL has also developed several IIoT-based digital interventions to optimize the existing asset performance in the refineries. For instance, EIL's digital solutions to enhance the energy efficiency of fired heaters in the refineries have immense potential for refineries to reduce the operational energy requirement. It has already been demonstrated in one of the refineries in India. EIL has also developed a web-based platform for realistic assessment of industrial CO2 footprints (EngCO2चित्रण) delineating the operational boundaries of the units. The assessment models developed by EIL have adopted the latest GHG emission calculation protocol for mapping the emissions in different scopes. EIL offers various digital products and services through a dedicated Digital Technology Solutions (DTS) department catering to the emerging needs of the energy sector clientele.

Carbon Capture Utilization and Storage (CCUS)

The discussion on energy transition for the Oil & Gas sector to net zero carbon emission can not be bereft of avenues for CCUS in the existing hydrocarbon assets. There has been a strong push for the development of technologies both for Direct Air Capture (DAC) and carbon capture from point sources and its valorization in recent years. CCUS technologies have a greater role to play in decarbonizing the power sector which still utilizes around 70% fossil fuel for electricity generation. Further, its application is critical in the hard to electrify and hard to abate sectors utilizing fossil fuels in the process itself.

It is important to note that the blue hydrogen (which utilizes carbon capture technology in the SMR pathway) versus green hydrogen debate has seemingly shifted to the implementation of green hydrogen facilities at large scale in the refineries to bring down the cost of green hydrogen production in the years to come. This is further corroborated by a surge in investments in the past few years in green hydrogen technology development across the world.

Biofuels

Bio-fuels are transforming the landscape of green fuel availability especially Gasoline in India at an unimaginable speed. The National Biofuel Policy 2018 and its amendment in May 2022 allowing more feedstocks, advancing target blending of 20% to the Ethanol Supply year 2025-26, etc. paved the way towards decarbonization while meeting the energy demand in the country.

Snapshot of Biorefinery Project implemented at ABRPL, Assam

The feedstock supply, especially for Bioethanol is not only fragmented and unpredictable but also has to compete with other commercial applications and is subject to changes in weather patterns affecting crop production, Inter-state movement of Ethanol from surplus states to deficit states, Ethanol pricing, development of suitable infrastructure by OMCs for storage of Ethanol at different locations across India for blending and deployment of E20-compliant dispensing facilities. It is also limited by Engine testing for High Ethanol blending. Recently, the Ethanol blending in Petrol crossed 15% for the first time in India. Almost 14,600 retail outlets are already dispensing an average of 20% Ethanol blended Gasoline lowering the carbon emissions by 5-6%. The technology development in this area is also opening the avenues for the production of other value-added products from bioethanol such as Bio-Ethylene or even Alcohol to Jet (ATJ) fuels.

EIL has also marked its footprint in the Biofuels projects implementation. It is providing its services in the implementation of one of largest capacities Biorefinery project in India for Assam Biorefinery Private Limited (ABRPL), a JV of NRL, Fortum and Chempolis OY. The project is being implemented by EIL based on the technology supplied by Chempolis OY, Finland. This is one of the firsts that EIL has done so far in its six decades' long journey of providing services and building the nation's energy infrastructure. This project is anticipated to set the benchmark for India's Biorefinery programs in the coming years that have been implemented by EIL directly from the pilot/ demo to the commercial level.

Sustainable Aviation Fuels (SAF) is another key sector where refiners are keen to investments in the near future owing to its projected demand of around 400 metric tons per day as India onboards the CORCIA regulation (1% SAF blending in the ATF) in the year 2027. EIL is spearheading the initiatives to set up Bio-ATF plants in India in Collaboration with CSIR-IIP and has already developed a Basic Engineering and Design Package (BEDP) for one of the Indian refiners.

Technological advancements that use 3G biofuel pathways like the conversion of off-gases containing CO, CO2, H2 to both fuel-grade ethanol and Biojet are also nearing commercialization which would further assist the refinery in meeting their emission reduction targets.

Green Hydrogen

Green Hydrogen is an important alternative energy carrier having huge potential for decarbonizing the industry at a large scale. The demand for hydrogen in industrial applications has been continuously growing. The current hydrogen demand is almost entirely fulfilled from fossil fuels with almost 6% of global natural gas used towards hydrogen production.

Recognizing the significance of green hydrogen in achieving climate goals and energy security, India launched the National Green Hydrogen Mission and the Strategic Interventions for Green Hydrogen Transition (SIGHT) Program with an objective to produce 5 MMTPA green hydrogen by the year 2030 which would require around 125 GW of renewable energy for green hydrogen production. Oil & Gas sector in India has already initiated activities to install green hydrogen production facilities using different water electrolysis technologies available in the market at appropriate levels of deployment.

A Typical snap of Hydrogen Blending in the Existing CGD network based on EIL recommendation commenced in Indore City

EIL has been a front runner in implementing projects related to Green Hydrogen as well both for its production through electrolyzers and assessment of blending hydrogen in the existing natural gas pipelines.

For instance, EIL is providing EPCM services to GAIL for the execution of the balance of plant (BoP) and associated facilities for the installation of a 10 MW green hydrogen production facility in Vijaipur, Uttar Pradesh. This plant is designed to produce 4.3 tonnes per day (TPD) of green hydrogen using renewable energy from the grid.

EIL has also carried out an assessment study to ascertain the impact of hydrogen blending in the existing Natural Gas pipelines / City Gas Distribution Networks that could be the benchmark for the percentage of green hydrogen that can be blended in the existing natural gas pipeline without affecting the material integrity. In addition, EIL is delivering services to various other clients for green hydrogen/ green ammonia production projects that are critical to decarbonizing the industrial sectors.

Conclusion

There has been a paradigm shift in the strategy and investments both from the Government and organizations for the development and deployment of green energy technologies across various energy transition imperatives pertinent to the Oil & Gas sector to achieve net zero carbon emissions. The investments have pushed the R&D efforts in various areas related to emission reduction both in industry and academia and have provided a fillip to the skill development of professionals in clean technologies.

Further, it has offered opportunities for multisectoral collaborations in the areas of interdisciplinary sciences and technologies. Here, the role of an experienced energy consultancy organization like EIL becomes more important in the assessment and deployment of an eclectic mix of clean energy technologies for the Oil & Gas companies in achieving their energy transition objectives.

By leveraging new technologies, enhancing infrastructure, and integrating renewable energy, the oil and gas sector can continue to support India's economic development while transitioning to a more sustainable and resilient energy

NET ZERO EIL

12 SUPERGAS -Navigating to Net-Zero Goal

Shri Shreekanta Kumar Parida,
VP- Marketing SUPERGAS

In India, the consumption of LPG has been on an increasing trend, marking a notable shift toward lower carbon emission fuels. However, the journey towards transitioning to cleaner fuels is far from over. While LPG is a staple for cooking, it's significance extends beyond for its reliability and versatility across numerous commercial and industrial applications. From keeping hospitality warm and welcoming to powering laundry systems and industrial processes like ceramic baking, galvanizing, agriculture, and more, LPG offers precise heat control and clean efficiency. With over 100 industrial applications, LPG empowers businesses to excel while minimizing environmental impact.

As India sets itself an ambitious goal of 'Net Zero Carbon Emission' by 2070, it is crucial to

accelerate the adoption of sustainable fuels across applications. Rethinking the dependency on conventional fuels like petrol, diesel, coal, and electricity plays a pivotal role in this transition. By embracing this shift for a wide range of applications, we can lower our Scope 1, 2, and 3 emissions. This comprehensive approach not only aligns with India's Net Zero goal but also sets a benchmark for companies to address issues like global warming and climate change.

Understanding Scopes 1, 2, and 3

The fight against climate change depends on assessing and managing Scope 1, 2, and 3 emissions. Scope 1 emissions are directly produced from sources owned and controlled by the entity. Scope 2 captures indirect emissions from purchased electricity, which powers office buildings, manufacturing processes and facilities. Scope 3 encompasses all other indirect emissions, including supply chain activities, product use, and disposal.

At SUPERGAS*, we are guided by the 'operational control' principle to reduce the emissions from our activities. Through determined and innovative initiatives, we are moving towards lowering the emissions in scope-1 and 2, even though the scale of business & operation is on the rise. This is the first step we have planned out, with a set target based on various factors of business growth, alternate environmentally sustainable options, availability and scalability of such alternatives. At the same time, we do explore various options of reducing the scope-3 emissions.

Initiative to Reduce Emissions

At SUPERGAS, we have ambitious initiatives on our timeline to reduce emissions. These initiatives are a testament to our proactive approach and confidence in fulfilling these targets.

Sustainable Logistics and Mobility

While the transportation industry significantly impacts global carbon emissions, the urgency of embracing sustainable logistics and mobility cannot be overstated. It is crucial in reducing Scope 1 & 3 emissions. Addressing these concerns, we have implemented a multi-prolonged approach to reduce carbon emissions across the value chain. From using SAP management tools to automate truck and driver management to implementing CNG and electric mobility for plant operations and last-mile delivery, we promote resilience and sustainability in our supply chain.

Beyond that, we encourage eco-friendly business choices for business travel and opting for electric or hybrid lease cars. These comprehensive measures showcase how SUPERGAS is enhancing operational efficiency and leading by example in the ongoing journey towards a greener planet.

Green power and Energy efficiency

We prioritise efficiency and environmental responsibility by choosing green energy sources for operations. As of June 2024, 85% of our operations utilise green energy. We have established three in-house solar power plants, elevating our solar capacity from 352kW to

512kW, contributing to 43% of our filling plant's energy and aiming to integrate an additional 150kW by 2025. Pioneering green initiatives within the SHV Energy companies, we have signed a 4MW solar power purchase agreement for our Tuticorin Terminal from SunSource Energy in 2023 which has gone live this year July. We're constantly exploring even greener solutions, with an ongoing feasibility study to transition diesel generators to propane or natural gas.

Digitising Processes

In today's world, digitalisation offers a powerful tool to minimise environmental impact. We embrace this approach by actively digitising processes. This includes initiatives like transitioning plant records to digital formats, significantly reducing paper usage. Furthermore, innovation plays a crucial role in our sustainability efforts. Our SUPERGAS Care App and Site Suitability application empower customers and streamline interactions, minimising paperwork and travel.

Water Conservation

Conserving water is crucial in reducing our environmental footprint and sustaining life and ecosystems. SUPERGAS has innovatively incorporated floating tiles in the water storage containers of our firefighting systems across 15 filling plants. This method significantly minimises water evaporation, a common challenge in water storage facilities. Through this initiative, we proudly save approximately 15 million litres of water annually, reflecting our commitment to responsible management of precious natural resources.

Tree Plantation

The act of planting trees is more than a simple gesture; it's an investment in our planet's future. We have proudly partnered with Grow-Trees.com to deepen our commitment to sustainability. For every employee's birthday, a tree is planted in Sundarbans National Park, West Bengal, India. Moreover, we celebrate partnerships and milestones by planting trees at our customers' and partners' locations during commissioning events. Our filling plants and terminals also witness occasional tree-planting activities.

Effective Fuel Consumption

Saving fuel in operational processes is economically beneficial and vital for the environment. Reducing fuel consumption directly translates to a lower carbon footprint. Effective fuel management and adopting cleaner, more efficient technologies can significantly reduce energy consumption. Such measures help curb environmental pollution and foster sustainable business practices in compliance with global environmental standards. Our energy-saving solutions encourage our customers to save fuel in their industrial activities. These innovative products help optimise fuel consumption and reduce fuel and electricity costs.

Heater less Vapouriser is one such innovative solution that utilise the principles of thermodynamics to achieve vaporisation without any external heat source. Since the process does not involve burning fossil fuels or using electricity, it produces zero direct emissions. This approach highlights its standing as an environmentally friendly solution.

Transitioning to Cleaner Fuel

Industries and the fuels they choose significantly impact their carbon footprint. Cleaner fuels, such as LPG, burn more efficiently, produce fewer pollutants, and minimise greenhouse gas emissions, major contributors to climate change, air pollution, and declining air quality. This shift is about complying with stricter environmental regulations and taking a proactive stance in preserving our ecosystem. We consistently advocate and encourage industries to make informed choices not only for the efficiency and cost-effectiveness of their operations but also for the long-term welfare of our planet.

In 2023, our collaborative efforts with existing customers led to an impressive reduction of 1,76,048 metric tonnes of CO2. With the onboarding of new customers, we further reduced 32,847 metric tonnes of CO2 during their initial contractual period.

Sustainable Energy Solutions

In 2018, SHV Energy (our parent company) became a pioneer by being the first company globally to distribute bioLPG, spearheading the provision of sustainable energy transition solutions to customers. To further this commitment to developing non-fossil fuel resources,

SHV Energy launched Futuria Fuels in 2023. This dedicated business unit leads all SHV Energy's initiatives related to sustainable fuels. Futuria Fuels, a sister concern of SUPERGAS, aims to innovate and expand the production of renewable liquid gases like rLPG (renewable LPG) and rDME (Renewable & Recycled Carbon Dimethyl Ether), providing these sustainable resources to SHV's global operations and clientele.

Expanding its operations in India, Futuria Fuels has collaborated with SUPERGAS to explore different production methods for rDME. Taking a step forward in the production capacity, Futuria has partnered with Thermax Limited to undertake a pre-feasibility study to produce 50,000 tonnes of rDME annually within the region. With India generating over 600 million tonnes of agricultural residues and over 60 million tonnes of municipal solid waste each year, there is a massive potential to locally produce sustainable fuels using these abundant indigenous resources, which could significantly meet global LPG demands.

Hence, we see renewable liquid gases such as rDME and LPG as an important part of decarbonising our business and India's energy transition toward Net-Zero.

LPG for Transportation

As the transportation industry is a significant contributor to air pollution, with studies suggesting that it accounts for nearly 25% of global CO2 emissions, it is crucial to have cleaner fuel alternatives. LPG emerges as a compelling option. LPG offers significant environmental benefits compared to traditional fuels like petrol and diesel– it burns cleaner, reducing harmful emissions like nitrogen oxides and particulate matter. With government initiatives and subsidies offered, alternate fuels are still in the adoption stage. SUPERGAS is well-positioned with its extensive network of 47 auto LPG dispensing stations across India. It is at the forefront of this transition, providing vehicle owners with accessible, cleaner fuel options

Conclusion

As industries and businesses increasingly prioritize sustainability, LPG stands out for its efficiency and lower carbon emissions. Its role in transportation, particularly in auto LPG, aligns with urban air quality improvement goals and reduces dependency on more polluting fuels. By adopting LPG, India can significantly advance toward its net-zero emission targets, benefiting from this cleaner energy alternative in diverse sectors, from manufacturing to services.

*SUPERGAS, is a wholly owned subsidiary company of the renowned Dutch Multinational SHV Energy. SUPERGAS has built a reputation as a leading LPG Supplier in India to customers across Industrial, HoReCa, Domestic and AutoLPG segments. Across the country, we have access to 7 import terminals, 20 filling plants and retained the coveted CRISIL Rating No.1 for its infrastructure, technical excellence, prompt customer service, and a strong commitment to safety.

NET ZERO 2045

13 Dhamra LNG & Net Zero –A Perspective

Shri SP Singh,
CEO, Adani Total Private Limited

Introduction

Net Zero, in the context of climate change-related policies, refers to the balance between the amount of greenhouse gases emitted into the atmosphere and the amount removed from it. Achieving net zero means that any greenhouse gas emissions produced by human activities are counterbalanced by an equivalent number of emissions being removed, leading to no net increase in atmospheric greenhouse gases.

To achieve Net Zero, countries and organizations must significantly reduce their greenhouse gas emissions through various measures such as adopting cleaner/ renewable energy (RE) sources, enhancing energy efficiency, and implementing sustainable practices in industries, agriculture, and transportation.

In addition to reducing emissions, Net Zero requires the removal of existing greenhouse gases from the atmosphere. This can be achieved through natural processes like afforestation and reforestation, as well as technological solutions like carbon capture and storage (CCS) etc.

Net Zero is a global challenge that requires cooperation between countries, industries, and communities. Collaborations among nations and international agreements plays a crucial role in aligning efforts and sharing best practices.

Notwithstanding the challenges above, achieving Net Zero is critical for mitigating the adverse impacts of climate change and ensuring a sustainable future for the planet.

India and Net Zero

Speaking at the 26th Conference of Parties (COP-26) in Glasgow, our Honourable Prime Minister committed that India will achieve Net Zero emissions by 2070. The PM also announced many important initiatives and plans that will be executed in achieving the target. Some of these measures included raising India's non-fossil energy capacity to 500 GW by 2030 while meeting 50 per cent of its energy demand through renewables. India has also committed to reducing one billion tonnes of projected emissions from now till 2030 and achieving carbon intensity reduction of 45 per cent over 2005 levels by 2030.

The inter-dependency of fossil fuels and renewable energy in the march to Net Zero

It is important to note the word 'Net' in 'Net Zero' emissions. Net Zero emissions signify a balance between the amount of greenhouse gases emitted and removed from the atmosphere. Net Zero does not imply the removal of all emissions from the atmosphere as is believed in some quarters. The entire energy requirements of the world cannot be met by renewable energy alone (think petchem for instance). However, it is universally accepted that a capricious growth in fossil fuel consumption without accounting for the environmental cost of the same will take us on an unacceptable trajectory from a climate change perspective. Renewable sources of energy offer a far lower operating footprint but ironically still require the energy provided by fossil fuels to start production. Some renewable sources are also intermittent in the energy they produce (e.g., solar) – one of the options to mitigate such intermittency is via flexible power produced using fossil fuels such as gas. The inter-dependency of fossil and RE is accordingly a reality and the best outcomes will be those that can harness such complementary strengths to make best offerings to meet the needs of the customer.

To reiterate, achieving Net Zero will require the offset of emissions from non-RE sources by demonstrable equivalent removals. The transition away from fossil fuels will take time, and for the foreseeable future, especially given the strong growth projected globally for energy, the world will continue to rely on them to some extent. The world today is in a transition mode to move away from dirty fossil fuels to cleanly burning fossil fuels in co-existence with renewables like wind and solar.

As advocates for the development of gas infrastructure and industry in India, we recognize that natural gas plays a crucial role in the country's energy mix. Natural gas is significantly cleaner than coal and oil, offering a viable transition towards a more sustainable energy future.

Dhamra LNG

Dhamra LNG Terminal (DLTPL[1]) is a 50:50 JV between the Adani Group of India and TotalEnergies of France. DLTPL is the operator of a 5 million tons per annum (mtpa) LNG terminal located at Dhamra Port (Bhadrak District) in Odisha. It is the first LNG terminal located in the Eastern part of India and the presence of natural breakwater at Dhamra Port ensures year-round availability

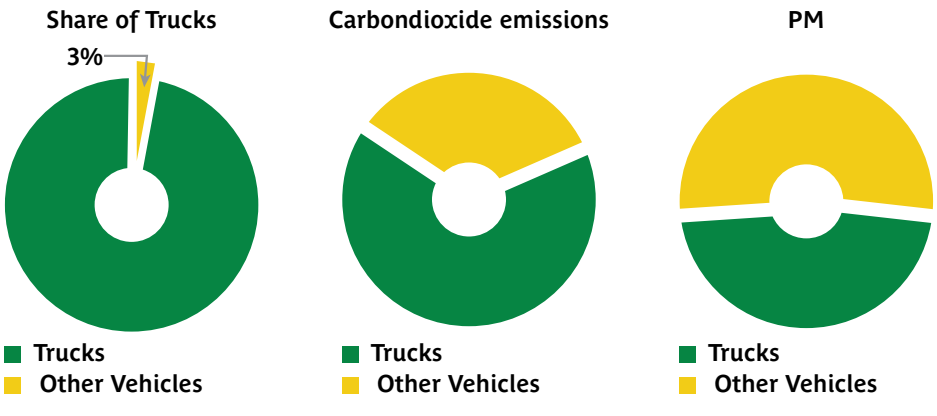
of terminal for cargo berthing.

DLTPL will play a pivotal role in India's net zero targets. It is the closest source of natural gas for approximately 35% of India's population, providing a cleaner burning energy solution for refineries, industries, homes and vehicles. Natural Gas (52 kg CO2/ mmbtu) replaces carbon heavy fuels such as Coal (~100 kg CO2/ mmbtu), Furnace Oil, Naphtha (~68 kg CO2/ mmbtu), Diesel etc. Being the only LNG terminal in eastern part of India, the gas supplied from DLTPL truly replaces existing fuels (Coal and Liquid Fuels) as demand served from Dhamra cannot be practically served from other existing sources of supply.

DLTPL contribution to net-zero

Reduced emissions

- When generating electricity, coal emits significantly more CO2 than natural gas. Coal-fired generation produces approx. 2,257 pounds[2] of CO2 per megawatt hour (MWh) of electricity. Natural gas-fired generation produced less than half that amount at 976 pounds of CO2/ MWh.
- Natural Gas use reduces approximately 55% and 30-40% CO2 when it replaces Coal and HSD/ FO respectively.
- At 5 mtpa throughput, Dhamra LNG terminal will help in reducing 5.4 million tons of CO2 (considering average reduction of 40% CO2 vis-à-vis alternative fuels) annually. To put that into prospective the reduction in emissions is equivalent to planting 218 million trees annually. This aligns with the principle of achieving net-zero by reducing emissions through efficient measures.
- DLTPL has the potential to expand, and by 2040, LNG from the terminal could potentially reduce approximately 0.6% of India's carbon emissions.
- Transportation sector is a major contributor to GHG emissions, which contributes almost 10% of overall CO2 emissions in India[3]. Trucks which constitute only 3% of overall vehicles but contribute 53% of Particulate Matter Emissions and 35% of CO2 emissions of transportation sector (Graph:1). In 2021, MDTs and HDTs were responsible for emitting around 1.6 million tonnes of NOx and 53,000 tonnes of PM emissions. Dhamra LNG terminal has truck loading bays which can facilitate faster transition towards adoption of LNG as fuel for trucks. Every year, India adds approximately 300,000 trucks to its fleet. If even 20% of these new trucks are fuelled by LNG, it would result in a reduction of approximately 1 million tons of CO2 emissions annually, with cumulative benefits over time.



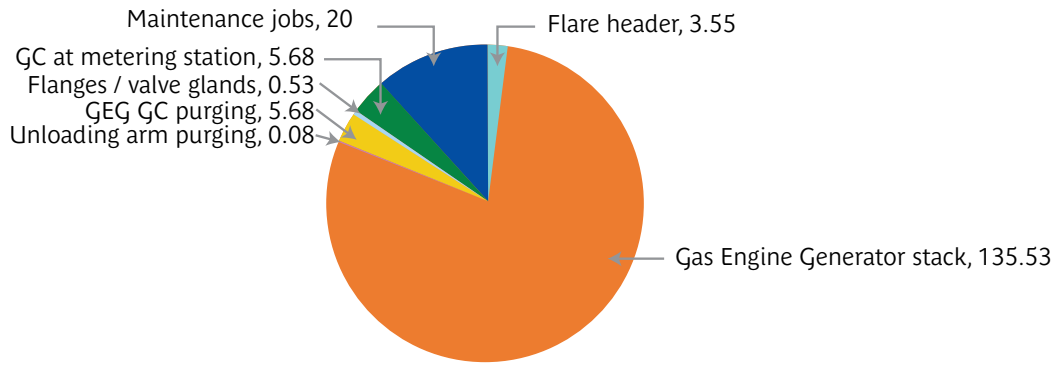
Share of trucks vs emissions

Mitigating methane slippages

Methane is a significant concern due to its higher potential to harm the environment and pose safety risks. Global methane emissions have steadily increased over recent years, largely driven by human activities such as agriculture, fossil fuel production, and waste management. The energy sector accounts for more than one third of total methane emissions. Methane slip refers to the unintended methane release during the production/ transportation of natural gas. Methane would trap about 80 times[4] as much heat as the same amount of carbon dioxide (CO2) over 20 years. DLTPL has taken steps to identify, measure, and mitigate methane slippages at the Dhamra LNG Terminal, addressing this critical environmental and safety issue.

- ***Identification of sources of methane slip***
  - The quantity of methane slip at Dhamra LNG is estimated around 171 tons/ year (~4275 CO2e).
  - This represents about 0.003% of terminal's send out capacity and is comparable to other regasification terminals in the world.
  - More than 80% of these emissions have been identified to be released by Gas Engine Generators (GEG) followed by maintenance jobs (~15%) and flare header (~2%).

Sources of Methane Slip at DLTPL (values in tpa)



*Represents 0.003% of send out capacity & comparable to other regas terminals (source Oxford Institute)

Sources of Methane slip at DLTPL

- ***Measure employed to reduce Methane emissions***
  - Usage of nitrogen as sweep gas instead of fuel gas in flare systems,
  - Minimizing Lower Explosive Limit in unloading arm before disconnection,
  - Eliminating venting of Boil-Off Gas (BOG) for cooldown of BOG compressors,
  - Reducing flanges in design (in future designs, expansion),
  - Periodic monitoring for leakages and drone surveys for methane detection.

Notwithstanding the minimal methane slippage, DLTPL is proactively looking at ways to minimise such slippage.

Other sustainable features/ practices

- The technology used by DLTPL has ensured that the terminal produces more water than it consumes, making it a net water positive industrial unit.

- Using chilled water (produced during regasification) for HVAC thus avoiding gas driven power requirement.
- DLTPL ensures that no affluent is discharged to sea and no harm is caused to mangroves.
- The cold energy stored at DLTPL will be utilized in processes that require cooling/cold temperatures. Once harnessed, this will result in reduced emissions by avoiding the energy typically required for cooling processes.
- DLTPL with assistance from the Dhamra Port has planted more than 19,000 native plant species in over 4.5 hectares along with plantation of mangroves in 9 acres area. DLTPL will consistently increase green belt/cover and mangroves around LNG terminal over coming years and reach towards net-zero.

As advocates for increasing the share of Natural Gas in India's energy mix, we recognize that reducing methane leakages can significantly widen the emissions gap between natural gas and coal. This enhancement allows natural gas to fulfil a more optimal role as a transition fuel. With a footprint as low as 30,000 tons of greenhouse gas (GHG) emissions, DLTPL has the potential to reduce emissions by 100 times its footprint when operated at full capacity. Therefore, the creation of such infrastructure undoubtedly contributes significantly to achieving India's net-zero goals and must be expanded and maximized to its fullest potential.

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1 *https://dltpl.adani-total.in/*

2 *Source: EIA*

3 *NITI Aayog, RMI, Transforming Trucking In India: Pathways to Zero Emission Truck Deployment, September 2022*

4 *Source: https://www.edf.org/*

14 Net Zero Plans for Oil & Gas Companies- bp's net zero ambition

NET ZERO 2050

Ms Mitali Sarkarr,
Head of Communication, bp India

bp's net zero ambition

Today, we remain mostly in oil and gas. In a world aiming for net zero, we believe our net zero ambition positions bp for success. Our group's purpose is reimagining energy for people and our planet. We want to help the world reach net zero and improve people's lives. You can read more about bp's ambition in our Sustainability Report[1] and our Net Zero Progress Update[2] Report. In this article, we provide a brief overview of bp's strategy, and then go on to consider bp's activity in India.

Net zero operations and production

bp aims to be net zero across operations and production by 2050 or sooner.

Operational efficiency

bp is working to implement energy efficiency measures, electrify [some of] our centralized facilities, reduce routine flaring and venting, and manage methane across our operations. Emissions reduction activities may include process optimization, steam heat recovery and powering refineries and onshore upstream assets using power with lower carbon attributes.

Portfolio optimization

Becoming net zero on an absolute basis across the carbon in our upstream oil and gas production is partly linked to reducing that production. We have stated in our March 2024 Net Zero Ambition Progress Update[3] that we are aiming for a reduction in oil and gas production by around 25% by 2030, compared to 2019. This aim takes into account anticipated base decline of existing fields, new projects coming online and the ongoing strategic high-grading of our portfolio – which we are designing to be operationally and economically robust, and resilient to unplanned or unexpected factors such as price volatility and geopolitical risk.

Reducing methane

Our aim was to install methane measurement at all our existing major oil and gas processing sites by 2023, publish the data, and then drive a 50% reduction in methane intensity of our operations. We have completed the implementation of our planned methane measurement approach across our upstream oil and gas assets.

Non-operated joint venture (NOJV) activities

We are working to help our NOJVs improve the reporting and mitigation of their methane emissions. We have prioritized collaboration with NOJVs that have the greatest potential to reduce methane emissions, and we are working on multiple aspects related to methane emission reductions, including measuring and reporting, the use of technology and setting meaningful targets. We are helping different NOJVs make progress and in many instances we are also learning from them.

Collaboration and methane advocacy

In 2023 we retained gold status[4] for our plans to measure methane emissions under the OGMP 2.0 reporting framework. This award recognized the work of many bp teams and collaborations with our partners including NOJVs.

More investments into the energy transition

Although bp is still mainly an oil and gas company, we are aiming to increase the proportion of investment we make into our non-oil and gas businesses. We increased the proportion of our global annual investment that went into our lower carbon and other transition businesses from around 3% in 2019 to around 23% in 2023.

Bioenergy

bp plans to grow our established bioenergy businesses. In 2022 we acquired US based biogas business Archaea Energy, which continued its growth throughout 2023. In October, Archaea Energy started up its modular design renewable natural gas (RNG) plant in Medora, Indiana, US, which represents an industry first and can help to streamline and accelerate build times for other RNG plants.

EVs

Together with bp's strategic convenience site network, bp is investing in EV charging. We believe that for road transport to decarbonize at the pace and scale required to achieve the goals of the Paris Agreement, it is necessary for the roll out of EV charging infrastructure and use of EVs to be scaled up in parallel with, or even ahead of, the required decarbonization of electricity grids. We're plugging in high-speed charging points in the right locations to boost consumer confidence in driving electric. And aiming to roll out more than 100,000 charging

points globally by 2030. We've already made great strides, with more than 29,000 charge points switched on worldwide. Almost all new public charge points that we roll out now are rapid or ultra-fast, because we know that's what our customers want. In the US, we announced that bp pulse has entered into an agreement with Tesla for the future purchase of a $100 million of ultra-fast chargers. The investment will facilitate the expansion of the bp pulse public network across the US and support EV fleet customers by deploying chargers at their private depots.

Convenience

Our customers on the move also want compelling convenience offers while they charge their vehicles – that's why we'll be providing convenient amenities at many of our charging locations. We had 2,850 strategic convenience sites at the end of 2023, with an aim to grow this total to around 3,000 by 2025 and around 3,500 globally by 2030. In May 2023 we acquired TravelCenters of America, a leading travel centre operator in the US with a network of 290 travel centres strategically located on major highways across the US. This acquisition complements our US convenience and mobility business and brings growth opportunities for our transition growth engines: EV charging via bp pulse, convenience, bioenergy and in time, hydrogen. We believe we are well positioned to combine our capabilities and reach in both convenience and EV charging – helping us to provide customer focused, lower carbon transport solutions over time.

Renewables and power

According to the IEA's World Energy Outlook 2023[5], the share of wind and solar power in total generation is set to rise from 12% to about 30% by 2030. bp is helping to build that supply in onshore and offshore wind, where we are building capability in major markets worldwide, and by scaling solar power. Recently, bp has agreed to acquire the 50.03% interest it does not already own in Lightsource bp, one of the world's leading developers and operator of utility-scale solar and battery storage assets.[6]

Hydrogen

bp aims to build a global position in hydrogen – initially aiming to supply our own refineries and then potentially by scaling up to meet growing customer demand. In parallel, as markets evolve, we aim to develop global export hubs for hydrogen and its derivatives.

bp is putting plans in place today to bring lower carbon hydrogen into service where it really counts, close to industrial clusters. We're in action now to grow our hydrogen business, working towards more than 10 projects across Europe, the US and Australia. We are also exploring ways in which we could potentially increase the use of "blue" and "green" hydrogen at our refineries, potentially reducing the GHG emissions associated with the use of natural gas and "grey" hydrogen. By 2030, we aim to produce 0.5-0.7 million metric tonnes of lower carbon hydrogen per year.

Where we are now: Our destination is unchanged: we want to be a net zero company by 2050 or sooner and help the world get to net zero too.

bp is four years into the strategy it set out in 2020 – transforming from an international oil company into an integrated energy company, investing in today's energy and helping build tomorrow's. For the full picture of bp's progress on its aims please take a look at bp's Net Zero Ambition Progress Update Report.

Reimagining energy for people

We believe the world wants and needs a better and more balanced energy system that delivers secure, affordable and lower carbon energy. We're playing our part by investing in today's energy system, which is mainly oil and gas – and, not or – in our transition and the energy transition.

bp's work in India is a great example of bp's strategy in action.

bp in India

India, a key growth market, is a priority country for bp. As bp works towards transforming from an international oil company to an integrated energy company, its purpose and ambition is well aligned with that of the Government of India. bp is supporting the country's drive towards net zero and achieving energy independence. bp aims to become a trusted partner to the Government of India, as it works towards its stated goal of equitable growth for its citizens and net zero by 2070[7].

Together with our partners, Reliance Industries Limited – we're investing in the oil and gas the country needs today (currently producing around 30% of India's domestic gas and supplying 15 percent of the country's gas demand). We recognize that the Government of India continues its drive to decarbonize India's economy. bp is investing in transition growth engines that may help support the Government of India's energy transition ambitions for its country. For example, Jio-bp, our mobility retail JV with Reliance, provides EV charging infrastructure (set up over 240 fixed charging stations with over 4000 charging points) and compressed biogas solutions. In addition, we are in discussions with large corporates to help them develop integrated solutions (including low carbon fleet mobility) to help support their decarbonization journeys.

This article describes bp's Net Zero journey with some examples. This is not the complete representation of bp's net zero ambition, sustainability aims or related progress update. For further information on this please read more here: https://www.bp.com/en/global/corporate/sustainability.html

1 *https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/group-reports/bp-sustainability-report-2023.pdf*

2 *https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/investors/bp-net-zero-progress-update-2024.pdf*

3 *https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/investors/bp-net-zero-progress-update-2024.pdf*

4 *https://www.bp.com/en/global/corporate/news-and-insights/energy-in-focus/bp-awarded-gold-standard-by-the-un-for-our-methane-plans.html*

5 *https://origin.iea.org/reports/world-energy-outlook-2023*

6 *https://www.bp.com/en/global/corporate/news-and-insights/press-releases/bp-agrees-to-take-full-ownership-of-lightsource-bp.html*

7 *https://pib.gov.in/PressReleasePage.aspx?PRID=1768712*

NET ZERO 2030

15 Cairn Oil & Gas' low carbon trajectory to achieve Net Zero by 2030

Dr Steve Moore,
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India is the third largest consumer of energy in the world and imports 87% of its crude requirements. The impending rise in energy demand for a fast-growing large economy, driven by a growing population and per-capita consumption, underscores the need for energy self-sufficiency. Along with this, India is also leading global energy transition efforts to achieve Net Zero goal, while balancing its needs for energy security, affordability and sustainability.

As the leading private oil and gas exploration and production (E&P) company in India, Cairn, part of Vedanta Group, has been leading the strategy for innovative technological solutions to decarbonise its operations and accelerate efforts to achieve 'Net Zero Carbon by 2030'.

Cairn has a vision of contributing 50% domestic oil and gas production and supporting India's journey towards achieving energy security. For us, growth and sustainability are mutually reinforcing, and we aim to use this synergy to ensure that our

business remains resilient while also contributing to the environment and society. To drive energy transformation, we have embedded sustainability at the core of our business strategy.

We have adopted a comprehensive Environmental, Social and Corporate Governance (ESG) strategy, implementing innovative technological solutions in the E&P industry to significantly decarbonise our operations through renewables, flare gas reduction, energy efficiencies, carbon sequestration and nature-based solutions.

Minimising dependence on more polluting sources of power and setting a precedent in the industry, our aspirations are to enhance our operational performance in synergy with climate change mitigation. To ensure this, we are enabling use of clean and renewable energy sources, upsurge energy efficiency, reduce flaring and minimise fugitive emissions. This is done through process optimization, improved reliability, innovative low carbon technologies, opportunities in Waste to Energy and Carbon Capture Utilization & Storage (CCUS or CCS) and adoption of GHG reduction measures.

Renewable Energy Sourcing

- Cairn is sourcing up to 70 MW of renewable energy by 2030, with a renewable Power Delivery Agreement for 25 MW set to commence in FY'25.
- With the aim to harness solar energy and reduce reliance on conventional energy sources, Cairn has installed solar rooftop Photovoltaics of 2 MW across all locations.

Flare Gas Reduction

Cairn has made significant progress in flare gas reduction and witnessed a 60% decrease in potential gas flaring volume over the past four years.

- Flare Gas utilisation from KW-02 through gas cascading and bottling (annual GHG reduction potential ~6,000 tonnes of CO2 e/annum).
- Utilisation of flare gas from satellite fields through bottling and cascading to CNG players.
- Transporting gas from satellite fields to terminals through pipelines.
- Optimization of recycled gas compressors and installation of ejectors to reduce flaring in terminals.
- Process interventions and digital solutions to optimize parameters and reduce flare gas volumes.

Waste to Power and Carbon Capture Utilization and Storage (CCUS)

Cairn is conducting a feasibility study on the 'Waste to Power' project to utilise lean gas, CO2 rich gas, solid waste and other industrial waste, to generate power through pressurised oxy combustor technology. The resulting CO2 gas can then be further utilised for enhanced oil recovery.

Electrification and Energy Efficiency

To optimise fuel gas consumption and energy requirements in our operations, we are aggressively working on the electrification of our equipment and adopting energy efficient solutions.

- Installation of variable frequency drives and replacement of conventional lighting fixtures with energy-efficient LEDs.

- Deployment of more energy-efficient equipment, fittings, and technologies has been prioritised to enhance operational efficiency and reduce energy waste.
- Induction motors are being converted to Permanent Magnetic Motors (PMMs) to improve energy efficiency, reducing power consumption and operational costs.
- Conversion of steam-driven pumps to electric motor-driven pumps.
- Energy-efficient lighting systems and solar lightings across fields.
- Commissioned motor-driven power fluid pump at one of the largest oil processing facility - Mangala Processing Terminal in Rajasthan to replace the stream-driven pump. This has an Annual GHG reduction potential of ~86,000 tonnes of CO2 e/annum. Conversion of 2 more steam driven pumps to motor is underway which will reduce the emission by 1,36,000tCO2e/annum.
- Introduction of Electric Vehicles at our facilities.

Tree Plantation & Nature-based Solutions for Carbon Offsetting

- We are committed to preserving our biodiversity to create a positive impact on the environment and society. This is reinforced by our ongoing tree plantation initiatives across the regions of our operations. We have pledged to plant 2 million trees by 2030, supporting the local biodiversity of the region, ensuring No Net Loss.
- Cairn has developed 2,835 acres of greenbelt across our operational areas in Rajasthan, Gujarat and Andhra Pradesh, including 458 acres of mangroves.
- Ravva, our offshore asset in Andhra Pradesh has now been transformed into a vibrant wetland of mangroves spread over 86 acres.
- In Barmer, Rajasthan, we have planted 0.2 million trees across 988 acres of forest land and are reviving Khejari (Prosopis Cineraria) with 15,000 plants in the Thar Ecosystem. The overall greenbelt in Rajasthan covers 1600 acres.
- Gujarat coastal areas have been transformed with 372 acres of mangrove forest.

Innovations and New Technologies

- Cairn is also looking at the adoption of alternative cleaner fuels like synthetic hydrocarbons, biodiesel, biomethanol, and refused-derived fuel.
- We are exploring possibilities for incorporating green hydrogen into the energy mix.

By prioritising renewable energy sourcing, reducing flare gas, enhancing energy efficiency, and adopting innovative technologies, we are not only reducing our carbon footprint but also contributing significantly to India's energy independence.

We strongly believe that it is possible to meet the rising energy demands while minimising environmental impact. This responsible approach to energy production underscores our dedication to both operational excellence and the well-being of the planet, ensuring a resilient and sustainable business model for years to come.

NET ZERO 2038

16 Net Zero Plans of Oil and Gas Companies, an Indian Context

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At the 26th session of the Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Glasgow, United Kingdom, the Government of India presented the following five nectar elements (Panchamrit) of India's climate action :

- Reach 500GW Non-fossil energy capacity by 2030.
- 50 per cent of its energy requirements from renewable energy by 2030.
- Reduction of total projected carbon emissions by one billion tonnes from now to 2030.
- Reduction of the carbon intensity of the economy by 45 per cent by 2030, over 2005 levels.
- Achieving the target of net zero emissions by 2070.

India emphasized the importance of the transfer of climate finance and low-cost climate technologies for the implementation of climate actions by developing countries. The country also called for the tracking of climate finance and for developed countries to increase their ambitions on climate finance .

India's Energy Trilemma: A Complex Balancing Act

India is poised to the fastest growing large economy in the world. Govt. has already drawn a plan to make India one of the top three economies in the world within the centennial year from Independence – Amrit Kaal (2047). However, our nation also needs

to solve a formidable energy trilemma, characterized by the simultaneous pursuit of energy security, energy equity (affordability and accessibility), and environmental sustainability. This intricate challenge necessitates a delicate balancing act, wherein the nation strives to ensure reliable energy supply for its burgeoning population and rapidly growing economy while mitigating the adverse environmental impacts of energy production and consumption. The three points of the challenge are:

Energy Security

India's energy security is primarily threatened by its heavy reliance on fossil fuel imports, particularly crude oil. This dependency exposes the nation to volatile global energy markets and geopolitical risks. Additionally, ensuring uninterrupted energy access for all citizens, especially in remote and rural areas, remains a pressing concern.

Energy Equity

Energy poverty continues to plague a significant portion of India's population. Affordability and accessibility of clean energy sources are crucial for uplifting marginalized communities and achieving inclusive growth. Balancing the need for economic development with social welfare necessitates innovative solutions that ensure equitable energy distribution.

Environmental Sustainability

India's reliance on fossil fuels contributes significantly to greenhouse gas emissions, exacerbating climate change concerns. As a signatory to the Paris Agreement, India has committed to reducing its carbon footprint. This necessitates a transition towards cleaner energy sources and the adoption of sustainable practices across the energy sector.

Navigating the energy trilemma demands a multi-pronged approach, encompassing the following strategies:

- **Diversification of Energy Sources**: Expanding the share of renewable energy in the energy mix, promoting the use of natural gas as a transitional fuel, and exploring nuclear energy options.
- **Energy Efficiency Enhancement**: Implementing energy-efficient technologies and practices across industries, buildings, and transportation sectors.
- **Technological Innovation**: Investing in research and development of clean energy technologies, including energy storage solutions and smart grid infrastructure.
- **Policy and Regulatory Reforms**: Creating a conducive policy environment for clean energy investment, promoting energy conservation, and incentivizing sustainable practices.
- **International Collaboration**: Partnering with other nations and international organizations to access technology, finance, and expertise for a smoother energy transition.

By adopting a holistic and integrated approach, India can successfully address the energy trilemma and pave the way for a sustainable and equitable energy future.

Net Zero Emissions - A perspective from the Oil & gas industry

Today, oil and gas operations account for around 15% of total energy-related emissions globally, the equivalent of 5.1 billion tonnes of greenhouse gas emissions. The International Energy Agency's Net Zero Emissions by 2050 Scenario suggests that the emissions intensity of oil and

gas operations falls by 50% by the end of the decade. Combined with the reductions in oil and gas consumption in this scenario, this results in a 60% reduction in emissions from oil and gas operations to 2030. Oil and gas producers have a clear opportunity to address the problem of emissions from their activities through a series of ready-to-implement and cost-effective measures. These include tackling methane emissions, eliminating all non-emergency flaring, electrifying upstream facilities with low-emissions electricity, equipping oil and gas processes with carbon capture, utilization, and storage technologies, and expanding the use of hydrogen from low-emissions electrolysis in refineries .

The current Refining capacity in India is about 250-260 MMTPA and it is expected to grow to about 350 MMTPA in the next decade. Assuming the average energy consumption data of a moderately complex (Nelson Complexity index ~10), the GHG emission under Scope 1 & 2 is approximately 100 -120 MMTPA of CO2e by 2035 (Business As Usual case, with no GHG emission abatement program). The scale of the task taken up by Indian Oil & Gas sector is commendable given the quantum of emissions to be handled as above.

The Oil & Gas sector in India is taking steps towards achieving net-zero emissions. According to data from corporate announcements, Indian oil companies are targeting net zero by 2046 as they decarbonize operations to cut emissions and transition to cleaner fuels. While India has pledged net zero carbon emissions by 2070, state-owned companies have set targets ranging from 2038 (ONGC) to 2046 (IOC) . Indian oil and gas companies are demonstrating a strong commitment to Net Zero through substantial investments in renewable energy, biofuels, green hydrogen, CCUS, and energy efficiency measures. While the timelines and specific strategies vary, the collective ambition of these companies is a significant step towards India's broader net zero goals.

In terms of investment and funding support, India has seen a surge in clean energy investment in recent years. Almost half of this was devoted to low-emissions power generation, which includes solar PV. Fossil fuel investment grew by 6% over the same period, in response to rising demand for fuel and coal-fired power generation . Indian oil companies such as Indian Oil have also announced planned investments to help them reach their net-zero targets for operational emissions .

There are several areas in a typical refinery where greenhouse gas (GHG) emissions can be reduced. Typically, GHG process emissions from the refinery sector include emissions from venting, flares, and fugitive leaks from equipment such as valves, flanges, and pumps. In addition to emissions from petroleum refining processes, the sector also includes combustion emissions from stationary combustion units located at these facilities .

Planning for GHG reduction in a typical refinery can involve several measures. According to BCG, refineries can offset their emissions by developing their own renewable energy sources, both to power their own operations and to sell back into the power grid. Another option is fuel switching, where refineries explore low-carbon alternatives to the fuel that they use. Carbon Capture, Utilization, and Storage (CCUS) is another technology that can be essential for refineries to meet their net-zero emissions goals. Refineries can implement energy-saving measures like heat recovery systems, equipment upgrades, and explore low-carbon alternatives to the fuel that they use, such as replacing natural gas with CBG or installing on-site renewable energy systems such as the production of green hydrogen.

Beyond Energy Trilemma - Additional considerations

In addition to the main objective of tackling the energy trilemma, Indian Oil Sector companies need to factor the following assessments and bring in an optimal fitment into the solution space.

- **Socioeconomic Impact**: The transition to net zero must be just and equitable. This means creating new jobs in the clean energy sector, supporting workers in transitioning industries, and ensuring affordable energy access for all.
- **Research and Development**: India needs to invest heavily in R&D for clean technologies. This will not only help reduce the cost of these technologies but also create new opportunities for innovation and economic growth.
- **International Collaboration**: India can benefit from international collaboration on clean energy technologies. This can include technology transfer, joint research projects, and access to international climate finance.
- **Lifecycle Analysis**: It's essential to consider the entire lifecycle of refinery products, from production to consumption. This includes reducing emissions from the transportation and use of fuels, as well as developing sustainable end-of-life solutions for products.

The journey towards net zero becomes a calibrated approach while maintaining the right balances throughout. The dynamism of the energy market makes the task highly demanding and the collective wisdom of the industry need to be augmented with the guidance of policy bodies and Govt. agencies to charting the arduous course.

Strategies and Plans for a Pragmatic Transition

A combination of ground-up and top-down approaches. The objective is to capture some of the easy targets or 'low-hanging fruits'. With the impetus thus gained raise the levels to higher reduction of GHG by more direct interventions.

- **Digital Transformation**: Implement advanced data analytics and artificial intelligence to optimize refinery operations, reduce energy consumption, and identify opportunities for further emissions reduction.
- **Electrification**: Where feasible, electrify refinery processes using renewable energy sources. This can include using electric heaters, pumps, and compressors, as well as electrifying transport within the refinery.
- **Circular Economy**: Explore opportunities for a circular economy within the refinery, such as recycling water, reusing byproducts, and recovering valuable materials from waste streams.
- **Nature-Based Solutions**: Invest in nature-based solutions like afforestation and reforestation to offset emissions and enhance biodiversity.
- **Supply Chain Decarbonization**: Work with suppliers and customers to reduce emissions across the entire value chain. This can involve using low-carbon transportation, sourcing materials from sustainable sources, and encouraging customers to use fuels more efficiently.

There is one clear incentive for the reduction of Scope 1 & 2 emission, that is nothing but the pure commercial interest. It can be easily demonstrated that electrification of operation will not only reduce carbon footprint, but also reduce the cost of energy. A recent benchmarking survey indicated that Indian refineries incur almost 80% of their OpEx through energy costs. Here the linkage pf GHG emission reduction via electrification to bottom line margin is evident, and electrification is just one of the levers available for Scope 1&2 emission reduction.

Based on the above approach, a tentative plan for Net Zero approach for a standard, moderately complex Refinery is presented for illustration.

Roadmap for Implementation

- **Short-Term (1-5 years)**: Focus on energy efficiency improvements, renewable integration, and the development of a supportive policy framework.

- **Medium-Term (5-10 years)**: Begin implementing CCUS technologies, explore alternative feedstocks, and accelerate the deployment of clean technologies.
- **Long-Term (10+ years)**: Achieve net zero emissions through a combination of emissions reduction, renewable energy, CCUS, and negative emissions technologies.

Like every project, the success in Net Zero plan also is in the timely and planned execution. Monitoring the objective through certain Key Performance Indictors would guide the implementation plans and allow for any course correction, should there a need arise. The suggested areas for KPIs are as below.

Key Performance Indicators

- Reduction in greenhouse gas emissions (both absolute and intensity-based).
- Increase in renewable energy use.
- Improvement in energy efficiency.
- Progress in CCUS deployment.
- Adoption of circular economy practices.
- Reduction in air and water pollution from refinery operations.

The above could serve as a starting template for Net Zero Plans. However, elaborate and meticulous preparation and planning are imperative in the Net Zero campaign as the investments are of the order of few tens of thousands of crore rupees and the timeline for investment also need to be carefully drawn. Certain projects such as efficiency improvement can be without major investment, while other involving green hydrogen and renewable as feedstock can demand large capex.

Conclusion

A pragmatic approach to net zero for Indian refineries involves a multi-faceted strategy that addresses the energy trilemma while considering India's unique socioeconomic context. By focusing on energy efficiency, renewable integration, CCUS, alternative feedstocks, and circular economy principles, Indian refineries can not only reduce their environmental impact but also create new opportunities for innovation, economic growth, and sustainable development.

This journey requires a concerted effort from all stakeholders, including government, industry, academia, and civil society. With a clear vision, strong leadership, and collaborative action, India can achieve its net-zero goals and become a global leader in clean energy transition.

References

1 *India – World Energy Investment 2024 – Analysis - IEA, https://www.iea.org/reports/world-energy-investment-2024/india*

2 *Emissions from Oil and Gas Operations in Net Zero Transitions, https://www.iea.org/reports/emissions-from-oil-and-gas-operations-in-net-zero-transitions*

3 *Press Information Bureau, https://pib.gov.in/PressReleasePage.aspx?PRID=1795071*

4 *The World Energy Council India's National Energy Trilemma Index 2022*

5 *Observer Research Foundation: "Navigating the Indian Energy Trilemma"*

17 NET Zero Strategies for Oil & Gas Organizations

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India has committed to achieve the Net Zero target by 2070, and this ambitious goal includes reducing the Emissions Intensity of its GDP by 45% by 2030, compared to 2005 levels. These targets reflect India's dedication to sustainable development and its role in the global transition towards a low-carbon future.

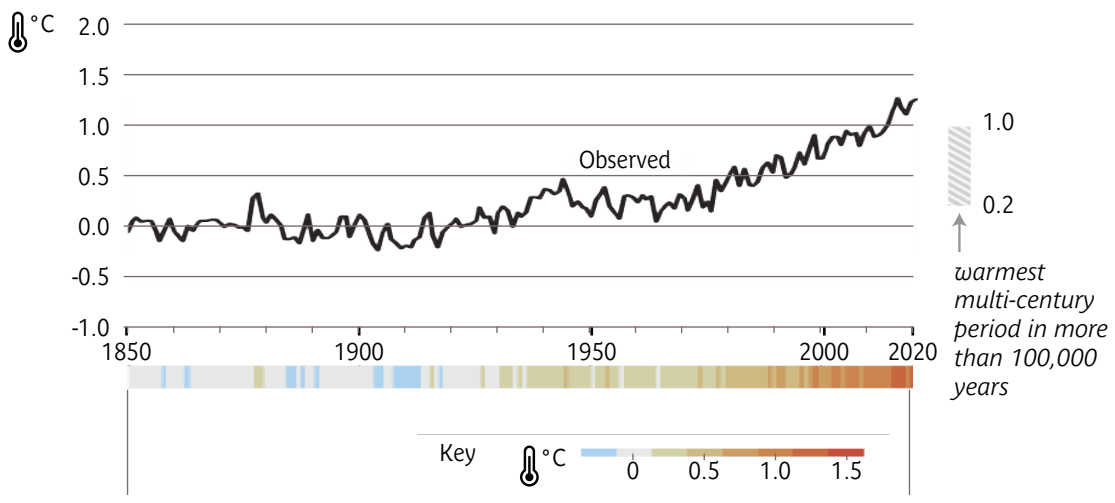
Understanding Net Zero

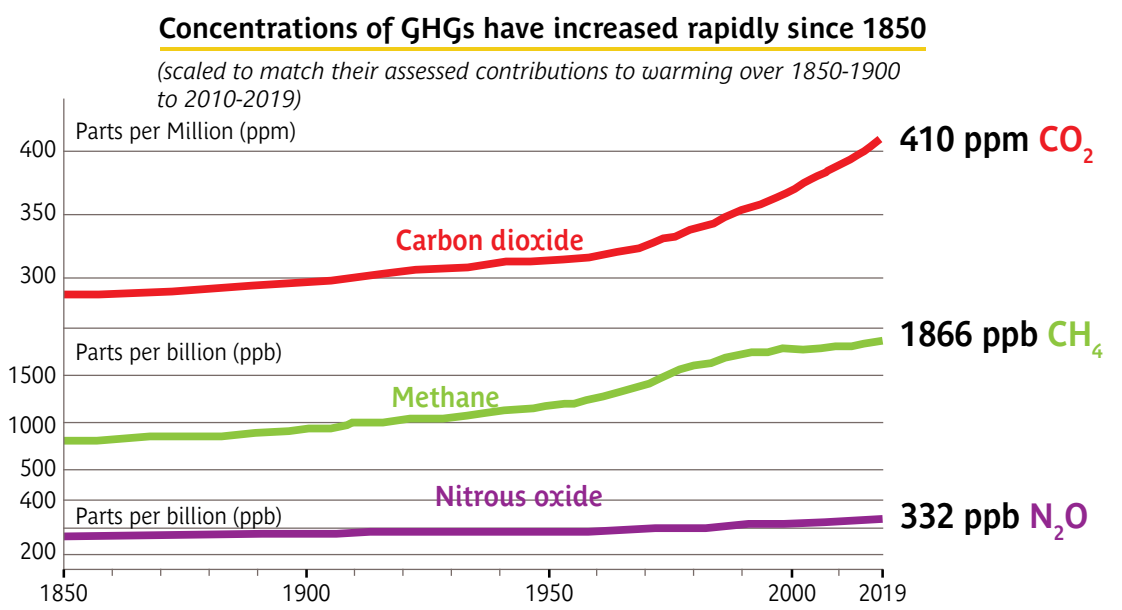
As per UN, Net Zero means cutting carbon emissions to a small amount of residual emissions that can be absorbed and durably stored by nature and other carbon dioxide removal measures, leaving zero emissions in the atmosphere.

The Imperative of Net Zero

The urgent quest for Net Zero CO2 emissions is driven by the severe consequences of greenhouse gases (GHGs) on global warming. Fossil fuel combustion releases CO2, disrupting the Earth's climate system and worsening the greenhouse effect. Human activities, primarily through GHG emissions, have unequivocally caused global warming, with the global surface temperature reaching 1.1°C above the 1850–1900 levels during 2011–2020.

Global surface temperature has increased by 1.1°C by 2011-2020 compared to 1850-1900





This warming has caused rapid alterations in the atmosphere, ocean, cryosphere, and biosphere. Human-induced climate change is impacting weather and climate extremes worldwide. For instance, global mean sea level rose by 0.20 meters between 1901 and 2018. The average rate of sea level rise has increased from 1.3 mm per year (1901-1971) to 1.9 mm per year (1971-2006), which further accelerated to 3.7 mm per year (2006-2018). Some ecosystems are approaching irreversible damage, such as the hydrological changes from glacier retreat and the alterations in certain mountain and Arctic ecosystems.

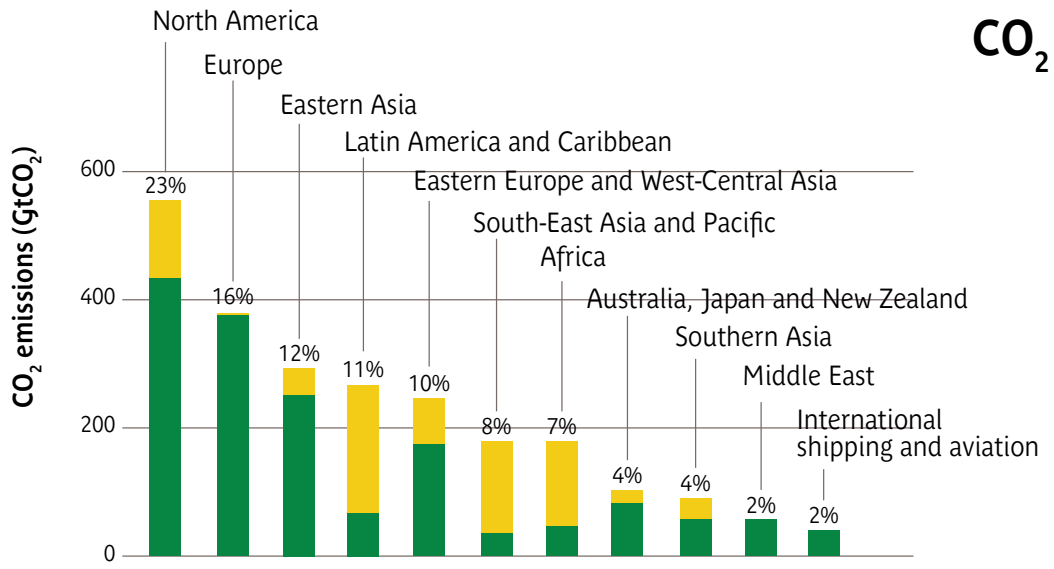
Increased extreme heat events have led to higher rates of human mortality and morbidity across all regions. The incidence of climate-related food-borne, water-borne, and vector-borne diseases has risen. With global warming now exceeding 1.1°C above pre-industrial levels, immediate and significant reductions in GHG emissions are crucial to avoid surpassing the critical 1.5°C threshold set by the Paris Agreement.

Global Momentum towards Net Zero

The global push for Net Zero is gaining significant traction, with over 140 countries setting Net Zero targets covering approximately 88% of global emissions. Some of the major countries target includes Germany (2045), USA (2050), UK (2050), Japan (2050), UAE (2050), Russia (2060), and China (2060). Additionally, more than 9,000 companies and over 1,000 cities have committed the Race to Zero campaign, pledging to take stringent actions to halve global emissions by 2030. This unprecedented cooperation between governments and businesses demonstrates a unified commitment in the battle against climate change.

India's Net Zero Commitment

India's historical contribution to global warming is minimal; with cumulative emissions from 1850 to 2019 constituting less than 4% of the world's total CO2 emissions during the pre-industrial era, despite being home to 17% of the global population. Additionally, India's current annual per capita emissions are about one-third of the global average. Despite its lower per capita emissions, India is taking a global leadership role in climate change by committing to achieve net-zero emissions by 2070, as announced at COP 26.



Historical cumulative net anthropogenic CO2 emissions per region (1850-2019)

Relevance of NET ZERO in Oil & Gas sector

According to the International Energy Agency (IEA), oil and gas operations account for about 15% of global energy-related emissions, equating to 5.1 billion tonnes of greenhouse gases. These emissions arise from various sources along the oil and gas supply chains. On average, each barrel of oil equivalent (boe) produces 105 kg CO2-eq, representing 20% of the full life cycle emissions intensity of combusted oil. For natural gas, scope 1 and 2 emissions amount to just over 65 kg CO2-eq/boe produced, which is 15% of the full life cycle emissions of combusted natural gas. Further, companies that fail to address climate change concerns may struggle to secure funding and could experience a reduced shareholder confidence.

Governance and Methodology

As per United States Environmental Protection Agency, Scope 1 emissions are direct greenhouse emissions that occur from sources that are controlled or owned by an organization and Scope 2 emissions are indirect greenhouse emissions associated with the purchase of electricity, steam, heat, or cooling.

Achieving Net Zero requires robust governance structures, including board-level oversight and shareholder support. The Science Based Targets Initiative (SBTi), incorporated as a charity, with partners like United Nations Global Compact, World Resources Institute (WRI), and the World Wide Fund for Nature (WWF), provides a framework to organizations for setting and achieving Net Zero targets. By 2023, over 4,200 companies and financial institutions had committed to net-zero by setting emissions reduction targets validated by the SBTi. A similar organization could be established in India to provide a Net Zero framework tailored to local conditions. By offering guidance and standardized practices, such an organization would facilitate Indian businesses to align with both national and international climate goals.

Another governance strategy is to establish a wholly-owned subsidiary dedicated to managing all green and emerging business opportunities under one umbrella, as implemented by energy majors like ONGC and HPCL.

Net Zero Roadmap

Government of India is leading from the front by implementing critical policies towards Net Zero targets. Government has launched schemes like "Sustainable Alternative Towards Affordable Transportation (SATAT)" for Compressed Biogas, PM-JIVAN for 2G ethnaol, the National Biofuel Policy and the National Hydrogen Mission among others. Globally, India has also taken a leadership role with initiatives like the Global Biofuel Alliance and the International Solar Alliance.

Major Oil & Gas CPSEs have committed more than Rs 7 lakh crore to achieve their Net Zero targets. Net Zero target years of major CPSEs are as below:

Sl. No	CPSE	Net Zero target
1	GAIL	2035
2	EIL	2035
3	ONGC	2038
4	OIL	2040
5	BPCL	2040
6	HPCL	2040
7	IOCL	2046

NET ZERO targets provide oil and gas companies a clear opportunity to address emissions from their operations through transformative measures. These include integrating renewable energy; tackling methane emissions; eliminating non-emergency flaring; usage of Hydrogen, biomethane and electrification for heating; equipping oil and gas processes with carbon capture, utilisation and storage technologies; expanding the use of green hydrogen and incorporation of energy storage solutions. Each organization must adopt a comprehensive, multi-pronged strategy tailored to their operations to effectively achieve Net Zero targets. Some of the key strategies are outlined below:

Renewable Energy

The necessity for renewable energy has never been more pressing as the world grapples with the dual challenges of climate change and depleting fossil fuel reserves. Transitioning to renewable energy is vital for reducing carbon footprint, ensuring energy security, and fostering economic growth through creation of green jobs and technological innovation. The COP28 commitment to triple renewable energy capacity underscores the widespread acknowledgment of this imperative. Oil & Gas companies should prioritize maximizing electrification wherever feasible, sourcing energy from renewable projects. This includes replacing fossil fuel-based equipment with electric alternatives to reduce carbon footprints.

Offshore Wind Energy

Offshore wind energy offers distinct advantages over onshore wind and solar, such as greater reliability and lower storage demands. The Union Cabinet has approved the Viability Gap Funding scheme for offshore wind energy projects in India. Given the substantial power requirements of offshore operations in the upstream sector, which cannot be adequately met through conventional grids and predominantly rely on natural gas, developing offshore wind projects becomes crucial. The sector's expertise in floating facilities, anchors, and moorings uniquely positions it to spearhead advancements in offshore wind technology.

Green Hydrogen

To meet significant heating demands, oil and gas companies should consider adopting hydrogen, either directly or by blending it with natural gas/ bio-methane. Green hydrogen, which can be integrated into existing pipelines, is crucial for reducing emissions and promoting sustainability.

Energy Storage

Battery Energy Storage Systems (BESS) play a critical role in enabling the broader adoption of renewable energy generation by mitigating its intermittency. BESS can replace diesel generators to provide backup power and ensure a consistent and reliable energy supply. Additionally, pumped hydro storage is a viable option for energy storage.

Carbon Capture, Utilization, and Storage (CCUS)

CCUS is a global initiative focused on decarbonizing the environment by capturing CO2 from major emission sources and either storing it underground permanently or utilizing it in industrial processes.

Compressed Bio Gas (CBG)

The government launched SATAT initiative, with the objective of creating an ecosystem for producing CBG from waste and biomass sources; with 68 projects already commissioned. Oil and Gas companies may make substantial investments in CBG infrastructure to facilitate the transition from Natural Gas to a blend of biomethane and Hydrogen, particularly for heating and power.

Methane Emission Reduction

Methane emissions account for nearly half of the Oil & Gas sector's scope 1 and 2 emissions globally. Addressing these emissions is a cost-effective strategy for reducing greenhouse gases due to methane's potency as a greenhouse gas and the potential to monetize captured gas, offsetting abatement costs. Measures such as leak detection and repair, optimizing energy use, and using centralized production facilities can reduce methane and flaring intensity. Oil & Gas companies are encouraged to use satellite-based technologies for monitoring large methane emissions. For instance, Methane Alert and Response System (MARS) is a pioneering global satellite technology to detect and notify about significant methane emissions worldwide.

Flaring Reduction

Non-emergency flaring and venting in oil field operations contribute significantly to greenhouse gas emissions. Existing technologies can mitigate nearly 95% of these emissions. Options to utilize flared natural gas include integrating it into existing gas networks, reinjection to maintain reservoir pressure, or converting it into LNG, CNG, or methanol. Mobile mini-LNG production equipment is another innovative solution that helps reduce flaring during short-term operations like well testing.

Biofuels

Government has set target of 20% blending of ethanol in petrol by 2025-26. Through usage of biofuels like biodiesel, bioethnaol and bio CNG, transportation can be made green and sustainable. Additionally, Government's initiative of blending Aviation Turbine Fuel with Synthetic Aviation Fuels marks a significant step towards greening aviation.

Electric Vehicles (EVs)
Transitioning from diesel to EVs is crucial for reducing emissions and promoting resilient, green and sustainable transportation. Investing in EV infrastructure, such as ultra-fast chargers and battery swap hubs, would further enhance the sustainability and resilience of future transportation systems.

Energy Efficiency
Energy efficiency often referred as the "first fuel" in clean energy transitions, offering rapid and cost-effective CO2 mitigation and reducing energy costs. Strategies include optimizing processes, digitalization, switching to natural gas, and improving boiler/furnace efficiency among others.

Nature-Based Solution
Organizations can significantly contribute to carbon sequestration by undertaking large scale afforestation projects, which help offset carbon footprints and support global climate goals.

Key Enablers

Financing the Transition
As per IEA, upfront investments totalling USD 600 billion would be required globally to halve the emissions intensity of oil and gas operations by 2030. Oil and gas companies can explore alternative and innovative financing sources, such as Social Impact Bonds and Green Bonds, to fund Net Zero initiatives.

Internal Carbon Pricing
Oil & Gas companies shall strive for implementing Internal Carbon Pricing (ICP) in respective organizations, to incorporate the cost of carbon emissions into financial decisions. By assigning a monetary value to carbon emissions, companies can better assess the environmental impact of their operations and investments.

Research and Development (R&D)
Oil & Gas companies may invest heavily in R&D to drive innovations that reduce greenhouse gas emissions to net zero. This includes developing technologies in renewable energy, energy storage, carbon capture, and enhancing energy efficiency across sectors. Oil and gas companies should also invest significantly in the capacity building of their employees to ensure they are future-ready.

Sales and Lifecycle Emissions
Downstream companies should reduce the carbon intensity of their energy products by considering lifecycle emissions from production to use. By increasing alternative energy sources in their product mix, companies can significantly lower well-to-wheel or well-to-wire emissions, promoting a sustainable energy system.

Way forward - Transparency and Disclosure
Publishing annual Net Zero plans and achievements is essential for reaffirming organizational ambition and tracking progress towards sustainability. Transparent reporting enhances

credibility and encourages continuous improvement towards a sustainable future.

Supporting a Just Transition

India's oil and gas sector faces challenges and opportunities in transitioning to Net Zero emissions. The journey to Net Zero is not just an environmental imperative but also an opportunity to create a more sustainable and equitable world for all.

Achieving Net Zero requires a fundamental transformation within the oil and gas sector. Traditional oil companies must evolve into integrated energy companies that meet growing energy demands with increasingly lower emissions. This shift will shape the future energy system, promoting sustainable development and prosperity in the country.

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References

1. *United Nations https://www.un.org/en/climatechange/net-zero-coalition*
2. *International Energy Agency – IEA (Emissions from Oil and Gas Operations in Net Zero Transitions)*
3. *https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf*
4. *IEA (2023), Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach, IEA, Paris*
5. *https://sciencebasedtargets.org/*
6. *https://www.iea.org/energy-system/fossil-fuels/gas-flaring*
7. *IEA : The Oil and Gas Industry in Net Zero Transitions*
8. *https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance*
9. *Press Information Bureau (PIB)*

18 Oil and Gas Industry in Net Zero Transitions

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International Energy Agency

Condensed from IEA's World Energy Outlook Special Report "The Oil and Gas Industry in Net Zero Transitions" published in November 2023

Introduction

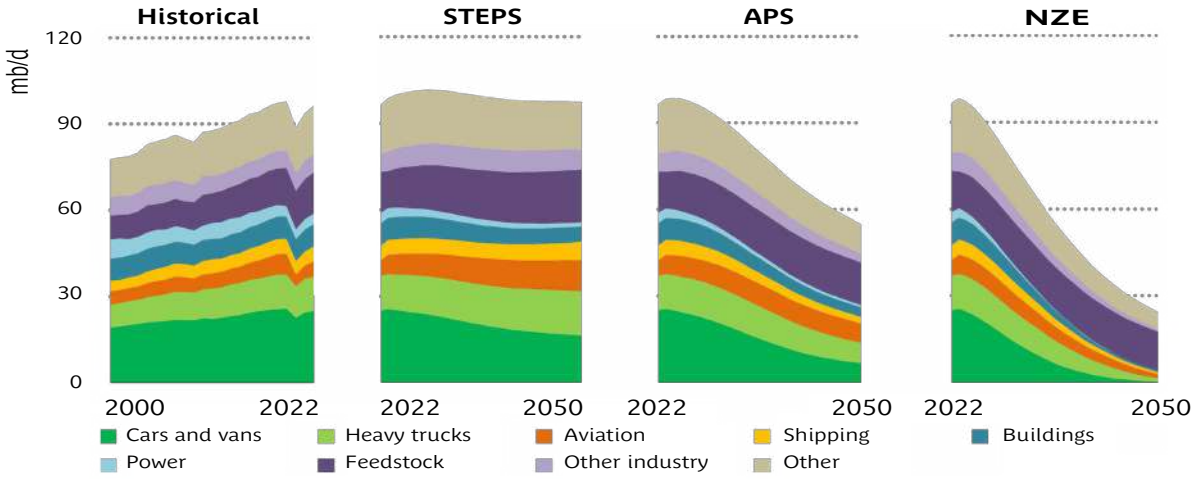
Structural changes in the energy sector are now moving fast enough to deliver a peak in oil and gas demand by the end of this decade under today's policy settings. After the peak, demand is not currently set to decline quickly enough to align with the Paris Agreement and the 1.5 °C goal. But if governments deliver in full on their national energy and climate pledges, then oil and gas demand would be 45% below today's level by 2050 and the temperature rise could be limited to 1.7 °C. If governments successfully pursue a 1.5 °C trajectory, and emissions from the global energy sector reach net zero by mid-century, oil and gas use would fall by 75% in 2050.

The implications of net zero transitions are far from uniform: the industry encompasses a wide range of players, from small, specialised operators to huge national oil companies (NOCs). While the focus is usually on the role of the majors, which are seven large international players, they hold less than 13% of global oil and gas production and reserves. On the other hand, NOCs account for more than half of global production and close to 60% of the world's oil and gas reserves.

The Outlook for Oil and Natural Gas Demand and Supply in Net Zero Transitions

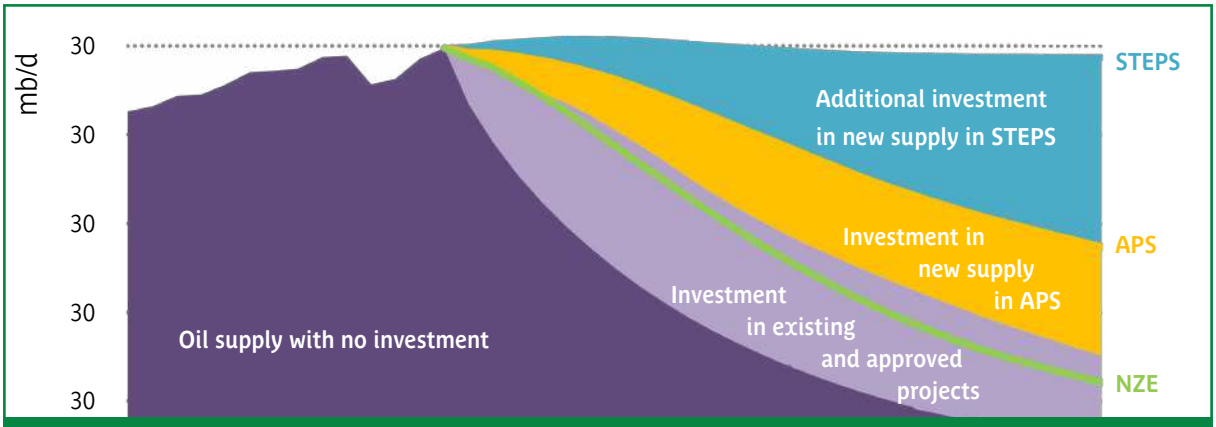
Oil

Global oil demand rebounded since the steep 9 mb/d drop caused by Covid-19 in 2020. In the Stated Policies Scenario (STEPS), oil demand reaches a maximum level of 102 mb/d in the late 2020s before declining to 97 mb/d in 2050. There are large declines in oil use in cars, buildings and power generation, although most of this is offset by growth in oil use in trucks, aviation and petrochemicals. Here investment in all types of production is required to ensure adequate supply. In the Announced Pledges Scenario (APS), oil demand soon peaks and declines to 93 mb/d in 2030 and 55 mb/d in 2050. In the Net Zero Emissions by 2050 Scenario (NZE), demand falls to 77 mb/d in 2030 and 24 mb/d in 2050.



Oil Demand by Scenario 2000-2050

In the STEPS, although demand peaks before 2030, the annual average rate of decline thereafter is less than 0.2% to 2050 and investment in all types of production is required to ensure that there are no shortfalls in supply. In the APS, oil demand falls by 0.5% each year on average to 2030 and by around 2.5% each year between 2030 and 2050. In aggregate, no further hydrocarbon exploration is needed to meet these demand levels, although new conventional oil discoveries may in some cases be produced at a lower cost than existing sources of production. In the NZE Scenario, the pace of decline is sufficiently strong that no new long lead time upstream conventional projects need to be approved for development.

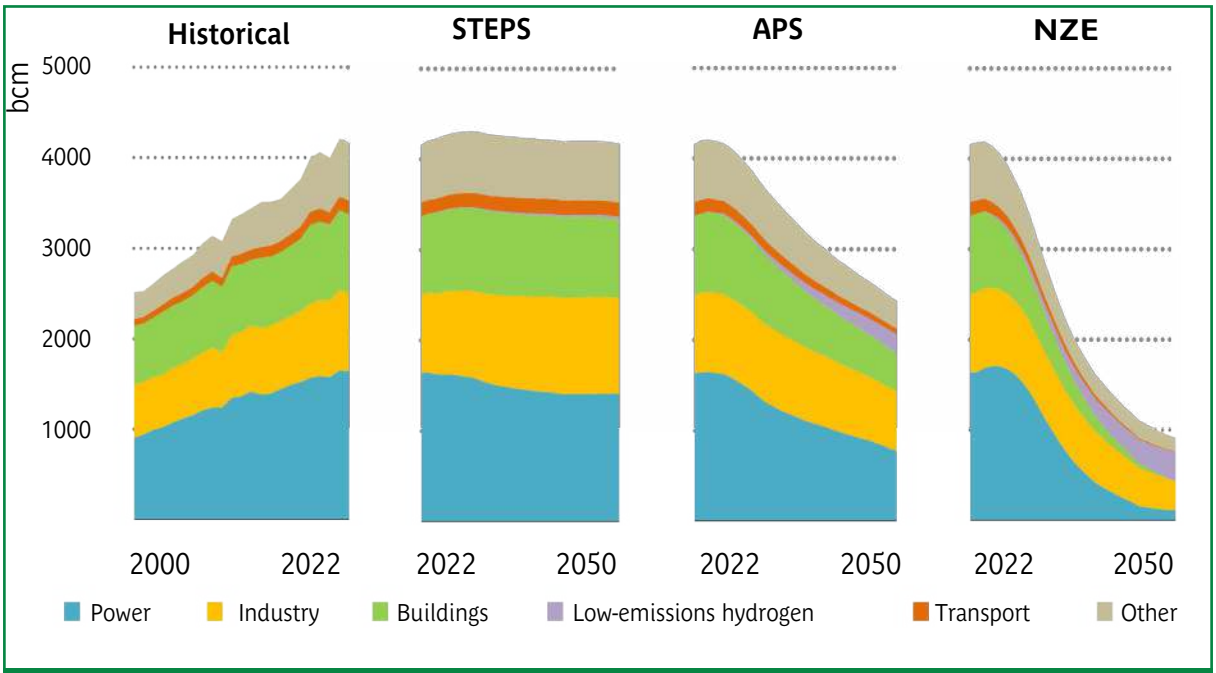


Oil Supply by Scenario 2000-2050

Natural Gas

Natural gas markets were upended by Russia's invasion of Ukraine. The sharp reduction in pipeline supply to Europe tightened global gas markets, resulting in record high prices and a drop in global demand of around 1% in 2022. Prices moderated in 2023 and are expected to come under downward pressure in the second half of the 2020s as a large new wave of LNG export facilities starts operation. There is still significant scope for demand growth this decade, notably in industry, despite the near-term risks brought about by the supply squeeze. Nonetheless, increasingly cost-competitive low-emissions options for power generation and heating – alongside increased climate ambitions among many emerging market and developing economies in Asia – raise major questions about the long-term outlook for natural gas demand.

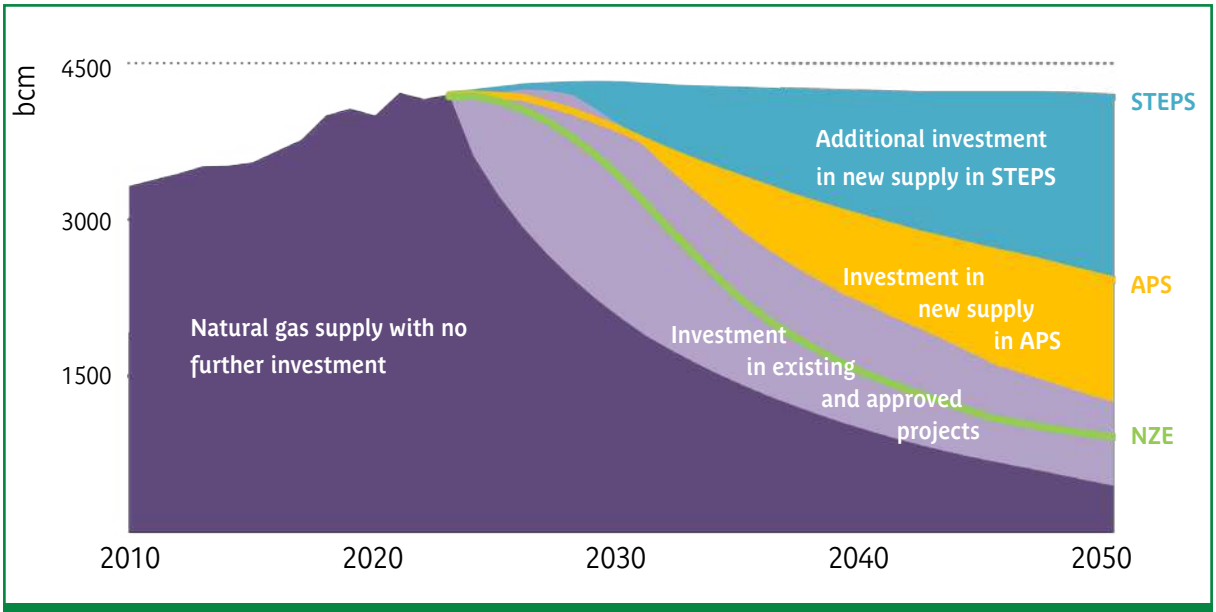
In the STEPS, natural gas demand growth to 2030 is considerably lower than the 2.2% seen on average between 2010 and 2021. Demand peaks before 2030, after which moderate



Natural Gas Demand by Scenario 2000-2050

growth in some emerging market and developing economies is offset by declines in advanced economies, resulting in relatively stable demand globally between 2030 and 2050. In the APS, global natural gas demand soon peaks and by 2030 is nearly 10% lower than in 2022. In the NZE Scenario, natural gas falls rapidly in all sectors and demand is 20% lower in 2030 than in 2022.

In the STEPS, new sources of gas supply are essential to meet demand and offset declines in existing sources of supply. Meeting the level of demand under APS requires around 1200 bcm of supply from new projects in 2050, which in aggregate can be met without any further natural gas exploration. In the NZE Scenario, natural gas demand falls on average by 2.5% per year between 2022 and 2030. Demand could be met in aggregate without any new long lead time upstream conventional projects, but some projects that have already been approved help ensure gas demand can be met at the country and regional level. Between 2030 and 2040, demand in the NZE Scenario declines by around 7.5% per year, a rate faster than implied by aggregate declines in existing sources of production. Globally, around 650 bcm of production capacity would be surplus to demand requirements in 2040 and some higher-cost projects would close before reaching the end of their technical lifetimes.



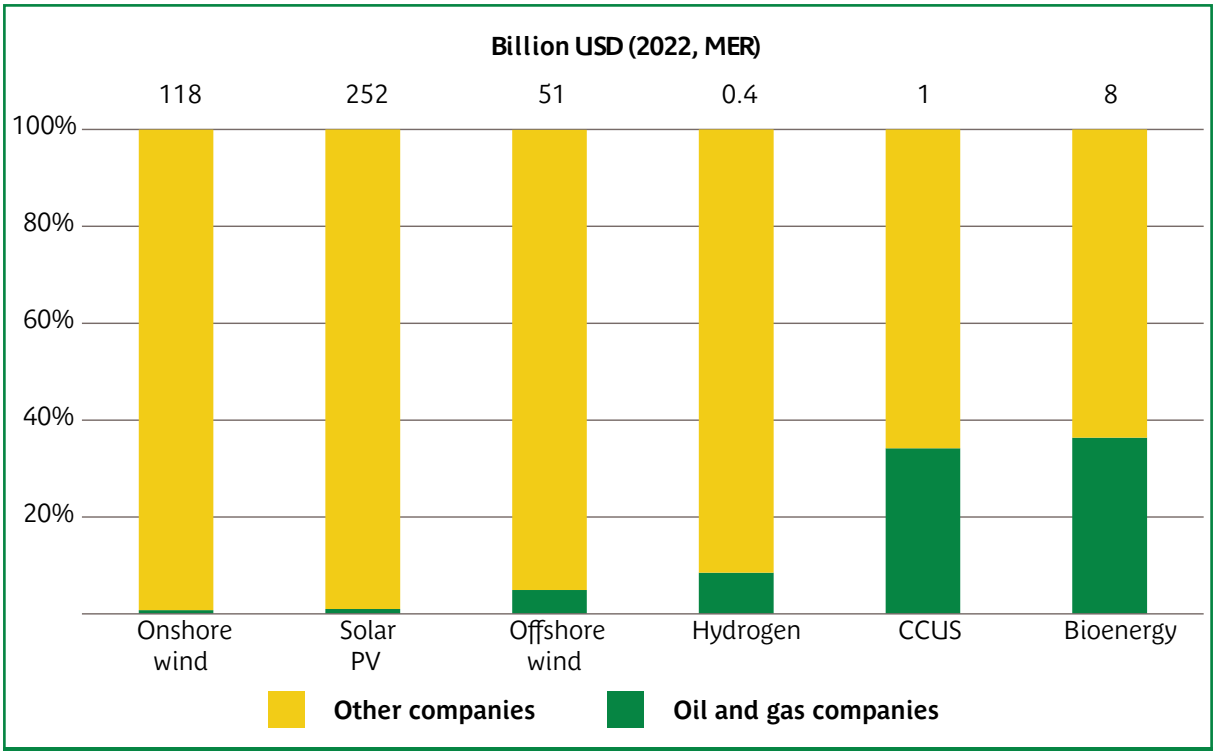
Natural Gas Supply by Scenario 2010-2050

The Role of Oil and Gas Companies in Energy Transition

Most oil and gas companies are currently watching the energy transitions from the sidelines. Oil and gas producers account for only 1% of total clean energy investment globally. More than 60% of this comes from just four companies. Companies that have announced a target to diversify into clean energy account for just under one-fifth of current oil and gas production. The oil and gas industry invested around 2.5% of its total capital spending in clean energy in 2022. While there is no single blueprint for change, there is one element that can and should be in all company transition strategies: reducing emissions from the industry's own operations. As things stand, less than half of current global oil and gas output is produced by companies that have targets to reduce these emissions. A far broader coalition – with much more ambitious targets – is needed to achieve meaningful reductions across the oil and gas industry.

Oil and gas operations result in around 15% of global energy-related greenhouse gas emissions. To align with a 1.5 °C scenario, these emissions need to be cut by more than 60% by 2030 from today's levels and the emissions intensity of global oil and gas operations must near zero by the early 2040s. For producers that choose to diversify and are looking to align with the aims of the Paris Agreement, IEA's bottom-up analysis of cash flows in a 1.5 °C scenario suggests that a reasonable ambition is for 50% of capital to be invested in clean energy projects by 2030, on top of the investment needed to reduce scope 1 and 2 emissions.

Some 30% of the energy consumed in a net zero energy system in 2050 comes from low emissions fuels and technologies that could benefit from the skills and resources of the oil and gas industry. These include hydrogen and hydrogen-based fuels; carbon capture, utilisation and storage (CCUS); offshore wind; liquid biofuels; biomethane; and geothermal energy. Oil and gas companies are already partners in a large share of planned hydrogen projects that use CCUS and electrolysis and are involved in 90% of CCUS capacity in operations around the world. However, for other sectors, such as for offshore wind – oil and gas industry only accounts for the development of around 2% of offshore wind capacity in operation. Nevertheless, plans are expanding, and the technology frontier for offshore wind – including floating turbines in deeper waters – moves this sector closer to the strong areas of oil and gas company strength.



Average annual investment (Billion USD ([2022])

Investments in Oil and Gas in Net Zero Transitions

The volatility of fossil fuel prices means that revenues could fluctuate from year to year – but the bottom line is that oil and gas becomes a less profitable and a riskier business as net zero transitions accelerate. If demand and prices follow a scenario based on today's policy settings, it would value today's private oil and gas companies at around USD 6 trillion. If all national energy and climate goals are reached, this value is lower by 25%, and by 60% if the world gets on track to limit global warming to 1.5 °C.

Oil and gas projects currently produce slightly higher returns on investment, but those returns are less stable. We estimate that the return on capital employed in the oil and gas industry averaged around 6-9% between 2010 and 2022, whereas it was 6% for clean energy projects.

Continued investment in oil and gas supply is needed in all scenarios, but the USD 800 billion it currently invests each year is double what is required in 2030 to meet declining demand in a 1.5 °C scenario. In a scenario that hits global net zero emissions by 2050, declines in demand are sufficiently steep that no new long lead-time conventional oil and gas projects are required. Some existing production would even need to be shut in. In 2040, more than 7 million barrels per day of oil production is pushed out of operation before the end of its technical lifetime in a 1.5 °C scenario.

In net zero transitions, new project developments face major commercial risks and could also lock in emissions that push the world over the 1.5 °C threshold. The distribution of future supply among producers will depend on the weight assigned to lowering costs, ensuring diversity of supply, reducing emissions, and fostering economic development. Market forces naturally favour the lowest-cost production, but that leads to a high concentration in supply among today's major resource holders, notably in the Middle East. Prioritising the least emissions-intensive sources drives progress towards climate goals, but this often favours low-cost producers, so supply still becomes more concentrated. It is much better for transitions if

all producers take targeted action to reduce their emissions. If production from low-income producers is favoured, these projects may not ultimately be very profitable in a well-supplied market. And if countries prefer domestically produced oil and gas to buttress energy security, they reduce reliance on others but risk finding themselves with relatively high-cost projects in a low-price world.

Two pitfalls for the discussion about the future of oil and gas

A productive debate about the oil and gas industry in transitions needs to avoid two common misconceptions.

The first is that transitions can only be led by changes in demand. "When the energy world changes, so will we" is not an adequate response to the immense challenges at hand. An imbalanced focus on reducing supply is equally unproductive, as it comes with a heightened risk of price spikes and market volatility. In practice, no one committed to change should wait for someone else to move first. Successful, orderly transitions are collaborative ones, in which suppliers work with consumers and governments to expand new markets for low-emissions products and services.

The second is excessive expectations and reliance on CCUS. Carbon capture, utilisation and storage is an essential technology for achieving net zero emissions in certain sectors and circumstances, but it is not a way to retain the status quo. If oil and natural gas consumption were to evolve as projected under today's policy settings, this would require an inconceivable 32 billion tonnes of carbon captured for utilisation or storage by 2050, including 23 billion tonnes via direct air capture to limit the temperature rise to 1.5 °C. The necessary carbon capture technologies would require 26 000 terawatt hours of electricity generation to operate in 2050, which is more than global electricity demand in 2022. This would require over USD 3.5 trillion in annual investments all the way from today through to mid-century, which is an amount equal to the entire industry's annual average revenue in recent years.

The Way Forward

Economies that are heavily reliant on oil and gas revenues face some stark choices and pressures. These choices are not new, but the prospect of falling oil and gas demand adds a timeline and a deadline to the process of economic diversification. Today's producer economies retain energy advantages even as the world moves away from fossil fuels. Most major producers of low-cost hydrocarbons also have expertise and ample, under-utilised renewable energy resources that could anchor positions in clean energy value chains and low-emissions industries. Reducing emissions from traditional supplies, including end-use emissions; putting domestic energy systems on a cleaner footing by phasing out inefficient subsidies and boosting clean energy deployment; and developing low-emissions products and services offer a way forward.

Dialogue across all parts of oil and gas value chains remains essential to deliver an orderly shift away from fossil fuels – and to ensure that today's producers have a meaningful stake in the clean energy economy. The industry must change, but this dialogue also needs clear signals from consumers on the direction and speed of travel to guide investment decisions, to assign value to oil and gas with lower emissions intensities, to develop markets for low emissions fuels, and to collaborate on technology innovation. Energy transitions can happen without the engagement of the oil and gas industry, but the journey to net zero will be more costly and difficult to navigate if they are not on board.

19 Climate-related policies and actions by OPEC Member Countries

OPEC Secretariat,
Vienna, Austria

Organization of the Petroleum Exporting Countries

It is evident that OPEC Member Countries have made significant strides in contributing to collective greenhouse gas (GHG) emission reductions with the objective to achieve the Paris Agreement goals, to which all OPEC Member Countries are signatories.

In recognizing the issue, OPEC Member Countries are contributing to global efforts to reduce emissions and achieve the Paris Agreement goals, while considering their national circumstances and capabilities. Historically, OPEC Member Countries have accounted for only around 4% of cumulative global CO2 emissions since 1850 (see table).

Table – Share of global cumulative CO2 emissions, 1850-2022

	(%)
US	24.13
UK	4.26
G7	43.12
EU27	16.69
OPEC	4.04

Source: Our World in Data

Climate policies of OPEC Member Countries

This section provides an overview of the climate targets set by OPEC Member Countries, with each country establishing targets to reduce emissions. However, it is crucial to highlight the conditional elements of some targets, which are dependent on a variety of forms of international support. Furthermore, it is imperative to understand that there are not one-size-fits-all solutions to tackle climate change.

Algeria submitted its Intended Nationally Determined Contribution (INDC) in 2015 and ratified the Paris Agreement a year later. To further underscore its commitment, Algeria submitted a Voluntary National Review (VNR) in 2019. The country aims to reduce GHG emissions by 7%-22% by 2030, using 2012 as the reference year. It plans to achieve a 7% reduction in emissions through national means and up to 22% with conditional measures,

including external support in finance, technology development and transfer, and capacity building.

Congo ratified the Paris Agreement in 2017, following its signature in 2016, and submitted its INDC in 2015. Additionally, in 2019, Congo presented a VNR to the UN High-Level Political Forum on Sustainable Development (HLPF). Most recently, in a revised NDC in 2021, the country pledged to unconditionally reduce GHG emissions by 17% by 2025, relative to business-as-usual (BAU), and over 21% by 2030. Moreover, Congo has set conditional targets to reduce emissions by 39.88% by 2025 and 32.19% by 2030.

Equatorial Guinea ratified the Paris Agreement in 2018, after submitting its Intended INDCs in 2015. In 2018, it submitted its first NDC and later revised it in 2022, along with a VNR to the HLPF. The NDC outlines goals to reduce emissions by 35% by 2030 and 50% by 2050, based on 2019 levels, conditional on international support.

Gabon ratified the Paris Agreement in 2016, and submitted its INDC in 2015, followed by NDCs in 2016 and 2022, along with a VNR to the HLPF in 2022. The country aims to remain carbon-neutral indefinitely and commits to maintaining a net absorption of at least 100 million metric tons of CO2 equivalent annually beyond 2050, contingent on certain conditions.

IR Iran signed the Paris Agreement in April 2016 but has yet to ratify it, citing the need for sanctions to be lifted first. Despite this, IR Iran remains committed to global GHG mitigation and adaptation efforts. The country submitted its INDC in 2015, outlining its GHG emission targets. IR Iran aims to reduce emissions by 4% by 2030, with a conditional target of 12% contingent upon the removal of sanctions and access to international resources such as financial support, technology transfer, and carbon credits.

Iraq ratified the Paris Agreement in 2021, demonstrating an active role in global climate governance. The Member Country submitted a revised NDC in 2021 and a VNR in 2021. Iraq aims to reduce GHG emissions by 1-2% by 2030 unconditionally, with a conditional goal of a 15% reduction by 2030, contingent upon international support. This goal is crucial for Iraq's transition to sustainable energy, especially considering infrastructure needs, estimated at $54 billion in 2021, due to national circumstances.

Kuwait submitted its first NDC in 2018, followed by an updated version in 2021. Additionally, a second VNR was published in 2023. These important documents outline Kuwait's objectives, which include reducing emissions by 7.4% by 2035 through unconditional measures. Kuwait aims to achieve these measures by also transitioning to a circular carbon economy (CCE) and conforming to its 4 pillars: reduce, reuse, recycle and remove. Looking ahead, Kuwait has set a goal of achieving net-zero emissions by 2060 and reach net-zero emissions in the oil and gas sector by 2050.

Libya signed the Paris Agreement in 2016 but has yet to ratify it. In 2020, it submitted a VNR to HLPF. In 2020, Libya's total emissions were 75.37 MTCO2e, accounting for around 0.25% of global emissions.

Nigeria presented its NDC in 2021, announcing a national target of reducing GHG emissions by 20% by 2030. Additionally, Nigeria has announced a conditional GHG reduction target of 47% compared to BAU by 2030, contingent on external support. The country also ratified the Paris Agreement in 2017. In June 2020, Nigeria submitted its VNR to the HLPF, demonstrating its commitment to sustainable development goals. In addition, in 2021, it published a long-term strategy for 2050–2070 and set forth the goal of reaching net-zero emissions by 2060.

Saudi Arabia is dedicated to establishing sustainable governance, having ratified the Paris Agreement in 2016 after publishing an INDC in November 2015, which has since been updated in October 2021. The recent submission sets the target of reducing GHG emissions by 278 MtCO2e annually by 2030, with 2019 being the baseline year. This goal has been set without any conditional measures. In the long term, Saudi Arabia's commitment to sustainability is aptly reflected in the Saudi Green Initiative that aims to achieve net-zero carbon emissions in

the country by 2060. Furthermore, the Saudi led Middle East Green Initiative is a regional effort aimed at mitigating the impact of climate change, fostering increased cooperation, developing essential infrastructure to reduce emissions, and protecting the environment. Moreover, the Circular Carbon Economy (CCE) framework, introduced during Saudi Arabia's G20 Presidency and subsequently endorsed by G20 countries, represents a comprehensive strategy to manage greenhouse gas emissions.

The United Arab Emirates (UAE) has demonstrated a level of dedication towards addressing the challenges posed by climate change by releasing a third update of its second NDC in 2023. On this occasion, the UAE reaffirmed their ambition of reaching net zero by 2050 through unconditional measures. As the UAE hosted COP28 in Dubai, it aimed to lead by example and accelerate the implementation of progressive, inclusive, and responsible climate policies.

Venezuela ratified the Paris Agreement in 2017 and submitted one VNR to the HLPF in 2016. As part of its commitment to environmental action, Venezuela submitted its first NDC in 2018, which was later revised in November 2021. However, it is important to note that Venezuela's NDC target does not include any national unconditional measures. Instead, they have set a conditional target of reducing GHG emissions by 20% by 2030. As part of its approach, both adaptation and mitigation methods will be employed, but adaptation has been prioritized.

Actions undertaken by OPEC Member Countries

To achieve climate targets, OPEC Member Countries are implementing comprehensive strategies. As a result, in recent years, OPEC Member Countries have been increasingly investing in decarbonizing technologies, renewables, nuclear and hydrogen.

There is a recognition among OPEC Members Countries of the crucial role that renewable energy can play in diversifying their economies, mitigating emissions, and enhancing energy security. For instance, Saudi Arabia, under its Vision 2030, aims to generate 50% of its power from renewable energy sources by 2030, from less than 0.2% in 2021. NEOM, a project on Saudi Arabia's Red Sea coast, is to be a futuristic region powered by 100% renewable energy. In 2023 alone, Saudi Arabia invested nearly $10 billion on energy transition projects. Similarly, the UAE has set a target to generate 50% of its energy from clean sources by 2050, reflecting substantial commitments to solar and nuclear energy. Nigeria has set an ambitious goal of achieving 30% of its energy mix from renewable sources by 2030. In the same vein, Kuwait has announced its plan to produce 15% of its total energy mix from renewables by 2030. Algeria has announced its goal of 27% renewable power generation in their mix by 2030.

OPEC Member Countries have significant potential for solar and wind power, however, capitalising on this potential requires substantial investments, supportive policy frameworks, and advances in renewable energy technologies. Currently, several commercial-scale wind and solar plants are operational with several more already under development or announced. For instance, Saudi Arabia's renewable capacity stands at 2.8 GW in 2024, with 2.1 GW of this capacity coming in 2023 alone. Furthermore, new developments in nuclear power have been increasing the share of low-carbon energy connected to electricity grids. For example, the Barakah power station will provide a huge 5.6 GW of capacity to the UAE's electricity grid. Saudi Arabia plans to initially build two nuclear reactors (1.4 GW) and increase to 16 GW by 2040, enhancing energy security and sustainability goals.

Another use of abundant renewable energy sources is for the generation of hydrogen through electrolysis. Additionally, blue hydrogen that is produced from hydrocarbons but is coupled with CCUS offers a lower-cost alternative to hydrogen production. Algeria's National Hydrogen Roadmap states an aim to produce and export 30 to 40 MWh of hydrogen and hydrogen derivatives by 2040. The country's hydrogen roadmap consists of three phases: start-up (2023-30), which will include pilot projects; expansion and market creation (2030-40); and industrialisation and market competitiveness (2040-50).

Furthermore, the first shipment of low-carbon ammonia from Saudi Arabia, produced with the use of CCUS technology, arrived in Japan for power generation in 2023. In 2024, the UAE then delivered another shipment to Japan containing low-carbon ammonia.

Like many other countries on the continent, African OPEC Member Countries have showed interest in using hydrogen as an energy carrier. Consequently, the African Hydrogen Partnership was established to facilitate cooperation in this area. Several African countries have partnered with the German Government to develop a hydrogen potential. Germany has set up so-called Hydrogen Offices in Nigeria to facilitate dialogue with this country.

There is a strong emphasis on investing in technologies such as CCS and CCUS to mitigate carbon emissions. Currently, several CCS facilities exist in OPEC Member Countries and more projects are already under development or have been announced. Furthermore, other Member Countries have announced plans to explore the development of CCS.

The strategies extend beyond national plans to include major international oil companies (IOCs) and national oil companies (NOCs) operating within OPEC Member Countries. These entities are implementing measures to reduce GHG emissions in their operations throughout the entire hydrocarbon supply chain and contributing to a collective effort toward a sustainable future by deploying CCUS and hydrogen technologies.

Companies such as Aramco aim for zero gas flaring by 2030 and address emissions through efficiency gains, renewables, and CCUS. For instance, the Jubail CCUS hub will capture up to 9 million metric tons of CO2 per year starting in 2027. Aramco's share is due to be 6 million metric tons per year and the remaining 3 million metric tons will be from neighboring industrial emitters. Furthermore, Aramco has developed on-board carbon capture units for ships, similar to SOx scrubbers, to support the continued use of oil products in the shipping industry. In the UAE, ADNOC has achieved ISO 50001 certification for energy management systems, reduced gas flaring, and has been investing in hydrogen and CCS.

Other NOCs, including GEPetrol (Equatorial Guinea), NOCs and IOCs in Iraq, KPC (Kuwait), LNOC (Libya), NIOC (IR Iran), NNPC (Nigeria), PDVSA (Venezuela), SNPC (Congo), SNPG (Gabon) and Sonatrach (Algeria), are also investing in CCUS, renewables, low-carbon fuels, and CCS, demonstrating a collective commitment from MCs to emission reduction.

Conclusion

As oil and gas are expected to remain a crucial part of the energy mix in the foreseeable future, OPEC is committed to providing secure and reliable energy supplies to the world. To this end, assessing needs, planning, and timely investment in upstream hydrocarbon sector capacity are crucial given the significant costs and lead times involved. OPEC's World Oil Outlook 2023 estimated a cumulative oil sector investment requirement of $14 trillion to meet demand by 2045, with around 80% in the upstream sector. Major oil producers, notably within OPEC, are spearheading investment efforts to expand capacity. Calls for 'oil divestment' are misguided, considering the increasing demand. This narrative is detached from reality and poses a threat to energy security. The best approach is to diversify investments across all energy sources to ensure affordability for all consumers.

OPEC Member Countries have demonstrated a commitment to climate governance, as illustrated by their unanimous engagement with the Paris Agreement. They are undoubtedly making strides towards a sustainable energy future through energy sector strategies and through investments in low-emissions hydrocarbon technologies as well. These technologies not only promise a more sustainable future but also pave the way for an inclusive energy system. To realise the full potential of these policies, developed countries need to meet their commitments under the Paris Agreement.

20 Energy and the future of climate change action

Ms Sunita Narain,
Director, Centre for Science and Environment

Climate change is real. The 2021 report of the Intergovernmental Panel on Climate Change (IPCC) confirms what we already know and can see in the world around us – from wildfires because of extreme heat and moisture loss; to devastating floods because of extreme rain events; and tropical cyclones – are linked to a warmer Planet. The future is here and it should worry us enormously. We also know that the energy question is at the core of the climate crisis -- energy is a determinant of our economic wellbeing but the use of fossil fuel based energy is the key contributor to greenhouse emissions that threaten our very existence. Today, it is crucial that we discuss the future trajectory of energy, particularly clean energy, for the global challenges that confront us. We need to reset the global agenda for energy.

It is also an irrefutable fact that few countries have appropriated the carbon budget and their accumulated emissions are the cause of the temperature increase, which is taking the world towards catastrophe. The 'old' industrialized countries and new entrant

China have appropriated 73 per cent of the carbon space till 2019 and even with the reduction targets they have given, will still occupy 70 per cent by 2030. China alone will take up 33 per cent of the available carbon budget between 2020 and 2030.

Look at it in terms of annual emissions and it is the same. The world emitted 36.44 gigatonnes of CO2 in 2019. India added 7 per cent to the world's total CO2 emissions in 2019. The entire continent of Africa, with 17 per cent of the world's population, contributed a mere 4 per cent to the world's total CO2 emissions in 2019. Put this in another perspective, these countries are today way down in the human development index. They will need to grow economically – provide energy to their people; industrialize and urbanize. All of this will add to emissions because as yet, emissions of CO2 are directly linked to GDP. By 2030 at current rates of emissions, the world will run of its carbon budget to keep temperatures below 1.5°C.

This then is the first agenda for climate change negotiations: not to work to erase the reality of climate injustice, but to embrace it for the future. The fact is that in 1992 at the Rio Conference when the UN Framework Convention on Climate Change (UNFCCC) was agreed upon, it was built on principle of common but differentiated responsibility (CBDR). This meant simply that already rich countries would reduce, create space for the emerging world to grow and that the emerging world would grow differently with enabling funds and technology. There cannot be an effective or ambitious climate agreement, without it being equitable and fair. Countries will only cooperate if there is fair burden sharing and this needs to be understood for the last decade that we have to keep the world below the guardrail of 1.5°C. The biggest agenda then is finance – real, tangible and at the scale of the transformation that is needed.

India's agenda for net-zero: co-benefits

A country like India, which has not contributed to the stock of emissions in the atmosphere; but it is a victim of climate change – the poor in our world are the worst hit today because of intensification of tropical cyclones or extreme weather and rain -- must act to reduce carbon dioxide emissions in its self-interest. It must do so, not only to help the Planet combat climate change, but to ensure that its toxic health burden from a fast-degrading environment is reduced.

It is here that we must recognize the announcements made by the Indian Prime Minister, Narendra Modi at the Glasgow climate change conference (COP26). The commitments are extremely bold and ambitious – and yes, also challenging to achieve. India has not been an historical contributor to the greenhouse gas emissions – from 1870 to 2019, its emissions have added up to a miniscule 4 per cent of the global total. And, we have a huge need to grow our economy and to meet the energy needs of millions of our people. So, from every angle, we did not have to take these global targets to reduce our carbon emissions. India's climate change targets for all these reasons are laudable and put the ball firmly in the court of the already rich world to now show that they mean business. The time for procrastination is over.

All this means that we have accepted a massive transformation of our energy systems, which will be designed for the future and compliant with climate change goals. The big issue that must concern us as we move ahead will be to ensure that growth is equitable and that the poor in the country are not denied their right to development in this new energy future. The per capita emissions of India remain low, because we have burgeoning population of the country who still need energy for their development. Now, in the future, as we have set ourselves the goal to grow without pollution, we must work on the increasing clean, but affordable, energy for the poor.

First, there is the challenge of electricity supply. The government has an aggressive plan to reach every household with electricity. Energy poverty is still crippling vast numbers of Indians, who cannot use this crucial enabler to progress – from education to employment. This is our challenge.

Second, there is the challenge of clean cooking energy. This is the world's wicked, wicked problem. Women, across the developing world – including China and India – are exposed to toxic emissions because of the biomass they burn to fuel their cooking stoves. Globally, it is estimated that 2.6 billion people still rely on biomass for cooking food, with 80 per cent of Sub-Saharan Africa. In India, despite PMUY connections to poor households, rural India is using inefficient and polluting biomass as a primary fuel for cooking. This adds up to roughly half the developing world and 40 per cent of the world. Even in 2030, the International Energy Agency estimates that 43 per cent of the developing world (33 per cent of the world's people) will continue to cook on biomass.

In India, Census 2011 revealed that 75 per cent of rural households used biomass and dung to cook, as against 21 per cent of urban Indian households. In addition, data from the National Sample Survey Organisation (NSSO) on energy sources of Indian households for cooking and lighting reveals that nothing changed in the two decades of 1990s and 2000. In 1993-94, as many as 78 per cent households in rural India used biomass as cooking fuel and in 2009-10, 76 per cent used this fuel. Therefore, in this period, when urban India moved to LPG (from 30 per cent to 64 per cent), rural India remained where it was, cooking on highly inefficient and dirty stoves. This shift to cleaner energy in urban areas was not incidental. It happened because government provided subsidised LPG cylinders to middle-classes – people like you and me.

This has changed to some extent in the last five years. The Indian government's aggressive and much needed push to provide LPG to poor households has made a dent in the cooking energy sector. The national UJJWALA programme, which provides cheaper cooking energy to households below poverty line aims to correct an historical injustice, by transferring the subsidy to the poor. It does not focus on the cooking appliance but instead focusses on providing vast amounts of LPG, a fossil fuel, but cleaner and one that most urban Indians use to the rural and to the poor.

But households may still be using dirty biomass fuel to an extent, from firewood, leaves and cowdung, for cooking food. This is because it is free – the labour of women is always discounted as is their health. There is a definite correlation between income and cooking fuel.

The third challenge is air pollution. Almost every city of the country is reeling under choking air, which is literally making us ill. There are deep connections to energy in the air we breathe. The growing fleet of petrol and diesel powered vehicles emit toxins. Then there is the fact that industries do not use clean fuel – everything from the bottom of the barrel pet coke to anything that they can get which is cheap and so sadly also dirty. Industry is competing to reduce costs unless there are mandates and restrictions like in case of Furnace Oil usage in NCR states. So, they continue to use polluting fuels and continue to pollute.

Fourth, without any doubt, is the coal conundrum. India continues to use coal as its key energy source. The question is how can it replace coal and yet provide this energy security?

India's national plan for energy transition is based on our realities; One, to augment and grow energy infrastructure but to do this so that it is green and based on renewable energy. We need to double our energy production and consumption by the end of the decade. Two, to provide for affordable energy so that the needs of the poorest are secured and three, to develop domestic supply chains for new energy systems.

What, then, are the options ahead? In India, we need to address the issue of toxic air pollution because of coal burning. The strategy should be to vastly increase the rates of electrification in the country so that we can reduce coal combustion in millions of industrial boilers that are inefficient and highly polluting, and to move towards electrification of vehicles, which in turn will reduce air pollution in our cities.

The zillion-dollar question then is, how will this electricity be produced? Our first task is to reduce dependence on coal even as we vastly increase our energy supply. This means doing

more of what the Indian government is also committed to doing; limiting coal and investing in cleaner natural gas and renewable energy. Reducing India's coal power dependence in the electricity mix to 50 per cent from over 70 per cent now, would mean upping our target for renewable energy from 450 GW to 650-700 GW by 2030. This scale of transformation will need financing, especially if we want to keep the cost of new renewable energy capacity low so that energy is affordable. This is where international partnerships must be sought; both to reduce the cost of finances and to provide additional finance.

The global community needs to rework its proposals. The transition to clean energy means focusing on making the cost of finances to the emerging world, which is 2-6x higher than the developed OECD countries, much lower and more accessible. Second, the global energy transition pathway has to be for all fossil fuels—coal and natural gas. This would not only show that richer countries have exhausted their quota for using natural gas, but also make gas available at affordable costs to emerging countries that face the twin problems of local and global emissions. Let's be clear, the science of climate change is also the politics of inclusion and responsibility. This is where we must get it right.

All this means that we have accepted a massive transformation of our energy systems, which will be designed for the future and compliant with climate change goals. The big issue that must concern us as we move ahead – and this will remain the discussion for the future – will be to ensure that growth is equitable and that the poor in the country are not denied their right to development in this new energy future. The per capita emissions of India remain low, because we have massive numbers of people who still need energy for their development. Now, in the future, as we have set ourselves the goal to grow without pollution, we must work on the increasing clean, but affordable, energy for the poor.

So, how will it happen? The fact is that energy security for vast numbers of the poor requires an energy delivery system that is different. It will require reaching energy, which costs less but is advanced and cleaner, into households that cannot even afford to buy basic fuel or light. It will require cutting length of supply lines, leakages and losses and everything else that makes energy costs more so that it is affordable. There is no clear idea what will work. But what is clear is that we have to push the envelope so that renewable energy becomes transformational – not because it is produced – but because it is an agent of transformation of society and environment.

What is clear is that we need to do ask deliberately what it would take to put clean energy into the hands of the poor. For this, we will need to do everything to make the transition to clean power. Similarly, we need to ask how clean and renewable energy can work to clean up local air in our cities. It is not just about battery vehicles, but clean power to power the batteries. It is not about shifting the source of pollution. But really cleaning it up. Every house needs to generate this clean power; every vehicle – ideally a bus or cycle – and every industry needs to be powered from a renewable source. This is the way forward.

The same is the case with the wicked problem of cooking energy of the poor woman. We need clean energy to be the basis of the electricity that powers the cookstove – from solar, wind to biogas and all other ways in which it can be supplied into the hearth. It can be achieved if it is available; if it is convenient, affordable and clean. The basis for this transition has to be the health of the last person, in this case the woman behind the cookstove.

Clean and renewable energy has to be the moral and economic imperative for a sustainable and more inclusive world.

21

Opportunities and challenges of oil and gas sector in India's decarbonization journey

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The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

With the global climate crisis looming large, both developing and developed economies are in different stages of energy transition from fossil to non-fossil fuel-based energy resources. At COP 26 summit in Glasgow in 2021, Hon'ble Prime Minister of India had announced that India would achieve net zero greenhouse gas (GHG) emissions by 2070. As it aspires to achieve the twin goals of becoming a developed nation and decarbonization of its growing economy, India's development journey will still need a significant rise in energy consumption in the next few decades.

Therefore, for India to achieve its net zero goals, it is imperative that the rise in energy consumption should be decoupled with its associated emissions. India's energy sector emissions will continue to rise till the incremental energy demand will be met by carbon intensive technologies. And will reach their peak when the incremental demand is fully met by clean and greener technologies. At this point the emissions will plateau while the energy consumption will continue to rise, indicating decoupling between emissions and energy consumption. The emissions will start to decline once the existing carbon intensive systems start to decommission from the system.[1]

Oil and gas are among the key sectors in India's energy mix which will be affected with the changing energy dynamics. Figure 1 represents the trend of natural gas and crude oil's share in India's total primary energy supply (TPES) from 2017-18 to 2022-23 (provisional values).[2]

It can be inferred that the total share of crude oil and natural gas in TPES, averages around 40% in the country's energy mix in last few years, which is quite high, indicating their importance in India's energy mix.

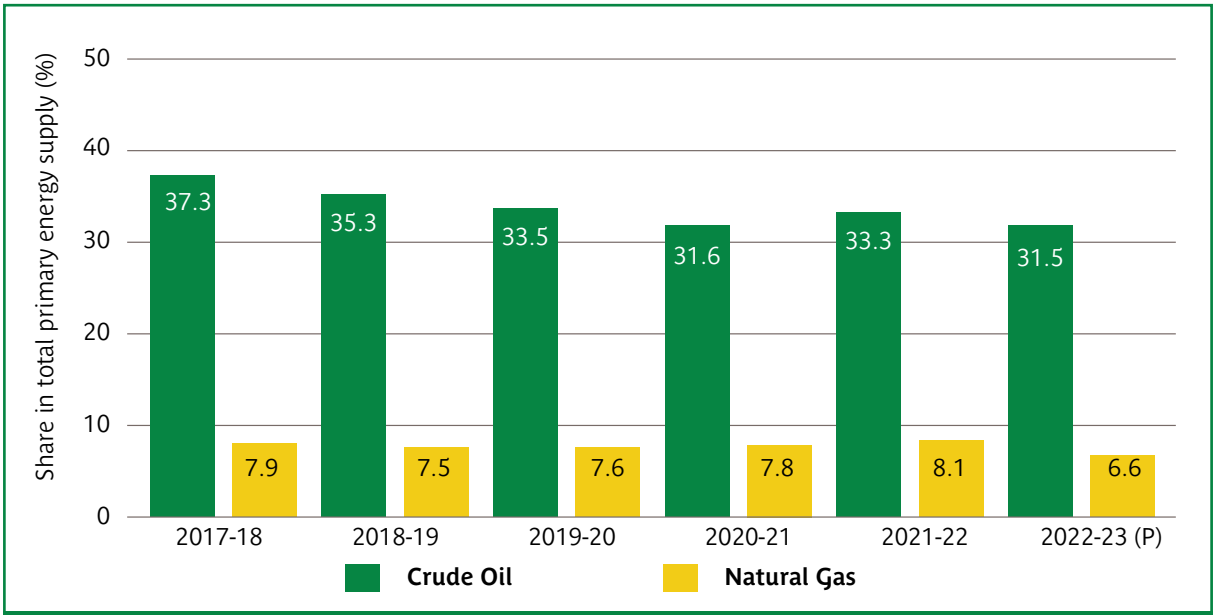

Figure 1 Share of crude oil and natural gas in India's TPES

However, the import dependency of crude oil and natural gas is very high, about 87% (provisional 2022-23) and about 44% (provisional 2022-23) respectively, as shown in Figure 2.[3]

From the figure, it is observed that while the crude oil import dependency is increasing, the natural gas trend is fluctuating, since due to import dependency of these products, the nation is affected by volatility in global markets, geopolitics and adversities like war.

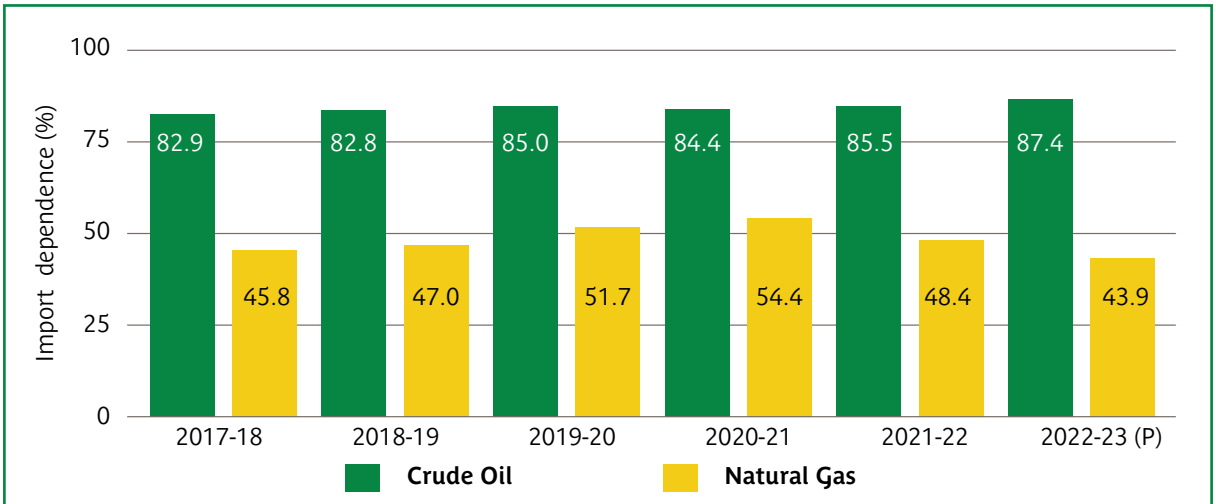

Figure 2 India's import dependence (% share) on crude oil and natural gas

Also, due to limitations of domestic gas supply, high priority sectors such as fertilizers and city gas distribution take higher precedence over electricity generation for domestic supply usage.

Gas based electricity generation is thus majorly dependent on higher priced imported supply resulting in low plant load factor of gas-based power plants despite gas being a cleaner option than coal.[4]

In the oil sector, India also re-exports petroleum products, obtained from refining imported crude oil, leading to net gains. Figure 3 represents import and export statistics for 2022-23 for some of the key petroleum products.[5] It can be seen from the figure that there is net monetary gain for diesel, petrol, aviation turbine fuel and naphtha.

Indian government targets to increase the share of natural gas in its primary energy mix to 15% by 2030,[6] which currently is about 7%.[7] The government targets to increase the consumption of natural gas by 2030, to 500 million metric standard cubic meters per day (MMSCMD) from

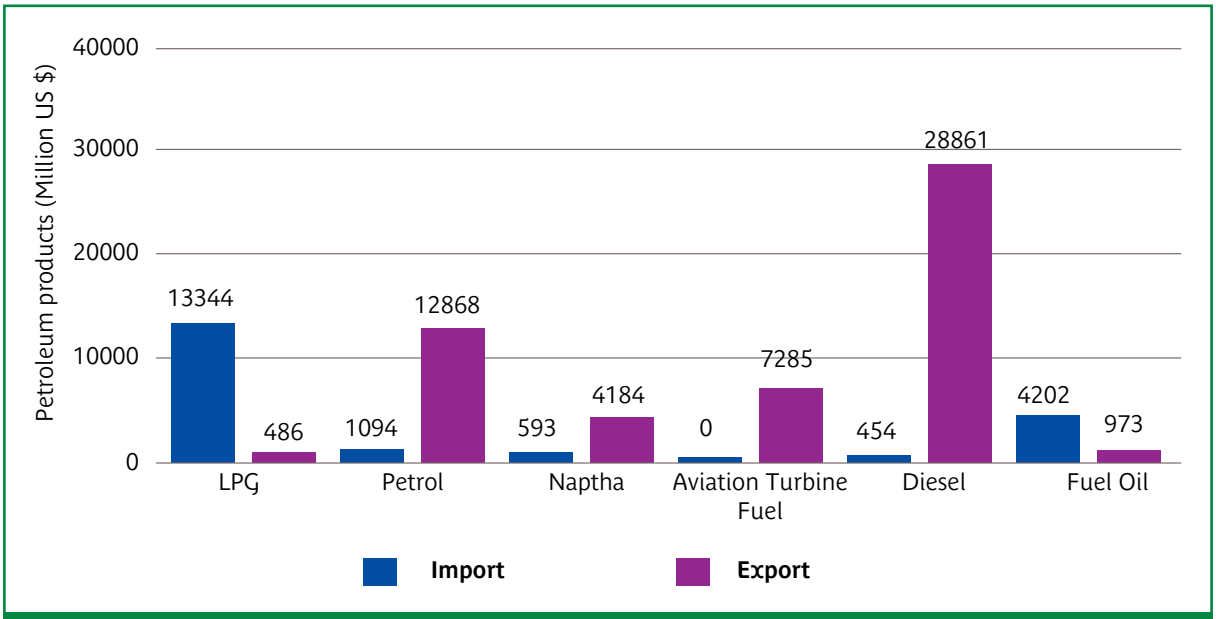

Figure 3 India's petroleum products import and export in Million US$

the current levels of about 185 MMSCMD. The government has further committed to invest $67 billion in the natural gas sector in the next six years to promote its consumption.[8]

In the oil domain, there is a national policy on biofuels, which was approved in 2018. The objective of the policy is to ensure increased consumption of biofuels in the economy while ensuring their availability. With the success of 10% ethanol blending with petrol programme, the government has advanced its 20% ethanol blending target, to 2025, from 2030.[9] The Global Biofuel Alliance, formed under India's G-20 presidency is an appreciative step in this regard, which will facilitate adoption of global best practices, namely, technical support, policy lessons, trade aspects. PM-JIVAN Yojana is an initiative by the government to promote commercial projects in the second-generation ethanol sector. Sustainable Alternative Towards Affordable Transportation (SATAT) scheme focuses on compressed biogas production for providing an alternative transportation fuel. The Galvanizing Organic Bio-Agro Resources Dhan (GOBARdhan) scheme aims to promote circular economy by utilizing organic waste, such as agriculture residues, and cattle dung to produce biogas, compressed biogas, and Bio-CNG. All these policies, besides aiming for the obvious overarching goal of combatting environmental concerns, also aim to reduce crude oil's import dependence.

Hon'ble Union Cabinet Minister, Ministry of Petroleum and Natural Gas (MoPNG), has expressed the government's intent to increase the crude oil refining capacity from about 250 million tonnes per annum (mtpa) to 450 mtpa.[10]

Oil and gas products are consumed across all the energy consuming sectors, and alternative technologies would be required across all sectors to not only reduce the demand for oil and gas fuels, but to also achieve decarbonization of the sectors. The transport (excluding aviation and maritime), residential cooking and commercial cooking sectors are more amenable to decarbonization since electrification of end-use demands is available as a low-hanging fruit for decarbonization.

In the transport sector, the two and three-wheeler segment is rapidly moving towards electrification. The four-wheeler segment, especially commercial vehicles and buses is also gradually reflecting a rise in electrification. Moreover, the Indian Railways have already announced a net zero target by 2030. In the heavy-duty truck segment, green hydrogen is a carbon free alternative, but its maturity as a full-fledged technology and uptake at scale is expected only in the medium to long-term. Residential and commercial cooking is based on a mix of fuels such as liquified petroleum gas (LPG), piped natural gas (PNG), traditional biomass, and electric cooking, with varying use of these options across rural and urban India. The extent of decarbonization in these sectors depends on the penetration rate of electric cooking in Indian households.[11]

With the energy transition becoming an inevitable necessity, it is important for the oil and gas companies to assess their future goals and strategize their future investments with a focus on infrastructure for low carbon projects. There is a need to increase the natural gas network for easy access to industries. Biogas can also be envisaged to be transferred through existing natural gas pipelines and compressed at point of use. Possibility of blending green hydrogen with gas in pipelines can be explored[12] which would require detailed research and development (R&D) on the technical feasibility of pipelines being used for natural gas and gaseous hydrogen. Pilot projects can be implemented to identify additional costs involved and technological safety aspects. The sector should rationally assess its plan for development of pipelines envisioning the changing future energy mix.

In the oil sector, there is a clear opportunity to enhance expertise in biofuels. The government should strive to achieve the 20% ethanol blending with petrol, which is about 1016 crore litres[13], and address the availability issue of ethanol due to lower than expected or no production by distilleries, in some cases. This should be addressed swiftly through policy support, and monitoring of on ground implementation. Estimated annual ethanol production capacity utilizing the surplus in field crop residues is about 5100 crore litres.[14] Further, reduction of emissions from refineries can come through use of green hydrogen, and increased electrification in their manufacturing/ refining processes.

Given that India's energy access and basic infrastructure needs to continue growing rapidly following the aspiration of Viksit Bharat, although India has a long-term target of Net Zero by

2070, the demand for oil and gas-based products is expected to continue to rise for some time, before it starts to decline. Further there are many hard to abate sectors like industry, aviation and maritime transportation, where clear carbon free alternatives are not yet available at an affordable cost. Hence carbon capture and storage (CCS) and carbon capture utilization and storage (CCUS) technologies need to be considered. CCS/CCUS technology is in a nascent stage in India and only a few projects are implemented globally in countries such as USA, China, Japan. Pilot projects should also be taken up by individual players in this sector or as a group to look at the techno-economic feasibility. Once the pilot projects are under operation, policy options and market push can be explored to scale up the technology. Dedicated R&D is required for developing such technologies to identify storage sites, reduce costs, especially during carbon capture and viability of storage options such as pre-combustion, post combustion, and oxy-combustion, and ensuring technological viability of the entire process covering all the potential safety and environmental risks. A task force titled "Upstream for CCS/CCUS" has been set up by MoPNG, to provide a 2030 roadmap for CCUS.

With changing times, artificial intelligence (AI) and machine learning (ML) techniques with their advanced analytical capabilities have become common tools for various industries in their decision making and planning. AI and ML algorithms can be leveraged for short- and long-term future demand estimation, possibility of decreasing energy requirements under different processes in the industries along with minimizing energy consumption in manufacturing processes and optimizing supply chain operations thereby reducing associated emissions. Digital twinning can be used to simulate and generate a comparative assessment of new technology adoptions and visualize changes in associated operational efficiencies, cost implications, potential safety issues, failure risks, etc.

The oil and gas sector can invest in the changing ecosystems, such as providing EV charging points at their refueling stations, diversify its business by developing/ investing in renewable energy power plants, focus on chemicals which have fewer carbon free or low carbon alternatives available, and R&D on new alternative technologies and fuels. The material and technological requirement for new infrastructure development is also an opportunity for promoting indigenous industries in line with the goal of Atmanirbhar Bharat.

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1 *India's journey to net zero: A conceptual framework for analysis, The Energy and Resources Institute, 2024*

2 *Energy statistics, MOSPI, 2024.*

3 *Indian Petroleum and Natural Gas Statistics, MoPNG, 2022-23.*

4 *India's LNG imports at 44-month high in June as gas-based power output jumps amid severe heatwave, The Indian express (online), 5th July 2024.*

5 *Indian Petroleum and Natural Gas Statistics, MoPNG, 2022-23.*

6 *Share of natural gas in total energy mix, PIB, 18th December, 2023.*

7 *Energy statistics, MOSPI, 2024.*

8 *Govt targets three-fold rise in natural gas consumption to 500 MMSCMD by 2030, boosts ancillary industries, ET Energyworld.com, 5th March 2024.*

9 *Blending of Biofuels, PIB, 11th December, 2023.*

10 *Petroleum sector to see policy continuity, will build on work done in recent years, The Indian Express (online), 12th June 2024.*

11 *India's journey to net zero: A conceptual framework for analysis, The Energy and Resources Institute, 2024.*

12 *India's Long-Term Low-Carbon Development Strategy, 2022.*

13 *Blending of Biofuels, PIB, 11th December, 2023.*

14 *ICAR-TIFAC Estimation of surplus crop residues in India for biofuel production, October 2018.*

22 Best Practices and Roadmap for Achieving Net Zero in the Oil and Gas Industry

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In 2020, a massive methane leak occurred at the SoCal Gas Aliso Canyon storage facility in Los Angeles, California. The leak released an estimated 100,000 metric tons of methane, equivalent to the annual emissions of 5 million cars! Thousands of families were forced to evacuate their homes due to the strong odour and potential health risks associated with methane exposure. This wasn't a small valve malfunction – it was a four-month long uncontrolled leak from a poorly maintained underground well. The surprise here wasn't the leak itself, but the scale of it. The incident became a national news story, highlighting the environmental and public health dangers associated with aging oil and gas infrastructure.

The oil and gas sector is one of the highest emitting industries globally, eventually contributing to accelerated climate change. The industry accounts for around 15% of emissions from the energy sector, which translates to roughly 5.1 billion tonnes of CO2 equivalent annually, as of 2022 data. The production,

transportation, and processing of oil and gas releases greenhouse gases, primarily methane and carbon dioxide. These emissions directly contribute to global warming, which is why, it is absolutely crucial for oil and gas industry to achieve net zero emissions for combatting climate change and ensuring sustainable future.

However, it is evident that such a thing is easier said, than done. It is about achieving a delicate balance between global energy demand and meeting NetZero goals. This requires a multipronged strategy. Organizations must offer quantifiable, long-term objectives such as achieving net zero by 2050 or earlier, as well as specific metrics for monitoring progress toward intermediate targets for 2025 and 2030. The first step towards ensuring governance commitment is to include emission reduction goals in organizational strategy and business decisions.

The International Renewable Energy Agency (IRENA) estimates that hydrogen could meet up to 12% of global energy demand by 2050, significantly reducing emissions. Hydrogen and CCUS technologies offer significant potential to decarbonize the industry. Hydrogen can serve as a clean fuel source, while CCUS captures emissions from existing processes and leverages geological storage. Oil and gas companies have the expertise to manage large projects and infrastructure, making them well-suited to invest in renewable energy sources like wind and solar. Collaboration with governments, clean energy companies, and research institutions is also crucial for accelerating innovation and developing new solutions. Forming board-level committees to oversee progress towards net zero can ensure focused and effective efforts.

Reducing Operational Emissions

Low-Hanging Fruit

To start, oil and gas companies should target easily addressable sources of emissions. Reducing leaks, minimizing flaring (burning excess gas), and improving energy efficiency can significantly cut emissions without major technological shifts. For example, according to the International Energy Agency (IEA), eliminating routine flaring and minimizing leaks could reduce global oil and gas industry emissions by 350 million tonnes of CO2 equivalent annually.

Electrification

Electrifying oil and gas rigs using renewable electricity can further reduce emissions. Upgrading equipment with variable frequency drives (VFDs) on compressors and pumps can decrease energy use and pollution. Additionally, switching to electric drilling tools and support equipment can reduce reliance on fossil fuels. Electrification has the potential to reduce offshore platform emissions by up to 50%.

Advanced Technologies for Emission Reduction

Methane Emission Mitigation

Methane is a potent greenhouse gas with a Global Warming Potential (GWP) 28 times that of carbon dioxide. Implementing robust Leak Detection and Repair (LDAR) programs using advanced technologies like satellite monitoring, cameras, and drones can efficiently identify and fix methane leaks. According to the Environmental Defense Fund (EDF), robust LDAR systems can lead to an 80% reduction in methane emissions. High-efficiency equipment like vapor recovery units and flare gas recovery systems can further reduce emissions.

Carbon Capture and Storage (CCS)

The Global CCS Institute reports that CCS can prevent up to 90% of industrial CO2 emissions. Investing in CCS systems to collect CO2 emissions from companies and power plants can significantly control emissions. Pre, post, and oxy-fuel combustion techniques can enhance CCS efficiency. Additionally, storing CO2 in Enhanced Oil Recovery (EOR) processes can accelerate oil recovery and reduce emissions.

Digital Technologies

Utilizing digital technologies such as IoT for real-time monitoring, AI for predictive maintenance, and advanced analytics can lead to significant energy savings. New drilling technologies like Managed Pressure Drilling (MPD) and Extended Reach Drilling (ERD) can also reduce energy use and pollution.

Transition

Transitioning to cleaner and low-carbon fuels is the obvious thing that all know that they need to do. High-emission fuels like coal and oil should give way to low-emission alternatives like natural gas, which emits half the emissions of coal when used for electricity generation. Exploring offshore solar and wind energy for remote operations can further reduce emissions. Integrating offshore wind turbines and solar panels can reduce dependence on diesel generators and provide renewable power for offshore platforms. Floating wind farms adjacent to offshore facilities and utilizing tidal energy for subsea infrastructure can also enhance renewable energy integration.

Innovation and Research

Establishing specialized innovation hubs and research facilities focused on energy efficiency, pollution reduction, and sustainable operations can drive the development of low-carbon technologies. Collaborative research with academic and research institutions can accelerate innovation.

Increasing funding for hydrogen production technologies, especially green hydrogen produced by electrolysis using renewable energy sources, is crucial. Research on efficient hydrogen production methods like Proton Exchange Membrane (PEM) and Solid Oxide Electrolysis Cells (SOEC) can enhance viability. Investing in improved battery storage systems like lithium-ion and solid-state batteries can support renewable energy integration. Exploring fuel cells for backup power and distributed generation can further stabilize energy systems.

Green Hydrogen

Unlike traditional fossil fuels, green hydrogen produced using clean sources like solar or wind, slashing greenhouse gas emissions during production. This green fuel can power drilling rigs, refineries, and vehicles, significantly reducing the industry's carbon footprint. Green hydrogen can even be used for clean heat in refineries, further lowering emissions. Existing oil and gas pipelines might be repurposed for transporting green hydrogen, leveraging existing infrastructure. The picture isn't all sunshine though. Currently, producing green hydrogen is more expensive, and building the infrastructure for production, storage, and transportation requires significant investment. Scaling up production is also crucial for widespread impact; which also needs to be addressed.

Carbon Credit/Offset Projects

Investing in credible carbon removal offset projects following globally accepted standards like the Gold Standard and the Verified Carbon Standard (VCS) ensures the effectiveness of offset efforts. Developing a diverse portfolio of offset projects, including reforestation, renewable energy, and energy-saving initiatives, can enhance impact.

Engaging in large-scale reforestation and afforestation projects can boost CO2 sequestration and enhance biodiversity. Implementing wetland and mangrove restoration projects can significantly contribute to emission reduction goals. Integrating agroforestry and regenerative agriculture practices on company-owned lands can further enhance carbon sequestration.

Policy Advocacy and Industry Collaboration

Active participation in policy advocacy is essential for promoting a low-carbon economy. Supporting carbon pricing, renewable energy incentives, and stringent emission guidelines can drive industry-wide change. Taking an active role in creating and promoting industry standards for sustainability can set benchmarks for best practices.

Supportive government policies and regulations are essential for incentivizing investment in clean technologies. Advocacy for carbon pricing, renewable energy incentives, and stringent emission guidelines can create a level playing field and drive the industry towards net zero. This is also a policy-based incentive which has to come from the administrative side of the government. Ultimately, consumer choices and a shift towards low-carbon alternatives will drive the pace of change. Consumers are getting more aware and willing to adapt to this change. Transparent communication and periodic reporting on climate performance will build consumer trust and demonstrate commitment to sustainability.

Participating in industry-wide initiatives and collaborations to exchange best practices and foster collective action towards net-zero goals is crucial. Collaborating with various sectors like transportation, manufacturing, and utilities can create comprehensive solutions for reducing emissions. Involvement in consortia and initiatives such as the Oil and Gas Climate Initiative (OGCI) can enhance collaborative efforts.

Transparent Communication and Reporting

Transparent communication and periodic reporting on climate performance are essential for achieving net zero. Adopting frameworks like the Global Reporting Initiative (GRI), Business Responsibility and Sustainability Reporting (BRSR), and Task Force on Climate-related Financial Disclosures (TCFD) can enhance accountability.

Aligning emission reduction targets with the Paris Agreement goal will demonstrate commitment to global climate goals. Transparent tracking and reporting of progress can build stakeholder trust and drive continuous improvement.

Employee Engagement and Training

Implementing comprehensive training programs to ensure employees understand the importance of sustainability and their role in achieving net zero is vital. Encouraging employees to engage in innovation challenges and sustainability projects can cultivate the creation of imaginative solutions for decreasing emissions. Motivating employees to actively participate in sustainability initiatives can drive organizational change.

Resilience and Adaptability

Maintaining flexibility in strategies allows organizations to adapt to evolving technologies, regulatory landscapes, and market conditions. Proactive decision-making through scenario planning and assessing climate risks and opportunities can strengthen resilience. Creating flexible governance structures and fostering innovation ecosystems can enhance the capacity to adjust and succeed. Encouraging continuous improvement and adaptability ensures long-term success in achieving net zero goals.

Things to Consider

A shift to a low-carbon future will require retraining and upskilling the workforce. Providing comprehensive training programs will ensure a smooth transition, avoid any operational disruptions and prevent job losses. Encouraging employees to engage in innovation challenges and sustainability projects can also foster a culture of creativity and environmental stewardship.

In a Nutshell

It is challenging but achievable to reach net-zero emissions in the oil and gas industry. A comprehensive strategy should cover operational efficiency, renewable energy integration, technological innovation, engagement with the supply chain, and strong governance.

The oil and gas industry faces a monumental challenge: achieving net zero emissions while meeting global energy demands. A multi-pronged approach is definitely the need for it. Companies must set clear goals, invest in clean technologies like hydrogen and CCUS, and reduce operational emissions through electrification and leak mitigation. Collaboration with governments, research institutions, and other industries is central for accelerating innovation. Investment in carbon offset projects and policy advocacy for carbon pricing are essential. Transparent communication, employee engagement, and continuous adaptation will ensure success on this critical journey.

By implementing these recommended strategies and adhering to a well-defined plan, oil and gas companies can minimize their ecological footprint and guarantee their viability and adaptability in an ever-evolving energy industry. Working on to achieve net-zero is a difficult goal that brings both challenges and opportunities and demands for bold leadership, strategic investment and consistent commitment to sustainability. With all the efforts and collaboration across the industries, the oil and gas sector can play a significant role to address climate change and transitioning to a low-carbon economy.

23 A roadmap to Net Zero for Indian Oil & Gas Companies

Shri Anish De,
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The Net Zero Imperative for Indian Energy Companies

As the global climate crisis intensifies, nations and industries worldwide are adopting ambitious targets to achieve net-zero carbon emissions. In India, a country of 140 billion with burgeoning energy demands and economic growth consistently in the range of 7.5 – 8% per annum, the oil and gas companies will play a critical role in this transition. Predominantly led by public sector enterprises, the journeys of these organizations will heavily influence India's attainment of Net Zero by 2070 as a country.

Decarbonizing while growing as an economy is hard. Our energy systems are designed around fossil fuels and making this large engine of growth transition so rapidly to a low carbon system will present formidable challenges. As the recently published Energy Institute Statistical Review of World Energy (formerly bp Statistical Review of World Energy) showed, in 2023 global fossil fuels have

touched all-time highs and greenhouse gas (GHG) emissions scaled 40 Gigatonne (GT) for the first time in the history of the planet. Coal consumption also increased to record levels, driven by countries like China and India where, despite impressive growth in renewable energy installed capacity, energy demand far exceeded the incremental clean energy production.

Having said that, the spectre of global warming looms large on the planet and must be tackled with greater commitment and practical interventions on the ground. India will inevitably have to play a major role. India's commitment to combating climate change is underscored by its pledge to achieve net-zero carbon emissions by 2070. This ambitious target aligns with the global effort to limit global warming to 1.5 degrees Celsius above pre-industrial levels, as outlined in the Paris Agreement. To realize this goal, India's energy sector, particularly its oil and gas industry, must undergo significant transformations.

Progress thus far

The commitment of Indian energy companies towards decarbonization is very visible. Public sector enterprises (PSEs) like Oil and Natural Gas Corporation (ONGC), Indian Oil Corporation Limited (IOCL), Bharat Petroleum Corporation Limited (BPCL), and Hindustan Petroleum Corporation Limited (HPCL) and GAIL Ltd. are at the forefront of this initiative. These companies are major contributors to India's energy supply and have historically been dependent on fossil fuels. Therefore, their transition to greener practices is crucial for the country's overall decarbonization efforts. Alongside the private sector will have to play its role. Given the presence of behemoths like Reliance Industries Limited (RIL) and others and their own net zero commitments, it will be a combination of public and private sector action that has to transform the Indian energy landscape.

There has been progress and Indian companies have shown the necessary commitment. ONGC, India's largest oil and gas producer, has set a target to achieve net-zero emissions by 2038 for Scope 1 and 2 emissions. This goal is ambitious, given the scale of its operations. ONGC is focusing on increasing the share of renewable energy in its portfolio, enhancing energy efficiency, and investing in carbon capture and storage (CCS) technologies. It is also exploring hydrogen production and other clean energy alternatives to reduce its carbon footprint. In the downstream segments IOCL aims to achieve net-zero emissions by 2046, while GAIL, BPCL and HPCL have committed to 2040 goals for Net Zero for Scope 1 and 2. The approach of these organizations involves a comprehensive roadmap that includes the adoption of cleaner technologies, transitioning to alternative fuels, and scaling up renewable energy capacity. The company plans to invest in biofuels, electric vehicle (EV) infrastructure, and green hydrogen projects, which are expected to play a significant role in reducing its overall emissions. All these organizations are rapidly increasing renewable energy footprint, with investments in wind, solar, and bioenergy projects. These companies are also working on green hydrogen initiatives, which hold promise for decarbonizing various industrial processes and transportation sectors. Apart from deployment there is significant focus on new technology development and adaptation, as was on display at the India Energy Week (IEW), 2024 in Goa earlier in the year.

Improving energy efficiency is a critical component of the net-zero strategies of these companies. Energy efficiency must be at the centre of the net zero interventions through tangible goals and deliberate actions. Energy Efficiency has been termed as the "first fuel" and presents the lowest hanging fruits. However, implementation of energy efficiency projects is often time and effort consuming. It is also necessary to create viable business models for energy efficiency that are different from today's models.

In various ways technological innovation is key to achieving net-zero goals. There is progress in this regard and Indian energy companies have done better than other counterparts in investing in new technologies. ONGC is actively involved in research and development (R&D) to explore new technologies for carbon capture, utilization, and storage (CCUS). The company is also investing in the development of hydrogen fuel and other low-carbon technologies.

IOCL is focusing on developing and deploying biofuels, hydrogen, and EV infrastructure. The company's R&D efforts are aimed at finding sustainable and scalable solutions to reduce its carbon footprint and support the broader energy transition. It is scaling up the R&D facilities further to bring in more capabilities for low carbon products. Similarly other public and private sector organizations are progressing on setting up or expanding their labs and obtaining patents for new transformative technologies. The Centre for High Technology (CHT) also has a critical role to play in bringing in transformative technologies for improving efficiency and reducing emissions.

Challenges and the Road Ahead

Despite the progress, many challenges remain. The transition to net zero requires substantial financial investments, technological advancements, and regulatory support. The high initial costs of renewable energy projects and CCUS technologies can be a barrier, especially for state-run enterprises with limited financial flexibility. Moreover, the integration of renewable energy into the existing infrastructure poses technical challenges. The intermittency of renewable sources like wind and solar requires robust grid management and storage solutions. Additionally, the development of hydrogen infrastructure and the adoption of EVs need supportive policies and market incentives to scale effectively. Below are seven areas where focus has to be accorded.

Raise the ambitions on scale and pace of implementation

The scale of investment required is enormous, and the pace of implementation needs to be accelerated to meet the ambitious targets. While the planned investments are substantial, but timely execution and effective project management are crucial.

Bring forward technological advancements

The success of initiatives like CCUS and green hydrogen production heavily depends on technological advancements and cost reductions. Continuous innovation and adoption of best practices from global leaders in these technologies will be essential. Collaborative approaches are needed to make sure that this global challenge is being addressed collaboratively rather than in balkanized ways.

Ensure regulatory and policy support and harmonization

Strong regulatory frameworks and policy support from the government are necessary to facilitate the transition. This includes incentives for renewable energy projects, support for R&D in new technologies, and clear guidelines for carbon pricing and trading. A vibrant carbon domestic market has become an imperative. Many regulations will also need harmonization to make investments possible and viable.

Enhance public and private sector collaboration

Collaboration between public sector companies and private players can enhance the effectiveness of decarbonization efforts. Partnerships for technology development, joint ventures for renewable energy projects, and shared infrastructure for EV charging can drive faster progress. It is also necessary that the large organizations – whether public or private – find ways to collaborate with the innovation ecosystem and especially the start-ups who are doing amazing work in frontier areas.

Make industry - academia partnership wide and deep

Academic research in frontier technology areas has been a weak point for India despite the formidable intellectual and knowledge base of the country. Industry needs to actively partner with academia, providing pertinent research challenges and also funding support. There is a need for academia to work in industry (on tenured deputation) and vice versa for both sides to learn about the priorities and the ways of working of the other. This is currently weak or absent.

Embrace AI and Generative AI

The energy sector is no stranger to AI/ML, with machine learning algorithms having been commonly deployed for generation forecasting, supply and demand predictions and predictive maintenance. The emergence of Generative AI in late 2022 has opened a new set of possibilities. Generative AI allows for several capabilities that democratise AI, putting its power in the hands of the end user. These include easy and intuitive interactivity, iterative and conversational problem solving, and improved flexibility and adaptability to new inputs. Energy companies need to embrace these technologies for rapid, transformative change.

Take a comprehensive approach

A holistic approach that includes not only reducing operational emissions but also addressing supply chain emissions and promoting sustainable practices across the value chain is needed. This includes focusing on circular economy principles and reducing waste. Also, while the companies have made commitments for Scope 1 and 2, eventually they have to look at their Scope 3 emissions and help their users and suppliers decarbonize. While this is hard and out of the way of the regular lines of business, it is nonetheless essential.

In conclusion – the story of convergent goals

India's oil and gas companies are making commendable efforts toward achieving net-zero emissions. While they have set ambitious targets and initiated various projects to reduce their carbon footprint, the journey ahead is fraught with challenges. These companies are among the biggest in the country. If India has to attain its Net Zero goals along with the wider economic and social objectives the oil & gas companies have to lead from the front. If they succeed in their attaining their goals, we will be well on course to attain the national goals on many fronts. If they do not, it is implausible that India will achieve it's 2070 Net Zero goal, which has become even more important for the country and the world in the face of accelerating climate change and its perilous impacts that are becoming apparent every passing day.

24 Roadmap for Net Zero for the oil and gas organisations

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The Oil and Gas sector has been contributing to GHG emissions accounting for around 15% of total energy-related emissions globally with ~5.1 billion tonnes equivalent of greenhouse gas emissions[1]. The sector is facing increased pressure to decarbonize and achieve net zero targets globally and in India. This article focusses on the following areas:

- Key levers for decarbonisation.
- Initiatives taken by O&G players using the identified levers.
- Potential enablers to accelerate the net zero ambition.

Key levers for decarbonisation

Some of the key levers which firms are considering for decarbonisation include:

Energy efficiency

Increasing overall operational efficiency is a longstanding endeavor and should continue to contribute to GHG reduction. Investment in energy efficiency could also lead to decrease in demand for fossil fuels and increased efficiency may drive monetization of fugitive emissions (through flaring and other forms).

Clean energy

Switching to low-carbon electricity is one option for replacing high-carbon electric consumption, subject to the availability of sufficient green electricity supply. Use of biomass (derived from plants & animals) to produce bio-based hydrocarbons to replace conventional fuels and use of green hydrogen are being evaluated. However, scale, application alignment, and penetration are in early phases and resource availability may therefore be the critical issue.

Carbon offset

Carbon capture, utilization, and storage (CCS) technology is being implemented at varying pace, depending on the region and the level of discussions on suitable storage locations and costs. While carbon capture and utilization (CCU) and other technologies are yet to mature, CCS may be considered as a bridging technology to help reduce CO2 output in the near- to mid-term.

Sustainable Supply Chain Management

This requires collaborating with suppliers to reduce emissions across the supply chain. There is a need to adopt sustainable practices in procurement and logistics. It is important to factor circular economy practices viz. Recycling and reusing materials and waste products across the value chain.

Methane Emissions Reduction

In O&G context, it is imperative to look at detecting and repairing leaks in infrastructure. In addition, investment in utilizing low-emission technologies for extraction and processing is required for decarbonization.

Initiatives taken by O&G players

The potential roadmap being considered by the O&G players for the identified levers include:

Energy efficiency

- **Upstream** : Enhancing energy-efficient design in upstream operations is a key strategy for reducing emissions. For example, Shell's Vito deep water platform was designed to cost 70% less than the anticipated cost of the original design, an example of creating more value with less emissions. Similar approach is also taken by Shell in its upcoming Whale deep water platform in Gulf of Mexico. Shell will use the experience of the Vito and Whale projects to enhance the design and energy efficiency capabilities of its other upstream assets too[2]
- **Midstream** : Energy efficiency improvement is based on 2 steps – identification of areas of improvement and use of equipment, strategies and solutions to reduce waste and

improve energy efficiency in pipeline and storage operations. For example, ABB provided ADCO (UAE) with variable speed drive systems (VSDS) to reduce energy consumption in compression operations[3]

- **Downstream** : Using energy management systems combined with technology and data analysis to monitor and control energy usage in production and refining is a key strategy for downstream companies to enhance efficiency. For example, ExxonMobil's Global Energy Management System (GEMS) identified over 200 best practices and performance measures, revealing opportunities to improve energy efficiency by 15% at its refineries and chemical plants worldwide[4].

Clean energy

- **Upstream :** Electrifying operations and incorporating renewables to fulfill power needs; For example: ADNOC is implementing first-of-its-kind sub-sea transmission network in the MENA region to connect ADNOC's offshore operations to clean onshore power network, unlocking cost-savings and environmental benefits. The supply of clean grid power will reduce the carbon footprint of the offshore upstream operations by up to 50% and support the UAE 'Net Zero by 2050 Strategic Initiative'[5]. Similarly, Equinor is considering electrification of offshore assets.
- **Midstream** : Pipeline modernization for blending alternative cleaner molecules such as compressed biogas (CBG) and hydrogen in the natural gas grid. For example - Indian Government has mandated use of 5% CBG in city gas distribution focusing on domestic and transport segment by FY2029[6]. Similarly, UK Government has taken a strategic policy decision to support blending of up to 20% hydrogen by volume into gas distribution networks by 2030[7].
- **Downstream** : Production of green hydrogen: India is targeting production of 5 MMTPA by 2030 and emerge as exporter of green hydrogen in the world[8]. EV charging: Fuel retailers are not only installing chargers at their outlets but also providing solutions for decarbonization of fleets. Focus on biofuels such as ethanol and CBG: Oil marketing companies are offering biofuels as alternative solution to retail fuel by blending it with traditional fuels or on a standalone basis.

Carbon offset

- **Upstream** : Activities that can help to sequester carbon such as reforestation, waste to energy, deployment of CCUS, etc. are few of many carbon offset strategies. For example - Equinor, Shell and TotalEnergies have invested in the Northern Lights project — Norway's first license for CO2 storage on the Norwegian Continental Shelf and a major part of the initiative that the Norwegian government calls Longship. This project is expected to be ready for operation in 2024. Under this project, CO2 will be injected into a saline aquifer.
- **Midstream** : Midstream companies are taking lead in developing CO2 infrastructure that support carbon capture utilization and storage. For example, Wolf Midstream (owner and operator of Alberta Carbon Trunk Line) gathers 1.6 MMTPA of CO2 from NWR Sturgeon refinery and Nutrien Redwater Fertilizer and delivers it to permanent storage in Alberta[9]
- **Downstream** : Downstream players are actively partnering with nature-based solution companies to support reforestation. For example, Shell, BP, Eni, TotalEnergies and Chevron have all partnered with project developers to generate carbon offsets through forestry projects[10]

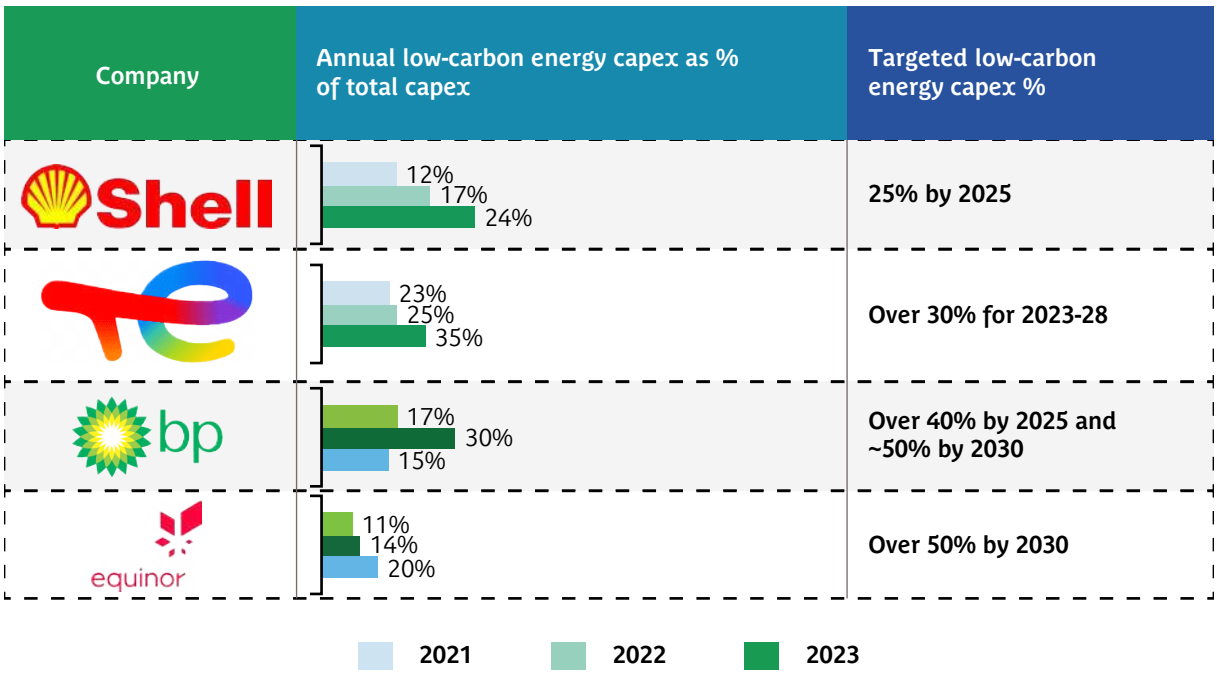
Sustainable Supply Chain Management

- **Improving logistics** to reduce fuel consumption. For example, some operators, invoking the principles of a sharing economy, coordinate logistics, including trucks, marine vessels, and helicopters, to optimize transport times and volumes.
- **Development of storage infrastructure** of feedstock storage for production of biofuels or biofuels itself. For example - Vopak has setup 16 new tanks with a combined capacity of 64,000 cubic meters at its Vlaardingen terminal in the port of Rotterdam[11]. The new tanks are designed to store waste-based feedstocks to produce biodiesel and sustainable aviation fuel. Vopak Vlaardingen has a long-term commercial agreement with Shell to store the feedstock for Shell's new biorefinery in Rotterdam.
- **Focus on production of SAF**: Under REFUEL EU, fuel uplift at EU airports must contain at least 2% SAF from the beginning of 2025. That percentage will increase gradually each year, with mandates including 6% by 2030, 20% by 2035, and eventually 70% by 2050[12]. These requirements will apply to all flights originating in the EU, regardless of destination.

Methane Emissions Reduction

- **Upstream** : Methane emission occur from leakages, unplugged wells, flaring, process vents and other/unspecified sources such as emission related to specific events (e.g. pipeline rupture). Upstream sector has been working towards reduction of methane emission from known and unknown sources. For example, TotalEnergies and Oil and Natural Gas Corporation (ONGC) have signed a Cooperation Agreement to carry out methane emissions detection and measurement campaigns using TotalEnergies' pioneer AUSEA (Airborne Ultralight Spectrometer for Environmental Applications) technology[13].
- **Midstream** : Midstream operations for natural gas such as compression contribute to methane emissions. Oil and gas companies operating natural gas based midstream infrastructure such as pipelines, terminals, etc. are implementing improved methane detection remedies as well as robust methodology to identify and plug the emissions. For example, Shell has reduced methane emissions at the QGC natural gas project in Australia by minimizing flaring and venting and using more precise methods for calculating fugitive emissions[10].
- **Downstream** : Within downstream sector, major source of methane emissions is identified as incomplete flaring and vented emissions from uncontrolled blowdown systems and other process vents. For example – Chevron is investing in methane management initiatives that includes development and deployment of satellites, aircraft based, drone based and facility scale near continuous monitoring technologies for methane detection[10].

The graph below provides annual and targeted low- carbon energy capex as % of total capex[10].



Notes: [1] Potential investments in low carbon energy includes investments in renewable energy, hydropower, CCUS, Hydrogen, Biogas among others

Potential enablers to accelerate the net zero ambition.

In many ways, achieving net zero in the oil and gas sector hinges on the adoption of new technologies capable of both measuring and reducing carbon emissions across the value chain. However, some of the enablers for O&G organizations to consider are:

Leadership, Governance and Strategic alignment

- Strong commitment from top management and the board of directors.
- Establishing clear governance structures for sustainability initiatives.
- Setting ambitious and transparent net-zero targets and timelines.
- Integrating net-zero goals into the organization's overall strategy and business model.
- Ensuring alignment between sustainability objectives and business operations.

Dedicated Resources

- Allocating sufficient financial and human resources to support decarbonization projects.
- Fostering collaboration across departments (e.g., operations, finance, R&D, marketing) to ensure holistic implementation.
- Creating cross-functional teams focused on sustainability projects.

Baselining and reporting

- Developing a detailed understanding of current and future value-chain emissions profiles.
- Institutionalization of ESG Accounting and Preparation of Sustainability Report.
- Assessing the costs, benefits and implementation risks of abatement projects across all assets and operations.
- Reviewing the value chain for each product line to assess if competitive advantage can be gained from decarbonizing some operations ahead of others.

Investment priorities and strong fiscal discipline

- Optimizing abatement projects to reduce costs and unlock value while still achieving stated emissions reduction targets.
- Prioritizing project deployment to maintain optionality and deliver the greatest benefit for the least cost.
- Reviewing asset portfolios to ensure optimum development and the ability to maintain favorable valuations and cost of capital.

Regulatory Incentives

- Exploring financial instruments and incentives that support net-zero projects (e.g., green bonds, carbon credits).
- Incorporating carbon pricing and internal carbon accounting.
- New policy mandates and push for circularity: New policy mandates on push for reducing the net emission by purchasing carbon credits from market-based carbon exchange/trading platforms. Also, circularity has a pronounced impact on end-of-life emissions and is being supported in many geographies. Ongoing progress in collection and advanced recycling is beginning to help drive its expansion.
- Establishing common standards and leading practices for improved energy efficiency and decreased emissions
  - Adhering to environmental regulations and standards.
  - Leveraging government incentives for low-carbon technologies and practices.

Investment in R&D/ technology

- Operational and Technological transformation through enhanced efficiency in exploration, production, and refining processes.
- Integration of digital technologies (IoT, AI) for real-time monitoring, tracking and optimization of fugitive emissions.
- Using data analytics, AI, and IoT to optimize operations and reduce emissions.
- Implementing predictive maintenance and real-time monitoring to enhance efficiency.
- Encouraging innovation and research to develop new low-carbon solutions and technologies.
- Partnering with academic institutions, research organizations, and other industries for collaborative innovation.
- Investing in R&D for new technologies and methods to reduce emissions.
- Collaborating with academia, research institutions, and other industries to drive innovation.

Managing internal and external stakeholders

- Preparing communication plans for employees, customers and shareholders, customizing them as the company progresses on the journey to net-zero.
- Reviewing the public positioning of industry associations to which the company belongs.
- Determining if publicly stated targets are consistent with action plans, executive incentive schemes, and budget allocations.
- Building cross-functional capabilities across the workforce through curated learning and development programs focused on the net zero journe

Conclusion

In conclusion, the oil and gas sector plays a significant role in global greenhouse gas emissions, and the pressure to decarbonize and achieve net-zero targets is on rise. To address this, companies are adopting key decarbonization levers, including enhancing energy efficiency, transitioning to clean energy sources, implementing carbon offset initiatives, and improving sustainable supply chain management. Methane emissions reduction is also a critical focus, with advancements in detection and repair technologies. The success of these efforts relies heavily on strong leadership, governance, and strategic alignment, along with dedicated resources and investment in R&D and technology. Additionally, regulatory incentives and stakeholder engagement are essential to drive and sustain these changes. By embracing these strategies and enablers, the oil and gas industry can significantly reduce its environmental footprint and contribute to a more sustainable future.

References

1 *IEA report on Emissions from Oil and Gas Operations in Net Zero Transitions (A World Energy Outlook Special Report on the Oil and Gas Industry and COP28), 2023*

2 *Shell publications on 'Energy efficiency in our operations' on their website*

3 *ABB publications/brochure on midstream operations*

4 *Exxon Mobil publications on GEMS*

5 *ADNOC Annual reports, press releases and sustainability reports*

6 *PPAC and MoPNG*

7 *Department for Energy Security and Net Zero, Government of the UK*

8. *Ministry of New and Renewable Energy, Govt of India*

9 *Wolf Midstream Company Press Releases*

10 *Annual reports and sustainability reports of oil and gas companies*

11 *Royal Vopak press release*

12 *International Trade Administration news report*

13 *Press Release by TotalEnergies on Feb 6, 2024, titled 'TotalEnergies and ONGC in India Join Forces to Detect and Measure Methane Emissions'*

14 *Oil, Gas and Energy Transition: How the oil and gas industry can prepare for a lower-carbon future, Deloitte insights*

15 *Addressing the challenge of decarbonization - An oil and gas perspective, Deloitte insights 2021*

25 Redefined Energy Ecosystem for People and Planet-The Indian Perspective

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Abstract

The global growth in the share of clean energy consumption has steadily risen with 8.8 % CAGR post the 2015 Paris Agreement for Climate Change, manifesting collective commitments from advanced and developing nations to contribute their part towards achieving 2030 SDG targets. Further, with the intensifying debate on Climate Change, the advanced countries have proclaimed to achieve "Net Zero" carbon emissions by 2050, while India has set its target for 2070 by adopting the "Panchanmrit" and the concept of the mass movement for " LiFE." The government has fixed intermittent milestones to achieve the target, suiting local conditions and people's choices, underpinning decarbonized economic growth with the urgency to eradicate energy poverty for improved life and well-being. The aspirations are to diversify the country's primary energy consumption mix with ease of energy access at affordable prices, security and independence of supplies, enhanced sustainability, and socio-economic growth. As a result, India's energy landscape is set to change fast due to the introducing of new policy reforms that promote frugal innovation, deployment of advanced technologies, and indigenization to diversify the energy ecosystem with structural changes to incentivize investments. The government has carved out a multipronged approach to diversify its energy sources to slowly phase out fossil fuels, promoting Green Hydrogen, Renewables, and biofuels like renewable methane (Biogas), Ethanol, and biodiesel. The intentions are manifested by forming the Global Biofuel Alliance and the Solar Alliance, where India aspires to be a global leader. The rollout of several new policy guidelines encourages the production and consumption of these new energy resources with ease of business in a competitive market. This exploratory study aims to present the recent developments involving policy reforms, technological advancement, plans, and status for accelerating the energy transition in India to keep up with its voluntary commitments. This finding has implications for the Indian Energy Sector and associated stakeholders to advance the operationalization of India's aspirations towards Net Zero for decarbonized economic growth.

Key Words

Net Zero, Green Hydrogen, Bio-Fuel, Bio-Gas, Natural Gas, Renewables, Decarbonization, Energy Transition

Introduction

With 58.1% of worldwide primary energy use, fossil fuels like coal and oil dominate. These energy sources emit 35129.8 Million Tons of carbon dioxide worldwide from varied primary energy sources despite 0.2% and 0.90% growth rates between 2013 and 2023 [1]. Carbon dioxide from fossil fuel combustion is the main cause of global warming and climate change. However, Natural Gas(NG), a comparatively clean hydrocarbon mixture with 23.8% of the worldwide primary energy consumption mix, grew at 1.7% in the global consumption basket during the same period, showing people's preference for clean fuels. Global leaders have pledged to reduce greenhouse gas (GHG) emissions by phasing out coal and oil and switching to alternative energy. From simple activities like reusing and recycling to major lifestyle changes like switching to commercially available renewable energy sources and embracing "LiFE" can help safeguard the world. After the 2015 Paris Climate Agreement, advanced and developing countries voluntarily published country-specific NDCs and committed to advancing 2030 Agenda for Sustainable Development targets, which all UN Member States endorsed. The SDGs provide a "shared path for people and the planet to live in peace and prosperity now and in the future". After that, advanced nations pledged "Net Zero" carbon emissions by 2050. In response to local considerations, India's Climate Leadership announced "Panchanmrit"-based "Net Zero" carbon emissions by 2070 at the COP 26 Meeting on Climate Change in Glasgow. The commitment speeds India's Paris Agreement and UNFCC progress. Today's choices affect India's ability to meet 2030 and 2070 climate commitments thus climate leadership is crucial.

India aims to increase natural gas usage from 6% to 15% by 2030 as one of its initial moves toward sustainable energy. However, the security of affordable supplies, the volatile global energy market, customer affordability, natural gas taxation, and regional supply chain infrastructure imbalance limit gas consumption and its share in India's primary energy consumption mix. But, recent gas industry regulatory reforms, marketing and price reforms, and emphasis on boosting gas consumption from unconventional sources like CBM and renewable methane (Bio-Gas) show the government's commitment to speeding up the gas-based economic transition. Multidimensional measures to promote solar, wind, hydrogen, and biofuels on a commercial scale offer solutions to diversify India's primary energy consumption mix to meet its goals and obligations. While global renewable energy consumption from 2016 to 2023 was 8.8% CAGR, Indian consumption was 14.8% CAGR. However, growth has accelerated recently. This article examines India's renewable energy transition strategies and growth barriers. The rest of the article follows this structure. Indian energy ecosystem activities for clean energy transition are discussed in Section 2. Section 3 covers worldwide initiatives, section 4 covers energy transition issues, and the article concludes with India's way forward energy transition strategy.

Initiatives Shaping India's Energy Transition

An exploratory review reveals that the government has taken several strategic and policy interventions to pursue its energy transition aspirations. These initiatives are categorized at source, consumption, and utility levels. The deliberations follow:

Source Level

Source-level initiatives relate to promoting the production of clean energy to enhance its consumption.

Renewable Energy

- National Green Hydrogen Mission (NGHM) 2023 [2]: India's NHM aims to connect the hydrogen economy to renewable energy growth with an estimated GH2 generation of 5MMT by 2030. With a budget of Rs. 19,744 crore(2023-24 to 2029-30), NHM aims to reduce CO2 emissions by 50 MMT per year and make India a global leader in green hydrogen production, use, and export. The government has released guidelines for pilot projects for the use of Green Hydrogen under the NGHM with budget allocation in (i) the Transport Sector- until FY 2025-26, Rs. 496 Crore, (ii) the Steel Sector- until FY 2029-30, Rs. 455 Crore, and (iii) the Shipping Sector-until FY 2025-26 Rs. 115 Crore.
- National Biofuels Policy 2018 [3] and SATAT [4]: MOPNG's biofuel policy categorizes biofuels into Basic and Advanced categories. The policy prioritizes second-generation (2G) ethanol and MSW-to-drop-in fuels, requiring financial and fiscal incentives for each category. It promotes unfit crops like sugarcane juice, sugar beet, and rotten potatoes for ethanol production. The policy offers a Rs. 5000 crore VGF package for 2G ethanol refineries over six years. It also recommends tax incentives and higher prices than 1G biofuels. Other initiatives relating to this policy are:
  - Ethanol Blended Petrol (EBP) program [5]
  - Pradhan Mantri JI-VAN Yojana, 2019 [6]
  - Sustainable Alternative Towards Affordable Transportation (SATAT): SATAT aims to reduce LNG import by 2/3rd by producing Compressed Bio-gas (CBG) and bio-manure. India benefits from CBG by reducing dependency on LNG, GHG emissions, agricultural residue burning, farmer income, job development, and trash management. The Compressed Bio Gas Blending Obligation (CBO) requires blending in 2025-26 and voluntary CBO until 2024-25. So, PNG domestic and CNG transport customers will receive co-mingled Gas. 19,724 Tons of CBG sales were reported in FY 2023-24. The MOPNG also launched a pipeline infrastructure program for CBG injection into the CGD grid. These initiatives are expected to increase CBG production and consumption in the country rapidly.
  - GOBAR (Galvanizing Organic Bio-Agro Resources) DHAN scheme [7]: The initiative aims to convert agricultural waste into compost, biogas, and bio-CNG, improving rural cleanliness and boosting households' economic prospects.
  - Repurpose Used Cooking Oil (RUCO) [8]: The Food Safety and Standards Authority of India (FSSAI) has launched an initiative to create an ecosystem for the efficient conversion of used cooking oil into biodiesel.
- National Solar Mission (NSM) : The Indian Government launched NSM [9] to promote sustainable development and address energy-related issues. The goal is to position India as a global leader in solar energy by promoting widespread solar energy adoption. The current goal is to achieve 280 GW of solar-powered generation capacity by 2030.
- National Wind-Solar Hybrid Policy (NWSHP)2018:The policy[10] aims to establish a grid-connected wind-solar PV hybrid system to maximize transmission infrastructure and land utilization, mitigating renewable power generation fluctuations and improving grid stability. It promotes innovative technologies and approaches for integrated wind and solar photovoltaic facilities. India's INDC targets include 500 GW of non-fossil energy capacity by 2030 and 50% renewable energy requirements.
- Small Hydro Power (SHP): Hydropower plants with 25 MW or less are classified as SHP[11], aiming to integrate remote communities into the economy and improve socio-economic status. The government supports 600 SHP projects, aiming to generate 50% of India's energy from renewable energy by 2030.

Consumption and Utility Level

The initiative relates to enhancing the energy consumption generated through renewal sources and promoting clean energy production to improve its consumption.

Energy Efficiency and Industrial Decarbonisation

India's industrial sector, responsible for 32% of CO2 emissions by 2050, is expected to contribute significantly to its energy demand, with over 80% coming from fossil fuels. Following policy direction is crucial in this sector.

- Energy Conservation Amendment Bill, 2022: The Bill[12] aims to reduce India's fossil fuel-based power consumption by incentivizing clean energy, enhancing renewable energy consumption in industrial units, and extending its applicability to residential buildings.
- Unnat Jyoti by Affordable LEDs for All (UJALA) 2015: The UJALA [13] scheme replaces 77 Crore incandescent lamps with LED bulbs nationwide, promoting energy efficiency and reducing electricity bills. Phase-wise LED distribution provides affordable, energy-efficient appliances to grid-connected consumers, allowing them to purchase LED bulbs at 40% of market prices.
- Perform, Achieve, and Trade (PAT) Scheme[14]: India aims to improve energy efficiency and reduce emissions in industrial sectors through a market-oriented regulatory mechanism, converting energy conservation into transferable Energy Saving Certificates (ESCerts) for trading at Power Exchanges.

Electrification

Electrification is a promising strategy for reducing emissions and decarbonizing energy supply chains. The proportion of electricity in global final energy consumption is projected to rise from 20% in 2022 to over 27% in 2030.

- Green Energy Corridor (GEC): The GEC [15] initiative aims to integrate wind and solar energy with conventional power stations and install 450 GW of renewable energy capacity by 2030. It includes the Inter-State Transmission System (ISTS) and Intra State Transmission System (InSTS), a Renewable Energy Management Centre (REMC), and control infrastructure.
- National Smart Grid Mission (NSGM) 2015 and Smart Meter National Programme (SMNP): The Mission aims to modernize India's power sector by implementing Smart Grid technology. The NSGM has independent resources, authority, and financial autonomy to oversee Smart Grid policies and programs. The NSGM Framework document outlines Smart Grid initiatives' institutional framework, regulations, and economic models. The SMNP [16] aims to replace India's 250 million conventional meters with smart meters, benefiting energy suppliers and customers. Smart meters operate on a pre-payment mechanism, reducing revenue loss and promoting transparency. Implementation will improve India's energy security, reduce carbon emissions, and create employment opportunities.
- Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA)2017

The scheme[17], aims to provide reliable and affordable electricity to rural and urban households in India. The government has entered into MoUs with seven states to ensure uninterrupted electricity supply and sufficient power provision for agricultural consumers. As of March 31, 2019, all households were reported electrified, except for 18,734 in Left Wing Extremists-affected areas. Seven states reported 100% household electrification, with a total of 2.817 crore households electrified up to March 31, 2021. The schemes closed on March 31, 2022.

Sustainable Transport

The transportation industry significantly contributes to global carbon emissions due to fossil fuel combustion. Decarbonization can be achieved through alternative technologies like electric vehicles, alternative fuels, public transport improvements, active mobility promotion, and infrastructure upgrades.

- Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) 2015: The objective of the project is to advance India's vision for electric mobility that is dependable, cost-effective, and proficient. The FAME [18] initiative aims to mitigate the environmental impact resulting from using diesel and petrol-powered vehicles while simultaneously fostering the growth of electric and hybrid vehicle production. In the initial phase of the FAME India Scheme, the Ministry of Heavy Industries approved the allocation of 520 Charging Stations/ Infrastructure. Additionally, the Ministry authorized 2,877 Electric Vehicle Charging Stations in 68 cities spanning 25 States/Union Territories. Furthermore, 1,576 charging stations were approved for installation along 9 Motorways and 16 Highways as part of Phase II of the FAME India initiative. The Ministry of Heavy Industries allocated a capital subsidy of Rs. 800 Cr. to the three OMCs under the MoPNG. This subsidy is intended to support the development of 7,432 public charging stations for electric vehicles. FAME 2 subsidy was originally a 3-year plan but was extended. The faster adoption and manufacturing of electric vehicles II scheme (FAME II) closed in March'24. The government has given manufacturers and consumers a subsidy of Rs 11,500 crore under the scheme.
- Indian Railways Going Green [19]: Indian Railways is working towards achieving net zero carbon emissions by 2030 through initiatives like electrification, water and paper resource conservation, and wildlife protection. They have made significant strides in renewable energy, freight transportation efficiency, and technology implementation.
- Sustainable Aviation [20]: India's inaugural commercial passenger flight used a Sustainable Aviation Fuel (SAF) blend in May 2023, reducing carbon emissions and benefiting 500,000 farmers. The MoCA proposes blending targets of 1% by 2027 and 2% by 2028 for international flights.

Climate Smart Cities

The Climate Smart Cities Assessment Framework, introduced in 2020, provides a comprehensive roadmap for cities to tackle climate change challenges effectively, aiding in planning, implementation, and informed investment decisions.

- Smart City Mission (SCM) 2015 [21]: The Smart Cities Mission aims to create sustainable and resilient urban ecosystems through intelligent solutions, including area-based development, redevelopment, greenfield construction, and a Pan-city strategy for broader city areas.
- The Green Buildings Market [22]: The goal is to construct green buildings that prioritize resource efficiency, sustainability, and resilience, withstand climate change, and promote biodiversity. Sustainable construction materials like green concrete, composite waste, fly-ash bricks, and recovered steel can facilitate decarbonization in this sector.

City Gas Distribution

The CGD network, covering 307 Geographic Areas, is being developed rapidly, covering the entire country except Mizoram, Andaman, Nicobar Islands, and Lakshadweep. This initiative aims to enhance natural gas consumption, benefit households and transport segments, and contribute to SDG 7 attainment.

Clean Cooking

- Pradhan Mantri Ujjwala Yojana (PMUY) 2016[23]:The initiative aims to provide households with LPG cylinders to promote "Swacch Indhan, Behtar Jeevan" (Clean Fuel, Better Life). The original plan was to allocate 5 crore LPG connections to women below the poverty line. By March 2020, eight crore women were connected. Under Ujjwala 2.0, an additional one crore LPG connections were announced, providing deposit-free connections to low-income families, including migrants and non-migrants. MoPNG approved additional connections to clear pending applications and provide deposit-free connections to eligible households.

Carbon Credit Trading Scheme (CCTS), 2023

India revamped its CCTS[24] in 2024, allowing non-obligated entities to participate in the tradable carbon credits market. This will enable companies and individuals to voluntarily use carbon credits to address their emissions. The scheme also introduces an offset mechanism, allowing entities to register projects and obtain tradable carbon credit certificates (CCCs). The aim is to efficiently price emissions through CCC trading and expand the voluntary carbon market, the launch of which is set for 2025-26. Obligated entities can purchase additional credits or sell surplus ones, while businesses can trade CCCs to offset emissions.

Global Initiatives

Global Bio-Fuel Alliance (GBA) 2023[25]

India's GBA aims to promote sustainable biofuels, strengthen the biofuel market, facilitate global trade, and develop biofuel policy. The alliance will accelerate global biofuel adoption by promoting technological advancements, increasing sustainable biofuel use, and establishing comprehensive standards. It will also serve as a centralized knowledge repository and expertise hub. The primary objective is facilitating global collaboration in bioenergy, bio-economy, and energy transition. The alliance will collaborate with regional and international agencies, including the Clean Energy Ministerial Biofuture Platform, Mission Innovation Bioenergy initiatives, and the Global Bioenergy Partnership.

International Solar Alliance (ISA)[26]

The ISA is a platform aiming to promote solar energy technology adoption, enhance energy accessibility, promote energy security, and transition to sustainable energy sources among its member nations. It focuses on creating economically viable and revolutionary energy solutions for humanity, particularly in Least Developed Countries (LDCs) and Small Island Developing States (SIDS). The ISA collaborates with multilateral development banks, development finance institutions, commercial and public sector organizations, civil society, and other international organizations to facilitate global transformation. The 'Towards 1000' strategy aims to mobilize USD 1,000 billion in investments for solar energy solutions by 2030, providing clean energy solutions to 1,000 million individuals and facilitating the installation of 1,000 GW of solar energy capacity. The ISA comprises nine comprehensive programs, focusing on analytics and advocacy, capacity building, and programmatic support to create a conducive environment for solar energy investments. 119 nations have signed the ISA Framework Agreement, with 99 countries qualifying as full members.

Clean Energy Ministerial (CEM) [27]

The CEM is an international platform advocating for clean energy laws and initiatives, promoting knowledge exchange and successful strategies, promoting a global economy centered on clean energy, and fostering global collaboration for a sustainable energy economy.

Mission Innovation (MI) [28]

MI is a global initiative by 23 countries and the European Commission to accelerate the Clean Energy revolution and achieve the Paris Agreement goals. Its main objective is to catalyze action and investment in research, development, and demonstration to make clean energy affordable and accessible. Aim to invest in innovation in breakthrough clean energy technologies to deliver impact at scale.

Challenges to ensuring the energy transition

Global energy investment is crucial to prevent market and economic crises. Rising countries require $2.2 trillion annually for energy transformation while developing nations need $1.7 trillion annually. Foreign direct investment in clean energy reached $544 billion in 2022. GH2 can reduce carbon emissions in fertilizer, refinery, iron, and steel industries. The NHEM aims to reduce India's reliance on fossil fuels and establish the country as a green hydrogen producer. EVs are projected to reach 240 million by 2030, reducing carbon emissions and promoting environmentally friendly transportation. Having sufficient battery storage capacity is essential for continuous power supply. Policies can enhance renewable energy sustainability by allocating investments and establishing a circular economy.

Financing for the Transition

India faces challenges transitioning to renewable energy due to limited, cheaper investment access, lack of financing institutions, and technological difficulties.

Skill Development

The energy transition will significantly the alter job mix, structure, and skills, necessitating skill development to ensure people and communities are "future-ready."

Dominance of Coal in the Power Sector

Reducing coal's fuel mix proportion in the power sector remains a distant goal due to its cost-effectiveness compared to other commercial alternatives.

Decarbonizing the Transport Sector

India's 66% petrol consumption is attributed to two and three-wheelers, necessitating infrastructure expansion for electric vehicle charging stations and rapid agricultural waste biofuel production to boost renewable fuel availability.

India's Way Forward Strategy for Energy Transition

Through various initiatives, India aims to achieve energy independence by 2047, becoming a developed nation with a USD 30 trillion economy, focusing on green growth, sustainability, and innovation. Some of the initiatives that promise to promote India's aspirations for energy transition are:

Accelerating RE Deployment

Increasing RE power to meet electrical needs accelerates renewable energy capacity expansion, boosts productivity in rural areas, reduces economic disparities, generates employment opportunities, and addresses disparities across generations and geographical locations.

Realigning the Current Use of Coal Resources through Coal to Gas Projects

India aims to realign coal resource utilization to optimize efficiency. With an estimated coal reserve of 361411.46 million tonnes, the country aims for 100 million tonnes of coal gasification by 2030, reducing import dependency.

Accelerating the transition towards a gas-based economy

NG, a clean and sustainable energy source, is crucial for India's transition. However, its share in the Indian primary energy consumption mix is only 5.8%, compared to the world average of ~23.8% [1]. To increase NG consumption to 15% by 2030, India must address factors such as affordable supplies, unpredictable global markets, customer paying capacities, taxation structures, and regional supply chain imbalances.

Domestic Manufacturing of Clean Energy Components

India must develop renewable energy components domestically, attain energy independence, and create clean energy jobs. Cost competitiveness is the first challenge. Preference for domestic components may hinder energy transition implementation, but it will help achieve self-sufficiency and build the world's largest green workforce.

Leveraging the Power of Digitization

Digitalization and Big Data drive energy development as a service (EaaS), a $6 billion market by 2030. India is progressing towards low-carbon development with advanced technologies, investments, and efficiency improvements. A collaborative ecosystem with favorable government policies and industry clean energy investment can help achieve a renewable-dominated energy mix.

Global Collaboration

Forming a worldwide strategic alliance will ensure India's energy stability while enabling broad entry to India's growing domestic energy market.

References

1. *EI Review of World Energy 2024*
2. *National Green Hydrogen Mission (NGHM) 2023*
3. *National Biofuels Policy*
4. *Sustainable Alternative Towards Affordable Transportation (SATAT)*
5. *Ethanol Blended Petrol (EBP) program*
6. *Pradhan Mantri JI-VAN Yojana, 2019*
7. *GOBAR (Galvanizing Organic Bio-Agro Resources) DHAN scheme*
8. *Repurpose Used Cooking Oil (RUCO)*
9. *National Solar Mission (NSM)*
10. *National Wind-Solar Hybrid Policy (NWSHP)*
11. *Small Hydro Power (SHP)*
12. *Energy Conservation Amendment Bill, 2022*
13. *Unnat Jyoti by Affordable LEDs for All (UJALA) 2015*
14. *Perform, Achieve, and Trade (PAT)*
15. *Green Energy Corridor (GEC)*
16. *National Smart Grid Mission (NSGM) and Smart Meter National Programme (SMNP)*
17. *Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA)*
18. *Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) 2015*
19. *Indian Railways Going Green*
20. *Sustainable Aviation*
21. *Smart City Mission (SCM) 2015*
22. *The Green Buildings Market*
23. *Pradhan Mantri Ujjwala Yojana (PMUY) 2016*
24. *Carbon Credit Trading Scheme (CCTS)*
25. *Global Bio-Fuel Alliance (GBA) 2023*
26. *International Solar Alliance (ISA)*
27. *Clean Energy Ministerial (CEM)*
28. *Mission Innovation (MI)*

Young Voice

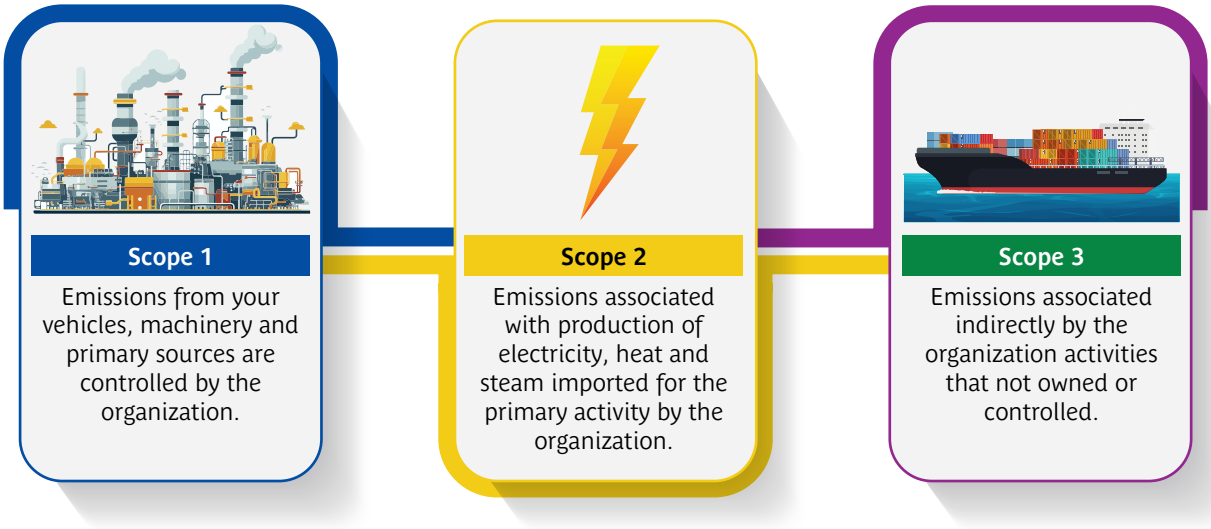
26 Net Zero Plans of Oil and Gas Organizations in India

Shri Mihit Shah,
Energy Research Analyst, U.A.E

Introduction

The global energy landscape is currently experiencing a profound transformation, fuelled by the urgent need to address climate change. As nations come together in their commitment to achieve 'net-zero emissions,' the role of oil and gas companies has gained significant importance. But what exactly does 'NET-ZERO' mean? In straightforward terms, it signifies a delicate equilibrium: the greenhouse gases we emit are offset by an equivalent removal from the atmosphere. In other words, our net contribution to emissions remains neutral.

Nowhere is this more evident than in India, where energy demand is soaring, and state-owned oil and gas organizations are taking bold steps toward sustainability. India's leading oil and gas players—ONGC, Indian Oil, BPCL, HPCL, and others—have made a resolute commitment: achieving net-zero emissions for both Scope 1 (direct emissions from operations) and Scope 2 (indirect emissions from energy consumption) by approximately 2040. However, this study goes beyond conventional boundaries. We delve into Scope 3 emissions, considering the full lifecycle impact, including those arising from supply chains, product use, and disposal.



Source: Standards & Guidance, from India GHG Program[1].

Figure 1: Explaining Scope of Emissions

The 2047 Vision 'Viksit Bharat': A Carbon-Neutral Oil and Gas Sector

By 2047, India will celebrate its 100th year of independence. As part of this historic milestone, the oil and gas sector must undergo a radical transformation. The target is ambitious yet imperative: a 90 percent reduction in emissions compared to current levels. This translates to roughly an annual reduction of 50-60 million metric tonnes of carbon dioxide equivalent (MMTCO2e). Achieving this goal demands innovative strategies and unwavering commitment.

Key Strategies for Emission Reduction

Geography Matters

Companies must tailor emission reduction initiatives based on their specific context. Factors such as geographical location (offshore vs. onshore), asset type (gas vs. oil), and refining efficiency play a crucial role. Local policies and regulations further shape the landscape.

Decarbonization Techniques

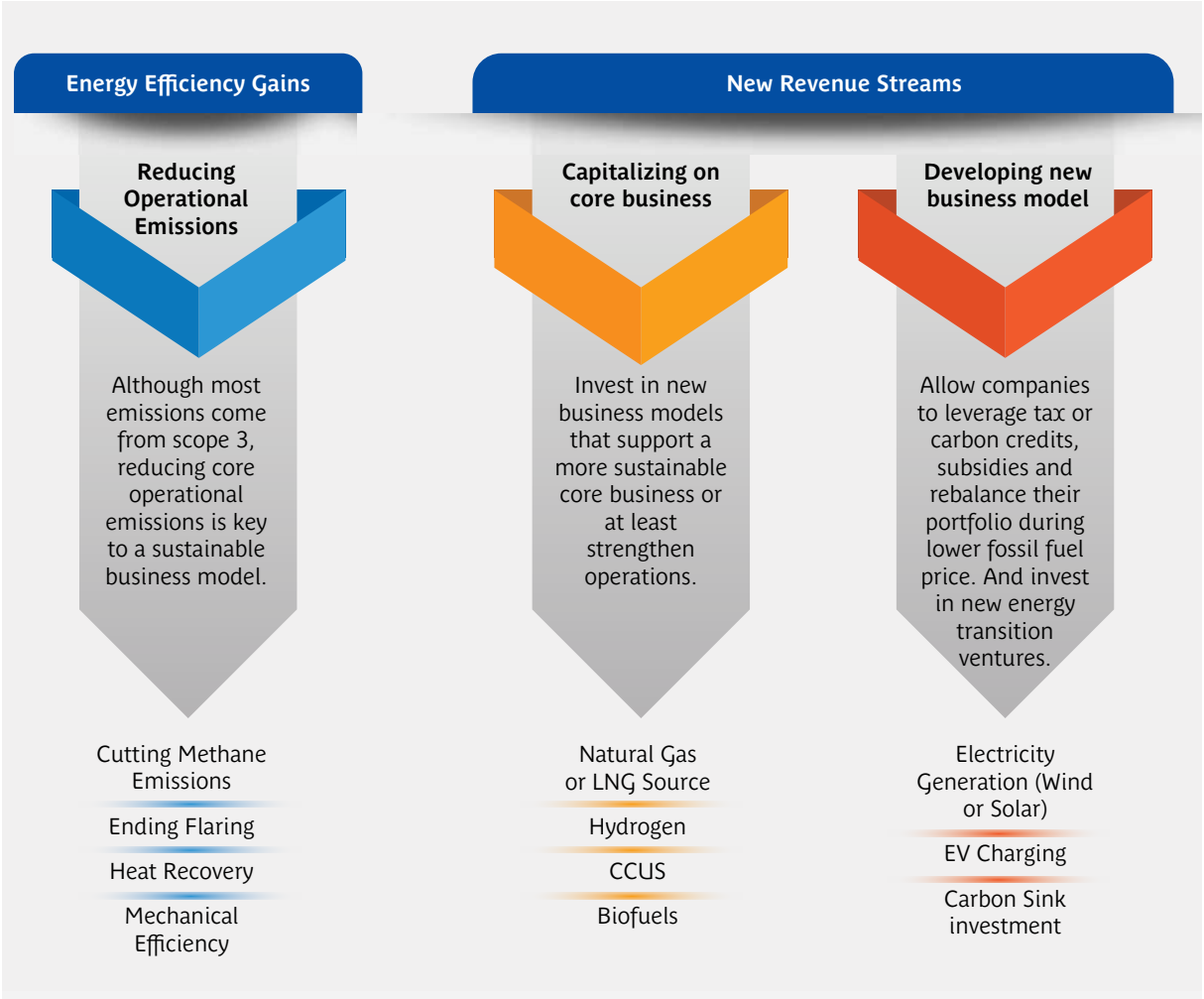
Many firms have already embraced effective methods. These include improved maintenance practices, rigorous monitoring to minimize methane leaks, and optimizing energy-intensive processes.

Cost-Effective Solutions

Balancing sustainability with economic viability is essential. Investing in energy-efficient technologies, retrofitting existing infrastructure, and exploring circular economy principles can yield substantial gains.

Leveraging Natural Carbon Sinks

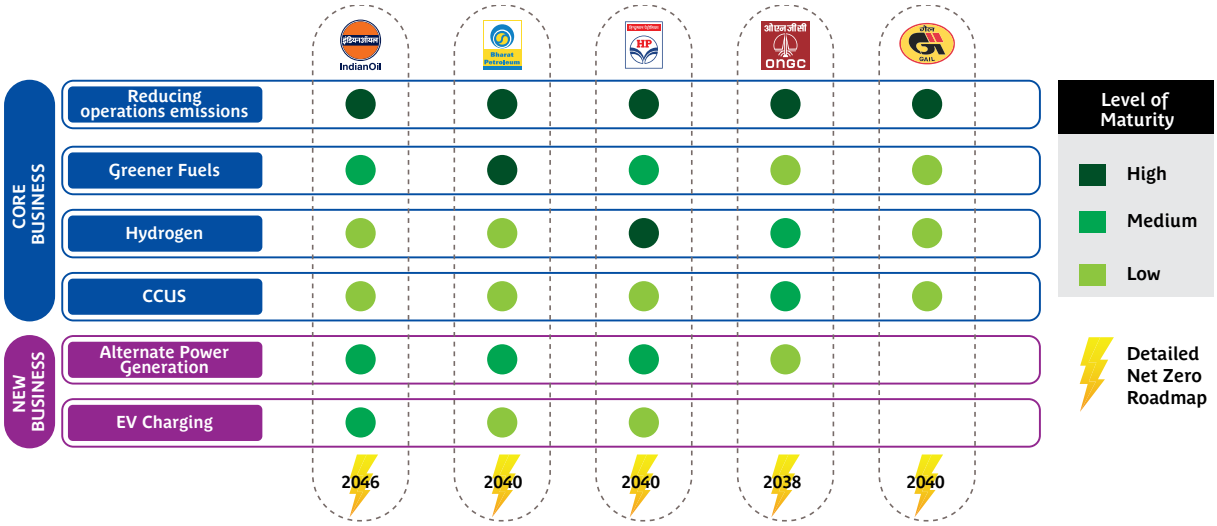
India's vast landmass offers unique opportunities. Initiatives that tap into natural carbon sinks—forests, vegetation, and soil—can offset emissions. Reforestation projects and carbon sequestration efforts hold promise too.



Source: McKinsey Insights[2]

Figure 2: Industrial Trend - Beyond reducing emissions, the Energy Transition offer lucrative opportunities

Let us now examine the critical Indian PSU supermajors that balance their core focus with strategic expansion into new business domains while pursuing ambitious net-zero targets,



Source: Sustainability Reports of the above-mentioned PSU companies[3].

Figure 3: Indian PSU Emissions Targets

Strategies for Upstream Operators: Navigating Emissions Reduction

Upstream operations wield substantial influence over sector-specific emissions, accounting for approximately two-thirds of the total. As the world grapples with climate change, oil and gas companies are proactively adopting a range of measures to mitigate their environmental impact.

Diversifying Power Sources

To reduce reliance on conventional fuels, operators are turning to on-site renewable power generation. Solar photovoltaic (PV) systems and battery storage offer cost-effective alternatives to diesel and coal. Example: Equinor's successful integration to onshore renewable electrical power grid at Johan Sverdrup field – an offshore asset located 140 kms from the coast, demonstrates the feasibility of sustainable power solutions in remote offshore locations.

Tackling Fugitive Emissions

Methane, a potent greenhouse gas, poses a significant challenge. Companies are implementing leak detection and repair (LDAR) programs and deploying vapor recovery units (VRUs). Advanced technologies, such as double mechanical seals and dry gas seals, further enhance emission control. Example: BP's commitment to reducing methane emissions across its operations exemplifies industry leadership in tackling fugitive emissions.

Electrification of Equipment

Transitioning from gas-fired boilers to electric steam-production systems minimizes direct emissions. This shift aligns with the broader trend toward electrification in the energy sector. Example: Shell's adoption of electric steam generators in its offshore facilities underscores the feasibility of this transition.

Mitigating Non-routine Flaring:

Operators recognize that a substantial portion (70 percent) of flaring emissions stems from non-routine activities. Predictive maintenance and timely equipment replacement are critical strategies to address this challenge. Example: TotalEnergies' predictive maintenance program significantly reduced flaring incidents in its offshore platforms.

Mitigating Routine Flaring: While some

flaring remains unavoidable due to infrastructure limitations, companies must strive for efficient management. The Permian Basin, for instance, witnessed record flaring in Q1 2019. Investing in additional gas processing facilities and robust transport infrastructure is essential. Example: ExxonMobil's collaboration with pipeline operators to minimize routine flaring in the Permian Basin exemplifies industry efforts.

Advancing Carbon Capture, Use, and Storage (CCUS)

While CCUS plays a relatively minor role in overall decarbonization efforts, oil and gas industry stakeholders can significantly influence its adoption. Enhanced oil recovery (EOR) projects provide a viable avenue for capturing and utilizing CO2 emissions. For instance, Chevron's strategic investment in EOR initiatives—where CO2 is sequestered while simultaneously enhancing oil production—demonstrates the dual benefits of CCUS. Meanwhile, prominent Indian public sector undertakings (PSUs) such as ONGC, Indian Oil, and Equinor have

collaboratively signed a memorandum of understanding (MoU) to explore opportunities and conduct research in this critical area.

Rebalancing Portfolio

Operators must critically evaluate their upstream portfolio choices. High-emitting reservoirs—such as complex, deep-water, or high-pressure fields—require careful consideration. Striking the right balance between profitability and sustainability is paramount. Example: ConocoPhillips' strategic divestment from high-emission assets underscores the importance of portfolio optimization.

Empowering Downstream Operators: Strategies for Energy Efficiency and Electrification

Downstream operators are proactively exploring strategies to enhance energy efficiency and electrify low to medium-temperature heat and energy. As the industry evolves, several common themes offer unique opportunities for sustainable transformation.

Waste-Heat Recovery

Deploying waste-heat recovery technologies within refineries significantly reduces primary energy consumption during distillation processes. By precisely forecasting steam usage and incorporating it into a thermodynamic model for equipment replacement, refineries can achieve substantial capital savings. Example: Chevron's waste-heat recovery system at its Pascagoula refinery demonstrates the economic and environmental benefits of this approach.

Green Hydrogen

Electrolysis-based hydrogen production has made significant strides in technical advancements and cost-effectiveness. Bloomberg New Energy Finance predicts a potential two-thirds reduction in hydrogen costs by 2050. Refineries can leverage renewable energy sources for electrolysis, creating "green hydrogen" and effectively reducing emissions. Alternatively, "blue hydrogen," produced through steam methane reforming (SMR) with Carbon Capture, Utilization, and Storage (CCUS), offers an immediate solution. Example: Shell's partnership with ITM Power to develop a green hydrogen electrolyser at its Rhineland refinery exemplifies the industry's commitment to sustainable hydrogen production.

High-Temperature Cracking

Pilot projects are exploring the use of electric coils (instead of fuel gas) for heat in refining processes. Although still in its nascent stage, this approach can be economically viable when aligned with natural investment cycles and favourable electricity pricing. Example: Total Energies' research on high-temperature cracking using electric coils in its petrochemical facilities showcases the potential of this innovative technique.

Greener Feedstocks

Replacing conventional oil feedstocks with bio-based or recycled materials represents a pivotal strategy for emissions reduction. By procuring feedstocks from sustainable and renewable sources, refineries can significantly curtail their carbon footprint. For instance, Neste, a leader in renewable diesel production, exemplifies this greener approach by utilizing renewable feedstocks—such as waste and residues. Meanwhile, in India, the government's ambitious Ethanol Blending Program (EBP) aims for a 20% blend of ethanol in petrol by 2025. However, it's important to note that the current focus remains on ethanol-petrol blends, Targets for

blending in diesel have been advanced by government to 2030. Notably, diesel consumption in India exceeds that of petrol by threefold.

In the International Energy Agency's (IEA) Net Zero Emissions by 2050 Scenario, the emissions intensity of oil and gas operations worldwide is projected to plummet by more than 50% by the end of this decade. This reduction, coupled with the decline in oil and gas consumption, translates to a remarkable 60% cut in emissions from these activities by 2040[4].

As India navigates its sectoral energy transition, collaboration among stakeholders—industry, policymakers, and civil society—will be pivotal. The oil and gas sector's journey toward net zero is not merely a corporate goal; it's a collective responsibility to safeguard our planet for generations to come. The path forward involves pragmatic and cost-effective solutions of mix like achieving energy efficiency in current assets with low-emission sources, carbon capture and storage (CCUS), electrification with renewables, bioenergy, hydrogen-based transition, and most important behavioural changes [5].

References

1 *India GHG Program, https://indiaghgp.org/explaining-scope-1-2-3.*

2 *Summarized in a diagrammatic manner using the McKinsey Insight Data, https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-big-choices-for-oil-and-gas-in-navigating-the-energy-transition.*

3 *Summarized in a diagrammatic manner using Sustainability Reports of the following:*

- a. *Indian Oil Sustainability Report 2022-23: https://iocl.com/uploads/IOCL-Sustainability-Report-2022-23.pdf*
- b. *Bharat Petroleum Sustainability Report 2022-23: https://www.bharatpetroleum.in/images/files/SUSTAINABLE%20DEVELOPMENT%20REPORT_22-23-05-02-24.pdf*
- c. *Hindustan Petroleum Sustainability Report 2022-23: https://www.hindustanpetroleum.com/documents/pdf/HPCL_Sustainability_Report_2022-23.pdf*
- d. *Oil and Natural Gas Corporation Corporate Sustainability, https://ongcindia.com/web/eng/sustainability/corporate-sustainability*
- e. *GAIL Sustainability Report 2022-23: https://www.gailonline.com/pdf/Sustainability/GAILSustainabilityReport202223new.pdf*

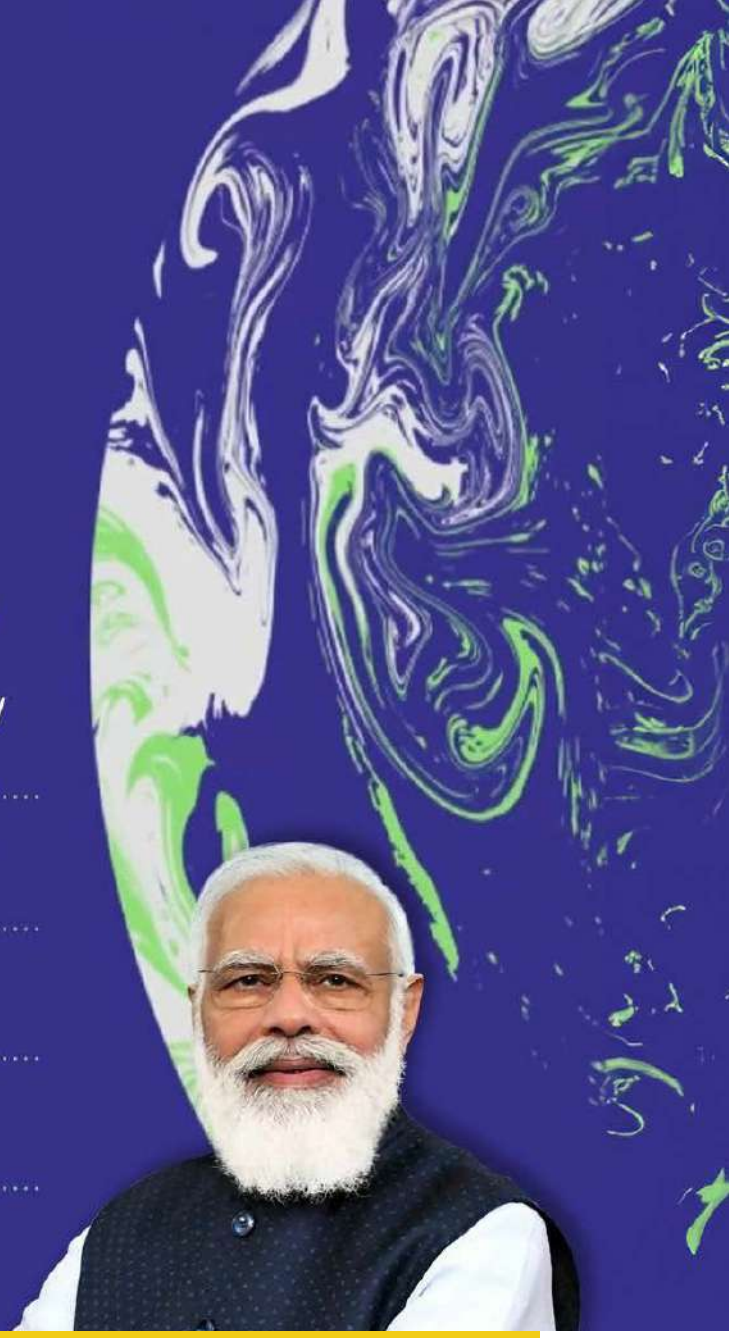
4 *Net Zero by 2050, A Roadmap for the Global Energy Sector, https://www.iea.org/reports/net-zero-by-2050*

5 *India's Energy Transition: More Energy, Fewer Emissions – by Dr. Atul Arya and Gauri Jauhar, https://www.spglobal.com/en/research-insights/special-reports/look-forward/india-s-energy-transition-more-energy-fewer-emissions*

INDIA'S 'PANCHAMRIT' AT COP26

by Prime Minister Narendra Modi

1. Reach non-fossil energy capacity to 500GW by 2030
2. Fulfil 50% energy requirements via RE by 2030
3. Reduce 1 bn carbon emissions by 2030
4. Reduce carbon intensity >45% by 2030
5. Achieve the target of Net-Zero by 2070



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IEW
INDIA ENERGY WEEK 2025

> This word is LiFE, which means 'Lifestyle for Environment'. Today, there is a need for all of us to come together and take Lifestyle for Environment forward as a campaign. This can become a mass movement towards an environmentally conscious lifestyle.
>
> *— Hon`ble Prime Minister Narendra Modi*

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