

SUSTAINABILITY IN ACTION

Building the Foundations of Sustainability
Integration in India's Oil & Gas Sector



RESPONSIBLE
GROWTH



COLLABORATION



EFFICIENCY



LOWER
EMISSIONS



RESILIENCY

Review of Initiatives : 2025-2026

Sustainability Cell

Petroleum and Natural Gas Regulatory Board

Foreword



“India's energy sector stands at a defining moment in its growth trajectory. As the nation advances towards becoming a developed economy, the demand for reliable, affordable and accessible energy continues to rise across industries, cities and households. At the same time, increasing global focus on environmental stewardship, resource efficiency and climate resilience has reinforced the need to ensure that future energy systems are not only secure and competitive, but also sustainable.”

The oil and gas sector has a critical role to play in this transition. Alongside enabling energy access and industrial development, the sector must increasingly focus on operational efficiency, emissions management, resource optimization and the adoption of sustainable practices. These priorities present an opportunity to align sectoral growth with broader national sustainability objectives.

Recognizing this evolving landscape, the Petroleum and Natural Gas Regulatory Board established the Sustainability Cell as a dedicated platform to promote knowledge creation, data-driven decision-making, stakeholder engagement, and the integration of sustainability considerations into the oil and gas sector. Through studies, benchmarking exercises, capacity-building initiatives and industry outreach, the Cell has sought to facilitate informed action and continuous improvement across the sector.

What makes this journey distinctive is its emphasis on enablement rather than prescription. Measurement has preceded mandate; benchmarking has preceded targets; and collaboration has preceded compliance. In a short span, sustainability has moved from the margins of sectoral discussion to the centre of the conversation on energy security, competitiveness and long-term resilience.

This publication presents a snapshot of that journey and highlights key initiatives undertaken to advance sustainability within India's oil and gas ecosystem. I commend all stakeholders whose contributions have supported these efforts and look forward to continued collaboration in building a cleaner, more efficient and future-ready energy sector for the nation.

Dr. Anil Kumar Jain

Chairperson

Petroleum and Natural Gas Regulatory Board



Preface

“India's energy independence is not one policy objective among many. It is the condition on which sovereignty, resilience and prosperity rest. Every molecule of crude, product and gas that this country produces, imports, refines, moves and delivers carries a claim on national resources and national choices. The question before our sector is therefore not only how fast the energy system grows, but how much of that growth we are able to hold on to — and on terms we set for ourselves.”



Seen in that light, sustainability is less an obligation borrowed from elsewhere than a matter of economic equation. Petroleum products including Gas lost from a network has already been imported, paid for in foreign exchange, compressed and carried before it is lost. A product moved by a costlier mode, a pump or compressor run below its best efficiency, a vapour loss at a terminal — each carries the same quiet cost. Every unit of energy saved is a unit India does not have to import.

That is why the Sustainability Cell sits within the Board. Given, the responsibilities entrusted upon PNGRB, establishing the Cell was not the creation of a parallel regulatory architecture. It was a decision to put an existing one to a further purpose — to steward and facilitate sustainable practice across the value chain until it trivializes into ordinary operations rather than standing apart as a separate exercise.

Its objective is to widen sovereign energy choices, that are practical, commercially viable and acceptable to those who must implement them to endure; choices made ahead of evidence tend not to endure. The Cell's method follows from that — measure before mandating, benchmark before setting targets, and collaborate before enforcing. This is why our first instinct has been to build evidence and shared understanding rather than to prescribe.

Much of what sustainability asks of this sector is already familiar under another name. **Safety and sustainability are, in large measure, the same discipline seen from two ends.** Over time, it is our intention to see sustainability-linked considerations reflected appropriately within the existing regulatory framework. That direction is shared here early and openly, so that entities may reflect on their own systems in their own time, well before any expectation takes firm shape.

The business case runs alongside the national one. Oil & Gas saved is gas available for sale; efficiency lowers operating cost; integrity reduces risk; better logistics lower both freight and emissions. Curbing wastage is not a burden added to industry — it is a well-established pathway to competitiveness, resilience and responsible growth, and one we would rather walk alongside the sector than behind it.

"The intent is not to impose future expectations on the sector, but to offer directional visibility into how regulatory thinking is evolving."

Maneesh David Singh

Director (Sustainability & Consumer Affairs)
Petroleum and Natural Gas Regulatory Board



About This Publication

"Sustainability is not a separate destination; it is a principle that guides every decision, every initiative and every step towards a resilient energy future."

This booklet documents the formative journey of the Sustainability Cell of the Petroleum and Natural Gas Regulatory Board, why it was created, how it works, what it has built, and where it intends to go.

It is written for the entities the Board regulates and works with: City Gas Distribution companies, natural gas and petroleum product pipeline operators, oil marketing companies, LNG terminal and refinery operators, and the wider community of policymakers, researchers, technology providers and practitioners who shape India's downstream energy landscape.

The publication is deliberately structured as a working record rather than a promotional account. Each initiative is presented with the problem it addressed, the approach adopted, the evidence generated and the outcome achieved. Where an initiative is still evolving, that has been stated plainly. The intention is that a reader in an entity should be able to look at any chapter and identify what it means for their own operations.

How to read this booklet. Chapter 1 sets the context, the national sustainability landscape and the case for regulatory engagement. Chapter 2 describes the institutional architecture of the Sustainability Cell: its vision, its four-pillar roadmap and its operating model. Chapter 3 covers the regulatory and operational initiatives, leaks and losses benchmarking, technical regulations, data architecture, knowledge products and field pilots. Chapter 4 presents the analytical studies. Chapter 5 records the ecosystem-building work: conferences, international collaboration, awareness and recognition. Chapter 6 consolidates impact and sets out the road ahead.

A note on data. Sectoral figures presented in this booklet are drawn from returns furnished by regulated entities, the Board's management information systems, and published national sources, which are cited alongside the relevant exhibit. Entity-level performance data has been presented in anonymised form. Figures relating to studies and pilots that are still under finalisation have been identified as indicative.

Four ideas run through this book

- › **Measure first.** What is not measured cannot be improved, benchmarked or funded.
- › **Use what exists.** The most effective sustainability regulation is often already embedded in technical, safety and integrity frameworks.
- › **Enable, then enforce.** Engagement builds capability; enforcement secures completeness.
- › **Share the learning.** A proven practice inside one entity is a sectoral asset only when it travels.

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The Journey at a Glance

307 Geographical Areas brought under sustainability data reporting	37 CGD entities, subsidiaries and joint ventures covered	100% Sector-wide data submission achieved on leaks and losses	1.77% First-ever national LUAG benchmark, FY 2024-25
39 Sustainability case studies curated into the Compendium	~120 Submissions received from 25 entities across the value chain	04 Major analytical studies completed on sectoral pathways	94,765 Tonnes of CO ₂ avoided through PNG & CNG, FY 2024-25

From an idea to an institution: the sequence of work

Foundation → The Sustainability Cell is established

A dedicated platform within PNGRB for knowledge creation, data-driven decision-making, stakeholder engagement and sustainability integration across the petroleum and natural gas sector.

Mar–Jun 2025: Framework design and industry engagement

Inter-divisional consultations and industry engagement to design a standardised data framework for leaks and losses across the CGD sector.

Jul 2025: Standardised reporting format issued

A uniform GA-wise and entity-wise data format released; entities begin adopting common collection and reporting systems.

Aug–Dec 2025: Data build-out and reconciliation

Continuous follow-up, workshops and clarification sessions; coverage rises from 12 entities to 27 as internal reconciliation processes mature.

Jan–Mar 2026: Escalation, coverage and action plans

Formal communications to priority and high-loss entities; coverage reaches 32 entities; GA-wise analysis identifies high-loss areas and action plans are sought.

Jun 2026: Methane capacity building goes global

Two-day workshop with EDF, OGDC, IMEO-UNEP and Carbon Limits on oil & gas methane abatement, New Delhi; World Environment Day 2026 observed sector-wide.

Jun 2026: Full sectoral visibility

100% data submission across all 307 GAs and 37 entities, the first complete, comparable picture of leaks and losses in Indian city gas distribution.

Ongoing → Institutionalisation

Sustainability reporting provisions embedded in the proposed Data Management and Information System Regulations; Sustainability performance metrics integration with Technical Regulations; sustainability criteria integrated into the PNGRB Excellence Awards.



CHAPTER ONE

Building the Foundations of Sustainability

"Sustainability is no longer about doing less harm. It's about doing more good."

— Jochen Zeitz, Former Chief Executive Officer, Harley-Davidson, Puma and LiveWire

India's energy demand is rising, its infrastructure is expanding, and its climate commitments are firming up, all at the same time. This chapter sets out the landscape in which the Sustainability Cell was conceived and explains why a downstream regulator is uniquely placed to convert sustainability ambition into measurable sectoral outcomes.

1.1 The Evolving Sustainability Landscape of India

India's oil and gas sector is undergoing a period of unprecedented transformation. As the world's fastest-growing major economy and the third-largest energy consumer, India's energy demand is projected to continue rising in the coming decades, driven by industrialization, urbanization, improving living standards and expanding access to modern energy services. To support this growth while maintaining energy security, the country has significantly expanded its oil and natural gas infrastructure through city gas distribution networks, natural gas pipelines, LNG terminals, refineries, storage facilities and petroleum product transportation systems.

Natural gas, positioned as a transition fuel, is expected to play an increasingly important role in India's energy mix owing to its lower carbon intensity compared to conventional fuels and its ability to complement renewable energy deployment. Simultaneously, the sector is witnessing rapid growth in infrastructure assets, operational footprints and energy throughput across the value chain.

While this expansion strengthens energy accessibility and economic development, it also brings greater focus on environmental performance and resource efficiency. Greenhouse gas emissions, methane emissions, energy consumption, operational losses, infrastructure resilience and resource utilization are emerging as key areas of attention for governments, investors, consumers and industry stakeholders alike.

Increasingly, sustainability is no longer viewed solely as an environmental consideration, but as a strategic enabler of operational excellence, competitiveness, investment attractiveness and long-term sectoral resilience.

India at a Glance:

- › World's **3rd largest** energy consumer.
- › Natural gas share targeted to rise to **15%** of India's primary energy mix.
- › Over **309 Geographical Areas** authorized for City Gas Distribution.
- › More than **35,000 km** of authorized & **25000 Km** operational natural gas pipeline network.
- › Rapid expansion of LNG, CGD, Pipeline and downstream infrastructure.





For India, this is not a question of choosing between growth and responsibility. It is a question of designing systems in which the two reinforce each other, where a molecule delivered with fewer losses is simultaneously a commercial gain, an emissions saving and a safety improvement.

Three transitions shaping the downstream sector:

1. The volume transition

Networks, terminals and pipelines continue to expand rapidly as gas moves towards a larger share of the primary energy mix. The defining question of the last decade was how quickly infrastructure could be built.

2. The performance transition

As assets mature, attention shifts from capacity created to efficiency delivered, losses, energy intensity, integrity and utilization. The defining question of this decade is how well the infrastructure performs.

3. The disclosure transition

Performance that was recorded internally is increasingly expected to be reported comparably to regulators, investors and consumers. This is the transition that makes the other two verifiable.

The Sustainability Cell was established at the meeting point of these three transitions, where growth, performance and disclosure have to be reconciled within a single regulatory system.



1.2 India's Progress on Sustainable Development

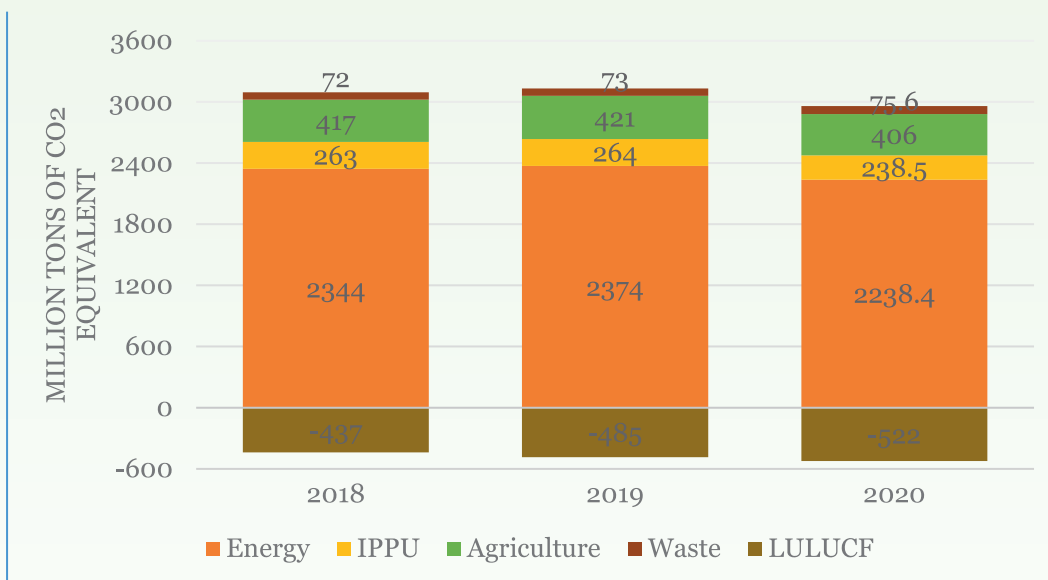


Figure 2: India's Greenhouse Emission Trend

(Source: India's 3rd and 4th Biennial Update Reports. IPPU: Industrial Processes and Product Use; LULUCF: Land Use, Land-Use Change and Forestry.)

India has made notable progress in advancing sustainable development while sustaining strong economic growth. According to NITI Aayog's SDG India Index 2023-24, the country's overall SDG score improved from 66 in 2020-21 to **71**, reflecting steady progress across multiple sustainable development goals.

At the global level, India has demonstrated that economic development and climate action can advance together. The Government of India has reported a **36% reduction in the emissions intensity of GDP between 2005 and 2020**, indicating a gradual decoupling of economic growth from greenhouse gas emissions.

Further, India achieved the milestone of meeting **50% of its installed electric power capacity from non-fossil fuel sources in 2025**, five years ahead of its 2030 Nationally Determined Contribution target.

Within this national picture, the energy sector remains the single largest contributor to emissions. That is precisely why efficiency, loss reduction and methane management in the downstream petroleum and natural gas sector carry disproportionate value: they act on the largest block of the national inventory, and they do so through interventions that are commercially rational for the entities undertaking them.

71 SDG India Index composite score, 2023-24, improved from 66 in 2020-21	36% Reduction in emissions intensity of GDP between 2005 and 2020	50% Installed electric power capacity from non-fossil sources, achieved 2025	5 years early Ahead of the 2030 Nationally Determined Contribution target
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Reading the national picture from a downstream perspective

- The energy block dominates the national inventory, sectoral interventions therefore carry national significance.
- Emissions intensity is falling even as absolute demand rises, which is precisely the pattern efficiency-led regulation is designed to reinforce.
- A cleaner power grid progressively improves the case for electrifying gas infrastructure, see the compressor electrification study in section 4.2.
- National commitments are met through sectoral action; sectoral action requires sectoral measurement.

1.3 India's Gas Economy in Numbers

The environmental case for natural gas is not abstract. It is visible in the volumes displaced, the fuels substituted and the emissions avoided. The exhibits on this page quantify what the expansion of city gas distribution, facilitated through PNGRB's authorization and regulatory framework, delivered in a single financial year, and how consumption has grown across segments.

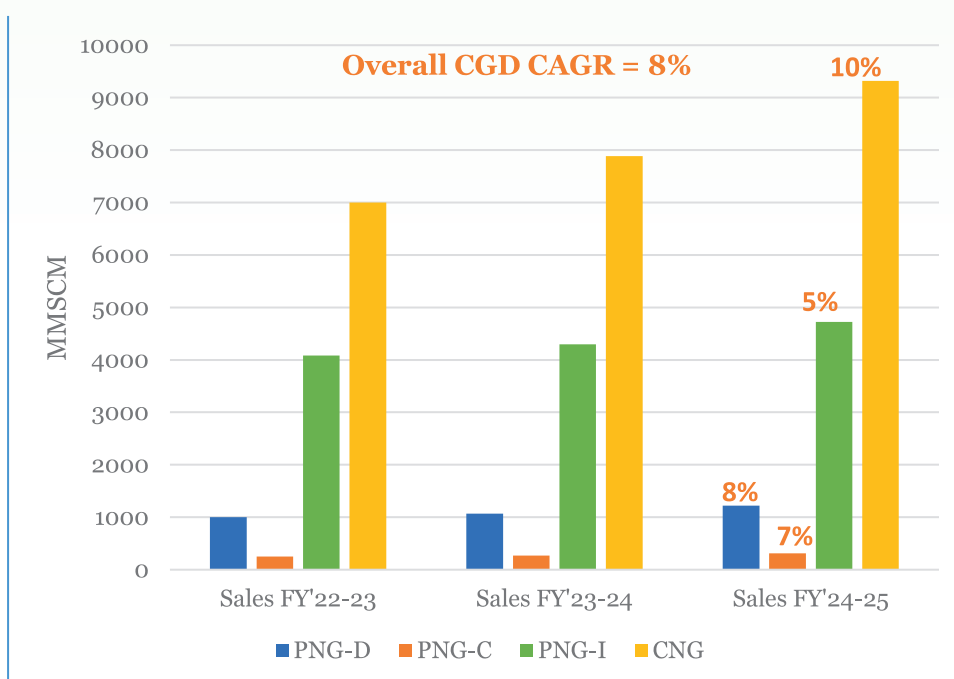


Figure 3: Sales volume growth in CGD

Source: PNGRB CGD MIS. Segment CAGRs shown for FY 2022-23 to FY 2024-25.

Between FY 2022-23 and FY 2024-25, overall CGD sales grew at a CAGR of approximately **8%**, with particularly strong growth in the CNG and PNG-Domestic segments. This expansion reflects the outcome of PNGRB's efforts in facilitating the development of city gas distribution infrastructure across the country.

By promoting fuel switching from LPG, petrol and diesel to natural gas, the expanding CGD network contributes to improved air quality, lower carbon emissions and a cleaner energy mix, while supporting India's energy security objectives.





The environmental benefit is quantifiable. Emissions avoided through PNG and CNG consumption across end-use sectors during FY 2024-25 are estimated at **94,765 tonnes of CO₂** equivalent to the annual carbon sequestration potential of nearly **2.4 million ten-year-old trees**.

Every geographical area authorized is not merely a market created. It is a substitution pathway opened, once metered and monitored, a measurable sustainability outcome.

Table 1: Emissions avoided through accelerating PNG and CNG consumption, FY 2024-25

Segment	Volume (MMSCM)	Energy (TJ)	Targeted Fuel	Tons of CO ₂ avoided
PNG-D	1224	2082	LPG	5205
PNG-C	314	534	LPG	1335
PNG-I	4722	8032	LPG	20080
CNG	9317	15848	MS (60%) & HSD (40%)	68145
Total	15577	26496		94765

Equivalent to CO₂e sequester by 2.4 million trees of 10 years age

1.4 Enabling Sustainability Through Regulation

Across the world, energy regulators are increasingly recognizing that sustainability and energy security are complementary objectives. While governments define climate ambitions and policy direction, regulators play a critical role in translating these aspirations into measurable sectoral outcomes through standards, monitoring frameworks, performance benchmarks, transparency mechanisms and stakeholder engagement. As a result, sustainability considerations are progressively being integrated into the regulation of energy infrastructure, operations and markets.

The oil and gas sector is particularly important in this transition. Given its extensive infrastructure footprint and strategic role in supporting economic development, regulators can facilitate improvements in operational efficiency, emissions management, resource utilization and adoption of best practices across the value chain. By promoting data-driven decision-making and performance transparency, regulators can create an enabling environment for continuous improvement while maintaining reliability, affordability and consumer interest.



Global Regulatory Approaches to Sustainability:

- › **United Kingdom:** integration of net-zero objectives, environmental performance considerations, innovation funding and support for low-carbon infrastructure.
- › **Australia:** climate and emissions reporting frameworks, methane management initiatives and energy transition planning.
- › **United States:** enhanced focus on emissions management, infrastructure modernization, safety and environmental assessments.

For India, the transition towards a more sustainable energy future requires institutions capable of translating national aspirations into sectoral action. PNGRB's vision of "*fostering a gas-based economy by ensuring consumer interest and facilitating growth through fair regulation*" and its mission of promoting efficient, transparent and sustainable development of petroleum and natural gas infrastructure align closely with the principles of sustainability.

As the regulator of critical downstream petroleum and natural gas infrastructure, PNGRB is uniquely positioned to facilitate improvements in operational efficiency, resource utilization, environmental performance and industry-wide adoption of best practices, thereby supporting both sectoral growth and long-term sustainability objectives.

Sustainability is most impactful when embedded within the systems that govern infrastructure, operations and performance. Ultimately, the role of regulation is not merely to enforce compliance, but to enable transformation. Regulators therefore have a critical role in enabling the transition from sustainability ambition to measurable sectoral outcomes.

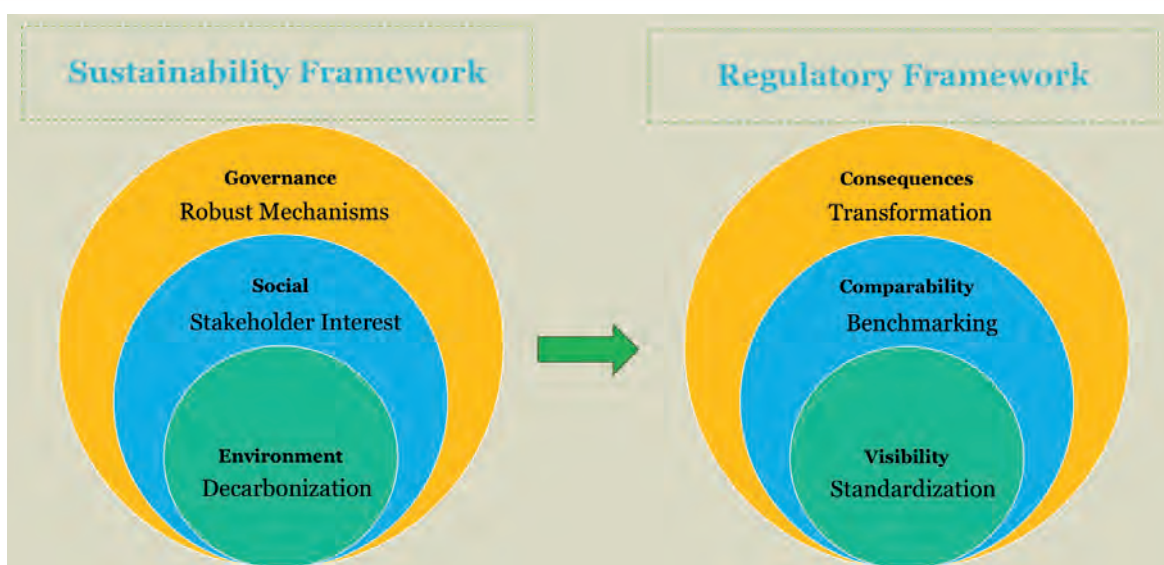


Figure 4: A Dual-Track Approach: Evolving Sustainability and Regulatory Frameworks Together





- **Visibility.** Common definitions and mandatory returns convert scattered operational data into a comparable sectoral picture.
- **Comparability.** Benchmarks let an entity see itself against peers, usually a stronger motivator than a penalty.
- **Consequence.** Recognition, tariff logic and compliance provisions ensure the picture translates into action.

1.5 Why the Regulator? Mapping Mandate to Sustainability

Sustainability did not require a parallel regulatory architecture. It required the existing architecture to be read with a sustainability lens and then instrumented so that what it already governs can also be measured, benchmarked and improved.

- No new compliance burden was created where an existing provision already generated the data.
- Sustainability metrics were derived from safety, integrity and metering requirements.
- Reporting was standardised once, then reused across benchmarking, awards and policy analysis.
- Entities were engaged as partners in framework design before any return was made mandatory.

Table 2: Sustainability linkages of regulatory functions

Regulatory Functions	What it governs today	Sustainability outcome it already influences
Authorization of CGD networks	Grant of Geographical Areas, minimum work programme, infrastructure roll-out obligations	Displacement of LPG, petrol and diesel; measurable avoided emissions; expansion of cleaner fuel access
Access codes and gas accounting	Lost and Unaccounted for Gas (LUAG), allocation, measurement and reconciliation	Methane loss quantification, operational efficiency, revenue protection for consumers
Technical standards (T4S)	Design, materials, construction and safe operation of pipelines and networks	Leak detection and repair, venting control, integrity of assets and prevention of fugitive releases
Integrity Management System	Risk assessment, surveillance, inspection and preventive maintenance regimes	Asset reliability, reduced unplanned releases, longer asset life and lower lifecycle emissions
ERDMP	Emergency response and disaster management preparedness	Containment of environmental incidents, spill management, hydrocarbon detection and isolation
Tariff and economic regulation	Transmission and compression tariffs, system use gas, capacity utilization	Incentives for efficient compression, modal optimization and infrastructure utilization over duplication
Consumer protection	Service standards, metering accuracy, grievance redress	Accurate measurement, reduced unaccounted volumes, trust in the delivered energy service
Data and information systems	Periodic returns, MIS, sectoral statistics	The evidence base on which every sustainability benchmark, target and incentive must rest



CHAPTER TWO

The Sustainability Cell: Genesis and Architecture

"We have not inherited the Earth from our ancestors; we are borrowing it from our children."

— Native American Proverb

An institution is defined less by what it declares than by how it works. This chapter sets out the Cell's vision and mission, the analytical case for sustainability oversight in the midstream and downstream sector, the four-pillar roadmap that guides its work, and the operating model through which ideas become sectoral outcomes.

2.1 The Foundation of the Sustainability Cell

"Sustainability is not a separate destination; it is a principle that guides every decision, every initiative and every step towards a resilient energy future."

VISION

To position PNGRB as a catalyst for environmental stewardship in India's petroleum and natural gas sector by promoting sustainable practices, fostering innovation, and facilitating the transition towards a cleaner, more resilient energy future while ensuring energy security and sectoral growth.

MISSION

To facilitate sustainability integration across the sector through:

- Monitoring and reducing emissions and operational losses
- Promoting efficiency and resource optimization
- Developing sectoral benchmarks and knowledge repositories
- Facilitating stakeholder collaboration and capacity building
- Supporting evidence-based policy and regulatory decision-making

Guiding Principles

1. Data Driven

Promoting evidence-based decision-making through robust data systems, analytics, benchmarking and measurable outcomes.

2. Collaborative

Partnering with industry, academia, government agencies and other stakeholders to drive collective progress and shared learning.



3. Practical

Balancing sustainability aspirations with operational realities, energy security priorities, affordability and sectoral growth objectives.

4. Progressive

Encouraging continuous improvement through innovation, emerging technologies, global best practices and adaptive learning.

What the Cell is and what it is not

It is

- A knowledge and evidence function that equips the Board and the sector to act on facts.
- A convenor that brings entities, experts and international institutions into one conversation.
- A design shop for frameworks, formats, benchmarks and indicators.
- A standing partner to every division of the Board, technical, commercial, legal and consumer divisions.

It is not

- A parallel compliance department creating duplicate returns.
- An environmental audit body substituting for statutory environmental authorities.
- A publisher of aspirations without an underlying dataset.
- A one-time project, the design intent throughout has been institutionalisation.

*The Cell's operating stance in one line: **not dormant, deeply active**, a small function measured by the frameworks it leaves behind rather than the circulars it issues.*

2.2 The Case for Sustainability Oversight

Why PNGRB should integrate sustainability oversight?

40% Share of total sectoral fugitive emissions attributable to midstream and downstream operations	~80× Global warming potential of methane relative to CO ₂ over a 20-year horizon	Cleaner gases Bio-gas injection and blending; infrastructure preparedness for hydrogen blending	Investment Sustainability performance reduces risk and creates value for investors in the sector
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Major emission hotspots across the regulated value chain

- **Methane leaks**
Fugitive releases from CGD networks, service lines, station equipment and transmission pipelines.
- **LNG terminal emissions**
Boil-off gas handling, flaring and venting during storage and regasification.
- **VOC losses**
Volatile organic compound releases from product storage tanks and depot operations.
- **Compressor and pump energy**
System Use Gas and electricity consumed at compressor and pumping stations.
- **Product transport fuel**
Diesel consumed in road movement of petroleum products over long distances.
- **Technical venting**
Planned blowdowns, purging, maintenance venting and CNG station losses.

The midstream and downstream petroleum and natural gas sector occupies a unique position in India's energy transition. Natural gas is widely recognized as a cleaner alternative to conventional fossil fuels due to its lower carbon dioxide emissions when combusted. However, its sustainability advantage is contingent upon efficient production, transportation, distribution and utilization across the value chain. Methane, the principal constituent of natural gas, is a potent greenhouse gas with a global warming potential nearly **80 times greater than carbon dioxide over a 20-year period**.

Consequently, emissions arising from leakages, venting, operational inefficiencies and infrastructure losses can significantly erode the environmental benefits associated with natural gas. Simultaneously, growing expectations around cleaner fuel integration, energy efficiency, resource optimization and climate resilience present substantial opportunities for improving sustainability performance across the sector.

These evolving challenges and opportunities underscored the need for a structured approach towards sustainability integration within the downstream petroleum and natural gas ecosystem.

Recognizing these emerging trends, PNGRB envisioned the need for a structured and evidence-based approach to mainstream sustainability within the sector. Rather than treating sustainability as a standalone objective, the aim was to create a framework that could systematically integrate sustainability considerations into infrastructure development, operational practices, performance assessment and regulatory decision-making, while balancing the priorities of energy security, affordability and sectoral expansion.

A molecule of methane released at a district regulating station is, simultaneously, an environmental loss, a safety risk and a commercial loss. Sustainability oversight is the discipline that makes all three visible at once.



2.3 Roadmap for Sustainability Integration

To achieve this objective, the Sustainability Cell developed a **Roadmap for Sustainability Integration** comprising four interconnected pillars: **Assessment, Norm Setting, Monitoring and Continuous Improvement**. The framework adopts a structured, data-driven approach, beginning with the identification of sustainability indicators, emission hotspots, performance drivers and sectoral baselines.

These insights provide the foundation for developing meaningful benchmarks and performance norms, supported by transparent monitoring mechanisms. The final pillar focuses on continuous improvement through stakeholder engagement, knowledge dissemination, adoption of best practices and periodic refinement of priorities.

Collectively, the roadmap provides a practical pathway for embedding sustainability within the downstream petroleum and natural gas sector while strengthening its efficiency, resilience and long-term competitiveness. Crucially, the pillars are sequential in logic but concurrent in execution: assessment of one sub-sector proceeds while norms are being set for another.

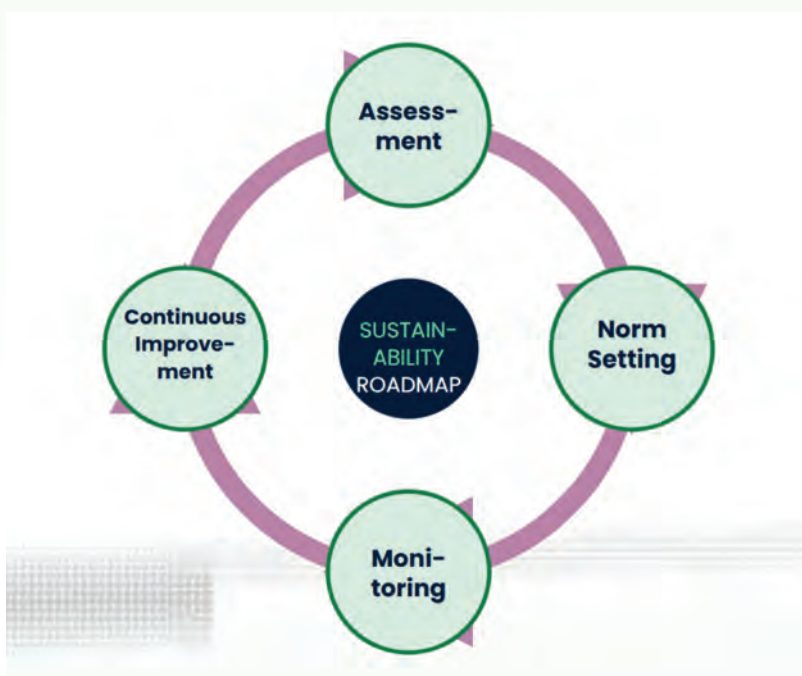


Figure 5: The four-pillar cycle: each turn of the loop tightens the sectoral baseline

1 • Assessment

- Standardized format, sub-sector wise
- Data collection mechanism
- Metric identification
- Data analysis at activity, entity and sub-sector levels
- Baseline study



2 • Norm Setting

- Segmentation catalogue per sub-sector (CGD, NGPL, PPPL, OMC, LNG, Refining)
- Target determination
- Piloting pathways for targets
- Identification of enablers
- Benchmarking → sectoral, national, global

3 • Monitoring

- Unified sustainability data reporting format
- Multilevel databases
- Dashboards on performance against KPIs
- Support and training to facilitate monitoring

4 • Continuous Improvement

- Penalties and incentives
- Monetary and non-monetary mechanisms
- Target revision
- Regulatory cycle updates

2.4 The Operating Model: How the Cell Works

Behind every initiative in this booklet lies the same working sequence. It was first applied to leaks and losses in the CGD sector and has since been repeated, with variation, for technical regulations, data architecture, knowledge products and analytical studies. Documenting it here allows entities to anticipate how the Cell will engage with them and allows the approach to be replicated by others.

DEFINE → the question | BENCHMARK → globally | CO-DESIGN → with entities | MEASURE → the sector | INSTITUTIONALISE

Step 1 • Define the question precisely

Most sectoral problems are stated too broadly to be actionable. "Reduce methane" becomes "define, measure and compare Lost and Unaccounted for Gas across 307 geographical areas on a common basis". A narrow, answerable question is the single greatest determinant of whether an initiative produces evidence or opinion.

Step 2 • Benchmark before designing

International practice is examined first, not to copy, but to avoid re-inventing definitions that mature regulators have already tested. Every framework in this booklet was preceded by a study of how the United Kingdom, United States, Australia and comparable jurisdictions handle the same parameter.



Step 3 • Co-design with the entities who must report

Formats are circulated in draft, discussed in workshops and virtual consultations, and revised against operational reality. Entities that helped write a format rarely dispute it later. This step is slower at the start and dramatically faster thereafter.

Step 4 • Measure the whole sector, not a sample

Partial data invites dispute. The Cell's practice is to pursue complete coverage, through follow-up, formal communication and escalation where required, because a benchmark derived from every entity is defensible in a way that a sample never is.

Step 5 • Institutionalise, then step back

A study answers a question once; a regulation answers it every year. Findings are therefore carried into reporting provisions, award criteria, technical annexures and management information systems, so that the measurement continues without depending on any single exercise.

Throughout • Publish and share

Every output is disseminated, through the sustainability section of the PNGRB website, digital knowledge products, workshops and conferences, on the principle that a finding held internally has no sectoral value.

The regulatory pathway in practice

Engagement	Enforcement	Compliance	Action
Consultation, format design, workshops and clarification sessions	Formal communications to non-responsive entities and escalation to senior management	Complete, comparable and validated sectoral data submission	Loss-reduction action plans, benchmarks, recognition and regulatory provisions



CHAPTER THREE

Catalysing Sustainable Transformation

"What is not measured cannot be improved."

— The working principle of the Sustainability Cell

This chapter records the operational core of the Cell's work: the first sector-wide measurement of leaks and losses in Indian city gas distribution, the discovery of sustainability value already embedded in technical regulations, the data architecture being built to sustain it, the knowledge products that carry it to the industry, and the field pilots and geospatial systems that extend it.

3.1 Curtailing Leaks and Losses in CGD Operations

"From measuring the unknown to driving sector-wide action."

Natural gas is widely recognized as a cleaner transition fuel capable of supporting India's energy security and decarbonization objectives. However, its environmental benefits are contingent upon efficient management across the value chain. Methane, the principal constituent of natural gas, has a global warming potential approximately **80 times higher than carbon dioxide over a 20-year period**. Consequently, leaks, venting, operational losses and measurement inaccuracies can significantly erode the sustainability advantage associated with natural gas.

Recognizing this challenge, the Sustainability Cell launched a first-of-its-kind initiative to systematically assess and curtail leaks and losses across India's City Gas Distribution sector.

A key challenge encountered at the outset was the absence of a standardized approach for measuring, defining and reporting leaks and losses across CGD entities. International benchmarking revealed that regulators across the United States, United Kingdom and Australia follow well-defined methodologies for tracking unaccounted-for gas, shrinkage, operational usage, metering inaccuracies, theft and network losses. While India's CGD Access Code Regulations defined **Lost and Unaccounted for Gas (LUAG)**, there was no sector-wide benchmarking framework or consistent mechanism to evaluate performance across entities and geographical areas.

Recognizing this gap, the Sustainability Cell undertook a comprehensive benchmarking exercise to compare global definitions, methodologies and reporting practices. This exercise initiated in March 2025, helped establish a common understanding of LUAG and laid the foundation for developing a standardized sector-wide framework for measurement and reporting by July 2025.

The initiative is distinctive because it moved beyond merely quantifying emissions. It sought to create a common language through which operational inefficiencies, methane emissions and economic losses could be measured consistently across the industry.



Why benchmarking LUAG matters

- Establishes a common definition and methodology across the sector
- Enables comparison of performance across entities and geographies
- Creates visibility into methane emissions and operational inefficiencies
- Supports evidence-based benchmarking and target setting
- Forms the foundation for future sustainability regulation and monitoring

What LUAG captures

The framework disaggregates losses so that action can be targeted at the right cause rather than at an aggregate number:

- **Technical venting**, planned blowdowns, purging and maintenance releases
- **CNG station losses**, compression, dispensing and cascade operations
- **Operational losses**, network leakage, service line and fitting releases
- **Metering and measurement**, inaccuracy, calibration drift and reconciliation gaps
- **Unexplained losses**, the residual that a mature gas accounting system must progressively shrink

"What is not measured cannot be improved. Standardizing LUAG measurement transformed leaks and losses from an invisible challenge into a measurable performance parameter."

3.2 Curtailing Leaks and Losses: What the Data Revealed

37 Entities, subsidiaries and joint ventures covered by the framework	307 Geographical Areas assessed on a comparable basis	0.84 MMSCMD Estimated total leaks and losses during FY 2024-25	1.77% Average industry LUAG, FY 2024-25, the sectoral reference point
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The outcome was the development of a standardized data framework covering **37 entities, subsidiaries and joint ventures across 307 geographical areas**, enabling for the first time a comparable and transparent assessment of leaks and losses across the entire CGD ecosystem. Analysis undertaken through the initiative estimated total leaks and losses of approximately **0.84 MMSCMD during FY 2024-25**, providing unprecedented visibility into an area that had historically remained fragmented and poorly understood.

The analysis revealed significant variation in LUAG performance across CGD entities, highlighting both leading practices and substantial improvement opportunities within the



sector. The average LUAG across the industry during FY 2024-25 was estimated at **1.77%**, which was subsequently used as a reference point for sectoral assessment.

Entity-level LUAG values ranged from near-zero levels in some networks to **more than 12%** in the highest-loss systems, demonstrating the diverse levels of operational maturity, network characteristics, gas accounting practices and loss management capabilities existing across the sector.

The entity with the highest LUAG recorded losses in excess of **12.7%**, while several entities maintained losses **below 2%**, demonstrating that low-loss operations are both achievable and practical within Indian operating conditions. This last point is the most consequential finding of the exercise: the performance gap is not explained by geography or gas quality alone, but substantially by management practice, and management practice is transferable.

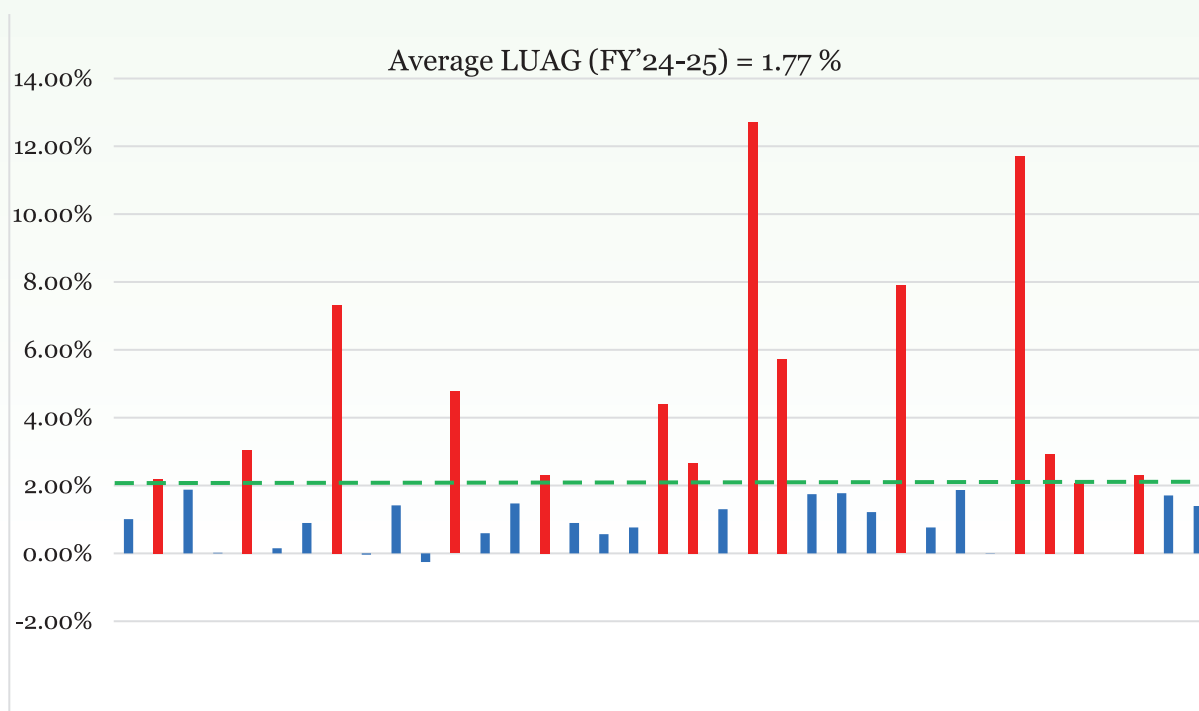


Figure 6: Entity-wise LUAG performance, FY 2024-25 (anonymized)

■ At or below the 2.0% preliminary benchmark ■ Above the 2% preliminary benchmark ■ preliminary benchmarked average 2.0%

Source: PNGRB Sustainability Cell, sector-wide leaks and losses data collection, FY 2024-25. Entity identities withheld; bars ordered as reported.

How to read this chart

The spread is the finding. A sector operating under broadly similar regulations, gas quality and equipment standards produces results ranging from near-zero to above twelve per cent. Because the low performers and the high performers face comparable external conditions, the difference is largely attributable to management practice, measurement discipline, reconciliation rigour, maintenance regimes and internal accountability. Practice, unlike geography, can be transferred.



3.3 Curtailing Leaks and Losses: Where the Losses Sit

The initiative generated several important insights. A preliminary benchmark of **2% total losses** was developed to identify high-loss entities and geographical areas, while analysis highlighted significant variations in performance across the sector.

Ninety geographical areas were identified with losses exceeding 2%, while **ten geographical areas** recorded losses exceeding 10%, highlighting substantial opportunities for improvement and targeted intervention. The concentration matters: a small number of areas account for a disproportionate share of the sector's total loss volume, which means that focused effort in a limited number of networks can move the national number materially.

The exercise also enabled the identification of dominant loss categories, including technical venting, CNG station losses, operational losses and previously unexplained losses, thereby providing entities with a clearer understanding of underlying drivers rather than a single opaque figure.

The 2% benchmark: how to read it

The 2% figure is a **preliminary screening benchmark**, not a regulatory ceiling. Its purpose is triage: it separates networks operating within the range already demonstrated as achievable in India from those requiring diagnostic attention. Final norms will follow the norm-setting pillar of the roadmap, segmentation by network characteristics, target determination and piloting of pathways.



Figure 7: Distribution of the 307 Geographical Areas against the 2% screening benchmark

Derived from reported figures: 90 GAs above the 2% benchmark, of which 10 exceed 10%.



Dominant loss categories identified across the sector

1. Technical venting

Planned operational releases, addressable through recompression, procedure change and blowdown minimisation.

2. CNG station losses

Compression, dispensing and cascade handling, addressable through equipment upgrade and maintenance discipline.

3. Operational losses

Network and service-line leakage, addressable through systematic leak detection and repair programmes.

4. Unexplained losses

The residual gap, addressable through improved metering accuracy, reconciliation discipline and gas accounting maturity.

3.4 Curtailing Leaks and Losses: The Regulatory Journey

The initiative was conceived as a collaborative, sector-wide exercise involving industry engagement, regulatory consultations, data framework development and progressive capacity building. Beginning with consultations to understand operational realities and data availability, the Sustainability Cell designed a standardized reporting framework and engaged CGD entities through workshops, virtual consultations, continuous follow-ups and clarification sessions. This phased approach spanning from November 2025 to April 2026, ensured that entities were aligned on data requirements and equipped to develop internal processes for measurement and reporting.

The journey evolved through a structured regulatory pathway of **Engagement** → **Enforcement** → **Compliance** → **Action**. Initial consultations and data submissions were followed by continuous stakeholder engagement, targeted interaction with entities facing reporting challenges, issuance of formal communications to non-responsive entities, and escalation to senior management levels where necessary. As a result, data coverage progressively increased from initial 12 entities to 27 by December 2025, then to 32 by the end of January 2026, eventually culminating in **100% sector-wide data submission** and visibility across all 307 geographical areas and 37 entities by June 2026.



Figure 8: Progressive build-up of sectoral data coverage



Coverage progressed from 12 to 37 entities and from partial to complete visibility across all 307 geographical areas.

3.5 The Regulatory Journey: Milestones

Input, process and outcome, stage by stage

Period	Input	Process	Outcome
Mar–Jun 2025	Industry engagement and inter-divisional consultations for data framework design	Alignment of entities on data requirements and feasibility of measurement and collection	Standardized sector-wide methodology for leak and loss measurement
Jul 2025	Standardized GA-wise and entity-wise data format issued	Entities adopt uniform data collection and reporting systems	Comparable and consistent dataset across 307 GAs and 37 entities
Aug–Oct 2025	Continuous follow-ups for data submission	Entities initiate internal data compilation and reconciliation processes	Progressive increase in coverage, submissions received from 12 entities
Nov–Dec 2025	Video conference with 37 entities to clarify doubts on data reporting	Resolution of data challenges, measurement gaps and accounting issues	Improved data quality and accuracy, submissions increased to 27 entities
Jan 2026	Formal letters issued to 10 entities for priority submission	Escalation-led compliance enforcement at senior management level	Acceleration in submissions from lagging entities, coverage reaches 32 entities
Mar 2026	Formal letters issued to 15 high-loss entities for action plan submission	Preparation of GA-wise analysis identifying high-loss areas	Structured, time-bound action plans for loss reduction sought from entities
Apr 2026	Analysis of 32 entities and their GAs presented to the Board	Emphasis on the variation in losses across GAs and entities, with associated economic value	Institutionalisation of leaks and losses monitoring through regulatory provisions, six entities submitted action plans
Jun 2026	Secretary-level intervention leading to final data submission	Closure of pending submissions through top-level regulatory push	100% data submission and full CGD sector visibility

Regulatory journey: Engagement → Enforcement → Compliance → Action.



3.6 Curtailing Leaks and Losses: From Measurement to Action

Beyond measurement and benchmarking, the initiative catalysed action. High-loss entities were requested to submit structured loss-reduction action plans, resulting in the identification of practical interventions such as leak detection and repair programmes, enhanced gas reconciliation, digital monitoring systems, metering improvement, preventive maintenance, asset upgrades and governance mechanisms. The exercise transformed leaks and losses management from a compliance-oriented activity into a strategic performance improvement agenda.

The significance of the initiative extends beyond the current assessment. By creating a standardized framework, generating high-quality sectoral data and establishing preliminary benchmarks, the initiative has laid the foundation for institutionalizing LUAG monitoring through future data and information systems, periodic reporting, benchmarking and continuous improvement mechanisms.

For the first time, the sector possesses a common reference point against which environmental performance, operational efficiency and methane management can be measured, monitored and progressively improved.

Interventions identified in entity action plans

- Leak detection and repair (LDAR) programmes with defined survey frequencies
- Enhanced gas reconciliation and gas accounting discipline
- Digital monitoring and SCADA-based loss visibility
- Metering improvement, calibration and accuracy assurance
- Preventive maintenance and asset upgrade programmes
- Internal governance mechanisms with accountability for loss performance

"The initiative's greatest achievement was not merely quantifying leaks and losses but establishing a standardized and benchmarked framework that enables the CGD sector to measure, compare, manage and progressively reduce methane emissions and operational inefficiencies over time."

What this means for a CGD entity

If you are below 2%

You are demonstrating what the sector considers achievable. The opportunity now is to document the practices that produced that result, through the Compendium of Case Studies and the Excellence Awards, so that they become sectoral property rather than an internal advantage.



If you are between 2% and 10%

The disaggregated categories in the reporting format will usually locate the problem quickly. Metering accuracy and reconciliation discipline typically deliver the fastest gains; venting procedures and CNG station handling follow.

If you are above 10%

A structured, time-bound action plan with board-level ownership is warranted. Losses at this level represent material foregone revenue in addition to emissions and are rarely attributable to a single cause.

The commercial case, stated plainly

Gas lost is gas purchased but never billed. At sectoral scale, the volumes quantified through this exercise represent a recurring economic loss carried by entities and, ultimately, by consumers. Loss reduction is therefore among the rare sustainability interventions that requires no trade-off argument: the environmental case and the commercial case point the same way.

3.7 Embedding Sustainability through Technical Regulations

Technical regulations already driving sustainability oversight

T4S (Technical Standards and Specifications including Safety Standards)

Ensures uniform engineering practices, safe operations and accident prevention through minimum safety benchmarks.,— **Coverage:** City Gas Distribution, Natural Gas Pipelines, Petroleum Product Pipelines, LNG Terminals, Refineries, LPG processing and bottling, Petroleum Installations (storage), Retail Outlets.

ERDMP (Emergency Response and Disaster Management Plan)

Builds readiness for handling emergencies and minimizing loss to life, property, environment and continuity of operations.,— **Coverage:** Applies across the regulated infrastructure spectrum, with environmental containment, spill management and hydrocarbon detection obligations.

IMS (Integrity Management System)

Ensures long-term reliability of assets, avoids failures and leaks, and protects public, environment and supply security, **Coverage:** City Gas Distribution, Natural Gas Pipelines, Petroleum Product Pipelines.

A common perception is that advancing sustainability requires the creation of entirely new regulations and compliance mechanisms. However, a detailed review undertaken by the Sustainability Cell revealed that many sustainability-related parameters are **already embedded within PNGRB's existing technical and safety regulations**. Rather than creating parallel reporting systems, a significant opportunity exists to leverage existing



regulatory provisions for measuring, monitoring and improving sustainability performance across the petroleum and natural gas sector. This approach allows sustainability integration to be achieved in a practical and phased manner while minimizing additional compliance burden on regulated entities.

The exercise initiated in March 2026, involved a comprehensive assessment of the T4S, IMS and ERDMP regulations to identify provisions that could support sustainability-related monitoring and reporting. The review covered a broad spectrum of infrastructure regulated by PNGRB, including City Gas Distribution networks, Natural Gas Pipelines, Petroleum Product Pipelines, LNG Terminals, LPG facilities, Refineries, Storage Installations and Retail Outlets.

The analysis demonstrated that many existing provisions relating to leak detection, gas measurement, venting, emergency response, energy management, integrity monitoring and environmental management can serve as effective **proxies for sustainability performance indicators**.

The finding in one sentence

The sector is already generating most of the operational data that sustainability oversight requires, it is simply being recorded for safety and integrity purposes and never aggregated as environmental performance.

This changes the economics of sustainability regulation. If the underlying measurement already exists as a safety obligation, converting it into a sustainability indicator costs the entity little beyond structured reporting, while delivering the sector its first comparable environmental dataset.

3.8 Sustainability Value Already Embedded in Regulation

One of the key findings of the exercise was that sustainability integration can be accelerated by linking existing technical compliance requirements with measurable **Performance Indicators**. For example, provisions relating to leak detection systems, gas detectors, venting activities, emergency reporting, integrity management, energy management systems, flare management, boil-off gas handling, hydrocarbon detection systems and environmental monitoring already generate valuable operational data that can be leveraged to track emissions, resource losses, fugitive releases, energy efficiency and operational resilience. By converting these existing requirements into structured sustainability metrics, entities can derive greater value from regulatory compliance while simultaneously improving their environmental performance.

The exercise further highlighted the possibility of developing a sustainability-focused reporting framework through **targeted annexures and performance indicators integrated within existing regulations**. Such an approach would enable the creation of sector-wide sustainability datasets, support benchmarking, improve transparency and facilitate evidence-based regulatory decision-making without fundamentally altering the regulatory architecture.

Importantly, it demonstrates that sustainability is not a separate or standalone agenda, but one intrinsically linked to safety, operational excellence, asset integrity, reliability and responsible infrastructure management.

"The most effective sustainability regulations are often not new regulations. They emerge by unlocking the sustainability value already embedded within existing technical, safety, integrity and operational frameworks."

Key sustainability themes identified across existing regulations.

Emissions Management

- Leak detection and repair programmes (LDAR), • Fugitive emissions monitoring, • Methane loss quantification, • Venting and blowdown management, • Flaring performance monitoring

Energy Efficiency

- Energy management systems, • Specific energy consumption, • Compressor and process efficiency, • Boil-off gas utilization

Performance Monitoring

- Loss and unaccounted-for product / gas, • Metering accuracy, • Equipment performance, • Benchmarking and reporting

Asset Integrity & Reliability

- Integrity Management Systems, • Pipeline surveillance, • Leak detection systems, • Preventive maintenance programmes

Environmental Risk Management

- Emergency response systems, • Incident reporting, • Spill management, • Hydrocarbon detection and isolation systems

Proposed way forward

- Introduce sustainability annexures within existing T4S, IMS and ERDMP reporting
- Define a compact set of performance indicators per sub-sector
- Aggregate returns into sector-wide sustainability datasets
- Use the datasets for benchmarking, recognition and periodic norm revision

3.9 Building the Sustainability Data Architecture

"The data architecture transforms sustainability from a reporting exercise into a measurable and manageable performance system."

Recognizing that sustainability can only be effectively managed when supported by reliable and consistent data, the Sustainability Cell initiated the development of a **sector-wide sustainability data architecture** in January 2026, designed to transform fragmented information into actionable intelligence. The objective was to create an institutional mechanism through which sustainability-related information could be systematically collected, validated, analysed, benchmarked and utilized for informed decision-making.

The framework encompasses standardized reporting formats, a digital submission portal, centralized databases, analytical dashboards and benchmarking systems that collectively



enable a structured approach towards monitoring sustainability performance across the petroleum and natural gas sector.

A key outcome of this work has been the incorporation of sustainability-related reporting provisions within the proposed **Data Management and Information System (DMIS) Regulations** notified in September 2026. This is the step that converts a successful one-time exercise into a permanent sectoral capability.

The initiative seeks to institutionalize sustainability data collection by moving beyond one-time studies and establishing a recurring, structured and technology-enabled reporting ecosystem. Once operational, the framework will enable the creation of comprehensive sectoral datasets, facilitate performance benchmarking across entities, generate management information systems, and support evidence-based policy and regulatory interventions.

By transforming data into insights and insights into action, the initiative lays the foundation for a transparent, accountable and continuously improving sustainability ecosystem within the petroleum and natural gas sector.

Design principles of the architecture

- **Report once, use many times** - a single validated submission serves benchmarking, MIS, awards and policy analysis.
- **Common definitions** - the dataset is only as comparable as the definitions beneath it.
- **Validation at entry** - errors are cheapest to correct at the point of submission.
- **Progressive disclosure** - entity-level detail for the regulator, aggregated and anonymised views for the sector.

From capture to context: the data value chain

- **Capture**
Raw sustainability metrics from diverse sources, emissions, energy, losses and supply chain parameters.
- **Validate**
Clean and verify submissions through a secure digital portal with in-built checks.
- **Store**
Hold validated metrics in a structured, query-ready sectoral data repository.
- **Contextualize**
Interpret performance against sectoral, national and global benchmarks.





3.10 Why It Matters: The Regulatory Data Loop

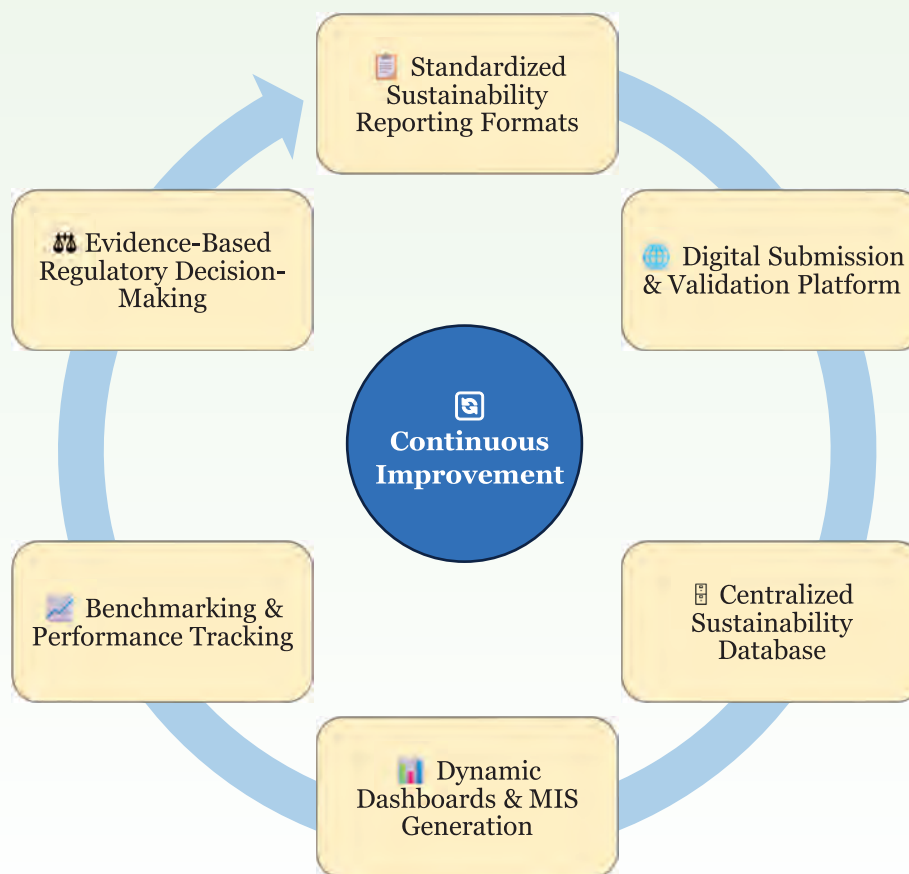


Figure 9: The regulatory data loop

Each cycle of the loop raises data quality, narrows the benchmark and shortens the distance between measurement and management action.

What the loop delivers to the Board

- A defensible evidence base for norm setting, target determination and regulatory impact assessment.
- Early visibility of outlier performance, enabling engagement before problems become disputes.
- A consistent basis for national and international reporting on sectoral environmental performance.

What the loop delivers to an entity

- Objective knowledge of where it stands relative to peers, on parameters it can influence.
- A single, predictable reporting obligation instead of episodic, ad-hoc data calls.
- Evidence for its own board, investors and disclosure obligations under BRSR and comparable frameworks.



Status

Sustainability reporting provisions have been incorporated into the proposed Data Management and Information System Regulations. Once notified and operational, periodic sustainability returns will move from exercise-based collection to a standing regulatory obligation, with dashboards and benchmarking generated as a routine output rather than a special study.

3.11 Compendium of Sustainability Case Studies

"Sustainability accelerates when good ideas are shared. The compendium transforms individual success stories into collective sectoral learning."

The transition towards a more sustainable oil and gas sector requires not only technological innovation and regulatory intervention but also the widespread dissemination of successful practices and practical solutions. While numerous entities across the petroleum and natural gas value chain have undertaken impactful initiatives, these experiences often remain confined within organizational boundaries, limiting opportunities for broader sectoral learning.

Recognizing this gap, the Sustainability Cell undertook the development of a **Compendium of Sustainability Case Studies**, aimed at identifying, documenting and disseminating exemplary sustainability initiatives implemented by entities across the sector. The objective was to create a centralized knowledge repository that would showcase practical solutions, encourage peer learning and facilitate the replication of successful interventions across similar operational environments.

The initiative started in June 2026, received an overwhelming response from industry stakeholders, reflecting the sector's growing commitment to sustainability and innovation. Following a structured evaluation process, a diverse portfolio of case studies spanning multiple sustainability themes was curated and compiled into a comprehensive publication launched during the 19th foundation day of PNGRB.

Collectively, these case studies demonstrate how targeted interventions can simultaneously enhance environmental performance, improve operational efficiency, strengthen business resilience and generate tangible economic benefits.

By showcasing proven solutions and measurable outcomes, the Compendium seeks to inspire organizations across the sector to adopt innovative approaches, accelerate sustainability integration, and contribute towards the development of a cleaner, more efficient and future-ready oil and gas ecosystem. It transformed individual sustainability success stories into a shared industry resource, enabling organizations across the petroleum and natural gas sector to learn from proven solutions and accelerate their own sustainability journey.

Themes featured in the Compendium

- Energy Efficiency
- Renewable Energy Adoption
- Circular Economy Practices
- Water Stewardship
- Waste Management
- Emissions Reduction
- Digital Innovation
- Resource Optimization
- Sustainable Operations

The Compendium journey



3.12 Compendium: Reach, Impact and Recognition

~120 Submissions received from across the oil and gas value chain	25 Participating entities contributing practices	39 High-impact case studies curated into the publication	>25% Digital engagement rate on disseminated knowledge products
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To expand its reach and engage a wider audience, selected case studies, ten in the first phase, were converted into concise digital knowledge products and disseminated through PNGRB's social media platforms. The outreach campaign recorded an **engagement rate exceeding 25%**, significantly higher than typical institutional communication benchmarks, along with strong click-through rates and stakeholder interaction. With the aim of covering all 39 featured case studies in a phased manner, the initiative helped translate technical sustainability interventions into accessible knowledge, enabling greater visibility and awareness of successful practices implemented across the sector.

The compendium also received appreciation from leadership across the oil and gas ecosystem, including senior executives and management of participating entities, who acknowledged its value as a first-of-its-kind repository dedicated to sustainability practices in the sector. Many stakeholders recognized the publication as an important mechanism for knowledge sharing,



peer learning and replication of proven solutions, thereby extending the impact of individual initiatives beyond organizational boundaries.

The significance of the initiative was further reinforced through the proposal to institutionalize the Compendium as an **annual flagship publication of PNGRB**, creating a recurring platform to document emerging innovations, recognize industry leadership and track the sector's evolving sustainability journey.

Beyond a publication: building a sustainability ecosystem

- › Annual Sustainability Best Practices Compendium
- › Recognition of sustainability leaders
- › Collaborative knowledge-sharing platform
- › Dedicated Sustainability Conference
- › Replication of proven solutions
- › Accelerating sustainability integration across the sector

Representative practices disseminated

- **Rooftop solarization** of CGD assets, city gate stations, CNG stations and offices, to reduce grid dependence and power own infrastructure.
- **Boil-off gas recovery** at LNG facilities, capturing and returning BOG to the distribution network instead of flaring or venting.
- **AI-enabled flare monitoring** at refineries, algorithms identifying root causes in real time and enabling corrective action without additional hardware.
- **Process optimization to control boil-off losses**, fuel-gas density and flash management across LNG fleet operations.



Figure 10: Digital knowledge product from the Compendium as disseminated on PNGRB's social media platforms



3.13 From Compendium to Conference

Building upon this foundation, PNGRB is conceptualizing a dedicated **Sustainability Conference for the Oil & Gas Sector**, envisioned as a first-of-its-kind platform bringing together regulators, industry leaders, policymakers, academia, technology providers, multilateral organizations and sustainability practitioners.

Unlike conventional conferences that focus primarily on policy discussion, the proposed platform is intended to showcase practical and proven sustainability solutions, facilitate peer-to-peer learning, enable cross-sector knowledge exchange and foster collaboration.

By creating a direct interface between innovators, implementers and decision-makers, the conference is expected to accelerate the replication of successful practices, catalyse new sustainability initiatives and contribute towards the development of a more resilient, efficient and future-ready petroleum and natural gas ecosystem.

"The Compendium preserves knowledge; the Conference will transform knowledge into action."

An invitation to entities

The Compendium works only if entities keep contributing. Three things make a submission genuinely useful to the sector:

- **A measured baseline.** What the parameter was before the intervention, on what basis measured.
- **A quantified outcome.** Energy, emissions, volume or cost, with the measurement method stated.
- **Replication conditions.** What another entity would need in order to reproduce the result: asset type, scale, investment range and payback.

Practices that are documented this way travel. Those that are described only in qualitative terms rarely do.

Selection criteria used

- Innovation
- Impact
- Scalability
- Replicability

Indicative design of the proposed Sustainability Conference

Proven solutions track

Implementers present interventions with measured baselines, quantified outcomes and replication conditions, not concept presentations.

Regulatory dialogue track

Open discussion of definitions, benchmarks, reporting burden and emerging provisions, ahead of formal consultation.

Technology interface

Detection, measurement, monitoring and abatement technology providers meeting the operating teams who would deploy them.

Recognition platform

Conference linked to the sustainability categories of the Excellence Awards, so that recognition and knowledge sharing occur together.

Who it is for

CGD entities, pipeline operators, oil marketing companies, LNG and refinery operators, technology providers, financiers, researchers, state agencies and policymakers, with deliberate emphasis on operating and asset-management personnel rather than corporate communication functions alone.

What success would look like

A measurable increase in the number of entities replicating a practice first documented by another entity. Attendance is an input; replication is the outcome the platform exists to produce.

3.14 Digital Knowledge Dissemination and Outreach

"In the digital era, knowledge achieves its greatest impact not when it is created, but when it is accessible, shared, and translated into collective action."

In an increasingly interconnected world, the effectiveness of sustainability initiatives is determined not only by their implementation but also by the extent to which knowledge and learnings are shared with stakeholders. Recognizing the importance of accessibility and wider stakeholder engagement, the Sustainability Cell adopted a **digital-first approach** to knowledge dissemination by establishing a dedicated sustainability section on the PNGRB website.

The platform was envisioned as a centralized repository for sustainability-related publications, studies, best practices, reports, presentations and other knowledge resources developed by the Board. The dedicated web platform serves as a single-point access for industry stakeholders, policymakers, researchers, academia and the general public to explore sustainability initiatives being undertaken within the petroleum and natural gas sector.

By making knowledge resources readily available in the public domain, the Sustainability Cell seeks to promote transparency, encourage sector-wide learning and facilitate the adoption of best practices across the industry.

Digital platforms have emerged as powerful enablers for accelerating awareness, fostering collaboration and democratizing access to information across geographies and organizational



boundaries. For a rapidly evolving sector such as petroleum and natural gas, timely dissemination of knowledge, best practices and emerging sustainability insights is essential for enabling informed decision-making and encouraging sector-wide adoption of innovative solutions.

Through its dedicated Sustainability Portal and outreach across professional and social media platforms such as LinkedIn and Instagram, the Sustainability Cell has significantly broadened the reach of sustainability-related discourse beyond conventional industry circles. These platforms have enabled engagement with a diverse audience comprising industry professionals, policymakers, researchers, academia, technical experts, students, consumers and sustainability practitioners, fostering a wider community of interest around sustainable energy development.

While LinkedIn has served as an effective medium for engaging decision-makers and professionals through thought leadership and knowledge sharing, social media platforms have helped simplify complex sustainability concepts and communicate them to a broader audience in an accessible and engaging manner.

Collectively, these initiatives represent a **strategic knowledge infrastructure** that supports continuous learning, transparency and stakeholder participation, while advancing PNGRB's vision of fostering a gas-based economy and its mission of promoting efficient, transparent and sustainable development of petroleum and natural gas infrastructure.

"Knowledge creates impact only when it is accessible. By leveraging digital platforms, the Sustainability Cell transformed sustainability knowledge from static publications into a dynamic and widely accessible sectoral resource."

What the sustainability section hosts

Leaders Guiding the Green Transition

Thought leadership and addresses from sectoral and institutional leaders.

Compendium of Case Studies

The full publication together with a navigable index of featured practices.

Sustainability Integration by Global Regulators

The benchmarking study on international regulatory practice.

World Environment Day 2026

Campaign material, competition outcomes and awareness resources.



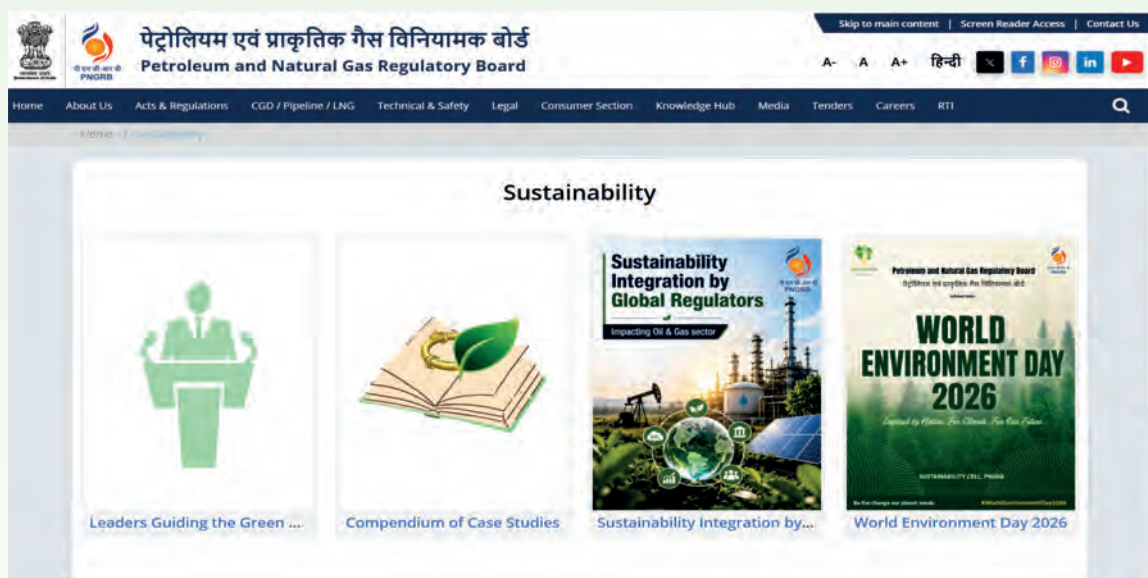


Figure 11: Sustainability Section on PNGRB Website

3.15 End-Use Efficiency: The PNG Domestic Stove Pilot

"Sustainability in a gas network does not end at the meter. It ends at the flame."

Most sustainability effort in gas distribution is directed at the network, leaks, venting, compression and metering. Yet a significant share of the energy delivered is determined by what happens at the point of combustion in the consumer's kitchen. If domestic appliances convert delivered gas inefficiently, the sector loses energy that no amount of network optimisation can recover, and the consumer pays for it.

Recognizing this, the Sustainability Cell conceptualized and developed a structured **pilot study on the efficiency of PNG domestic stoves**, undertaken with six City Gas Distribution entities spanning diverse geographies, gas compositions and consumer profiles:

- Assam Gas Company Limited (AGCL)
- Adani Total Gas Limited (ATGL)
- Bharat Petroleum Corporation Limited (BPCL)
- GAIL Gas Limited
- Indraprastha Gas Limited (IGL)
- Mahanagar Gas Limited (MGL)

The pilot was designed as a formal, documented regulatory exercise, supported by an office note, structured protocols for participating entities, and a defined analytical treatment for anomalous observations.

The consumption paradox

A recurring observation in domestic gas programmes is that measured consumption sometimes rises after the installation of a nominally more efficient appliance. The causes are behavioural and metrological rather than thermodynamic, changed cooking patterns, substitution away from other fuels, household composition and measurement artefacts.



To prevent such observations from contaminating the efficiency conclusion, the Cell developed a **four-tier treatment framework** that classifies each anomalous case and applies a defined analytical treatment before the dataset is aggregated. The framework allows genuine efficiency findings to be separated from behavioural and measurement effects, a methodological contribution that is reusable for any future end-use efficiency study in the sector.

Why this pilot matters

- It extends sustainability measurement **beyond the network boundary** to end-use performance.
- It creates a replicable protocol for appliance efficiency assessment under Indian domestic conditions.
- Efficiency at the burner translates directly into lower household energy cost and lower emissions per unit of useful heat.
- It informs future standards, labelling discussions and consumer awareness on appliance selection.

Indicative findings

Consolidated observations across participating entities indicated efficiency deviations in the range of approximately **7% to 13%** relative to the reference basis adopted for the study.

These figures are indicative and drawn from the pilot phase. Final findings, treatment of anomalous cases under the four-tier framework and any consequent recommendations will be reported on conclusion of the study.

The pilot illustrates a wider point about the Cell's method: a sustainability question is worth pursuing when it is measurable, when the measurement can be standardised across entities, and when the result changes a decision, in this case, decisions about appliance standards, consumer guidance and the true efficiency of the domestic PNG value proposition.

3.16 Geospatial Foundations: NHIMS and Infrastructure Intelligence

Sustainability performance is ultimately an attribute of physical assets in physical locations. A leak occurs on a specific section of a specific network; a compressor consumes fuel at a specific station; a geographical area's losses are a property of the pipeline kilometres, station count and network age within its boundary. Without a reliable spatial record of the country's hydrocarbon infrastructure, sustainability analysis remains a table of numbers detached from the assets that produce them.

The **National Hydrocarbon Infrastructure Management System (NHIMS)** addresses this gap. It is conceived as a national geospatial asset for the petroleum and natural gas sector, a single, authoritative spatial record of regulated infrastructure and authorized areas.



Use cases conceptualized

- **Dispute resolution** - authoritative boundary and alignment records to settle overlapping claims between authorized entities.
- **Third Party Access monitoring** - visibility of capacity, connectivity and access points across the network.
- **Pipeline integrity** - spatial correlation of asset age, material, terrain and inspection history.
- **Emergency response** - rapid identification of assets, isolation points and populations at risk during an incident.

What geospatial capability adds to sustainability?

- › **Normalisation.** Losses per kilometre of network, per station or per connection are far more meaningful than losses per entity.
- › **Targeting.** High-loss geographical areas can be examined against network vintage, terrain and density rather than treated as uniform outliers.
- › **Verification.** Satellite-based methane detection and alert systems produce geolocated plumes; without an asset map, an alert cannot be attributed to an operator or an asset.
- › **Planning.** Modal optimization, CBG injection points and hydrogen-blending readiness are all fundamentally spatial questions.

Connecting the threads

Read together, the initiatives in this chapter form a single system rather than a set of separate projects. The leaks and losses framework supplies the **metric**. Technical regulations supply the **legal hook**. The data architecture supplies the **pipeline of information**. NHIMS supplies the **spatial reference**. The Compendium and digital outreach supply the **transmission mechanism** by which good practice travels. Remove any one of them and the others lose force.



CHAPTER FOUR

Knowledge for Transformation

"What we know today defines the choices we make for tomorrow."

— Dr. Gro Harlem Brundtland, Former Prime Minister of Norway

Four analytical studies were undertaken to answer questions the sector had been debating without a common evidence base: how other regulators are integrating sustainability, whether compressor electrification is economically viable, whether petroleum product logistics can be optimised, and which vehicular fuels genuinely fit which segments. This chapter presents what each study set out to resolve and what it found.

4.1 Sustainability Integration by Global Energy Regulators

"The purpose of benchmarking global practices is not to replicate them, but to learn from them and adapt the most relevant ideas to local realities and national priorities."

As sustainability transitions from a voluntary aspiration to a strategic business and regulatory imperative, energy regulators across the world are increasingly integrating environmental and sustainability considerations into their regulatory frameworks. Recognizing the growing relevance of these developments for India's petroleum and natural gas sector, the Sustainability Cell undertook a comprehensive study on sustainability integration by leading energy regulators globally in December 2025.

The objective was to understand how regulators are responding to emerging sustainability challenges, identify practices relevant to the Indian context, and develop insights that could support the evolution of sustainability-oriented regulatory approaches within the sector.

The study examined regulatory frameworks and sustainability initiatives adopted by leading jurisdictions including the **United Kingdom, United States, Australia, Japan and Brazil**. The assessment revealed that while specific approaches vary across jurisdictions, regulators are increasingly focusing on common themes such as emissions management, sustainability disclosures, infrastructure efficiency, methane mitigation, environmental performance monitoring, low-carbon fuel integration and climate resilience.

Importantly, many jurisdictions are seeking to embed sustainability considerations within existing regulatory systems rather than creating entirely separate regulatory structures, thereby enabling a gradual and practical transition towards sustainable energy systems. This finding directly shaped the Cell's own approach, described in section 3.2.

Study design

- › Assessing global regulatory frameworks across five comparator jurisdictions
- › Mapping metrics and international benchmarks used by each regulator
- › Data analysis and extraction of transferable insights
- › Sectoral learnings tested for domestic adaptability
- › Articulation of a sustainability integration pathway for India





The benchmarking exercise highlighted that regulators across the world are increasingly adopting a diverse set of tools to support sustainability integration within energy infrastructure and operations. The assessment revealed strong international emphasis on environmental action plans, project lifecycle emissions considerations, sustainability disclosures, emissions reduction targets, methane management, and the use of financial and market-based mechanisms to drive environmental performance.

Importantly, the study also demonstrated that India has already established several foundational elements that support sustainability integration, mandatory sustainability disclosures through the Business Responsibility and Sustainability Reporting (BRSR) framework, environmental impact assessment requirements, carbon market development through the Carbon Credit Trading Scheme (CCTS), bio-methane promotion initiatives, and sustainable financing instruments such as sovereign green bonds.

Table 3: Comparative of sustainability tools incorporated by global energy regulators.

Sustainability tool	UK	Australia	USA	Japan	Brazil	India
Environment Action Plan / report (assured or verified)	✓	✓	✓	×	×	SEBI-mandated BRSR
Project lifecycle emissions in authorization mandate through EIS	✓	✓	✓	✓	✓	MoEFCC draft EIA notification, 2020
Annual reduction targets with financial incentives or penalties	✓	✓	×	×	✓	Under CCTS
Integration with emission trading schemes	✓	✓	×	✓	✓	Not in CCTS Phase 1
Activity-level and corporate-level disclosures	✓	✓	✓	×	×	SEBI-mandated BRSR



Sustainability tool	UK	Australia	USA	Japan	Brazil	India
Low-carbon methane blending mandates with linked incentives	✓ (bio-methane)	✓ (bio-methane)	×	✓ (e-methane)	✓ (bio-methane)	✓ bio-methane, no blending incentives linked
Linking financial instruments to support implementation	✓	✓	✓	✓	✓	RBI Sovereign Green Bonds

Source: PNGRB Sustainability Cell study on sustainability integration by global energy regulators.

The findings indicate that India's regulatory ecosystem already possesses many of the enabling building blocks observed globally, and that significant opportunities exist to further strengthen sector-specific sustainability integration by leveraging these national-level initiatives.

The study therefore reinforced the importance of a **phased, practical and context-specific approach** that builds upon existing strengths while facilitating continuous improvement in sustainability performance across the petroleum and natural gas sector.

One of the key observations was the increasing use of **performance-based regulatory frameworks** that encourage continuous improvement through monitoring, benchmarking, disclosure and accountability mechanisms. Regulators are progressively leveraging data, technology and stakeholder engagement to create transparency around sustainability performance while supporting innovation and long-term infrastructure modernization. Several jurisdictions have also established pathways for integrating emerging low-carbon fuels, strengthening emissions reporting and enabling investment in sustainable infrastructure.

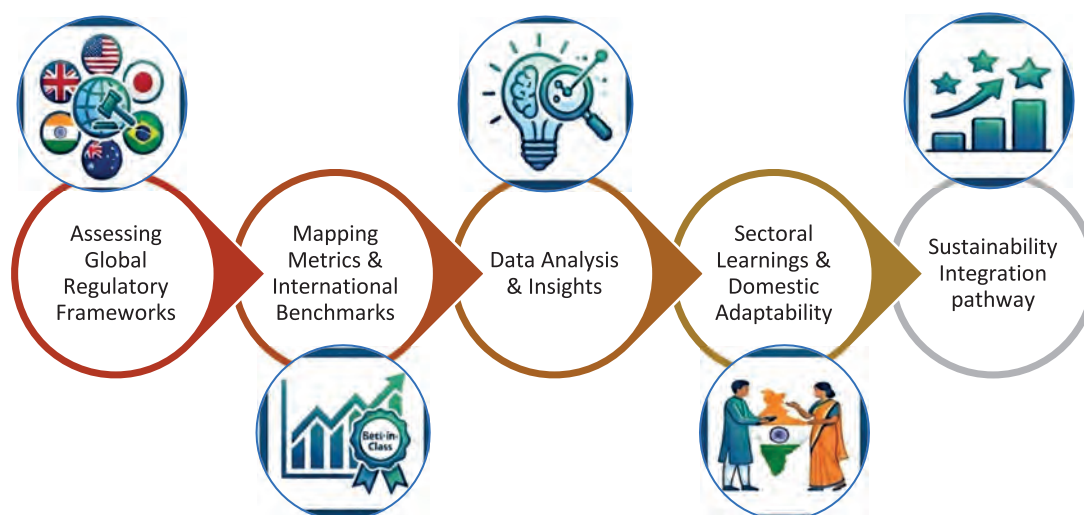


Figure 12: The approach towards designing the study





Where India is already aligned

Mandatory sustainability disclosure through BRSR, environmental impact assessment in project approval, and sovereign green bonds as a financing instrument place India alongside the more advanced jurisdictions on the foundational tools.

Reduction targets and market linkage are being developed through the Carbon Credit Trading Scheme. Sector-specific application to downstream oil and gas, including methane, is the question still to be settled.

Corporate-level disclosure exists; **activity-level** and asset-level environmental data does not yet exist on a comparable basis. That gap is precisely what the leaks and losses framework and the data architecture are built to close.

What the Study Established

- Established a structured understanding of global regulatory approaches to sustainability.
- Identified opportunities for leveraging regulatory frameworks to drive environmental performance improvement.
- Demonstrated how sustainability can be integrated within existing regulatory ecosystems.
- Created a knowledge base to support evidence-based decision-making and future regulatory thinking.
- Facilitated the adaptation of global best practices to the Indian petroleum and natural gas sector.

- Strong global focus on sustainability disclosures and reporting.
- Increasing integration of environmental considerations in infrastructure planning.
- Growing reliance on emissions reduction targets and market-based mechanisms.
- Financial instruments emerging as key enablers of sustainability transitions.
- India already possesses several foundational elements supporting sustainability integration, with significant opportunity to build upon sectoral strengths.

The study provided valuable insights into how sustainability can be incorporated within regulatory ecosystems while balancing energy security, reliability, affordability and sectoral growth. Rather than proposing direct replication of international models, the exercise focused

on identifying principles and practices that could be adapted to the unique characteristics of India's petroleum and natural gas sector.

The findings contributed to the broader understanding of sustainability integration pathways and supported the development of subsequent initiatives undertaken by the Sustainability Cell, most directly the review of technical regulations described in section 3.7 and the data architecture in section 3.9

Three transferable principles

- **Disclosure precedes targets.** Every jurisdiction studied built a reporting obligation before it built a reduction obligation.
- **Embed rather than duplicate.** The more mature the regulator, the more sustainability provisions sit inside existing instruments.
- **Money follows measurement.** Financial and market-based mechanisms only function where the underlying parameter is measured on a common basis.

4.2 Electrifying Gas Compressors in Natural Gas Pipelines

"Exploring economically feasible pathways for decarbonizing India's gas transmission infrastructure."

Natural gas transmission pipelines form the backbone of India's expanding gas-based economy. To transport gas across long distances and maintain pressure within pipeline systems, compressor stations consume significant quantities of natural gas, commonly referred to as **System Use Gas (SUG)**. While compression is essential for pipeline operations, it also represents a key source of operational emissions and energy consumption.

Recognizing the increasing focus on decarbonizing energy infrastructure, the Sustainability Cell undertook a study to evaluate the economic and environmental feasibility of replacing conventional gas-turbine-driven compressors with electric compressors across India's Natural Gas Pipeline network.

The study initiated in April 2026, was designed to move beyond asset-level technical feasibility assessments and develop a broader sector-wide decision framework. While earlier evaluations by pipeline operators had established that compressor electrification was technically feasible, the Sustainability Cell sought to determine **when, where and under what conditions** electrification would be economically viable, environmentally beneficial and scalable across the sector.

The assessment therefore integrated technology evaluation with economic analysis, emissions modelling, renewable energy considerations and macro-level implications for the national gas transmission network.

"The study shifts the discussion from whether compressor electrification is technically feasible to whether it is economically viable, environmentally beneficial and scalable across India's gas transmission network."



The transition in outline

- **Legacy configuration:** natural-gas-fired turbine drive on a centrifugal compressor, with a fuel gas system and an exhaust stack producing CO₂ and NO_x.
- **Modern configuration:** electric motor drive with variable frequency control on the same centrifugal compressor, supplied through a grid connection with renewable energy integration and zero on-site combustion emissions.

Variables modelled

Prevailing gas prices - APM, HPHT, weighted average gas-mix and RLNG; electricity sourcing arrangements; compressor efficiencies; infrastructure requirements; lifecycle economics.

Emissions configurations tested

Grid supply, solar, wind and hybrid renewable energy configurations, each evaluated against the emissions profile of conventional gas-driven compression.

Decision variables identified

Tariff structures, renewable energy availability, infrastructure readiness and lifecycle economics, the four factors that determine viability at a given station.

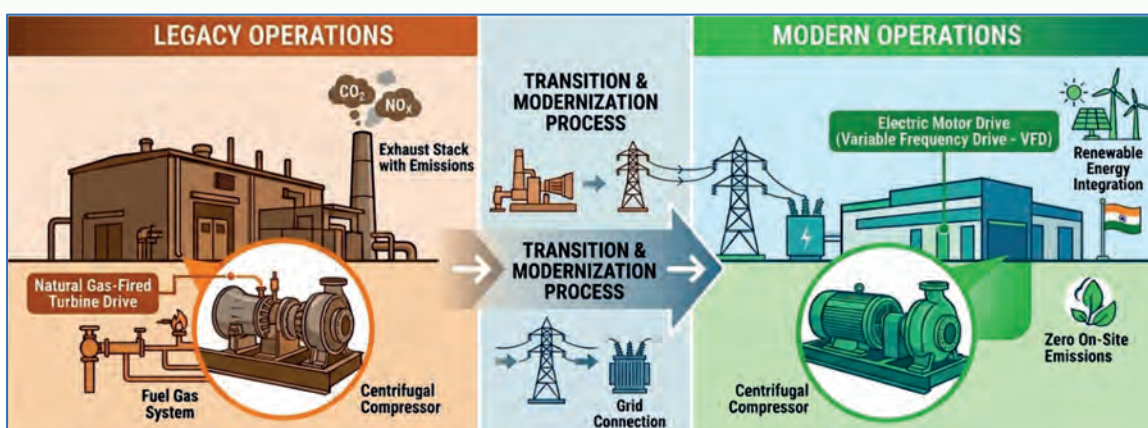


Figure 13: Legacy gas-turbine-driven compression transition to electric motor drive (VFD) configuration with renewable integration

Compressor Electrification: Findings and Framework

A comprehensive techno-economic model was developed to compare gas-driven and electric compressor configurations under multiple fuel and electricity price scenarios. In parallel, the study evaluated the emissions implications of electrification under grid, solar, wind and hybrid renewable energy configurations. The findings highlighted that the viability of compressor electrification is **highly dependent on fuel costs and electricity sourcing arrangements**.

Beyond project-level economics, the study examined the broader implications of compressor electrification at the sector level. Based on existing pipeline throughput and approved SUG consumption levels, the analysis indicated that compressor operations account for a significant volume of natural gas consumption annually. The study estimated that renewable-



powered electrification could result in substantial emission reductions while simultaneously reducing long-term dependence on gas-based compressor fuel consumption.

Most importantly, the study established a **structured decision-making framework** for evaluating infrastructure decarbonization opportunities within the natural gas transmission sector. Rather than providing a one-size-fits-all recommendation, it offers an evidence-based methodology through which pipeline operators, regulators and policymakers can assess electrification opportunities under varying operational, economic and environmental conditions.

Major findings

- Compressor electrification is **technically feasible and scalable** across major NGPL systems.
- Economic viability improves significantly under **higher gas price scenarios** such as HPHT, weighted average gas-mix and RLNG.
- **Hybrid renewable energy combined with grid supply** emerged as the most favourable configuration.
- Renewable-powered electrification offers **substantial emissions reduction potential** compared to conventional gas-driven compression.
- The study established a sector-wide techno-economic and environmental **decision framework** for future implementation.

How an operator should use this

- Start with stations where the fuel gas is priced at or near RLNG or gas-mix levels, the economics turn first there.
- Evaluate electricity sourcing before evaluating the compressor: open access, captive renewable and hybrid arrangements change the answer more than machine selection does.
- Treat SUG as a controllable cost line rather than a technical constant.
- Assess on lifecycle economics, not first cost, the emissions and fuel savings accrue over decades of operation.

Electrification is not a universal prescription. It is a conditional opportunity, and the value of the study lies in specifying the conditions precisely enough for an operator to test its own assets against them.



4.3 Optimizing Transportation of Petroleum Products

"The most sustainable molecule is often the one that reaches the consumer through the most efficient pathway."

The movement of petroleum products from refineries and import terminals to consumption centres represents one of the most critical and resource-intensive components of India's downstream petroleum value chain. Given the scale of petroleum consumption across the country and the diversity of transportation modes available, logistics efficiency has significant implications for operational costs, infrastructure utilization, energy consumption, emissions and overall sectoral sustainability.

Recognizing this opportunity, the Sustainability Cell undertook a study in May 2026 to evaluate the transportation economics of petroleum products across various transportation modes and identify opportunities for optimizing logistics from both cost and environmental perspectives.

The study examined the movement of **Motor Spirit (MS), High-Speed Diesel (HSD) and Liquefied Petroleum Gas (LPG)** across India's refining, transportation and distribution network. The analysis highlighted significant regional imbalances between petroleum product production and consumption, which continue to drive large-scale movement of products across the country. While western India serves as the primary refining hub with substantial production surpluses, several regions exhibit deficits that necessitate extensive transportation through pipelines, railways, roads and coastal shipping routes.

Share of primary transportation volumes by mode

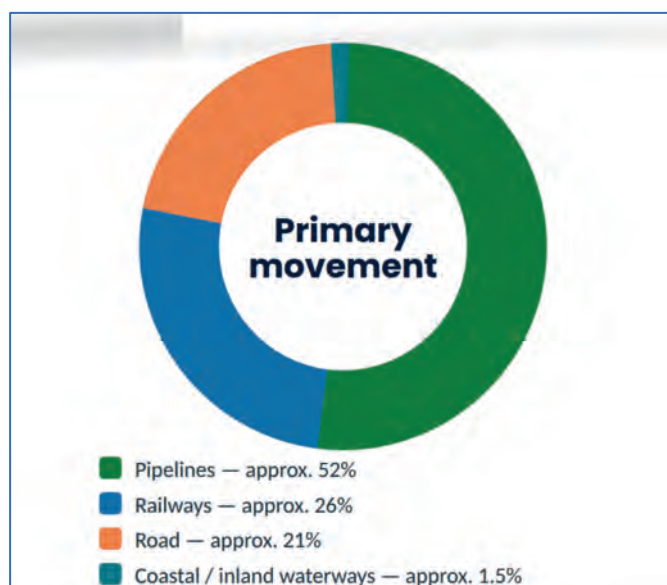


Figure 14: Share of primary transportation volumes by mode

A detailed assessment of petroleum product transportation patterns revealed that pipelines currently account for approximately **52%** of primary transportation volumes, followed by railways at around **26%**, road transport at approximately **21%** and coastal or inland waterways at nearly **1.5%**. The study also observed significant spare capacity within segments of the pipeline network, indicating opportunities for improving infrastructure utilization and reducing dependence on relatively expensive transportation modes.



To better understand the economics of logistics choices, the Sustainability Cell compared transportation costs across all major modes. The findings demonstrated that **road transportation is consistently the most expensive mode**, while railways, pipelines and marine transport offer significantly lower unit transportation costs depending on product type and route characteristics.

For example, transportation costs for MS and HSD through road networks were estimated to be **more than four times higher** than equivalent rail or pipeline movements. Similar trends were observed for LPG transportation.

Petroleum Logistics - Findings and Implications

Major findings of the study

- **Demand-supply imbalance**
Regional demand-supply imbalances are the primary drivers of long-distance petroleum product movement.
- **Costly road dependence**
Road transport accounts for approximately a fifth of petroleum product movement despite being the most expensive transportation mode.
- **Lower-cost alternatives**
Railways and pipelines offer significantly lower transportation costs compared with road transport.
- **Spare capacity exists**
Existing pipeline infrastructure offers opportunities for improved utilization and transportation efficiency.
- **Sector-wide savings**
Transportation optimization has the potential to generate substantial sector-wide logistics cost savings.
- **Emissions dividend**
Modal shifts from road to railways and pipelines can deliver measurable emissions reductions.

The study further assessed the macro-level implications of transportation optimization. Analysis indicated that transitioning existing road-based transportation volumes to railways could potentially generate **annual logistics cost savings exceeding ₹5,000 crore**, while increased utilization of petroleum product pipelines could also deliver substantial economic benefits.

Beyond financial considerations, the assessment demonstrated that transport optimization can contribute significantly to emissions reduction. The comparison of transportation modes showed that pipelines and railways exhibit considerably lower greenhouse gas emission intensities than road transport, thereby creating a strong sustainability case for modal optimization wherever technically and commercially feasible.

Importantly, the study moved beyond a simple cost comparison and sought to establish an evidence base for understanding the broader drivers of petroleum product movement in India.



The findings emphasized that regional production-consumption imbalances, infrastructure availability, logistics planning and network utilization patterns are among the key determinants of transportation decisions.

By highlighting opportunities for improving infrastructure utilization and promoting efficient transport modes, the study provides valuable insights for industry stakeholders and policymakers seeking to enhance both economic efficiency and environmental performance across India's petroleum supply chain.

The rare alignment

Modal optimization belongs to a small class of interventions in which the cheapest option is also the cleanest. Where a pipeline or rake can replace a road movement on a given route, the operator saves cost, the network gains utilization, road congestion falls and emissions per tonne-kilometre drop. The constraint is rarely economic logic, it is infrastructure connectivity, contracting practice and planning horizon.

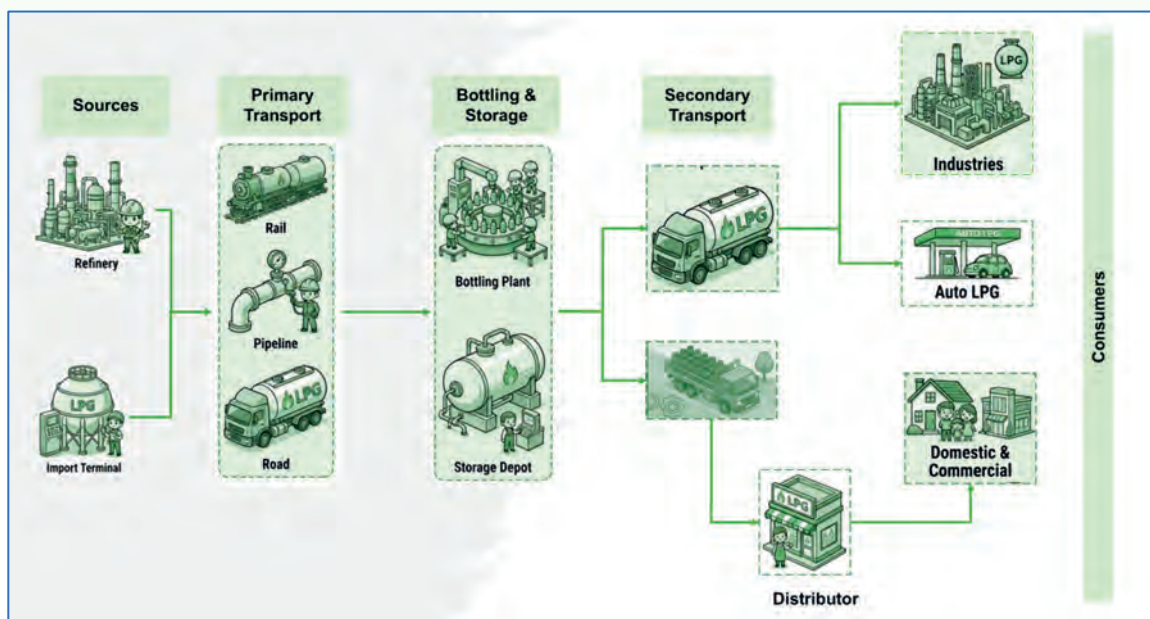


Figure 15: LPG Value Chain Map



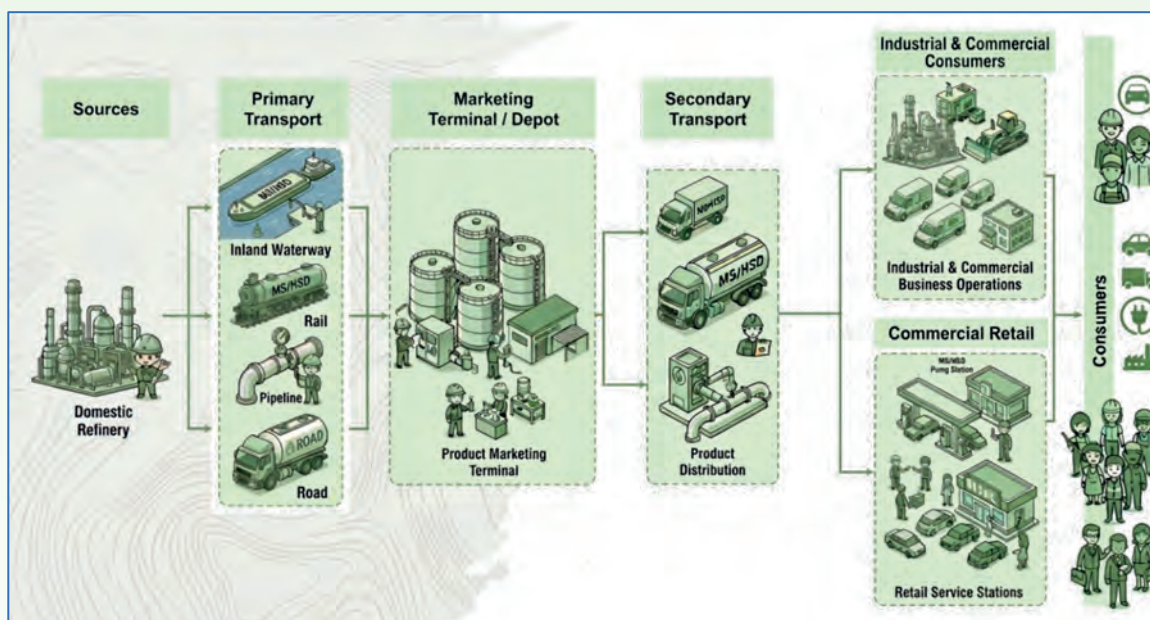


Figure 16: MS/HSD Value Chain Map

4.4 Comparative Assessment of Vehicular Fuels

Enabling a technology-neutral and evidence-based pathway for sustainable mobility.

India's transport sector is integral to economic growth and mobility, while also accounting for a significant share of energy consumption, greenhouse gas emissions, urban air pollution and crude oil imports. Transitioning towards cleaner mobility is therefore important for advancing India's climate commitments, improving air quality and strengthening energy security. However, the diversity of vehicle segments, operating patterns, infrastructure availability and regional characteristics means that **no single fuel or technology can provide an optimal solution across every application.**

Recognizing the need for a balanced assessment, The Energy and Resources Institute (TERI), with support from the Petroleum and Natural Gas Regulatory Board and leading City Gas Distribution entities, undertook the study titled **"Comparative Assessment of Vehicular Fuels in India's Energy Transition."** The study started in December 2025, comparing petrol, diesel, CNG, LNG and battery-electric vehicles across two-wheelers, three-wheelers, passenger cars, light commercial vehicles, buses and heavy-duty trucks.

The assessment combines primary and secondary research and evaluates the complete life cycle of different pathways, including raw-material extraction, vehicle manufacturing, fuel production, operation, maintenance and end-of-life management. This approach provides a more balanced representation of the economic, environmental and operational trade-offs associated with each fuel under Indian conditions.



A multi-dimensional assessment

Unlike conventional comparisons based primarily on tailpipe emissions or fuel costs, the study applies a comprehensive framework covering:

- Technical and operational performance
- Life-cycle environmental impacts
- Total cost of ownership
- Infrastructure readiness
- Consumer preferences
- Policy and fiscal support
- End-of-life management
- Energy and resource security
- Geopolitical and supply-chain considerations

A portfolio approach to sustainable mobility

The study finds that India's mobility transition should be **segmented rather than uniform**, with multiple fuel and vehicle technologies coexisting and serving the applications for which they are most suitable. Electric mobility demonstrates strong potential in two-wheelers, three-wheelers and selected urban applications characterized by shorter daily travel.

CNG presently offers a favourable combination of economics, environmental performance and operational practicality for passenger cars, taxis, buses and light commercial vehicles. LNG provides a practical lower-emission pathway for long-haul freight where battery-electric trucks face constraints relating to range, charging infrastructure and payload.

Segment-wise Transition Pathways

Table 4: Recommended transition pathway for various vehicle segments

Vehicle segment	Indicated pathway	Rationale	Key constraint or condition
Two-wheelers	Electric	Electric vehicles offer strong adoption potential for short-distance and urban mobility; total cost of ownership favours electric technology in scooters and commercial two-wheelers.	Petrol remains relevant where charging access is limited.
Three-wheelers	Electric and CNG, complementary	Both pathways are competitive; total cost of ownership favours electric in commercial three-wheelers under the study conditions.	Choice depends on utilisation pattern and local refuelling or charging infrastructure.
Passenger cars & taxis	CNG, with electric for defined urban use	CNG remains economical for high-mileage use and demonstrates competitive life-cycle costs; electric offers advantages for urban users with dependable charging access.	Charging dependability and daily running distance are the deciding variables.



Vehicle segment	Indicated pathway	Rationale	Key constraint or condition
Light commercial vehicles	CNG and electric	Both technologies are competitive, subject to route, utilisation and infrastructure availability.	Route predictability and depot charging feasibility.
Buses	CNG now; electric strengthening	CNG provides an immediately deployable solution using existing infrastructure; electric buses gain environmental advantage as the grid becomes cleaner.	Depot infrastructure, capital cost and grid emission intensity.
Heavy-duty trucks	LNG	LNG offers a practical lower-emission alternative for long-haul operations.	Electric trucks presently face payload, infrastructure and charging-time constraints.

Source: "Comparative Assessment of Vehicular Fuels in India's Energy Transition" - TERI, with support from PNGRB and leading CGD entities.

What Determines Adoption, and Why It Matters for Policy

Looking beyond the tailpipe

The life-cycle assessment reinforces the importance of looking beyond tailpipe emissions. Electric vehicles eliminate tailpipe emissions, but their overall environmental performance remains influenced by the electricity-generation mix, battery production and resource extraction. Under the conditions assessed, gaseous fuels generally demonstrate a lower overall environmental burden across several vehicle categories, while the environmental competitiveness of electric vehicles is expected to improve as India's electricity grid becomes cleaner.

What determines adoption

Infrastructure availability emerged as a major determinant of technology adoption. Access to charging stations, CNG dispensing facilities, LNG refuelling infrastructure and supporting service ecosystems materially influences consumer and fleet-operator choices. The study also found that real-world conditions, traffic congestion, road quality, climate, driving behaviour, payload and route characteristics, can result in performance outcomes that differ from laboratory-certified values.

Economic competitiveness similarly varies by vehicle segment and utilization profile. Primary surveys across **ten Indian cities** and use cases identified **lower operating cost** as the strongest adoption driver, followed by environmental awareness and regulatory requirements.



Policy significance

The study provides an evidence base for a diversified mobility strategy that:

- Recognizes the coexistence of multiple fuels and technologies
- Aligns fuel pathways with vehicle segments and regional conditions
- Supports parallel expansion of charging, CNG and LNG infrastructure
- Evaluates environmental performance across the complete life cycle
- Strengthens domestic alternative-fuel production, battery recycling and critical-mineral recovery
- Maintains technology neutrality while enabling innovation and consumer choice

Collaborative Knowledge-Building Initiative

A distinctive feature of this study was the collaborative ecosystem that underpinned its development. **TERI** brought multidisciplinary research expertise and methodological rigour to the assessment, enabling a comprehensive evaluation of transport fuels across technical, environmental, economic, social, policy and geopolitical dimensions.

PNGRB played the role of facilitator and knowledge partner by conceptualizing the study, defining its broad objectives, facilitating stakeholder engagement, and ensuring that the assessment remained aligned with national priorities relating to sustainable mobility, energy security and infrastructure development.

The participating **City Gas Distribution entities** contributed sectoral insights, operational perspectives and practical understanding of fuel infrastructure deployment, thereby enriching the study with real-world considerations. Collectively, this partnership enabled the development of a balanced and evidence-based assessment that extended beyond conventional fuel comparisons and addressed the broader challenges associated with India's mobility transition.

India's sustainable mobility pathway is best defined by coexistence rather than substitution: a diversified, technology-neutral and evidence-based portfolio in which each fuel serves the vehicle segments, operating conditions and regions where it delivers the greatest overall value.

Stakeholder engagement: bridging research and ground reality

Recognizing that a successful mobility transition must be informed by both analytical evidence and practical experience, the study incorporated a structured stakeholder engagement programme comprising thematic consultations with industry leaders, fleet operators, vehicle manufacturers, infrastructure providers, policymakers and technology experts. These interactions were designed to validate study findings, capture operational realities, evaluate infrastructure readiness, and understand consumer and industry perspectives that may not be evident from quantitative analysis alone.



The stakeholder interaction conducted in **Mumbai on 3rd of August 2026** brought together representatives from regulatory institutions, CGD entities, vehicle OEMs, public transport operators, logistics companies and energy infrastructure providers, generating valuable insights on fuel economics, technology adoption, infrastructure constraints, fleet operations and future transition pathways.

Discussions consistently reinforced the importance of a technology-neutral, segment-specific approach and highlighted that infrastructure availability, total cost of ownership, policy certainty and consumer behaviour will play a decisive role in shaping India's mobility future. As part of the broader study scope, additional stakeholder consultations are planned to further refine the findings and strengthen the relevance of recommendations through wider industry participation and consensus building.



Figure 17: stakeholder consultation, "Pathway for Sustainable Energy Adoption in the Mobility Sector" - PNGB, TERI and Mahanagar Gas, Mumbai

4.5 Emerging Knowledge Frontiers

The studies described in this chapter answered questions the sector was already asking. The next set of questions is arriving faster. The Cell's forward research agenda is organised around five frontiers where regulatory clarity will be needed before, not after, investment decisions are taken.

1 • Hydrogen blending readiness

Blending hydrogen into existing natural gas networks raises questions of material compatibility, metering and billing on an energy basis, end-use appliance tolerance, safety standards and odorization. Infrastructure preparedness is a regulatory question long before it is a commercial one, specifications written today determine what tomorrow's network can carry.



2 • Compressed biogas integration

CBG injection into CGD networks is technically established; the open issues are quality specification, injection protocol, measurement, offtake certainty and commercial terms between producer and distributor. International practice shows blending mandates typically succeed only where linked to incentives, a finding directly applicable here.

3 • Methane MRV to global standards

Moving from reported LUAG towards measurement-based reporting consistent with OGMP 2.0-type frameworks, including reconciliation of bottom-up inventories with satellite and site-level measurement, is the natural next stage after the leaks and losses baseline established in section 3.1.

4 • Green gas obligations and market design

If low-carbon gases are to occupy a defined share of the network, the sector will need certification, tracking and accounting mechanisms that survive scrutiny, together with an assessment of consumer tariff impact and the interface with the Carbon Credit Trading Scheme.

5 • Disclosure convergence: BRSR Core, ISSB, CSRD and CBAM

Indian oil and gas entities increasingly report into multiple disclosure regimes with overlapping but non-identical requirements. A sector-specific view of how BRSR Core assurance, ISSB-aligned climate disclosure, the EU's CSRD and the Carbon Border Adjustment Mechanism interact with PNGRB's own data requirements would reduce duplication for entities and improve the comparability of what the sector reports. The principle established elsewhere in this booklet applies with equal force here: **report once, use many times.**

Selection test for the next study

Decision-relevant	Measurable	Sector-wide	Institutionalisable
Will the finding change a regulatory, investment or operational decision?	Can the core parameter be quantified on a basis entities can replicate?	Does the answer serve the whole sector rather than a single asset owner?	Can the finding be carried into a format, indicator or provision that persists?



CHAPTER FIVE

Creating a Sustainability Ecosystem

"Sustainable development is a collective endeavour requiring partnerships among governments, businesses and communities."

— Ban Ki-moon, Former Secretary-General, United Nations

Frameworks and datasets do not change behaviour on their own. This chapter records the convening work, a national conference session that put sustainability at the centre of the energy security debate, international collaboration on methane, institutional partnerships, an organisation-wide awareness campaign, and the integration of sustainability into how excellence in the sector is recognised.

5.1 Sustainability at the Forefront

Bringing sustainability to the centre of the energy security discourse.

As sustainability increasingly becomes a strategic business and policy priority, there is a growing need to move discussions beyond environmental compliance and position sustainability as an enabler of energy security, operational efficiency, competitiveness and long-term sectoral resilience.

Recognizing this, the Sustainability Cell conceptualized and curated a dedicated sustainability session during PNGRB's national conference on **"Energy Security Through Gas"**- providing a platform for industry leaders, policymakers, and experts to deliberate on the role of sustainability in shaping the future of India's oil and gas sector held on 10th April 2026.

The session, titled **"Decoding the Sustainability Imperative in Oil & Gas - From Global Mandates to Indian Boardroom Action"**, represented one of the first sector-level dialogues that sought to bridge global sustainability trends with practical pathways relevant to the Indian petroleum and natural gas sector. Designed as a multi-stakeholder interaction, the session brought together leaders from industry, academia, consulting and regulation to discuss how sustainability can be translated from aspiration into measurable business and operational outcomes.



Figure 18: Dedicated sustainability session during PNGRB's national conference on "Energy Security Through Gas".



A key highlight was the special address delivered by **Dr. Ajay Mathur**, Professor at the School of Public Policy, IIT Delhi and former Director General of the International Solar Alliance. His address emphasized the evolving role of regulation in accelerating the energy transition and highlighted the importance of moving from traditional compliance-led frameworks towards enabling and adaptive regulatory approaches. The interaction underscored how proactive regulation can facilitate investment, encourage innovation and create market conditions that accelerate deployment of cleaner technologies and sustainable infrastructure.

The discussions highlighted several near-term opportunities capable of simultaneously enhancing economic performance and reducing emissions. These included compressed biogas injection into existing gas infrastructure, leak detection and repair programmes, electrification of gas compressors, and institutionalisation of sustainability-related performance measures.

Importantly, these interventions demonstrated that **sustainability and profitability need not be competing objectives**; rather, many sustainability measures unlock operational efficiencies, reduce costs, improve asset utilization and enhance long-term competitiveness.

"The session demonstrated that sustainability is no longer a peripheral consideration for the oil and gas sector; it is increasingly becoming a strategic imperative influencing investment, operations, regulation and long-term competitiveness."

The industry panel discussions further revealed broad stakeholder alignment on the importance of sustainability integration and the need for clear regulatory direction to support long-term investments. Industry leaders highlighted increasing investments in low-carbon fuels, renewable energy, LNG infrastructure, hydrogen-ready systems and other clean-energy solutions. Participants also emphasized the importance of regulatory certainty, sustainability benchmarks, incentive mechanisms and structured frameworks that provide adequate visibility to support investment decisions over extended planning horizons.

Beyond the immediate deliberations, the significance of the session lay in its ability to elevate sustainability from a specialist topic to a mainstream industry discussion. By bringing together diverse perspectives and highlighting practical pathways for implementation, the session helped create a shared understanding of how sustainability can support energy security, economic growth and long-term sectoral resilience.

5.2 Strengthening Methane Management Through Global Collaboration

Building capacity for methane measurement, reporting and mitigation.

Methane emissions have emerged as one of the most important sustainability challenges facing the global oil and gas sector. Although methane remains in the atmosphere for a shorter duration than carbon dioxide, its warming impact over a 20-year period is significantly higher - making methane mitigation one of the fastest and most cost-effective pathways for reducing near-term climate impacts.

As natural gas assumes a larger role in India's energy transition, strengthening the sector's ability to measure, monitor, report and mitigate methane emissions becomes increasingly



important for preserving the environmental benefits associated with natural gas while supporting national climate goals.

Recognizing this need, PNGRB collaborated with the **Environmental Defense Fund (EDF)**, the **Oil and Gas Decarbonization Charter (OGDC)**, the **International Methane Emissions Observatory (IMEO-UNEP)** and **Carbon Limits** in organizing a two-day capacity-building workshop titled "**Strengthening India's Energy Security: Capacity Building Workshop on Oil & Gas Methane Abatement**", held on **10–11 June 2026 in New Delhi**.

Designed specifically for policymakers, regulators and oil & gas companies, the programme sought to equip participants with practical knowledge and international perspectives on methane emissions management and mitigation.

Workshop themes

- › Global methane challenge and climate implications
- › Methane detection, measurement and quantification
- › Satellite monitoring and Methane Alert and Response System (MARS)
- › OGMP 2.0 reporting framework and target setting
- › Methane mitigation technologies and LDAR programmes
- › Regulatory approaches to methane management
- › Financing mechanisms for methane mitigation

The workshop brought together global experts, regulators, policymakers and industry representatives to deliberate on the full spectrum of methane management. The programme covered methane emission sources across the oil and gas value chain, modern technologies for methane detection and quantification, satellite-based monitoring systems, OGMP 2.0 reporting frameworks, mitigation technologies, financing mechanisms and international regulatory approaches.

Particular emphasis was placed on practical implementation, monitoring and verification systems, leak detection and repair programmes, and translating global best practices into actionable pathways for India.





Figure 19: "Strengthening India's Energy Security: Capacity Building Workshop on Oil & Gas Methane Abatement", New Delhi, 10 June 2026

Methane Management: Outcomes and Next Steps

A unique feature of the training programme was its emphasis on **building institutional capacity rather than simply raising awareness**. The workshop exposed participants to globally accepted methane management frameworks, including measurement, reporting and verification (MRV) approaches, near-zero methane target setting, regulatory interventions, and advanced technologies such as satellite-based methane monitoring systems. By facilitating interaction between international experts and Indian stakeholders, the programme enabled valuable exchange of experiences, challenges and practical mitigation strategies relevant to Indian operating conditions.

One of the most important outcomes was the recognition that methane mitigation within the downstream natural gas sector requires **targeted attention and dedicated capacity building**. Building upon the learnings from the workshop and subsequent stakeholder interactions, discussions were initiated for organizing a dedicated methane mitigation workshop focused specifically on the **City Gas Distribution sector**, with emphasis on leak detection and repair programmes, measurement methodologies, operational best practices and methane management strategies tailored to distribution networks.

Given the rapid expansion of CGD infrastructure across the country, such a forum could play an important role in strengthening sectoral awareness and enhancing practical capabilities for methane management. This represents a significant step towards translating global methane management principles into sector-specific action for India's rapidly expanding gas distribution infrastructure.

The collaboration also opened avenues for deeper institutional engagement between PNGRB and EDF in areas related to methane measurement, mitigation and capacity building. Discussions have been initiated on establishing a formal framework for collaboration through a **Memorandum of Understanding**, which could facilitate knowledge exchange, technical training, joint awareness programmes and access to global best practices in methane management. Such a partnership would provide an opportunity to strengthen institutional



capabilities and support the development of future initiatives aimed at improving methane emissions management across India's petroleum and natural gas sector.

Beyond the immediate benefits of the workshop, the engagement highlighted the value of international cooperation in addressing emerging sustainability challenges. As methane management gains increasing prominence globally, continued collaboration with knowledge institutions, industry bodies, multilateral organizations and technical experts can help strengthen India's preparedness and accelerate the adoption of effective and practical mitigation approaches across the energy value chain.

"Methane mitigation represents one of the most immediate and cost-effective opportunities for improving the sustainability performance of the oil and gas sector. Building institutional capacity is therefore a critical first step towards meaningful and measurable action."



How the methane agenda connects across this booklet

Measure	Verify	Mitigate	Institutionalise
Sector-wide LUAG framework establishes the national baseline (§3.1)	Satellite monitoring and MARS alerts require a spatial asset record (§3.16)	LDAR, venting control and station upgrades identified in entity action plans (§3.1)	Reporting provisions embedded in the proposed DMIS Regulations (§3.9)

5.3 International Engagement and Institutional Partnerships

Sustainability challenges in the downstream energy sector are not unique to India, and neither are the solutions. The Cell's international engagement has been directed at a single practical purpose: reducing the time it takes for a proven international method to become usable in Indian regulatory practice.



International Energy Agency

A Memorandum of Understanding between the IEA and PUNJABI has been finalised, with Board approval documentation completed. The arrangement provides for access to IEA publications on a gratis basis and participation in IEA workshops without fee - giving the Board and, through it, the sector direct access to global energy data, methodologies and analytical frameworks.

Why it matters: methodological consistency. Benchmarks constructed on internationally recognised definitions withstand scrutiny in a way that domestically improvised ones do not.

Environmental Defense Fund and partners

Collaboration with EDF, OGDC, IMEO-UNEP and Carbon Limits delivered the June 2026 methane abatement capacity building workshop. Discussions have been initiated on a formal MoU covering knowledge exchange, technical training, joint awareness programmes and access to global best practice in methane management.

Why it matters: methane MRV is a specialised technical discipline. Building it domestically from first principles would take years the climate arithmetic does not allow.

CERAWeek 2026, Houston

Participation in one of the principal global energy gatherings provided direct exposure to the trajectory of international energy markets, technology and policy thinking. Learnings were documented in a formal visit report and disseminated internally, ensuring that the value of attendance accrued to the institution rather than the individual - a small discipline that determines whether international travel produces institutional knowledge.

TERI and the domestic research community

The comparative assessment of vehicular fuels (\$4.4) demonstrated a workable model: an independent research institution supplies methodological rigour, the regulator supplies framing and convening power, and industry supplies operational reality. The output carries credibility that none of the three could achieve alone.

The Cell's approach to international practice

Adopt definitions, not prescriptions

Common definitions make Indian data internationally comparable. Targets and pathways must remain domestically determined.

Test for domestic adaptability

Every international practice examined is filtered through Indian operating conditions, network characteristics and affordability constraints before adoption.

Convert exposure into capability

Workshops and visits are followed by documentation, internal dissemination and where the learning is durable, a framework or format that outlives the event.

An open invitation

Entities in the sector engage internationally on their own account, through parent companies, technology partners, industry associations and global disclosure frameworks. The Sustainability Cell welcomes proposals for joint capacity building, pilot demonstrations and knowledge exchange where the learning can be made available to the sector as a whole rather than to a single participant.

5.4 World Environment Day 2026

"Sustainability becomes truly meaningful when it moves beyond policy and practice to become part of everyday behaviour, collective responsibility, and organizational culture."

World Environment Day 2026 served as an important platform for promoting environmental awareness, encouraging sustainable behaviours and strengthening engagement across the organization. Organized under the theme **"Inspired by Nature. For Climate. For Our Future."**, the programme reflected the Sustainability Cell's commitment to embedding sustainability into organizational culture through participation, learning and collective action.

The initiative was designed not merely as a commemorative event, but as an opportunity to build awareness, encourage dialogue and inspire individual responsibility towards environmental stewardship.

A structured week-long programme of activities was organized leading up to World Environment Day, engaging employees and their families through a series of interactive events. These included bilingual essay competitions, slogan competitions, poster-making competitions, environmental awareness activities and a plantation drive. The design of the programme ensured participation across different age groups, backgrounds and functional divisions, allowing sustainability messages to be communicated through creativity, learning and engagement.

The celebrations culminated on **5 June 2026** with a plantation drive led by senior leadership of PNGRB and employees across divisions. The initiative was aligned with the nationwide campaign **"Ek Ped Maa Ke Naam"**, encouraging participants to plant trees in honour of their mothers while symbolically reinforcing the connection between environmental stewardship and collective responsibility towards nature.

Programme highlights

- › Plantation drive aligned with "Ek Ped Maa Ke Naam"
- › Bilingual essay competition on sustainability and clean energy themes
- › English and Hindi slogan competition promoting environmental awareness
- › Poster competition for employees and children
- › Recognition and awards for outstanding entries
- › Participation from employees across divisions and organizational levels
- › Organization-wide celebration of environmental stewardship

The plantation drive served as a visible and enduring reminder of the role that individual actions can play in supporting broader environmental objectives.

Environmental awareness competitions formed another important component of the programme. The essay competition encouraged participants to deliberate on themes such as carbon neutrality in the energy sector, climate action and the role of clean fuels in reducing pollution. The slogan competition promoted concise and impactful environmental messaging across both English and Hindi, while the poster competition encouraged children and employees to creatively express their perspectives on environmental conservation and sustainability.



Figure 20: Plantation drive led by senior leadership; employee and family participation in World Environment Day 2026 activities at PNGRB





5.5 Recognizing Sustainability Excellence

"What gets recognized gets replicated. By celebrating sustainability excellence, the sector creates new benchmarks for performance, innovation, and responsible growth."

Recognition plays an important role in accelerating the adoption of sustainable practices. While regulations establish minimum standards and studies generate knowledge, recognition programmes create positive incentives that encourage organizations to strive for higher levels of performance and innovation.

With this philosophy, the Sustainability Cell initiated the integration of sustainability-related parameters into the framework of the **PNGRB Excellence Awards 2025**, creating a platform to acknowledge and celebrate sustainability leadership within the downstream petroleum and natural gas sector.

The initiative was conceived with the objective of institutionalizing sustainability as a **measurable performance dimension** alongside traditional operational and business metrics. By incorporating sustainability criteria into the award framework, the Sustainability Cell sought to encourage entities to systematically improve environmental performance, enhance operational efficiency, reduce emissions, strengthen resource management practices, and adopt innovative approaches that support long-term sectoral resilience.

A distinctive feature of the initiative was the development of **separate sustainability assessment frameworks for the City Gas Distribution and Natural Gas Pipeline segments**, recognizing the unique operational characteristics and sustainability challenges associated with each infrastructure category.

The framework was further designed to evaluate performance at both the **entity level and the Geographical Area level**, enabling recognition of excellence not only among organizations but also among individual operating regions. This dual-level approach encourages localized action while simultaneously fostering organization-wide commitment to sustainability improvement.

The proposed sustainability indicators were developed by drawing upon international best practices, emerging sectoral priorities, and insights generated through Sustainability Cell initiatives such as leaks and losses monitoring, sustainability benchmarking, infrastructure efficiency assessments, emissions management and sustainability data architecture development. The framework aims to progressively evolve into a comprehensive mechanism for recognizing sustainable operations, innovation, transparency and continuous improvement across the sector.

Why dual-level assessment matters

A large multi-GA entity can carry a strong national average while a specific network underperforms and conversely, a single excellent GA can be invisible inside a large organisation. Assessing at both levels ensures that neither outcome escapes notice, and gives local operating teams a recognition pathway of their own.



Figure 21: PNGRB Excellence Award 2025, "Leader in Sustainability and Green Initiatives in CGD", presented at the 19th Foundation Day

Recognition as a Regulatory Instrument

The introduction of sustainability categories under the PNGRB Excellence Awards received encouraging feedback from entities across the petroleum and natural gas sector, many of whom viewed the initiative as an important step towards recognizing and rewarding responsible growth alongside operational excellence.

Stakeholders appreciated the shift from traditional compliance-oriented assessments towards a framework that acknowledges innovation, environmental stewardship, efficiency improvements and long-term sustainability outcomes. More importantly, the initiative demonstrated how **regulators and regulated entities can collaborate towards a common objective** of sectoral growth and sustainability enhancement.

By creating a platform that recognizes positive performance rather than solely focusing on compliance, the awards framework has the potential to strengthen trust, encourage voluntary adoption of best practices, and promote a culture of continuous improvement across the sector.

Following the awards, the Sustainability Cell also initiated efforts to disseminate information regarding the award framework, sustainability criteria and winning practices across the industry. Such post-award engagement is important for ensuring that recognition translates into wider sectoral learning and replication.

By showcasing successful initiatives, communicating evaluation criteria and highlighting measurable outcomes, the awards can serve as a source of motivation for entities aspiring to improve their sustainability performance. Over time, the Sustainability Awards are envisaged to become an integral and enduring component of the annual PNGRB Excellence Awards programme, creating a recurring platform for celebrating sustainability leadership and encouraging broader participation in the sector's sustainability journey.



The recognition–measurement loop

- › Standardised data makes performance **comparable**.
- › Comparable performance makes recognition **credible**.
- › Credible recognition makes good practice **aspirational**.
- › Aspiration generates the next round of **submissions and data**.

What entities should note

Sustainability criteria in the awards are drawn from the same indicator set being developed through the leaks and losses framework, efficiency assessments and data architecture. An entity that reports well under the standard formats is, by that fact, already assembling the evidence base required for recognition. Good measurement and good performance are being deliberately placed on the same track.

Penalties correct the laggards. Recognition moves the median. A regulator building a sustainability culture needs both instruments, and they are most effective when they draw on the same data.

CHAPTER SIX

From Foundations to Future: Impact Achieved and the Road Ahead

"The transition to sustainability is one of the greatest opportunities of our time."

— Christiana Figueres, Former Executive Secretary, UNFCCC

What has been built so far is infrastructure of a particular kind: definitions, datasets, formats, benchmarks and relationships. None of it reduces an emission by itself. All of it determines whether the reductions that follow can be measured, compared and sustained.

6.1 Impact at a Glance

The initiatives undertaken by the Sustainability Cell over the past two years reflect a conscious effort to position sustainability as an integral component of sectoral growth, operational excellence and long-term resilience. While the journey is still at an early stage, meaningful progress has been achieved in establishing the institutional, knowledge, data and stakeholder engagement foundations necessary to support sustainability integration within India's petroleum and natural gas sector.

The Cell's approach has intentionally focused on **creating enabling mechanisms rather than stand-alone interventions**. These efforts have ranged from developing sustainability roadmaps and data architectures, benchmarking global regulatory practices and establishing monitoring frameworks, to facilitating thought leadership, industry engagement, capacity building and collaborative research.

Collectively, these initiatives have helped create greater awareness, encourage evidence-based decision-making, and promote a shared understanding of sustainability across diverse stakeholder groups.

Perhaps the most significant achievement has been the gradual transition of sustainability **from a niche environmental subject to a mainstream topic of discussion within the industry**. Increasingly, sustainability is being viewed not only through the lens of emissions reduction, but also as a driver of efficiency, innovation, competitiveness, infrastructure optimization and long-term value creation.

Institutional foundations

- Sustainability Roadmap for the oil & gas sector, four interconnected pillars
- Sustainability Data Architecture framework
- Standardised sustainability reporting formats and information systems
- Global regulatory benchmarking framework
- Review of T4S, IMS and ERDMP for embedded sustainability provisions



Knowledge creation

- Sustainability Best Practices Compendium, 39 curated case studies
- Studies on transport fuels, compressor electrification and logistics optimization
- White papers and analytical assessments for Board-level decision-making
- Dedicated sustainability knowledge portal on the PNGRB website
- PNG domestic stove efficiency pilot with six CGD entities

Sectoral monitoring

- LUAG benchmarking across the entire CGD sector - a national first
- Standardised sustainability metrics and key performance indicators
- Data collection frameworks covering all 307 Geographical Areas and 37 entities
- Foundation for benchmark-based performance evaluation and target setting
- Loss-reduction action plans sought from high-loss entities

Ecosystem development

- Multi-stakeholder conferences and dedicated sustainability sessions
- Industry consultations and capacity building programmes
- International collaboration on methane - EDF, OGDC, IMEO-UNEP, Carbon Limits
- Institutional partnership with the International Energy Agency
- World Environment Day awareness campaigns
- Sustainability integrated into the PNGRB Excellence Awards

6.2 The Road Ahead

"The journey of sustainability is not defined by a single milestone, study, or initiative. It is a process of continuous improvement, driven by knowledge, enabled by collaboration, and sustained through collective action."

Several first-of-their-kind initiatives have emerged from this journey. The development of a sector-wide leaks and losses monitoring framework has enabled unprecedented visibility into methane-related emissions within the CGD sector. The Sustainability Best Practices Compendium created a platform for sectoral learning and replication of proven solutions. Studies on compressor electrification, transport fuels, petroleum product logistics and global regulatory approaches have generated valuable insights into future pathways for sustainable infrastructure and operations.

Simultaneously, stakeholder consultations, conferences, awareness campaigns and collaborative engagements have contributed towards building a broader sustainability ecosystem around the sector.



While the foundations have been laid, the coming years present an opportunity to further institutionalize sustainability within the petroleum and natural gas ecosystem. Building upon the progress achieved thus far, the Sustainability Cell intends to focus on four broad areas.

1 • Strengthening data and transparency

The proposed Data Management and Information System framework provides an opportunity to institutionalize sustainability data collection, benchmarking and reporting across regulated entities. Strengthening data quality, digital platforms and performance analytics will be critical for enabling evidence-based decision-making.

2 • Deepening sectoral insights

Future studies on CGD operations, LPG value chains, low-carbon fuel integration pathways, methane mitigation and operational efficiency will continue to strengthen sectoral understanding and support informed policy and regulatory intervention.

3 • Expanding capacity building and collaboration

Collaborative engagements with industry associations, research institutions, academia, multilateral organizations and technical experts will remain important in building sector-wide capacity and facilitating knowledge transfer on emerging sustainability topics.

4 • Mainstreaming sustainability into sectoral decision-making

The long-term vision is to progressively integrate sustainability considerations into infrastructure planning, operational practices, performance benchmarking, capacity building and recognition mechanisms, such that sustainability becomes an inherent component of how the sector plans, operates and grows.

6.3 The Road Ahead: Indicative Forward Agenda

Workstreams, next steps and intended outcomes

Workstream	Next step	Intended outcome
Leaks and losses	Move from a single-year baseline to periodic reporting; refine segmentation and progress from a screening benchmark towards differentiated norms	Year-on-year measurable reduction in sectoral LUAG
Data architecture	Operationalise sustainability reporting provisions under the DMIS framework, with a digital submission and validation platform	Recurring, validated sectoral sustainability datasets and dashboards
Technical regulations	Develop sustainability annexures and performance indicators within existing T4S, IMS and ERDMP reporting	Sustainability metrics generated as a by-product of existing compliance



Workstream	Next step	Intended outcome
Methane management	Conduct a CGD-focused methane mitigation and LDAR workshop; formalise the collaboration framework with EDF	Practical mitigation capability in distribution networks
Knowledge products	Institutionalise the Compendium as an annual flagship publication; convene a dedicated Sustainability Conference	A recurring mechanism for replication of proven practice
Recognition	Embed sustainability categories as a standing component of the annual Excellence Awards, at entity and GA level	Sustained positive incentive for performance improvement
Emerging fuels	Advance work on hydrogen blending readiness, CBG integration and green gas market design	Regulatory clarity ahead of investment decisions

6.4 Collective Journey

*The transition towards a more sustainable petroleum and natural gas sector cannot be achieved by any single institution acting alone. It requires collaboration among regulators, industry participants, policymakers, academia, researchers, technology providers and consumers. The Sustainability Cell views its role as that of a **facilitator, knowledge partner and catalyst**, supporting stakeholders in navigating this transition while balancing sustainability, affordability, energy security and growth.*

As India advances towards its long-term developmental and sustainability aspirations, the petroleum and natural gas sector will continue to play a vital role in powering economic progress. Through continuous learning, innovation, collaboration and responsible stewardship, the sector has an opportunity to demonstrate that sustainable development and economic growth can advance together.

Everything documented in this booklet was produced through the participation of entities across the value chain, those that submitted data when the format was still unfamiliar, those that shared practices that had cost them effort to develop, those that sent officers to workshops and consultations, and those that engaged honestly with uncomfortable numbers about their own networks. That participation is what converted an institutional intention into a sectoral capability.



What we ask of entities in the year ahead

- › **Report accurately and on time.** The benchmark is only as good as the weakest submission inside it.
- › **Disaggregate your losses.** An aggregate number cannot be managed; a categorised one can.
- › **Submit your practices.** If an intervention worked in your network, it will probably work in several others.
- › **Act on your outliers.** Where a geographical area sits far above the sectoral reference, a time-bound plan with internal ownership is the appropriate response.
- › **Bring your questions.** The forward research agenda is shaped substantially by what entities say they cannot resolve on their own.

Contact

Sustainability Cell, Petroleum and Natural Gas Regulatory Board, New Delhi. Publications, studies and knowledge products referenced in this booklet are available in the Sustainability section of www.pngrb.gov.in.

Knowledge	Data	Collaboration	Transform
Studies, compendium and portal that make good practice visible	Definitions, formats and benchmarks that make performance comparable	Partnerships that bring global capability into domestic practice	Provisions and incentives that make improvement continuous

Sustainably speaking: the work is not finished, and it was never designed to be. It was designed to continue.



Annexure A • Register of Sustainability Initiatives

Sl No.	Initiative	Type	Scope and output	Status
1	Roadmap for Sustainability Integration	Framework	Four-pillar framework - Assessment, Norm Setting, Monitoring, Continuous Improvement	Adopted; guiding all workstreams
2	Leaks and losses (LUAG) benchmarking	Sectoral measurement	37 entities, 307 GAs; 0.84 MMSCMD estimated; 1.77% sectoral average; 2% screening benchmark; action plans sought	100% coverage achieved; moving to periodic reporting
3	Review of T4S, IMS and ERDMP	Regulatory analysis	Identification of sustainability provisions already embedded across regulated infrastructure categories	Completed; annexure design underway
4	Sustainability Data Architecture	Data systems	Reporting formats, submission portal, databases, dashboards and benchmarking; provisions incorporated in proposed DMIS Regulations	Provisions incorporated; operationalisation pending
5	Compendium of Sustainability Case Studies	Knowledge product	~120 submissions from 25 entities; 39 case studies curated; 10 converted into digital knowledge products in phase 1	Published; proposed as annual flagship
6	Digital knowledge dissemination	Outreach	Dedicated sustainability section on the PNGRB website; LinkedIn and Instagram outreach; engagement rate above 25%	Operational and continuing
7	PNG domestic stove efficiency pilot	Field pilot	Six CGD entities - AGCL, ATGL, BPCL, GAIL Gas, IGL, MGL; four-tier treatment framework for consumption anomalies	Pilot findings indicative; study continuing
8	NHIMS geospatial system	Digital infrastructure	National geospatial asset supporting dispute resolution, TPA monitoring, pipeline integrity and emergency response	Use cases conceptualised
9	Sustainability integration by global energy regulators	Study	UK, USA, Australia, Japan, Brazil benchmarked against India across seven sustainability tools	Completed and published
10	Electrification of gas compressors	Study	Techno-economic and emissions model across gas price and electricity sourcing scenarios; sector decision framework	Completed



Sl No.	Initiative	Type	Scope and output	Status
11	Optimizing petroleum product transportation	Study	MS, HSD and LPG modal analysis; pipelines 52%, rail 26%, road 21%, coastal 1.5%; potential savings above ₹5,000 crore annually	Completed
12	Comparative assessment of vehicular fuels	Collaborative study	TERI with PNGRB and CGD entities; life-cycle comparison across six vehicle segments; stakeholder consultation in Mumbai	Findings issued; consultations continuing
13	Sustainability session, "Energy Security Through Gas"	Convening	Multi-stakeholder session with special address by Dr. Ajay Mathur	Conducted
14	Methane abatement capacity building workshop	Capacity building	With EDF, OGDC, IMEO-UNEP and Carbon Limits; New Delhi, 10–11 June 2026	Conducted; CGD-focused edition proposed
15	IEA–PNGRB Memorandum of Understanding	Partnership	Access to publications and workshop participation	Finalised
16	World Environment Day 2026	Awareness	Week-long programme; plantation drive under "Ek Ped Maa Ke Naam"; essay, slogan and poster competitions	Conducted, 5 June 2026
17	Sustainability in PNGRB Excellence Awards 2025	Recognition	Separate CGD and NGPL assessment frameworks; entity-level and GA-level evaluation	Implemented; to be institutionalised annually

Acknowledgement

The Sustainability Cell records its appreciation of the City Gas Distribution entities, pipeline operators, oil marketing companies, LNG terminal and refinery operators who contributed data, case studies and operational insight; of TERI, the Environmental Defense Fund, the Oil and Gas Decarbonization Charter, IMEO-UNEP, Carbon Limits and the International Energy Agency for knowledge partnership; and of the divisions of PNGRB whose technical, legal, commercial, consumer affairs and statistical expertise underpins every initiative described in this publication.



Annexure B • Abbreviations

APM	Administered Price Mechanism
BOG	Boil-off Gas
BRSR	Business Responsibility and Sustainability Reporting
CBAM	Carbon Border Adjustment Mechanism
CBG	Compressed Biogas
CCTS	Carbon Credit Trading Scheme
CGD	City Gas Distribution
CNG	Compressed Natural Gas
CSRD	Corporate Sustainability Reporting Directive
DMIS	Data Management and Information System
EDF	Environmental Defense Fund
EIA / EIS	Environmental Impact Assessment / Statement
ERDMP	Emergency Response and Disaster Management Plan
GA	Geographical Area
GHG	Greenhouse Gas
HPHT	High Pressure High Temperature (gas)
HSD	High-Speed Diesel
IEA	International Energy Agency
IMEO	International Methane Emissions Observatory
IMS	Integrity Management System
IPPU	Industrial Processes and Product Use
ISSB	International Sustainability Standards Board
LDAR	Leak Detection and Repair
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LUAG	Lost and Unaccounted for Gas
LULUCF	Land Use, Land-Use Change and Forestry
MARS	Methane Alert and Response System



MIS	Management Information System
MMSCM / MMSCMD	Million Metric Standard Cubic Metres (per Day)
MoEFCC	Ministry of Environment, Forest and Climate Change
MoU	Memorandum of Understanding
MRV	Measurement, Reporting and Verification
MS	Motor Spirit
NDC	Nationally Determined Contribution
NGPL	Natural Gas Pipeline
NHIMS	National Hydrocarbon Infrastructure Management System
OGDC	Oil and Gas Decarbonization Charter
OGMP	Oil and Gas Methane Partnership
OMC	Oil Marketing Company
PNG-D / C / I	Piped Natural Gas - Domestic / Commercial / Industrial
PPPL	Petroleum Product Pipeline
RLNG	Regasified Liquefied Natural Gas
SDG	Sustainable Development Goal
SUG	System Use Gas
T4S	Technical Standards and Specifications including Safety Standards
TERI	The Energy and Resources Institute
TPA	Third Party Access
VOC	Volatile Organic Compound



Building Today, Sustaining Tomorrow



Together for a Resilient and Sustainable Future



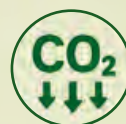
KNOWLEDGE



COLLABORATION



INNOVATION



RESPONSIBILITY



DRIVING
SUSTAINABILITY

Review of Initiatives : 2025-2026

Sustainability Cell

Petroleum and Natural Gas Regulatory Board

