INDIAN OIL CORPORATION LIMITED

R&D Centre, Faridabad.
Sector 13, Haryana 121007

IMPACT ASSESSMENT

CENTRE OF EXCELLENCE IN OIL, GAS & ENERGY (COE-OGE), IIT BOMBAY

2025-2026





Impact Assessment by:

Environmental Technical Services Pvt. Ltd.

FOREWORD

This study has been carried out by M/s Environmental Technical Services Private Limited, New Delhi, based on inputs received from Indian Oil R&D Centre, Faridabad. M/s Environmental Technical Services Private Limited would like to take this opportunity to extend their thanks to the Indian Oil R&D Centre, Faridabad management and officers who co-operated in supplying the data and information required, thus maximizing the effectiveness of the study. The study identified the possibilities for improvement along with Impact Assessment on CSR Projects for execution of a successful sustainability project. The above study, results, conclusion and recommendations were based on the information made available to Environmental Technical Services Private Limited at the time of study. Environmental Technical Services Private Limited exercised all reasonable skill, care and diligence in carrying out the study. However, this report should not be deemed as any undertaking, warranty or certificate and cannot be challenged in any court of law of the country.



Place : New Delhi

Date: 02.03.2026

Managing Director

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1. LIST OF ABBREVIATIONS

IOCL	Indian Oil Corporation Limited
CSR	Corporate Social Responsibility
ETS	Environmental Technical Services
CCU	Carbon Capture and Utilization
R&D	Research and Development
CPSEs	Central Public Sector Enterprises
DPE	Department of Public Enterprises
COE-OGE	Centre of Excellence in oil Gas and Energy
CMDS	Countermeasures Dispensing System
FY	Financial Year
SDG	Sustainable Development Goals
CCUS	Carbon Capture, Utilization & Storage
CBG	Compressed Biogas
ONGC	Oil and Natural Gas Corporation Limited
HPCL	Hindustan Petroleum Corporation Limited
BPCL	Bharat Petroleum Corporation Limited
GAIL	Gas Authority of India Limited
OIL	Oil India Limited
EIL	Engineers India Limited
BTG	Bridge-the-Gap

2. INTRODUCTION

Indian Oil Corporation Limited (IOCL) is India's largest commercial enterprise and a leading integrated energy company, playing a pivotal role in the country's energy security and economic development. With a strong presence across the entire hydrocarbon value chain—including refining, pipelines, marketing, petrochemicals, and research & development—Indian Oil has consistently demonstrated operational excellence, innovation, and sustainability-driven growth.

A key pillar of Indian Oil's technological leadership is its Research & Development Centre, established in 1972 at Faridabad, Haryana. The Centre is equipped with state-of-the-art infrastructure, advanced pilot plants, and sophisticated analytical facilities that support end-to-end research, from laboratory-scale innovation to commercial application. Over the years, Indian Oil has developed and successfully commercialized several indigenous technologies, catalysts, and additives, strengthening its position as a technology-driven organization.

In addition to its strong foundation in conventional petroleum domains such as refining, lubricants, pipelines, and petrochemicals, Indian Oil has significantly expanded its focus towards emerging and future energy areas. These include hydrogen energy, biofuels, carbon capture and utilization (CCU), energy storage systems, solar energy, and other clean energy technologies. This strategic shift aligns with national priorities related to energy transition, sustainability, and reduction of carbon emissions.

Through its integrated operations, strong R&D capabilities, and forward-looking approach, Indian Oil plays a critical role in driving innovation, enhancing energy efficiency, and contributing to India's vision of a secure, sustainable, and self-reliant energy future.

Vision

To be the most admired and trusted energy major, delivering value to stakeholders through innovation, operational excellence, and sustainable practices.

Mission

- To achieve leadership across the energy value chain with global standards in safety, quality, and reliability.
- To ensure energy accessibility, affordability, and sustainability for the nation.
- To drive innovation through technology and human capital development.
- To create shared value through inclusive growth and environmental responsibility.
- To uphold the highest standards of corporate governance and transparency.

OVERVIEW

On 29th August 2013, The Companies Act 2013 replaced the Companies Act of 1956. The New Act has introduced far-reaching changes that affect company formation, administration, and governance, and incorporates an additional section i.e. Section 135 – clause on Corporate Social Responsibility obligations ("CSR") for companies listed in India. The clause covers the essential prerequisites pertaining to the execution, fund allotment and reporting for successful project implementation.
India became the first country to legislate the need to undertake CSR activities and mandatorily report CSR initiatives under the new Companies Act 2013. This is the beginning of a new era for CSR in India.

WHAT IS CSR?

Corporate Social Responsibility (CSR) refers to the commitment of companies to operate in an economically, socially, and environmentally sustainable manner while contributing to the overall development of society. In India, CSR has been institutionalized under the Companies Act, 2013, which mandates eligible companies to undertake socially beneficial activities in areas specified under Schedule VII, including education, skill development, environmental sustainability, and promotion of technology and research.

The Centre of Excellence in Oil, Gas & Energy (COE-OGE) represents a strategic CSR initiative aimed at strengthening research, innovation, and capacity building in the energy sector, with a focus on sustainability, energy transition, and sectoral development.

DPE GUIDELINES

The Department of Public Enterprises (DPE), as the nodal authority for Central Public Sector Enterprises (CPSEs), formulates policies governing their performance, governance, and operational frameworks, including Corporate Social Responsibility (CSR) and sustainability. DPE has played a key role in institutionalizing CSR in India by issuing guidelines that mandate CPSEs to allocate a portion of their profits towards socially beneficial activities. The revised CSR and Sustainability Guidelines (effective from 1st April 2013) integrate global best practices with national development priorities, emphasizing inclusive growth, development of backward regions, upliftment of marginalized communities, women empowerment, environmental sustainability, and promotion of green and energy-efficient technologies. These guidelines also stress transparency, accountability, and responsible business practices, encouraging CPSEs to report their sustainability initiatives effectively. Overall, DPE guidelines have significantly strengthened the CSR framework in India, enabling CPSEs to create measurable socio-economic and environmental impact while reinforcing stakeholder trust.

3. CSR POLICY OF INDIAN OIL CORPORATION LIMITED

Indian Oil's Corporate Social Responsibility (CSR) framework is deeply embedded in its corporate ethos and aligns with the Companies Act, 2013, Government of India guidelines, and national development priorities. The CSR policy focuses on inclusive growth, social equity, environmental protection, and sustainable development.

Indian Oil believes that business success must go hand-in-hand with societal progress, and therefore integrates social responsibility into its core business operations.

Key Objectives of CSR Policy

- To contribute towards nation-building through strategic social investments.
- To support underprivileged, marginalized, and vulnerable communities.
- To enhance access to healthcare, education, skill development, and livelihood opportunities.
- To promote environmental sustainability, ecological conservation, and climate resilience.
- To encourage community participation and stakeholder engagement for long-term impact.

Focus Areas of CSR Initiatives

Indian Oil's CSR interventions broadly focus on the following thematic areas:

- Healthcare & Sanitation
- Education & Skill Development
- Women Empowerment & Gender Equality
- Environmental Sustainability
- Rural Development & Livelihood Promotion
- Sports Promotion & Cultural Development
- Support during Natural Disasters & Emergencies

4. APPROACH & METHODOLOGY

The impact assessment of the Centre of Excellence in Oil, Gas & Energy (CEOOGE), IIT Bombay was conducted using a comprehensive and evidence-based approach combining both qualitative and quantitative research methods. The assessment focused on evaluating the effectiveness, relevance, sustainability, and overall impact of the CSR-supported project across education, research, innovation, and institutional capacity building.

The study adopted a participatory and stakeholder-driven approach to ensure that insights were collected from multiple perspectives, including faculty members, researchers, students, industry partners, and project management representatives. Secondary data analysis was carried out using project documentation, research publications, infrastructure records, and the impact assessment database provided by the institution.

The methodology emphasized outcome-oriented evaluation rather than only activity-based assessment. The analysis examined how project inputs translated into measurable outputs such as research initiatives, publications, patents, training programs, infrastructure development, and technology platforms, and how these outputs contributed to broader societal and environmental outcomes.

4.1 RESEARCH STEPS

The following systematic steps were followed during the impact assessment process:

- **Project Understanding and Scoping** - Review of project objectives, implementation framework, timelines, and expected outcomes to establish the scope of assessment.
- **Review of Secondary Data and Documentation** - Analysis of project reports, research publications, infrastructure data, Excel-based databases, and supporting materials provided by CEOOGE.
- **Stakeholder Identification and Consultation** - Identification of key stakeholders including faculty, researchers, students, and industry representatives, followed by structured consultations to capture qualitative insights.
- **Data Compilation and Validation** - Consolidation of quantitative data related to research initiatives, publications, patents, laboratories, equipment, and technology platforms, ensuring accuracy and consistency.

- **Impact Analysis and Outcome Mapping** - Evaluation of project outcomes in terms of education impact, research excellence, innovation potential, and sustainability contributions.

4.2 RESEARCH DESIGN

The impact assessment followed a **mixed-method research design**, integrating both quantitative and qualitative evaluation techniques.

Quantitative Design

- Analysis of measurable indicators such as number of research initiatives, publications, patents, training programs, laboratories, and technology platforms.
- Review of infrastructure development and utilization data.
- Estimation of social value generated using indicative SROI methodology.

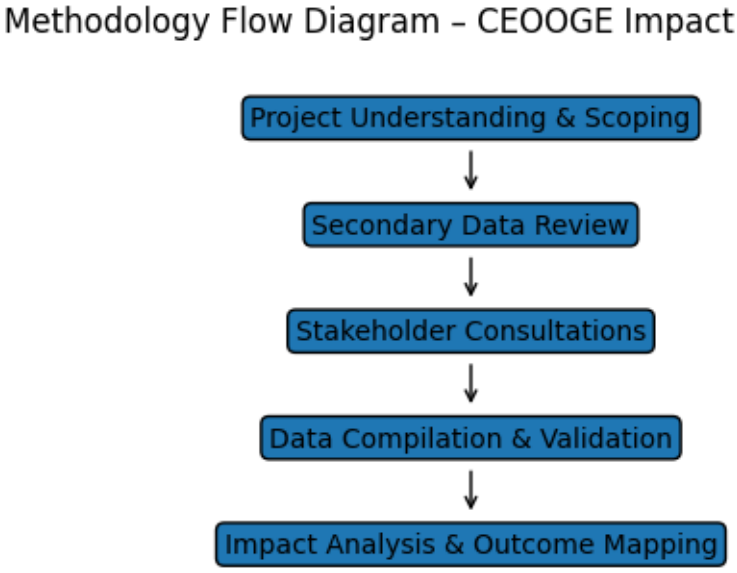
Qualitative Design

- Stakeholder consultations to capture experiences, perceptions, and long-term benefits.
- Case study analysis to illustrate project impact at institutional and individual levels.
- Thematic analysis of research contributions and sustainability outcomes.

Evaluation Framework

The research design aligned with standard CSR evaluation principles, focusing on:

- Relevance
- Effectiveness
- Efficiency
- Impact
- Sustainability



DESKTOP STUDY

As part of the Impact Assessment of the Centre of Excellence in Oil, Gas & Energy (COE-OGE), a structured desktop study was undertaken to review and analyse secondary data, institutional records, and project documentation. The study covered annual reports, project status data, research publications, intellectual property records, Industries collaboration details, training records, and CSR financial information.

The review focused on assessing research performance (completed and ongoing projects), intellectual outputs (patents and publications), industry engagement across various project channels, and capacity-building outcomes including training programs and professionals trained. Comparative and trend-based analysis was applied to evaluate sectoral relevance, institutional strengthening, and measurable outputs.

The desktop study provided a reliable evidence base for validating reported achievements and estimating socio-economic value, including the calculation of the indicative SROI ratio. It ensured that the impact assessment was grounded in verified data and aligned with national energy and sustainability priorities.

FORMULATION OF EVALUATION PROCESS

The evaluation process for the Centre of Excellence in Oil, Gas & Energy (CEOOGE), IIT Bombay was formulated to systematically assess the effectiveness, relevance, efficiency, impact, and sustainability of the CSR-supported initiative. The evaluation framework was designed to ensure a comprehensive understanding of project outcomes by integrating quantitative data analysis with qualitative stakeholder insights.

The process focused on assessing how project inputs and activities translated into measurable outputs and long-term outcomes, thereby enabling a holistic evaluation of the value generated through CSR investment.

The evaluation process involved multiple steps:

1. Review of project documents, research outputs, and infrastructure data.
2. Analysis of quantitative indicators including research initiatives, publications, patents, and technology platforms.
3. Stakeholder consultations to capture qualitative feedback and experiential insights.
4. Outcome mapping to link project activities with long-term benefits.

LIST OF CSR PROJECTS FOR IMPACT ASSESSMENT

S.No	Name of Project	Location
1	Centre of Excellence in Oil, Gas & Energy (COE-OGE), IIT Bombay	IIT Bombay, Maharashtra

Excellence in Oil, Gas & Energy (COE-OGE), IIT Bombay



5.1 EXECUTIVE SUMMARY

The Centre of Excellence in Oil, Gas & Energy (COE-OGE) at IIT Bombay is a key CSR initiative supported by Indian Oil Corporation Limited (IOCL), aimed at strengthening India's energy sector through research, innovation, and capacity building. The project, implemented with a total investment of ₹100 Crore (including ₹27.08 Crore by IOCL under CSR during FY 2019–20 to FY 2023–24), serves as a collaborative platform bridging academia and industry.

The impact assessment, conducted by Environmental Technical Services Pvt. Ltd., adopted a mixed-method approach combining quantitative analysis and stakeholder consultations, supported by a comprehensive review of project data and research outputs.

Key Achievements and Outcomes Research & Innovation Excellence:

The Centre has demonstrated strong research performance with **41 completed projects**, **32 ongoing projects**, and **16 projects under closure**, reflecting robust execution and sustained research momentum. The initiative has generated significant knowledge outputs, including **36+ research publications**, **26 conference papers**, **2 book chapters**, and **10 patents (including granted)**, showcasing its contribution to innovation and academic excellence. Translational mechanisms such as Bridge-the-Gap (BTG) projects further support the conversion of research into industry-relevant applications.

The project has also contributed to human capital development through structured training programs and research initiatives, creating a skilled workforce aligned with emerging energy sector needs. Additionally, it has strengthened institutional capabilities at IIT Bombay through advanced research infrastructure and interdisciplinary collaboration.

Sustainability & Energy Transition: - The research portfolio is aligned with national and global sustainability priorities, focusing on areas such as hydrogen, energy storage, biofuels, and decarbonization. The project contributes to key Sustainable Development Goals (SDGs), including:

- **SDG 7:** Affordable and Clean Energy
- **SDG 9:** Industry, Innovation and Infrastructure
- **SDG 13:** Climate Action

5.2 ABOUT CENTRE OF EXCELLENCE IN OIL, GAS & ENERGY (COE-OGE), IIT BOMBAY



The Centre of Excellence in Oil, Gas and Energy (COE-OGE) at IIT Bombay was established in 2019 with the objective of fostering research, technology development, and capacity building in the energy sector. The Centre is supported by leading Industries including IOCL, BPCL, HPCL, GAIL, ONGC, EIL and OIL, which operate across upstream, midstream, and downstream segments of the oil, gas and petrochemical industry. The Memorandum of Understanding (MoU) for establishing the Centre was signed on January 2, 2019 between the Chairpersons/CMDs of the participating Industries and the Director of IIT Bombay, in the presence of the Hon'ble Minister of Petroleum and Natural Gas, Shri Dharmendra Pradhan.

Objective of the Centre:

- To promote research and innovation in the oil, gas, and energy sector by integrating academic expertise with industry requirements, addressing emerging challenges across upstream, midstream, and downstream domains.
- To support the development of sustainable and efficient energy solutions, with a focus on environmental protection, decarbonization, and advancement of clean and alternative energy pathways.
- To strengthen industry–academia engagement by facilitating knowledge exchange, joint research initiatives, and the application of scientific and technological advancements to real-world sectoral challenges.
- To enhance human capital by developing skilled manpower and upgrading the technical capabilities of industry professionals through structured training, research, and capacity-building programs.
- To encourage interdisciplinary research in conventional and emerging areas of energy, including optimization of hydrocarbon resources, exploration of new technologies, and improved utilization of energy systems.
- To contribute towards national priorities in energy security, sustainability, and technological advancement by supporting innovation-led growth in the energy sector.

5.3 PROJECT INTRODUCTION



The Centre of Excellence in Oil, Gas & Energy (COE-OGE) at IIT Bombay is a flagship academic and research initiative established with the objective of strengthening India's capabilities in the energy sector through advanced education, high-impact research, and industry-relevant innovation. The total cost of the project is ₹100 Crore, reflecting a significant collaborative investment towards building national research capacity in the energy domain. Out of this, Indian Oil Corporation Limited (IOCL) has contributed ₹27.08 Crore under its Corporate Social Responsibility (CSR) framework during FY 2019–20 to FY 2023–24.

The COE-OGE has been developed with active participation from leading public sector energy organizations. The key industrial partners associated with the Centre include ONGC, Oil India Limited, Indian Oil, Hindustan Petroleum Corporation Limited (HPCL), Bharat Petroleum Corporation Limited (BPCL), GAIL (India) Limited, and Engineers India Limited (EIL). The involvement of these major energy sector organizations strengthens the industry relevance of the Centre and ensures alignment with practical operational and technological challenges.

The COE-OGE was conceptualized as a multidisciplinary platform that brings together expertise from engineering, materials science, earth sciences, chemistry, data analytics, and sustainability studies. The Centre focuses on addressing critical challenges faced by the energy sector, including energy security, decarbonization, efficiency improvement, safety, and the transition towards cleaner and sustainable energy pathways.

Through the establishment of advanced laboratories, research infrastructure, computational facilities, and collaborative research programs, COE-OGE has enabled cutting-edge work in areas such as petroleum engineering, reservoir characterization, carbon capture and utilization, hydrogen and energy storage technologies, clean fuels, advanced materials, and digital solutions for energy systems. In addition, the Centre has played a significant role in capacity building by supporting postgraduate and doctoral research, faculty-led innovation, and specialized training programs for industry professionals.

Overall, the COE-OGE project has emerged as a national knowledge and innovation hub that not only strengthens academic excellence but also contributes to energy transition, sustainability, and technological self-reliance. The CSR support provided by IOCL, along with the collaborative investment of industrial partners, has created long-term institutional assets and capabilities that will continue to generate educational, technological, and societal benefits well beyond the project duration.

Project Background & Rationale

India's rapidly growing economy and rising energy demand require a strong foundation of indigenous research, skilled manpower, and innovative technologies to ensure energy security while simultaneously addressing environmental and climate-related challenges. The energy sector is undergoing a significant transformation, marked by the need to reduce carbon emissions, improve efficiency in conventional systems, and accelerate the adoption of alternative and cleaner energy sources.

Against this backdrop, the establishment of the Centre of Excellence in Oil, Gas & Energy (COE-OGE) was driven by the recognition that academic institutions must play a central role in supporting the energy transition. While industry possesses operational expertise and scale, academic and research institutions provide the scientific depth, innovation capability, and long-term perspective required to develop future-ready solutions. The project was therefore designed to strengthen industry–academia collaboration and create a robust ecosystem for applied research and skill development.

Another key rationale for the project was the growing requirement for highly trained professionals capable of addressing complex challenges in areas such as reservoir management, energy storage, carbon capture, hydrogen technologies, pipeline safety, digitalization, and sustainability assessment. Traditional educational frameworks alone were insufficient to meet these evolving demands. COE-OGE was envisaged as a platform to integrate advanced research with education and professional training, thereby enhancing the employability and competence of students and working professionals alike.

Furthermore, the project aligns with national priorities such as *Atmanirbhar Bharat*, clean energy transition, and sustainable industrial development. By investing CSR funds in a premier institution like IIT Bombay, the project ensures efficient utilization of resources, high-quality outcomes, and long-term societal returns. The background and rationale of the project thus rest on the need to create enduring institutional capacity that supports innovation, sustainability, and inclusive growth in the energy sector.

Key Objectives of the Project:

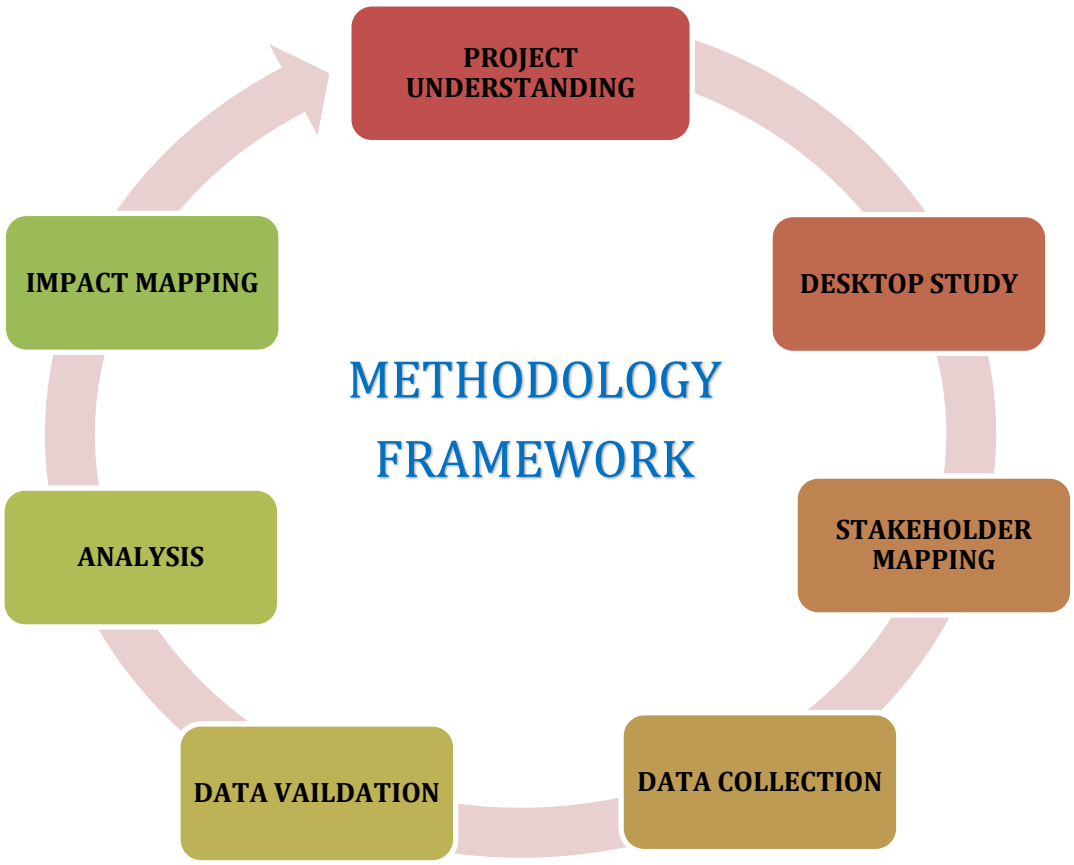
The key objectives of the Centre of Excellence in Oil, Gas & Energy (COE-OGE) project are as follows:

- **To strengthen advanced education and research capabilities -** To develop world-class academic and research infrastructure that supports high-quality teaching, postgraduate education, and doctoral research.
- **To promote innovation and applied research in the energy sector -** To encourage interdisciplinary and solution-oriented research addressing challenges in conventional energy systems as well as emerging areas such as hydrogen, carbon capture and utilization, clean fuels, energy storage, and digital energy solutions.
- **To build skilled human resources for industry and academia -** To support the development of highly skilled professionals through fellowships, research programs, and specialized training courses, thereby enhancing employability and technical competence.
- **To contribute to sustainability and energy transition goals** - To generate knowledge and technologies that support reduced environmental impact, efficient resource utilization, and the transition towards cleaner and more sustainable energy systems.
- **To create long-term institutional assets and knowledge platforms** - To ensure that the infrastructure, research outputs, and human capital developed under the project continue to deliver benefits beyond the CSR funding period.

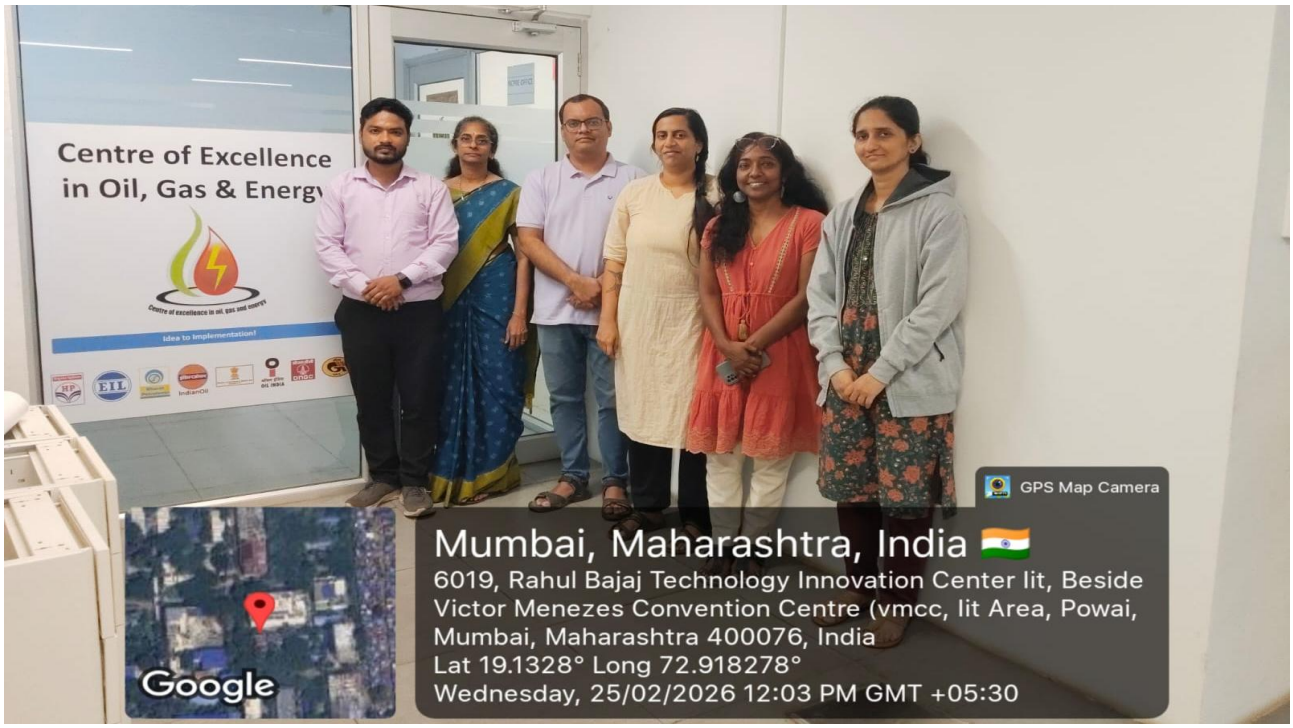
Impact Assessment Agency

The impact assessment study of the project was conducted by Environmental Technical Services Pvt. Ltd. as an independent third-party agency, commissioned by Indian Oil Corporation Limited, R&D Centre, Faridabad.

Methodology of Impact Assessment



5.4 IMPACT



The Centre of Excellence in Oil, Gas & Energy (COE-OGE) at **IIT Bombay** has generated significant and multi-dimensional impact across education, research, innovation, and sustainability during the project period from **FY 2019–20 to FY 2023–24**. The CSR investment of **₹27.08 Crore** has resulted in the creation of long-term institutional assets, enhanced human capital, and knowledge outputs that extend benefits well beyond the immediate project timeline.

Impact on Education and Human Capital Development

The Centre has significantly strengthened technical education and industry-relevant capacity building in the energy domain. With 50 completed training programs, 1470 industry professionals trained, and 66 faculty members involved, COE-OGE has created a strong learning ecosystem connecting academia and Industries. The participation of major organizations such as ONGC, IOCL, HPCL, BPCL, GAIL, OIL, and EIL demonstrate the Centre's national credibility in advanced energy education.

Additionally, 19 PhD Fellowship Projects and multiple Mission Mode and Seed projects have supported advanced research training, thereby nurturing the next generation of scientists, engineers, and technical leaders.

Impact on Research Excellence and Knowledge Creation

COE-OGE has delivered measurable research outputs across conventional and emerging energy domains. With **41 projects completed**, 32 ongoing, and 16 under closure, the Centre demonstrates strong execution capability.

Academic contributions include:

- 36+ research publications
- 26 conference papers
- 2 book chapters
- 10 patents (including granted patents)

Research verticals span upstream exploration (29%), energy transition (18%), battery storage (15%), hydrogen (10%), refining, water management, biofuels, and pipeline monitoring — reflecting both depth and diversification in research excellence.

Impact on Innovation and Technology Development

The launch of **Bridge-the-Gap (BTG) projects** marks a significant shift toward translational research and commercialization pathways. With **6 BTG projects**, the Centre is actively scaling laboratory innovations into field-ready technologies.

Patent filings and project diversification into applied sectors such as refining optimization, hydrogen technologies, and pipeline monitoring indicate tangible innovation outcomes beyond theoretical research. The Centre has effectively bridged the gap between academic discovery and industry implementation.

Impact on Sustainability and Energy Transition

COE-OGE's research portfolio demonstrates strong alignment with India's sustainability and decarbonization goals. Key focus areas include:

- Hydrogen technologies
- Battery storage systems
- Energy transition research
- Biofuels
- Water management
- Sustainable refining practices

By integrating conventional oil & gas research with clean energy domains, the Centre supports India's strategic transition toward a more sustainable and resilient energy system.



Institutional and Long-Term Impact

Beyond immediate outputs, the project has created enduring institutional capacity at IIT Bombay. The infrastructure, research culture, and collaborative networks developed under COE-OGE will continue to support future research, training, and innovation activities. The Centre is well-positioned to attract additional research funding, industry partnerships, and international collaborations, ensuring sustainability of impact even after the CSR funding period. This long-term institutional strengthening represents a high social return on CSR investment.

The Centre has created a strong institutional framework involving:

- 110 IITB faculty members
- 17 IITB departments
- 7 collaborating Industries
- 77 collaborating Industries personnel

This multi-stakeholder engagement model has institutionalized academia–industry collaboration. The project has built long-term research infrastructure, governance mechanisms, and monitoring systems that will continue to generate impact beyond the CSR funding period.

Impact on Policy Support and Strategic Decision-Making

Through high-quality research outputs, data-driven studies, and industry engagement, COE-OGE has supported evidence-based decision-making in areas such as upstream exploration, refining optimization, energy transition pathways, and hydrogen deployment strategies.

The Centre's alignment with national energy priorities positions it as a knowledge partner contributing indirectly to policy discussions and strategic planning within the energy sector.

Impact on Employability and Career Advancement

The Centre has enhanced employability prospects for research scholars and students through exposure to live industrial problems, Industries collaborations, and interdisciplinary research.

PhD fellowships, Mission Mode projects, and supervised learning initiatives have strengthened industry-relevant skill development, preparing students for careers in:

- Oil & gas exploration
- Energy analytics
- Hydrogen and clean energy technologies
- Refining and process optimization
- Sustainability consulting

Impact on Safety, Reliability, and Operational Efficiency

Research in upstream exploration, pipeline monitoring, and refining process optimization directly contributes to improved operational safety, reliability, and efficiency.

Industry-oriented projects supported under COE-OGE enable:

- Better subsurface characterization
- Improved refining performance
- Advanced monitoring systems
- Sustainable process optimization

Knowledge Dissemination and National Visibility

The Centre has significantly enhanced national visibility through:

- 36+ publications
- 26 conference presentations
- Book chapters
- Patent filings
- Industry training programs

Summary of Research Outputs and Institutional Assets Created under COE-OGE

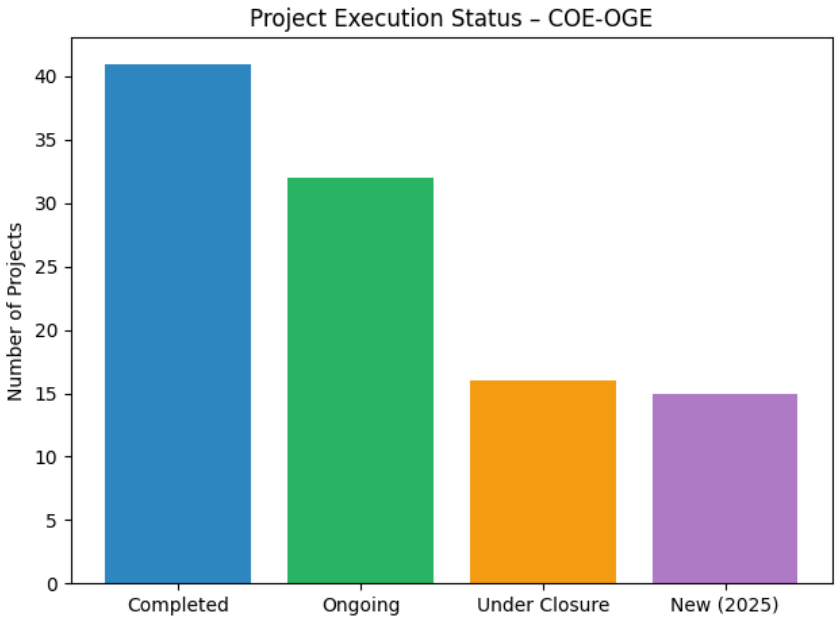
The Centre of Excellence in Oil, Gas & Energy (COE-OGE) has generated substantial and measurable outcomes across research execution, innovation development, human capital enhancement, and institutional strengthening. Over the project period, the Centre has established a diversified research portfolio supported by strong project governance, interdisciplinary collaboration, and structured industry engagement. The initiative has not only delivered tangible research outputs in the form of completed projects, patents, and publications, but has also created long-term institutional assets including advanced research ecosystems, academia–industry collaboration frameworks, and scalable training models.

The following tables summarize the key research outputs achieved and the institutional capabilities created under the COE-OGE initiative, demonstrating how CSR investment has translated into sustained academic excellence, technological innovation, and national-level strategic impact.



Table: Summary of Research Outputs

Category	Details	Key Numbers / Achievements	Impact Significance
Project Execution	Completed Projects	41	Demonstrates strong execution capability and milestone management
	Ongoing Projects	32	Sustained research momentum
	Projects Under Closure	16	Structured project lifecycle governance
	New Projects Initiated (2025)	15	Expansion of research portfolio
Project Types	Seed Projects	39	Early-stage innovation support
	Mission Mode Projects	34	Industry-driven applied research
	PhD Fellowship Projects	19	Doctoral research and knowledge creation
	Bridge-the-Gap (BTG) Projects	6	Translational & commercialization-focused research
	Supervised Learning Projects	8	Student-led applied learning initiatives
Intellectual Property	Patents	10 (including granted)	Tangible innovation output
	Copyright	1	Knowledge protection mechanism
Knowledge Dissemination	Research Publications	36+	Peer-reviewed academic contributions
	Conference Papers	26	National & international visibility
	Book Chapters	2	Scholarly contribution



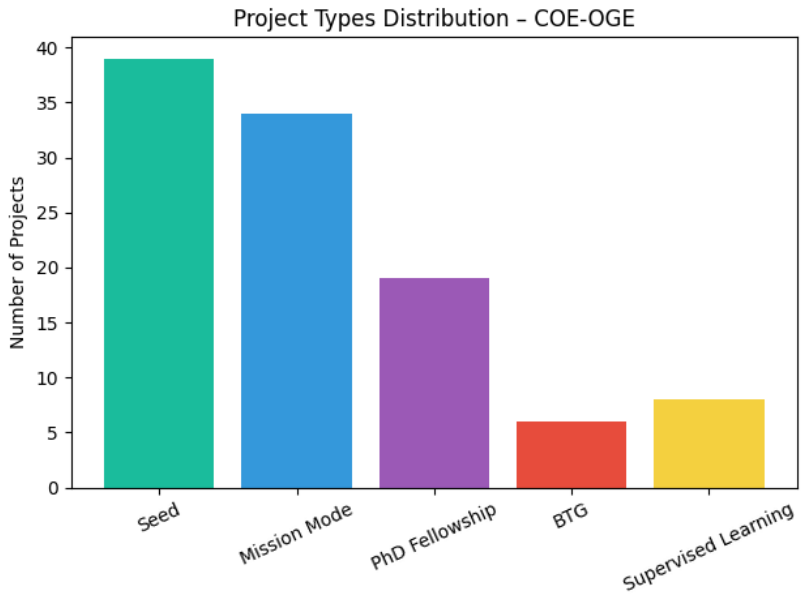


Table: Research Domain Coverage

Research Vertical	Share (%)	Strategic Relevance
Upstream Exploration	29%	Strengthening domestic exploration capability
Energy Transition	18%	Supporting decarbonization pathways
Battery Storage	15%	Advancing energy storage technologies
Hydrogen	10%	Clean fuel & future energy systems
Refineries	12%	Process optimization & efficiency
Water Management	7%	Sustainable industrial practices
Pipeline Monitoring	6%	Safety & operational reliability
Biofuels	3%	Renewable fuel research

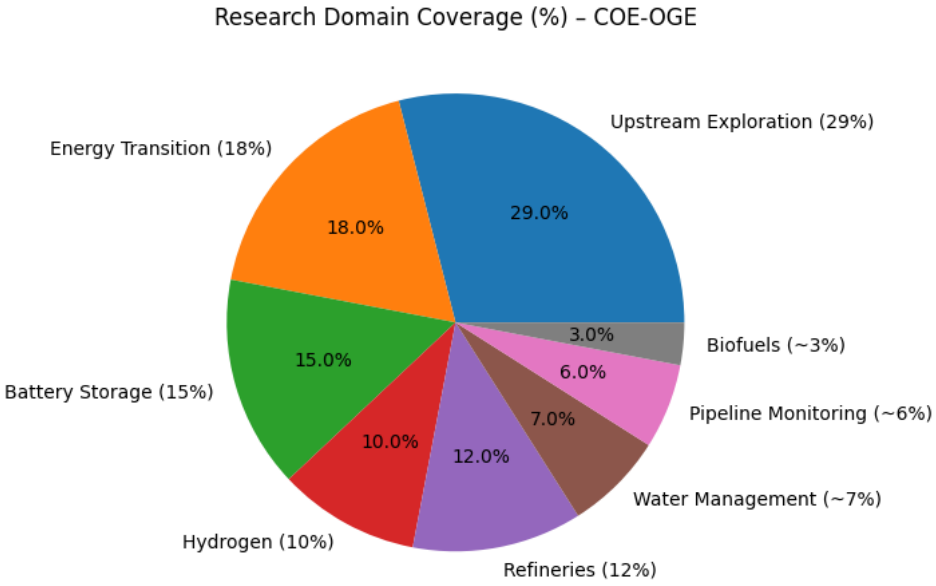
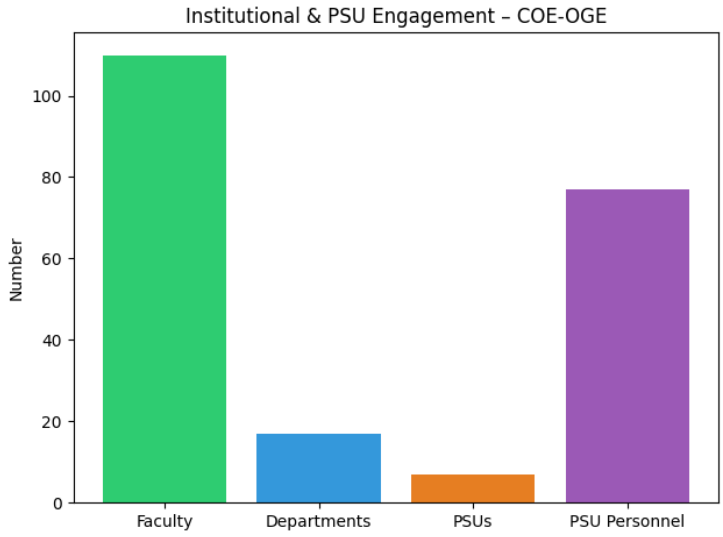
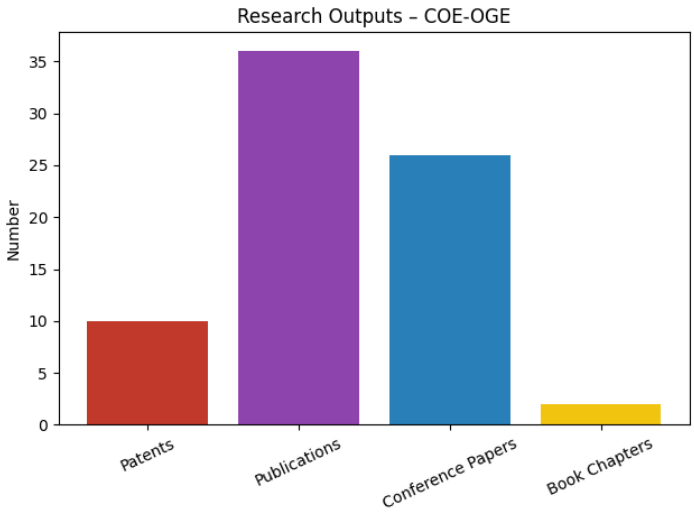


Table: Institutional Assets Created

Institutional Asset Category	Details	Numbers / Scope	Long-Term Value
Academic Engagement	IITB Faculty Involved	110	Strengthened interdisciplinary ecosystem
	IITB Departments Engaged	17	Cross-disciplinary collaboration
Industry Collaboration	Collaborating Industries	7	Strong academia–industry integration
	Industries Personnel Involved	77	Direct industrial knowledge exchange
Capacity Building	Training Programs Conducted	50	Structured knowledge transfer model
	Industry Professionals Trained	1470	Large-scale human capital development
	Faculty Involved in Training	66	Academic-industry teaching integration





Industries Involvement in Projects

The COE-OGE initiative demonstrates strong and diversified engagement with major Industries across the oil and gas sector. The level of engagement reflects active participation from multiple stakeholders representing upstream, midstream, and downstream segments of the industry.

This distribution highlights a well-balanced industry partnership ecosystem, ensuring comprehensive sectoral coverage and enabling research and innovation across the entire oil and gas value chain. The collaborative approach has facilitated knowledge exchange, industry-relevant problem solving, and the development of sustainable and technology-driven solutions aligned with national energy priorities.

Industries Involvement under Various Channels of Engagement

The engagement model is structured across five channels: **Seed Projects, Mission Mode (MM), PhD Fellowship, Bridge-the-Gap (BTG), and Supervised Learning (SL).**

- **Mission Mode (MM) projects dominate Industries participation**, indicating strong industry-driven applied research.
- **Seed projects are widely distributed**, showing early-stage innovation engagement across Industries.
- **HPCL exhibits the most diversified engagement**, including participation in SL and BTG initiatives.
- **PhD Fellowships are moderately distributed**, strengthening long-term research capacity.
- BTG and SL projects are selective, focused on translational and applied outcomes.

Overall Industries Involvement in Projects

Industries	Total Projects	Engagement Level
HPCL	35	Highest engagement
IOCL	25	Strong strategic collaboration
OIL	19	Active upstream participation
BPCL	16	Consistent downstream engagement
ONGC	15	Stable upstream involvement
GAIL	15	Midstream & energy transition support
EIL	8	Specialized engineering collaboration

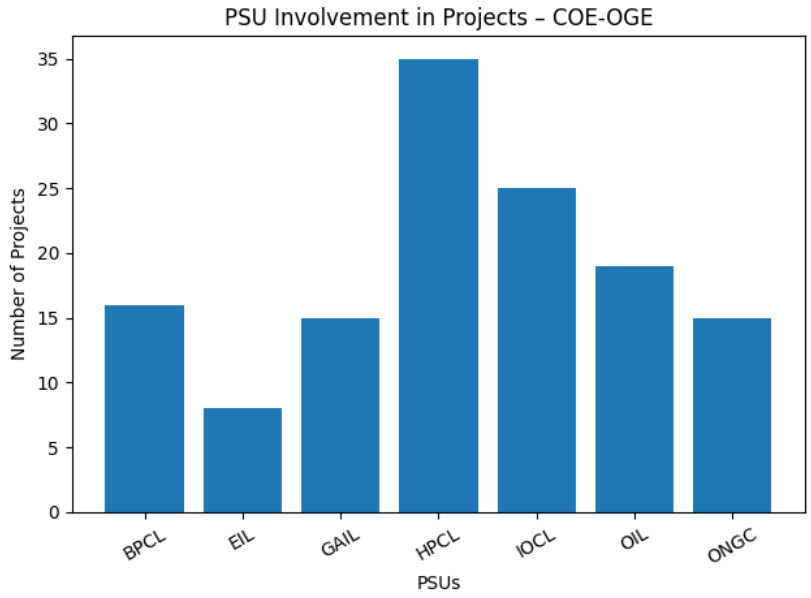


Table: Strategic Institutional Outcomes

Outcome Area	Asset Created	Strategic Impact
Research Infrastructure	Advanced lab & project systems	Sustainable research capability
Governance Systems	CSR-aligned monitoring & compliance framework	Accountability & transparency
Innovation Pathway	Bridge-the-Gap translational model	Lab-to-field technology transfer
Human Capital	PhD Fellowships & Student Projects	Skilled workforce development
National Positioning	Industries partnerships & publications	Enhanced national visibility

Research Undertaken by COE-OGE (IIT BOMBAY)

S. No.	Research Area / Theme	Nature of Research & Key Focus	Key Outputs / Evidence	Impact & Relevance (Explanation)
1	**Energy Transition & Clean Energy Systems**	Research on low-carbon energy pathways including energy transition frameworks, decarbonization strategies, and alternative energy sources	Peer-reviewed journals, conference papers, policy-oriented studies	Supports India's transition towards cleaner energy, net-zero goals, and long-term energy security
2	**Hydrogen Energy & Hydrogen Storage**	Studies on hydrogen arrangement, concentration behaviour, metal hydrides (Ni-hydride), and hydrogen interaction mechanisms	Research publications, experimental studies	Enables development of green hydrogen technologies and future hydrogen economy
3	**Carbon Capture, Utilization & Storage (CCUS)**	CO_2 capture mechanisms, utilization via catalysis, hydrate-based storage and sequestration studies	Journal articles, catalytic process research	Direct contribution to emission reduction and climate mitigation strategies
4	**Compressed Biogas (CBG) & Bioenergy**	Production, upgrading, and sustainability assessment of compressed biogas from biomass/agri-residues	Technical papers, applied research	Promotes circular economy, waste-to-energy solutions, and rural energy security

S. No.	Research Area / Theme	Nature of Research & Key Focus	Key Outputs / Evidence	Impact & Relevance (Explanation)
5	**Advanced Energy Storage & Batteries**	Solid-state batteries, anode less batteries, interfacial passivation, Li-ion performance improvement	ACS / international journal publications	Supports electric mobility, grid storage, and energy reliability
6	**Petroleum & Reservoir Engineering**	Reservoir characterization, fluid substitution, pore structure analysis, core-log integration	Research papers, modelling studies	Improves hydrocarbon recovery, reservoir management, and decision-making
7	**Source Rock & Basin Studies**	Source rock properties, paleo-stress analysis, geomorphic and morphotectonic studies	Geological research publications	Enhances understanding of basin evolution and hydrocarbon potential
8	**Pipeline Safety & Structural Health Monitoring**	Smart SHM systems using ultrasonic guided waves, FPGA-based defect localization	Scientific Reports publications, experimental validation	Improves safety, leak prevention, and integrity of energy infrastructure
9	**Process Monitoring & Digitalization**	AI/ML-based prediction of off-spec events in chemical and refining processes	Journal publications, process models	Enhances operational efficiency, safety, and cost optimization
10	**Combustion, Pyrolysis & Waste Utilization**	Pyrolysis of petroleum pitch, combustion kinetics, asphaltene-wax interaction studies	Springer chapters, journal articles	Enables waste valorisation, cleaner combustion, and material reuse
11	**Geothermal & Subsurface Energy**	Re-use of abandoned oil & gas wells for geothermal energy	International journal & conference papers	Promotes sustainable reuse of legacy infrastructure
12	**Advanced Materials & Nanotechnology**	Nano catalysts, microwave-assisted material synthesis, energy materials	High-impact journal publications	Drives innovation in catalysis, CO_2 conversion, and energy materials

5.5 POSITIVE IMPACT OF THE PROJECT

The COE-OGE initiative has generated significant positive outcomes across academic, industrial, technological, and national development dimensions. The project has strengthened India's energy research ecosystem while creating measurable socio-economic value.

Strengthening Research Excellence

- 41 projects successfully completed and 32 ongoing projects demonstrate strong research execution capability.
- 36+ peer-reviewed publications and 26 conference papers enhanced national and international academic visibility.
- 110 IITB faculty across 17 departments engaged, promoting interdisciplinary collaboration.

Impact: Elevated institutional research standing and strengthened India's knowledge base in strategic energy domains.

Creation of Tangible Innovation Assets

- 10 patents generated, reflecting technology-driven research output.
- Bridge-the-Gap (BTG) model initiated to support translational and commercialization-focused research.

Impact: Development of intellectual property and innovation pathways that can be deployed for industry applications.

Human Capital Development at Scale

- 50 training programs conducted.
- 1470 industry professionals trained.
- 66 faculty members involved in industry-focused training delivery.

Impact: Enhanced technical competencies within Industries, improved operational understanding, and strengthened industry-ready workforce capabilities.

Contribution to Energy Transition & Sustainability

Research portfolio includes:

- Energy transition (18%)
- Hydrogen (10%)
- Battery storage (15%)
- Biofuels & water management initiatives

Impact: Supports decarbonization, energy efficiency, and sustainable industrial practices aligned with national energy security goals.

Institutional Capacity Building

- Development of structured research governance mechanisms.
- Multi-channel engagement model (Seed, Mission Mode, PhD Fellowship, BTG, SL).
- Strengthened research infrastructure and long-term collaboration frameworks.

Impact: Establishment of a sustainable and scalable research ecosystem.

Improved Operational Efficiency & Reliability

Projects in:

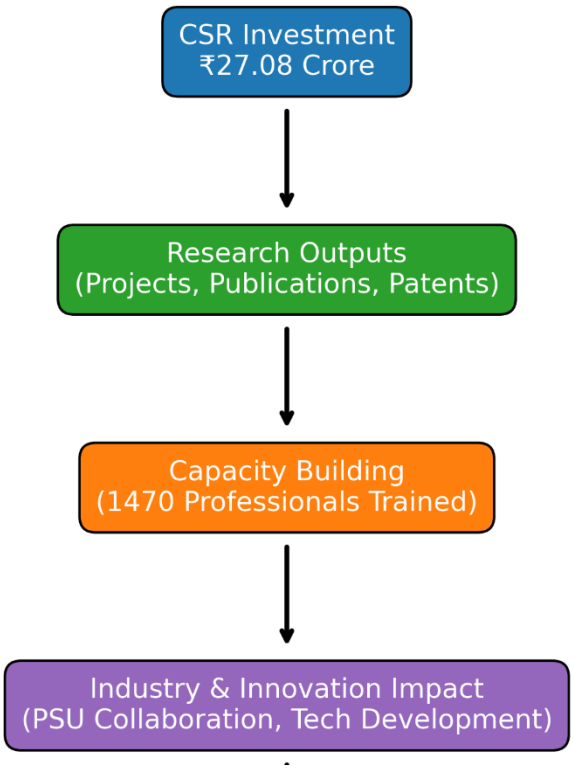
- Upstream exploration (29%)
- Refinery optimization (12%)
- Pipeline monitoring (6%)

Impact: Enhanced safety, reliability, and operational optimization within energy sector operations.

Enhanced National Visibility & Strategic Positioning

- Increased participation in conferences and academic forums.
- Strengthened Industries-academia partnership model.
- Recognized as a strategic CSR-backed research platform.

Impact: Positioned COE-OGE as a benchmark model for industry-aligned research excellence.



5.6 KEY FINDINGS / IMPACT ANALYSIS

S. No.	Key Area	Key Findings (Based on Project Data)	Impact Analysis / Significance
1	Research Execution	41 projects completed, 32 ongoing, and 16 under closure, with continuous addition of new projects	Demonstrates strong project execution capability, structured research lifecycle, and sustained research momentum
2	Research Output & Knowledge Creation	36+ research publications, 26 conference papers, 2 book chapters, and 10 patents (including granted)	Reflects high-quality academic output, knowledge dissemination, and tangible innovation generation
3	Innovation & Translational Research	Introduction of Bridge-the-Gap (BTG) projects (6 projects) to convert research into field-level applications	Strengthens lab-to-field transition, enhancing commercialization potential and industry applicability
4	Human Capital Development	50 training programs conducted, 1470 industry professionals trained, and 66 faculty members involved	Significant contribution to skill development, industry readiness, and capacity building in the energy sector
5	Academic & Institutional Engagement	110 IIT Bombay faculty members across 17 departments actively involved	Promotes interdisciplinary research ecosystem and strengthens institutional collaboration
6	Industry Collaboration	Participation of 7 major industry partners across upstream, midstream, and downstream segments	Ensures industry relevance, real-world problem-solving, and strong academia–industry integration
7	Research Domain Coverage	Research spread across upstream (29%), energy transition (18%), battery storage (15%), hydrogen (10%), refining, pipeline monitoring, and biofuels	Balanced and diversified research portfolio aligned with national energy priorities
8	Sustainability & Energy Transition	Focus on hydrogen technologies, CCUS, energy storage, biofuels, and sustainable refining practices	Contributes to decarbonization, clean energy transition, and environmental sustainability
9	Institutional Asset Creation	Development of advanced laboratories, research infrastructure, and governance systems at IIT Bombay	Creates long-term institutional capacity and ensures sustainability beyond CSR funding period
10	Employability & Skill Enhancement	PhD fellowships (19 projects), supervised learning, and industry-linked research exposure	Enhances employability, research capability, and industry-oriented skill development
11	Policy & Strategic Contribution	Research outputs supporting upstream exploration, refining optimization, and energy transition pathways	Enables evidence-based decision-making and supports national energy strategy

5.7 QUANTITATIVE RESULTS

S. No.	Indicator Category	Key Metrics / Data	Remarks / Significance
1	Total Project Investment	₹100 Crore (Total Project Cost) ₹27.08 Crore (IOCL CSR Contribution)	Significant CSR investment towards national-level research and capacity building
2	Project Execution	41 Completed Projects 32 Ongoing Projects 16 Projects under Closure	Reflects strong execution capability and structured research lifecycle
3	New Project Initiation	15 New Projects (Recent Phase)	Indicates continuous expansion and sustainability of research activities
4	Project Types	39 Seed Projects 34 Mission Mode Projects 19 PhD Fellowship Projects 6 BTG Projects 8 Supervised Learning Projects	Demonstrates diversified research approach (basic to applied to translational)
5	Research Output	36+ Publications 26 Conference Papers 2 Book Chapters	Strong academic contribution and national/international visibility
6	Intellectual Property	10 Patents (including granted) 1 Copyright	Indicates innovation-driven outcomes and technology development
7	Human Capital Development	50 Training Programs Conducted 1470 Industry Professionals Trained	Large-scale capacity building and industry skill enhancement
8	Academic Participation	110 Faculty Members Involved 17 Departments Engaged	Strong interdisciplinary academic ecosystem
9	Industry Collaboration	7 Major Industry Partners 77 Industry Personnel Involved	Effective industry–academia integration and knowledge exchange
10	Research Domain Distribution	Upstream (29%) Energy Transition (18%) Battery Storage (15%) Hydrogen (10%) Others (Refining, Biofuels, Pipeline Monitoring, etc.)	Balanced research focus aligned with sectoral and sustainability priorities
11	Capacity Building (Advanced)	19 PhD Fellowship Projects	Development of future research leaders and technical experts
12	Innovation Pipeline	6 Bridge-the-Gap (BTG) Projects	Supports commercialization and lab-to-field transition
13	Infrastructure Development	Advanced laboratories, pilot facilities, and research systems established	Creation of long-term institutional assets

5.8 KEY POINTS OF STAKEHOLDERS CONSULTATIONS



Stakeholder consultations conducted for the Centre of Excellence in Oil, Gas & Energy (COE-OGE), IIT Bombay highlighted strong appreciation for the project's focus on advanced education, research excellence, and industry relevance. Stakeholders acknowledged that the CSR-supported initiative has strengthened institutional capabilities, improved research infrastructure, and contributed meaningfully to skill development and innovation in the energy sector. Overall feedback indicated that the project is well-aligned with national energy priorities and has delivered sustainable, long-term value.

- **Improved Quality of Education and Research** - Faculty members and students highlighted that access to advanced laboratories, equipment, and research platforms has significantly improved the quality of academic learning and research outcomes.
- **Enhanced Skill Development Opportunities** - Beneficiaries emphasized that specialized training programs, research exposure, and hands-on experience have strengthened technical skills and industry readiness.
- **Contribution to Energy Transition and Sustainability** - Stakeholders recognized the project's role in advancing research related to clean energy, carbon management, hydrogen, and sustainability, supporting long-term environmental goals.
- **Availability of High-Quality Research Infrastructure** - Researchers acknowledged that the creation of modern laboratories and access to high-end equipment has enabled advanced experimentation and interdisciplinary research.
- **Support for Young Researchers and Scholars -** Doctoral scholars and early-career researchers appreciated the academic environment, mentorship, and research opportunities created through the Centre.
- **Long-Term Institutional Benefits -** Management and faculty representatives highlighted that the project has strengthened IIT Bombay's institutional capacity and will continue to generate benefits beyond the CSR funding period.

- **Scope for Expansion and Future Research -** Stakeholders suggested expanding the scope of research and training to include additional emerging energy technologies and increased industry participation.
- **Overall Satisfaction with Project Outcomes -** Overall, stakeholders expressed high levels of satisfaction with the project's planning, implementation, and outcomes, and recommended continuation and scaling of similar initiatives.

5.9 CASE STORIES

1. Name: Pramod Kumar

Department: Environmental & Engineering

Institution: IIT Bombay

Project Association: Centre of Excellence in Oil, Gas & Energy (COE-OGE)



Pramod Kumar, a student from the Environmental & Engineering Department at IIT Bombay, has significantly benefited from his association with the Centre of Excellence in Oil, Gas & Energy (COE-OGE). The CSR-supported initiative provided him access to advanced laboratory infrastructure, analytical tools, and interdisciplinary research collaboration that enhanced the quality and scope of his academic work.

Through COE-OGE, Pramod was able to engage in applied research addressing environmental challenges within the energy sector, including sustainability assessment, emission mitigation strategies, and environmentally responsible process optimization. The exposure to industry-relevant problems and interaction with faculty and Industries-linked research projects strengthened his technical competence and practical understanding.

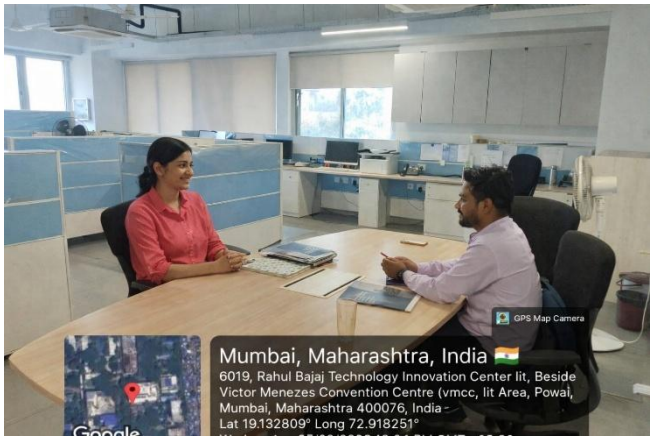
The initiative contributed to improving his research methodology, analytical capabilities, and confidence in translating academic research into real-world applications. Overall, Pramod's experience reflects how CSR investment in academic infrastructure and industry-aligned research can directly enhance student development while contributing to sustainable energy innovation.

2. Name: Teja Sree Addepalli

Department: Energy Science and Engineering

Institution: IIT Bombay

Project Association: Centre of Excellence in Oil, Gas & Energy (COE-OGE)



Teja Sree Addepalli joined the Energy Science and Engineering program at IIT Bombay with a strong interest in clean energy systems and sustainable technology pathways. However, translating theoretical knowledge into impactful research required access to advanced infrastructure and exposure to real-world energy sector challenges.

Her association with the Centre of Excellence in Oil, Gas & Energy (COE-OGE) became a turning point in her academic journey.

Through COE-OGE, Teja Sree became part of research efforts focused on energy transition technologies, including hydrogen integration, renewable energy systems, and decarbonization strategies relevant to the oil and gas sector. The Centre provided her access to high-end computational tools, modeling platforms, and industry-linked research discussions that bridged the gap between classroom concepts and practical deployment challenges.

Unlike purely academic projects, her research under COE-OGE involved understanding scalability, techno-economic feasibility, and policy implications — aspects critical for India's long-term energy transformation. Interaction with faculty across departments and engagement with Industries-linked initiatives strengthened her ability to view energy challenges from a systems perspective rather than a single-technology lens.

As a result, Teja Sree developed not only technical proficiency but also strategic insight into how clean energy solutions can be integrated within existing industrial ecosystems.

3. Name: Bhavesh Moorjani

Department: Chemical Engineering Department

Institution: IIT Bombay

Project Association: Centre of Excellence in Oil, Gas & Energy (COE-OGE)



Bhavesh Moorjani, a postgraduate student from the Department of Chemical Engineering at IIT Bombay, has been actively involved in research initiatives under the Centre of Excellence in Oil, Gas & Energy (COE-OGE). His academic focus is aligned with process optimization, clean energy systems, and advanced chemical engineering solutions relevant to the oil and gas sector.

Through the CSR-supported COE-OGE initiative, Bhavesh gained access to state-of-the-art laboratory infrastructure, advanced analytical instruments, and industry-linked research platforms. The interdisciplinary environment of the Centre enabled him to collaborate with faculty members and researchers across departments, strengthening both the theoretical and practical dimensions of his work.

His research engagement under COE-OGE provided exposure to real-world industrial challenges, particularly in areas such as refining efficiency, sustainable process development, emission reduction strategies, and energy transition technologies. This experience enhanced his capability in experimental design, computational modeling, and applied problem-solving.

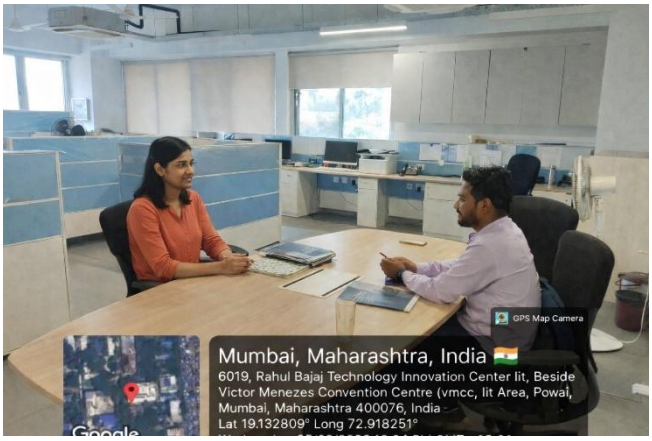
The initiative significantly contributed to improving his research depth, industry understanding, and professional confidence. Bhavesh's case reflects how CSR investment in advanced research infrastructure and industry-academia collaboration directly strengthens student capability while supporting innovation in the energy sector.

4. Name: Jyoti Kumari

Department: Chemical Engineering Department

Institution: IIT Bombay

Project Association: Centre of Excellence in Oil, Gas & Energy (COE-OGE)

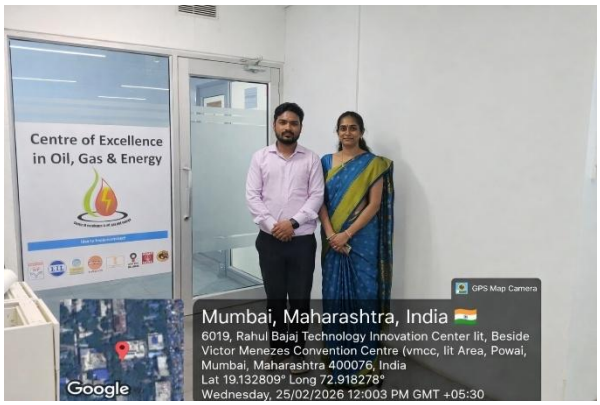


Jyoti Kumari, a postgraduate student from the Department of Chemical Engineering at IIT Bombay, strengthened her applied research capability through her association with the Centre of Excellence in Oil, Gas & Energy (COE-OGE). While her academic foundation was strong in core chemical engineering subjects, COE-OGE provided the platform to connect theoretical concepts with real-world industrial processes.

Through access to advanced process simulation tools, laboratory infrastructure, and industry-linked research exposure, she developed a deeper understanding of refining systems, process optimization, and sustainability considerations within energy operations. The interdisciplinary environment enabled her to integrate technical performance analysis with techno-economic and environmental evaluation.

Her experience under COE-OGE enhanced her ability to approach chemical engineering problems from a systems perspective rather than only a laboratory scale. Overall, the initiative contributed significantly to her professional readiness and industry-aligned research orientation.

5. Name: Mrs. G. Vijaylakshmi (Head – Projects Administration)



The Centre of Excellence in Oil, Gas & Energy has emerged as a transformative initiative within IIT Bombay, significantly strengthening the institute's engagement with India's strategic energy sector. The structured CSR support has enabled us to build strong administrative and operational systems that ensure transparency, accountability, and timely execution of research projects.

Over the years, we have witnessed remarkable growth in interdisciplinary collaboration, industry engagement, and research output. The Centre has successfully aligned academic research with real-world industrial challenges, particularly in areas such as hydrogen technologies, energy transition, upstream exploration, and sustainable refining practices.

From a project administration perspective, the initiative has established clear governance frameworks, milestone tracking mechanisms, and efficient coordination between faculty, scholars, and industry partners. This has ensured that projects move smoothly from conceptualization to implementation and deliver measurable outcomes.

I believe the COE-OGE model represents a strong example of how CSR investments can create long-term institutional capabilities, foster innovation, and contribute meaningfully to national energy priorities."

Under her administrative supervision:

- Project monitoring and milestone tracking systems were institutionalized.
- Financial governance and compliance documentation were aligned with CSR reporting standards.

Mrs. Vijaylakshmi's contribution ensures that research excellence is supported by robust administrative efficiency. Her role has been critical in translating strategic vision into operational execution, thereby enabling the Centre to function as a high-impact innovation hub.

6. Mr. Kuldeep S. Kulkarni (Assistant Manager – Training)



The training initiatives under the Centre of Excellence in Oil, Gas & Energy have significantly strengthened the knowledge ecosystem connecting academia and industry. Through structured training programs, we have been able to bridge the gap between advanced research and practical industrial applications in the oil and gas sector.

Over the project duration, the Centre successfully conducted multiple specialized training courses involving leading Industries. These programs were carefully designed to address emerging challenges in areas such as energy transition, hydrogen technologies, upstream exploration, refining optimization, pipeline monitoring, and sustainability.

The strong participation from Industries professionals and faculty members demonstrates the relevance and demand for advanced, industry-oriented academic training. By combining theoretical insights with real-world case studies, the Centre has enhanced technical competencies and strategic understanding among industry participants.

From a training management perspective, the COE-OGE initiative has established a scalable model for continuous learning and industry engagement. I believe this initiative will continue to play a vital role in building skilled human capital for India's evolving energy sector.

5.10 TESTIMONIALS

Testimonial 1 – Student Perspective



Teja Sree Addepalli (Energy Science and Engineering Department)

"The Centre of Excellence in Oil, Gas & Energy has played a crucial role in shaping my academic journey. Through COE-OGE, I gained exposure to real-world energy transition challenges and had the opportunity to work on research aligned with industry needs. The access to advanced computational tools and interdisciplinary collaboration significantly strengthened my analytical skills and understanding of sustainable energy systems. This experience has enhanced my confidence in contributing to India's clean energy future."

Testimonial 2 – Student Perspective



Sayem Irshad (Department of Earth Sciences)

"My association with the Centre of Excellence in Oil, Gas & Energy has significantly enriched my research experience in the field of Earth Sciences. Through COE-OGE, I gained access to advanced analytical tools and datasets relevant to reservoir characterization and subsurface analysis. The opportunity to understand geological challenges from an industry perspective helped me connect theoretical geoscience concepts with practical applications in oil and gas exploration.

Testimonial 3 – Senior Project Research Scientist



Dr. Krishna Priya G.S

The Centre of Excellence in Oil, Gas & Energy has provided a highly collaborative and interdisciplinary platform that enables meaningful research aligned with industry needs. As a Senior Project Research Scientist, I have witnessed how the Centre effectively bridges fundamental research with applied industrial solutions, particularly in emerging areas such as clean energy systems, hydrogen technologies, and sustainable process optimization. The structured project framework, strong industry engagement, and access to advanced research infrastructure have significantly enhanced the quality and impact of our work. This initiative not only strengthens academic research capabilities but also contributes directly to India's strategic energy priorities by fostering innovation, translational research, and skilled human resource development."

5.11 SUSTAINABILITY



The Centre of Excellence in Oil, Gas & Energy (COE-OGE) at IIT Bombay has been established with a strong emphasis on long-term sustainability. The project has created permanent academic and research assets, strengthened institutional capabilities, and promoted research aligned with national energy transition and sustainability goals. The infrastructure, knowledge systems, and human capital developed under the project ensure that the benefits of CSR investment continue well beyond the project period, generating sustained educational, technological, and societal value.

- **Creation of Permanent Research Infrastructure -** The project has established advanced laboratories, pilot facilities, and major scientific equipment that are permanent institutional assets. These facilities will continue to support research, teaching, and innovation activities long after the completion of the CSR funding period.

- **Continuous Utilization by Academic Community -** The infrastructure and technology platforms created under COE-OGE are being continuously utilized by postgraduate students, doctoral scholars, faculty members, and research staff. This ensures ongoing academic engagement and sustained knowledge generation.

- **Long-Term Capacity Building in the Energy Sector -** By supporting advanced education, doctoral research, and specialized training, the project has built long-term human capital capable of addressing complex challenges in the oil, gas, and energy sectors.

- **Support to Environmental Sustainability and Energy Transition -** Research under COE-OGE focuses on clean energy, carbon management, hydrogen, bioenergy, and energy storage, contributing to reduced environmental impact and long-term sustainability goals.

- **Institutional Strengthening and Knowledge Retention -** The project has strengthened institutional systems, research culture, and interdisciplinary collaboration, enabling IIT Bombay to retain and build upon the knowledge and expertise developed.

- **Scalability and Replicability of Research Outcomes -** Many research outputs and technology platforms developed under the project are scalable and can be replicated or adapted by industry and other academic institutions, enhancing long-term impact.

- **Alignment with National Policies and Development Priorities -** The project aligns with national initiatives related to energy security, clean energy transition, and self-reliance, ensuring continued relevance and policy support.

- **Sustained Social and Educational Benefits -** The development of skilled professionals, dissemination of research findings, and long-term availability of research infrastructure ensure ongoing benefits to society, academia, and the energy sector.

5.12 ALIGNMENT WITH UN SUSTAINABLE DEVELOPMENT GOALS (SDGs)

The Centre of Excellence in Oil, Gas & Energy (COE-OGE), IIT Bombay, supported under the CSR initiative of Indian Oil Corporation Limited, demonstrates strong alignment with the United Nations Sustainable Development Goals (SDGs). While the project primarily focuses on research, innovation, and capacity building in the energy sector, its outcomes contribute significantly to global sustainability objectives, particularly in the areas of clean energy, industrial innovation, and climate action.

The key SDGs addressed through the project are outlined below:

SDG 7: Affordable and Clean Energy

The COE-OGE initiative contributes to SDG 7 by promoting research and development in clean and sustainable energy technologies. Key areas such as hydrogen energy, biofuels, battery storage systems, and energy transition studies directly support the goal of ensuring access to affordable, reliable, sustainable, and modern energy.

Contribution:

- Research on hydrogen and alternative fuels
- Development of energy storage technologies
- Studies on energy transition and low-carbon pathways
- Promotion of efficient and sustainable energy systems

SDG 9: Industry, Innovation and Infrastructure

The project strongly aligns with SDG 9 by fostering innovation, strengthening research infrastructure, and enhancing industry–academia collaboration. The establishment of advanced laboratories, research platforms, and translational projects (such as Bridge-the-Gap initiatives) supports industrial innovation and technological advancement.

Contribution:

- Creation of advanced research infrastructure at IIT Bombay
- Development of patents, publications, and technology platforms
- Promotion of industry-driven research projects
- Strengthening of innovation ecosystems through academia–industry partnerships

SDG 13: Climate Action

COE-OGE contributes to SDG 13 through research focused on reducing environmental impact and supporting climate mitigation strategies. Areas such as carbon capture and utilization (CCU/CCUS), sustainable refining practices, and clean energy technologies directly address climate change challenges.

Contribution:

- Research on carbon capture, utilization, and storage
- Development of low-emission and sustainable energy technologies
- Studies supporting decarbonization and energy efficiency
- Contribution to climate-resilient and sustainable industrial practices

Overall SDG Contribution

The COE-OGE initiative demonstrates that CSR investments in research and innovation can play a critical role in achieving global sustainability goals. By integrating academic excellence with industry needs, the project contributes to long-term environmental sustainability, technological advancement, and energy security, thereby aligning with India's national commitments and global SDG agenda.

SDG MAPPING TABLE

SDG No.	SDG Name	Project Intervention	Key Activities / Evidence	Impact Contribution
SDG 7	Affordable & Clean Energy	Clean energy research & technology development	Hydrogen research, biofuels, battery storage, energy transition studies	Promotes sustainable, reliable and clean energy solutions
SDG 9	Industry, Innovation & Infrastructure	Strengthening R&D infrastructure & innovation ecosystem	Advanced labs, 41 projects, 10 patents, BTG projects	Enhances industrial innovation, technology development and infrastructure
SDG 13	Climate Action	Climate-focused research & decarbonization initiatives	CCUS research, sustainable refining, emission reduction studies	Supports climate mitigation and low-carbon energy transition

5.13 PROGRAM EVALUATION & CHALLENGES

STRENGTHS
• Strong industry-aligned research portfolio across upstream, midstream, and downstream sectors. • Diversified project channels (Seed, MM, PhD, BTG, SL) enabling both exploratory and applied research. • Significant human capital development (1,470 personnel trained; 50 training programs conducted). • Robust intellectual output (patents, publications, conference papers). • Structured governance and milestone-based monitoring framework. • Bridge-the-Gap (BTG) mechanism supporting translational research and commercialization potential. • Strong interdisciplinary faculty participation (110 faculty across 17 departments/centres).
WEAKNESSES
• Considering the inherent gestation period associated with research and innovation activities, certain outcomes may require additional time for scaling up and commercialization.
THREATS
• Rapid technological changes in the energy sector may require continuous upgradation of infrastructure and research focus. • Availability of sustained external funding may influence the pace of future research and expansion activities.
OPPORTUNITIES
• Strong potential for scaling research into industry-ready technologies and commercialization. • Alignment with national priorities on energy transition, clean energy, and sustainability. Opportunity to expand funding through government, industry, and international collaborations. • Scope to enhance skill development and employability in emerging energy domains. • Potential to establish the Centre as a national benchmark for industry.

CHALLENGES

S. No.	Challenge Area	Description	Potential Impact on Project	Mitigation Measures
1	Implementation Challenges	The involvement of multiple stakeholders, including academic institutions and industry partners, resulted in variations in administrative processes, approvals, and execution timelines.	May lead to delays in project initiation and completion of activities.	Strengthening project governance frameworks, defining clear timelines, and implementing regular monitoring mechanisms.
2	Research Delays & Gestation Period	Research and innovation activities inherently involve long gestation periods, particularly in emerging domains such as hydrogen, CCUS, and energy storage technologies.	Delay in realization of outcomes and limited immediate commercialization potential.	Adoption of phased research planning, pilot-to-scale transition strategies, and long-term performance evaluation mechanisms.
3	Coordination Issues	Coordination among diverse stakeholders, including faculty members, researchers, industry partners, and administrative teams, posed alignment challenges in terms of timelines and deliverables.	May impact efficiency, communication flow, and timely execution of research activities.	Establishment of structured coordination mechanisms, periodic review meetings, and integrated communication systems.
4	Infrastructure Constraints	Certain advanced research activities require highly specialized equipment, continuous technological upgrades, and enhanced technical support, which may not always be readily available.	May affect the pace of research execution and scalability of outcomes.	Continuous infrastructure upgradation, leveraging shared research facilities, and promoting external collaborations.
5	Dependence on Continued Funding	The sustainability and expansion of research initiatives are dependent on continued funding support and industry collaborations beyond the current CSR phase.	Potential limitation in scaling and long-term continuity of research programs.	Diversification of funding sources, strengthening industry partnerships, and exploring grant-based research opportunities.

5.14 GALLERY



Interaction of project team



Interaction of Students



Project Enhanced Coalbed methane recovery with Potential Carbon



Project of Underwater Inspection of pipeline



Department of Meteorological



Entrance of IIT Bombay



Greenhouse Gas Accounting and Mitigation



Renewable Energy & Sustainability



Training Course: Green Hydrogen - Production, Storage, Transportation & Uses



Wastewater Treatment Plant Operation



Liquid Effluent Management in Hydrocarbon Processing



Technology & Applications for Oil & Gas Industry

6. CONCLUSION & RECOMMENDATIONS

Conclusion:

The Centre of Excellence in Oil, Gas & Energy (COE-OGE) has emerged as a high-impact institutional platform integrating research excellence, industry collaboration, and human capital development within India's strategic energy ecosystem.
The project has demonstrated:

- Strong research execution capability (41 completed projects; 32 ongoing)
- Broad academic participation (110 faculty across 17 departments)
- Deep Industries collaboration (7 Industries; 1470 industry professionals trained)
- Tangible intellectual outputs (10 patents; 36+ publications)
- Alignment with national priorities such as energy transition, hydrogen, battery storage, and upstream optimization

The initiative has successfully strengthened academia–industry integration and established a structured translational research pathway through Seed, Mission Mode, PhD Fellowship, and Bridge-the-Gap (BTG) models.

Overall, COE-OGE represents a strategically positioned, scalable, and sustainable CSR intervention with long-term national relevance.

Recommendations:

- **Strengthen Industry Participation and Applied Research** - Increased involvement of industry partners in joint research projects and pilot studies will help accelerate translation of research outcomes into field-level applications.

- **Expand Focus on Emerging Energy Technologies** - Future initiatives may place greater emphasis on hydrogen, carbon capture and utilization, energy storage, and digital energy solutions to align with evolving energy transition needs.

- **Periodic Impact Monitoring and Evaluation** - Regular impact assessments at defined intervals are recommended to track long-term outcomes related to employability, technology adoption, and societal benefits.

- **Enhance Technology Commercialization Pathways** - Support mechanisms such as incubation, technology transfer, and start-up engagement can be strengthened to convert research outputs into deployable solutions.

- **Increase Training and Capacity-Building Programs** - Expanding the scale and reach of training programs will further enhance skill development among students, researchers, and industry professionals.

- **Promote Interdisciplinary and Collaborative Research** - Continued encouragement of interdisciplinary research across departments will help address complex energy challenges holistically.

- **Ensure Long-Term Financial Sustainability** - Diversifying funding sources through sponsored research, grants, and collaborations will help sustain and expand COE-OGE activities beyond CSR support.



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