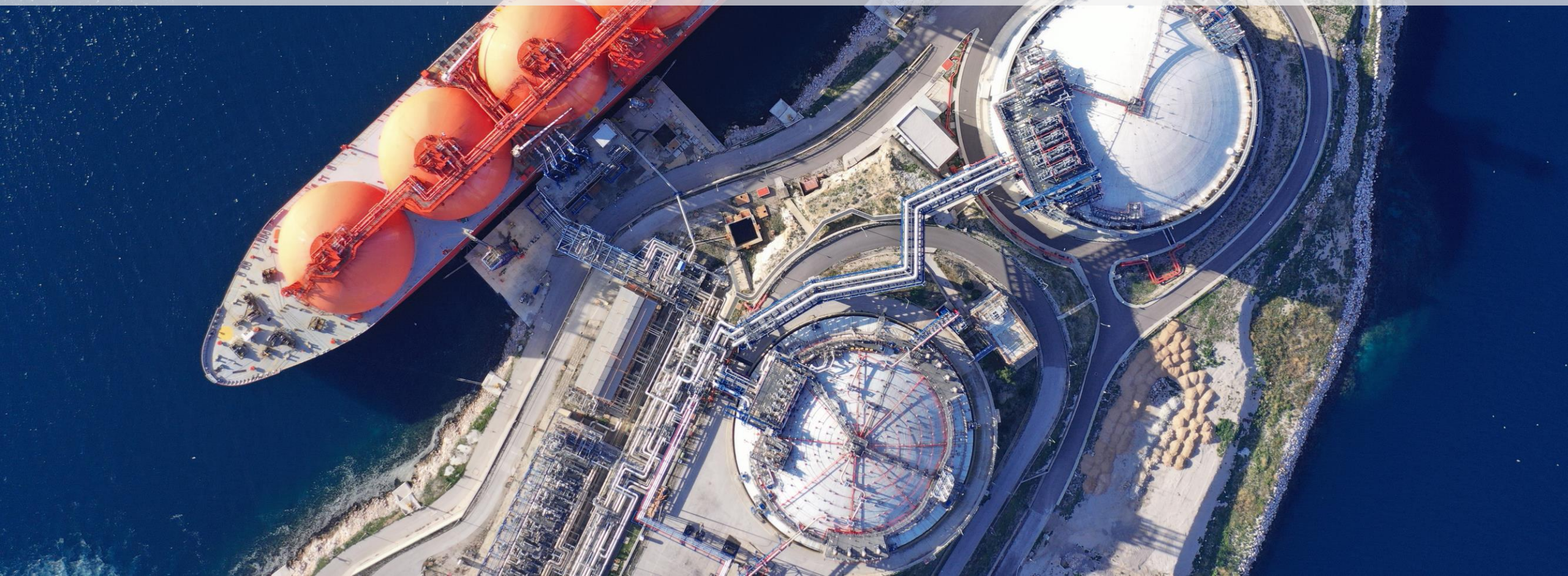
Assessment of Potential Interventions for Enhancing Gas Infrastructure and Distribution

PREPARED FOR PETROLEUM AND NATURAL GAS REGULATORY BOARD (PNGRB)
BY DELOITTE TOUCHE TOHMATSU INDIA LLP (DTTILLP)



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Foreword

"The only source of knowledge is experience." - Albert Einstein

Gajendra Singh

Member, PNGRB

I am delighted to present this comprehensive report, a compilation of five insightful studies conducted by Deloitte Touche Tohmatsu India LLP, which delve into critical aspects of the energy sector. The Petroleum and Natural Gas Regulatory Board (PNGRB), I am proud to endorse these studies, which are poised to contribute significantly to our understanding and strategic planning in the natural gas and petroleum sectors.

1. Zonal Study of LPG Pipelines: This study provides an analysis of the LPG pipeline infrastructure, highlighting regional disparities and suggesting improvements to enhance distribution efficiency and reliability.
2. Rapid assessment of "Pathways to Increase Share of Natural Gas from 6% to 15%": This report explores the potential for increasing the share of natural gas in India's energy mix. It outlines the benefits, challenges, and policy interventions required to achieve this ambitious target.
3. Global case studies of Transmission System Operator (TSO) : The study on global TSO models explores need of TSO establishment in the respective countries followed by the framework and best practices to oversee gas transmission networks, ensuring equitable access and optimizing operational efficiency
4. Report on Maturity or Development of natural gas market in India: This report assesses the maturity or development of the gas market in India, identifying key indicators and circumstances at the time of market liberalization in countries across the globe
5. Report on Market and Regulatory Framework for Gas Distribution Sector Across the Globe: This report provides a comparative analysis of global gas distribution exclusivity frameworks.

These studies are a testament to our commitment to fostering a sustainable, efficient and competitive energy sector in India. They offer valuable insights that will guide regulators, industry stakeholders, and researchers in navigating the complexities of the energy landscape. I extend my gratitude to Team Deloitte for their meticulous research and analysis, and to all the contributors who have made this report possible. I am confident that these studies will serve as a valuable resource in our collective efforts to build a resilient and forward-looking energy sector.

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Report
on
Zonal study on LPG pipeline: Potential new LPG pipelines to be Bid Out

Prepared For Petroleum And Natural Gas Regulatory Board (PNGRB)
By Deloitte Touche Tohmatsu India LLP (DTTILLP)

July 2024

Context of the Study

PNGRB is assessing potential LPG pipelines options that will improve connectivity, supply security and reduce the cost of transportation to LPG bottling plants

CONTEXT

PNGRB is evaluating the need for additional LPG pipelines to connect the remaining LPG bottling plants in India.

The objective of enhancing the LPG transmission network is to decrease the overall cost of transportation of LPG and improve LPG supply chain reliability and safety.

With this objective, the study evaluates the potential LPG demand and the potential routes for LPG pipelines that will connect the remaining LPG bottling plants and LPG sources

Scope of Work for each of the Modules

1 Module 1 – Overview of LPG Market

- LPG market overview in India
- Driver and inhibitors of LPG demand and projection of LPG demand with and without impact of alternate fuels
- Status of LPG Infrastructure
- Regulatory overview

2 Module 2 – LPG Pipeline Requirement Analysis

- Benefits of Pipelines
- Approach and Methodology for Determining Requirement of LPG Pipelines
- Current status of bottling plant connectivity and existing status of LPG pipelines
- Proposed routes for LPG pipelines
- Details and benefits of proposed LPG pipelines

3 Module 3 – Next Steps

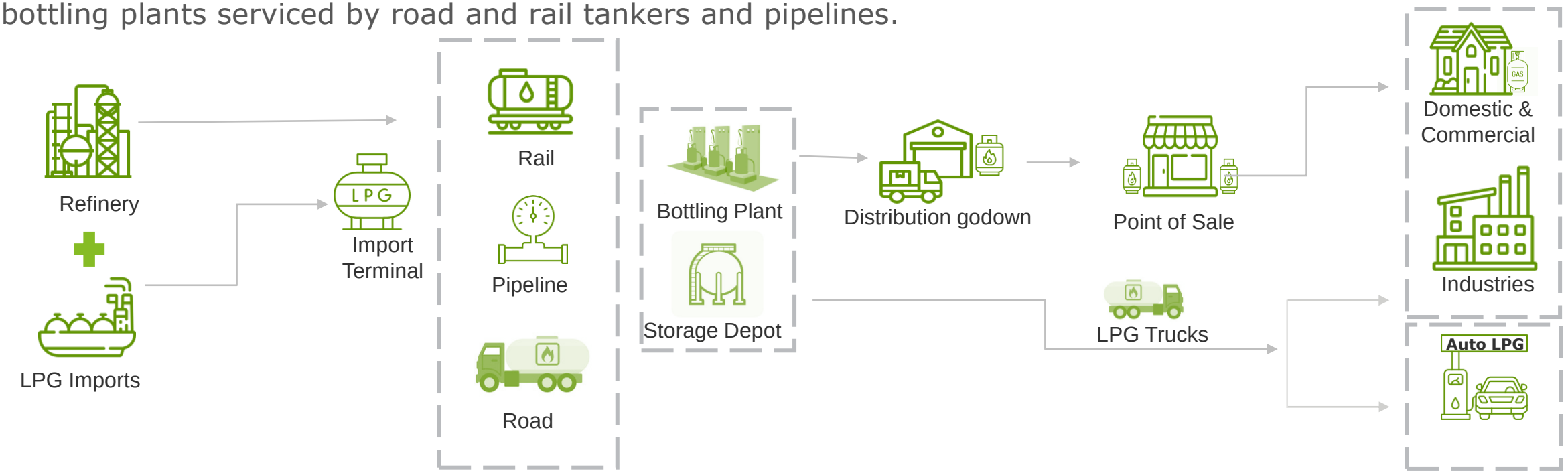
- Next steps on proposed LPG pipeline routes

Overview of LPG Market

1

LPG Value Chain

The LPG value chain for this analysis starts with supply from refinery and import terminals and ends with bottling plants serviced by road and rail tankers and pipelines.

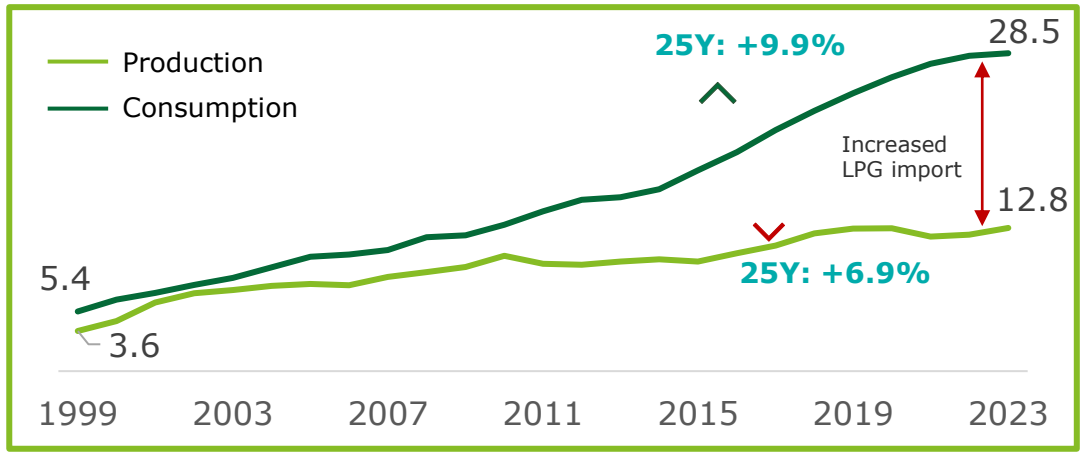


Import Terminal & Refinery	Midstream (Transportation & Storage)	Downstream (Bottling Plant)
Public: IndianOil, Bharat Petroleum, HP, ONGC, HMEL, NAYARA ENERGY	GAIL, Bharat Petroleum, HP, IndianOil	IndianOil, Bharat Petroleum, HP
Private: SUPERGAS, AEGIS, Reliance	BW LPG, Reliance, Confidence Group	SUPERGAS, Reliance, Indian Oil Petronas

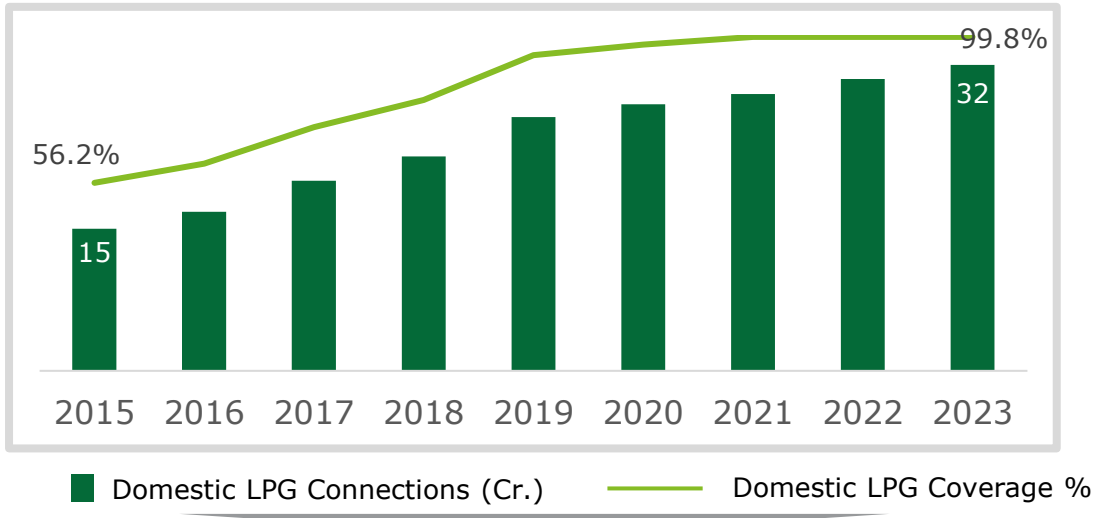
LPG | Indian Market Overview

The domestic production of LPG from refineries and fractionators has increased at a slower rate by 1.3x, requiring a massive increase in imports of 2.9x jumping from 6.1 MMT to 17.8 MMT. Indian refineries was producing only 4.8 percent of total crude processing capacity in 2022-23[2]

LPG Production and Consumption (MMT)



LPG Domestic Active Connections (Cr.)



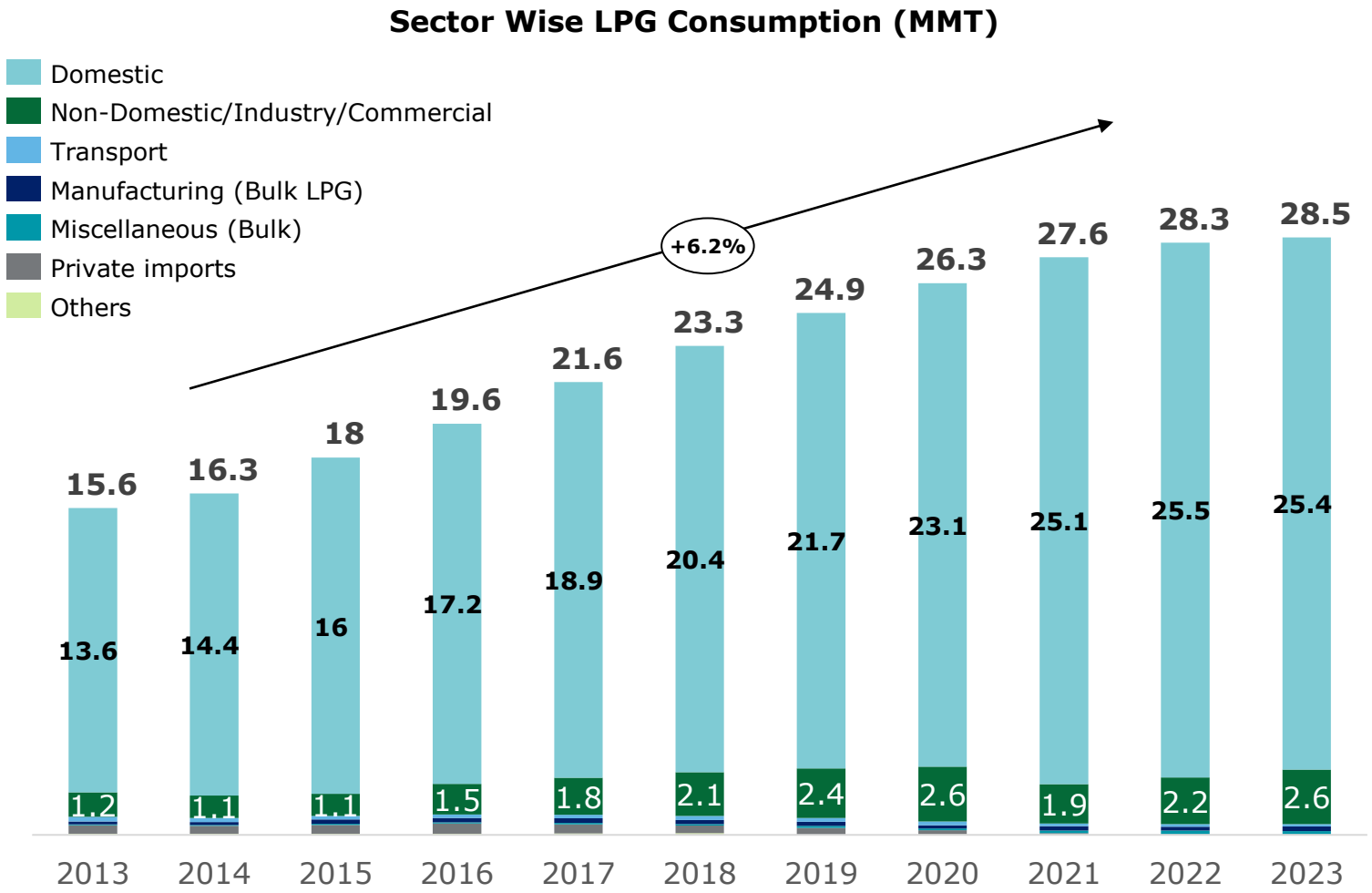
- There has been a difference between the rise in production and consumption, attributed to increasing consumption trend.
- With the surge in LPG usage driven by government initiatives such as PMUY, there has been a notable push towards reliance on imported LPG.
- Presently, India imports 64% of its LPG consumption.[1]
- A total of 9.59 crore PMUY beneficiaries have been covered under Ujjwala scheme 1.0 & 2.0 as on April 2023.

- The expansion of domestic LPG connections has achieved a CAGR of 8.7%, primarily driven by the PMUY initiative.
- Although domestic connection penetration reaching 99%, growth is anticipated to plateau due to diminishing demand due to PNG in authorized areas.
- Dependency on industrial LPG is expected to decrease as PNG is becoming fuel of choice.
- Domestic LPG customers in India has surged to approximately 31.4 crores in Q4 2023, marking a significant increase from the 14.9 crore customers recorded in 2015

Sources: 1. PPAC. 2. IPNG Stats

LPG | Sector wise Consumption

LPG consumption is primarily driven by domestic sector (89%), followed by non-domestic sector at 9% and bulk sector at 1.3%. Auto LPG is on a declining trend accounting for only 0.4% of total consumption



Domestic demand has been key driver of growth due to

- **Increased penetration** of LPG due to government push (PMUY)
- **Rapid growth in population** thereby increasing number of households
- **Development of LPG supply chain** in India

Non-domestic/I&C demand growth has been relatively slow but steadily driven by

- **Favorable cost economics of LPG** in industrial and commercial segments compared to diesel, petrol and other fuels.
- Regulations to phase out other polluting fuels

Sources: PNG statistics, PPAC

LPG | Drivers/Inhibitors for LPG demand

LPG consumption trend has pickup after PMUY with 14.8 cr. connection in 2015 to 32 cr. connections in by end of 2023

Increase in number of households

- LPG adoption has reached its peak in terms of reach, however there is potential in non-domestic and industrial segments.
- Urban migration has led to a significant increase in the adoption of LPG connections.

Expansion of manufacturing activity

- LPG is being used in diverse range of application like Heat treatment, forging, Surface coating, Baking, glass manufacturing, spray dying and sterilization.

Regulations favoring cleaner fuels

- State PCB are acting proactively on banning polluting fuels and adoption of cleaner fuel.
- Recent letters by Rajasthan PCB has clearly mentioned to ban on FO and polluting fuels.

Government push for adoption of LPG

- Government has planned to launch PMUY 2.0 to outreach the LPG connection to 100% population. 5Kg LPG cylinder has been introduced to BPL families.

Expansion of CGD Network

- CGD Infra is growing at tremendous pace & PNG has greater penetration in Tier–3 cities.[1]
- Policy push has given PNG adoption new direction.
- PNG is cheaper than Non-subsidized LPG cylinder.

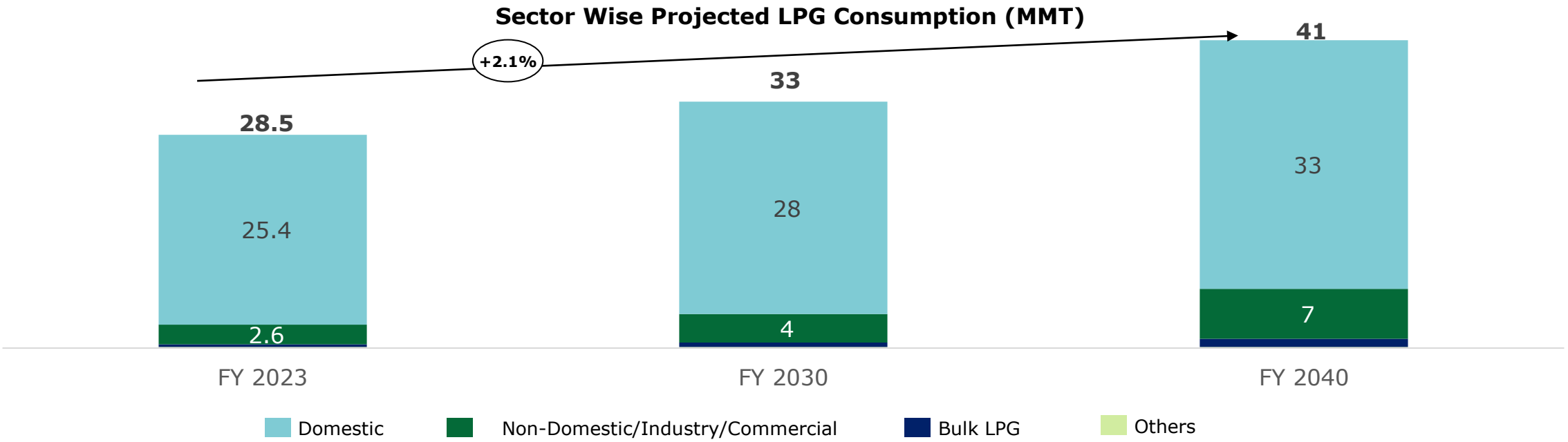
Energy transition

- LPG is among least polluting fuel, however not a probable candidate for Net Zero.
- In some developed countries, households are switching from gas/propane to electric induction cook tops for domestic use.

Sources: 1. Deloitte Analysis

LPG | Net Projected Demand Pre-Erosion

LPG consumption trend has picked up after PMUY with 14.86 cr connection in 2014 to 32 cr connections in 2023 encompassing 99% of population



Domestic

- Domestic LPG has already reached a high penetration (>99%)
- Future dom. LPG growth projected via past decadal (2011-2021) HH growth rate

Non-Domestic/Industry/Commercial

- Non dom. LPG is 9.1% of total LPG demand.
- Future growth projected via growth rate of gross value added of ~5.7% of the hotels segment (FY 2012-2022)

Bulk

- Bulk LPG is 1.3% of total LPG demand.
- Future growth projected via growth rate of ~6.6% of Gross Value Added of the manufacturing segment (FY 2012-2022)

Others

- Demand in others segment consist of transport, others, etc. with a small base and these segment have not shown any growth
- Future growth is assumed flat

Sources: PPAC, RBI | Note:HH = Household

LPG | Demand Erosion

LPG demand projection will be eroded by ~ 5.5MMT by 2030 due to uptake of CGD, primarily in the domestic segment

Hydrogen

- Hydrogen is a future candidate fuel especially in the industrial segment but current costs for producing green hydrogen are very high and infrastructure is lacking
- Bulk segment and industrial segment LPG demand is a small % of overall LPG demand and hence the funnel for erosion in future is even smaller.

Electric Vehicles

- Auto LPG is on the declining trend (-6% CAGR) and has a low demand base of 107 TMT
- As such EVs will not compete with LPG in the transport sector and impact will be insignificant for this analysis

Projected LPG Demand:
2030: 33 MMT
2040: 41 MMT

Projected LPG Demand (Post erosion):
2030: 28 MMT
2040: 33 MMT

LPG Demand Erosion from CGD:
2030: -5.4 MMT
2040: -8 MMT

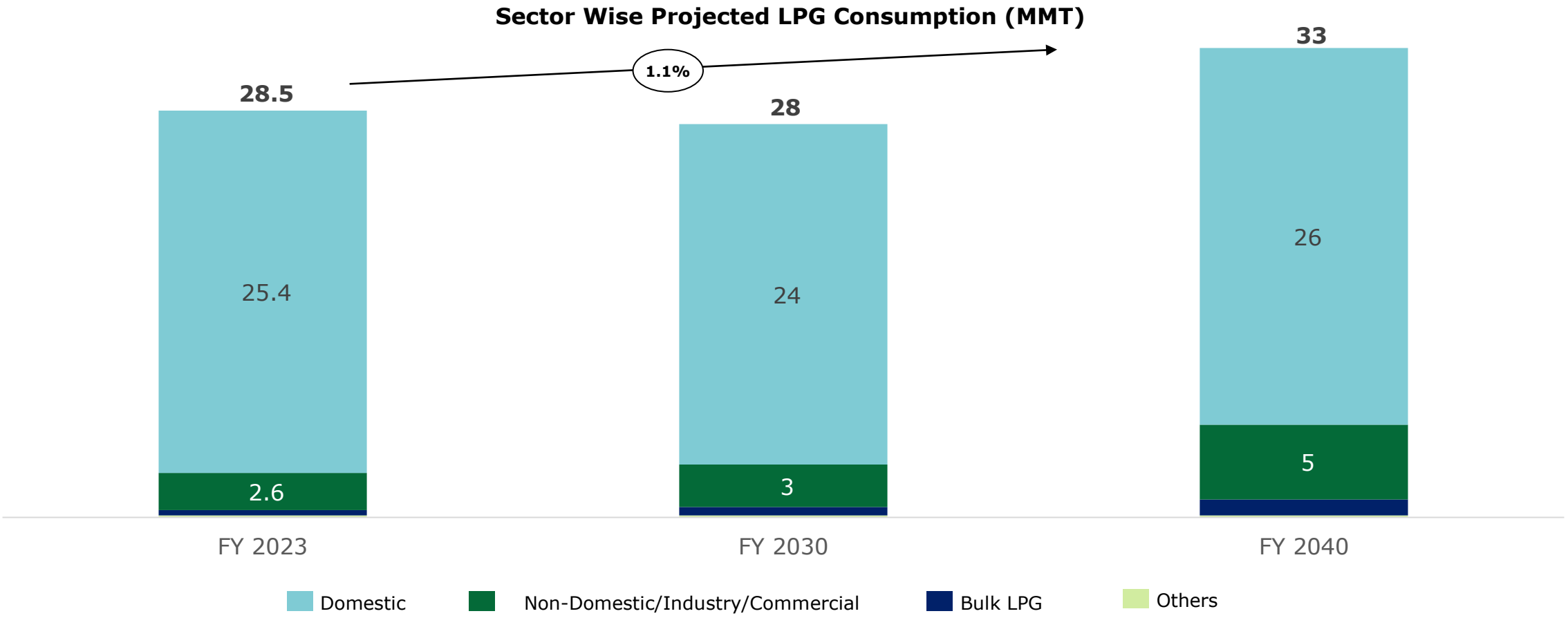
City Gas Distribution Sector

- As CGD sector grows, it will be the key factor that will erode LPG demand
- With conclusion of 12th round, entire landmass of India is under CGD authorization
- Demand erosion will be prominent in domestic segment as PNG – domestic & commercial is cheaper than LPG
- By 2032, as per PNGRB's MWP target domestic connections should reach 12.5 Cr, ~10x of current DPNG connections

Sources: Internal analysis

LPG | Net Projected Demand Post Erosion

LPG consumption will reach 28 MMT and 33 MMT in FY2030 and FY2040 respectively due to erosion from CGD sector



Note: Net demand projection in domestic segment is based on realization of PNG targets.

Sources: PPAC, Internal analysis

LPG Infrastructure (1/2)

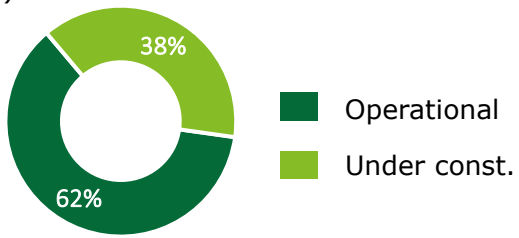
To enhance the supply, distribution, and reach of LPG, additional pipelines with a capacity of 9 MMT are currently under construction

LPG Pipelines

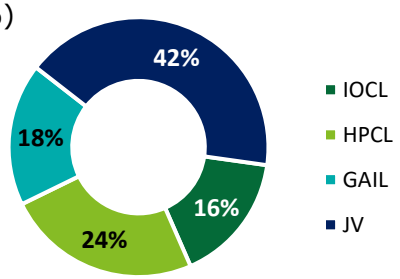
LPG PPL Length (%) Operation Vs Under construction

The country has a limited set of pipelines with 5,120 km under operation. Additional 3,234 km is under construction primarily as KGPL and KESPL which will significantly improve connectivity with the bottling plants.

LPG PPL Capacity Status (%)



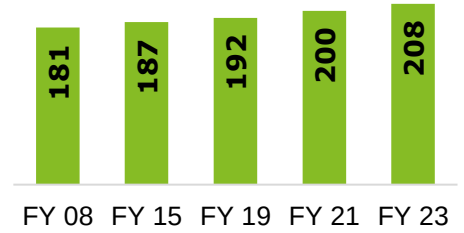
LPG PPL Capacity by players (%)



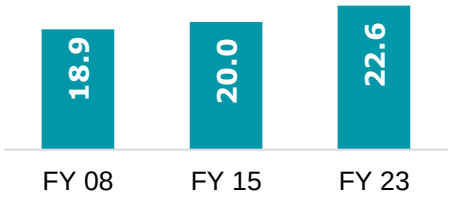
- The capacity of pipelines will increase from 16 MMT to 26 MMT with the commissioning of KGPL & KESPL by 2025
- While existing pipelines were operated individually by PSU entities, latest pipelines under construction follow the JV model
- HPCL will own 1/3rd capacity after commissioning of KGPL

LPG Bottling Plant

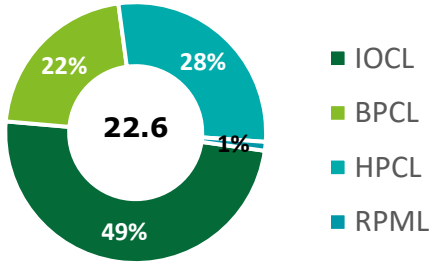
LPG Bottling Plants Growth (No.s)



LPG Bottling Plants Growth (No's)



LPG Bottling Plant Capacity by players (MMT)

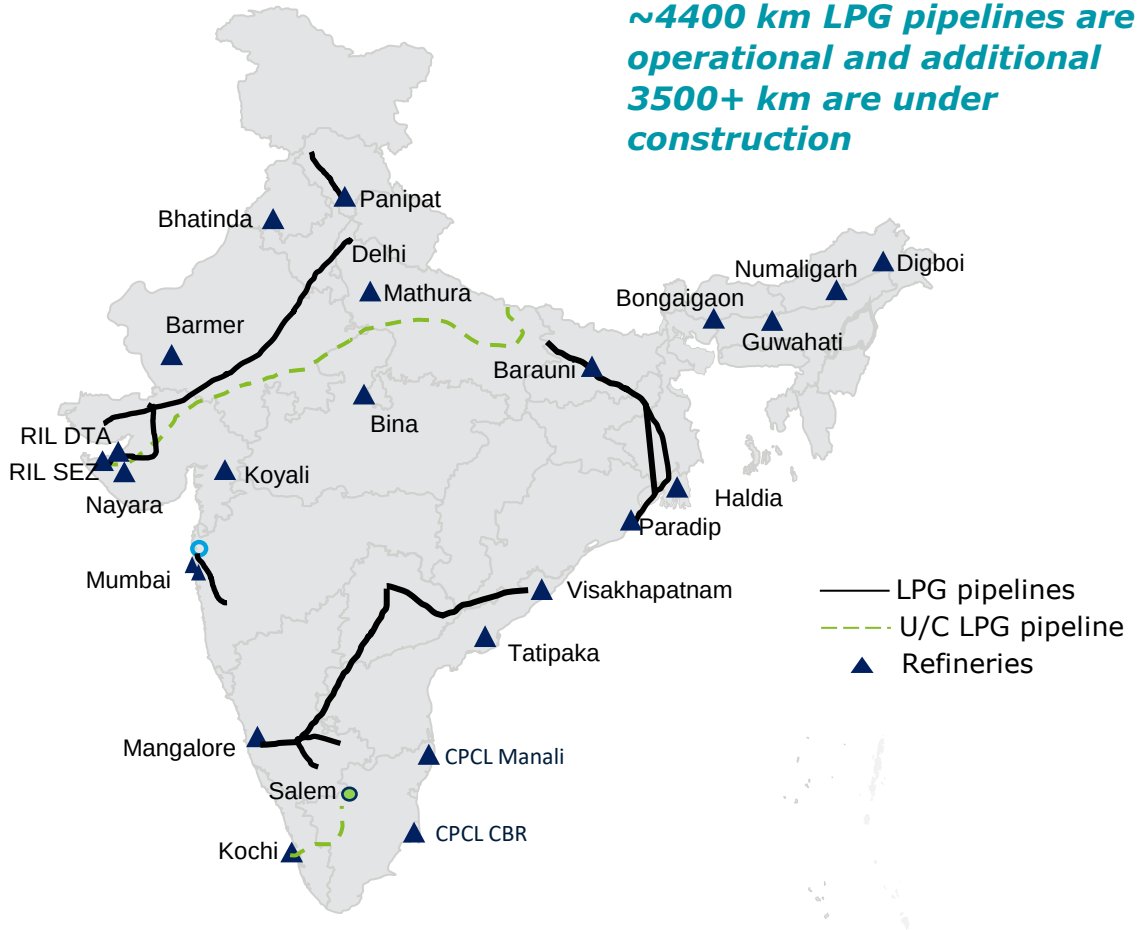


- IOCL leads other OMCs in both the number of bottling plants and overall capacity.
- Post 2015, HPCL and BPCL have significantly accelerated the addition of new bottling plants and capacity, surpassing the growth rate of IOCL in these areas.
- LPG consumption has surged by 58% since FY 2015, while bottling plant capacity has only increased by 12%, indicating significant under-capacity and rising demand outpacing supply.

Sources: PPAC & MoPNG

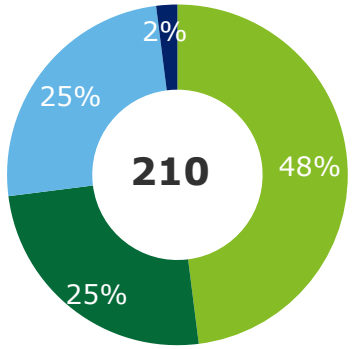
LPG Infrastructure (2/2)

The continuous timid growth in demand for LPG products will require optimizing and enhancing the infrastructure to develop a sustainable supply chain

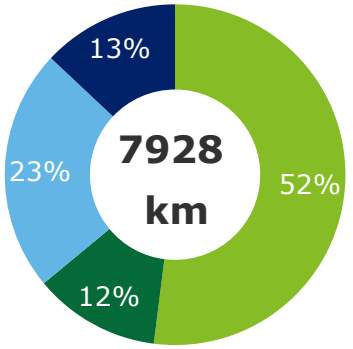


~4400 km LPG pipelines are operational and additional 3500+ km are under construction

Bottling Plants



LPG Pipeline Length



IOCL has the largest LPG infrastructure comprising of bottling plants and pipelines in India

Notes: The map shown above captures major LPG pipeline, Map is illustrative and is not to scale

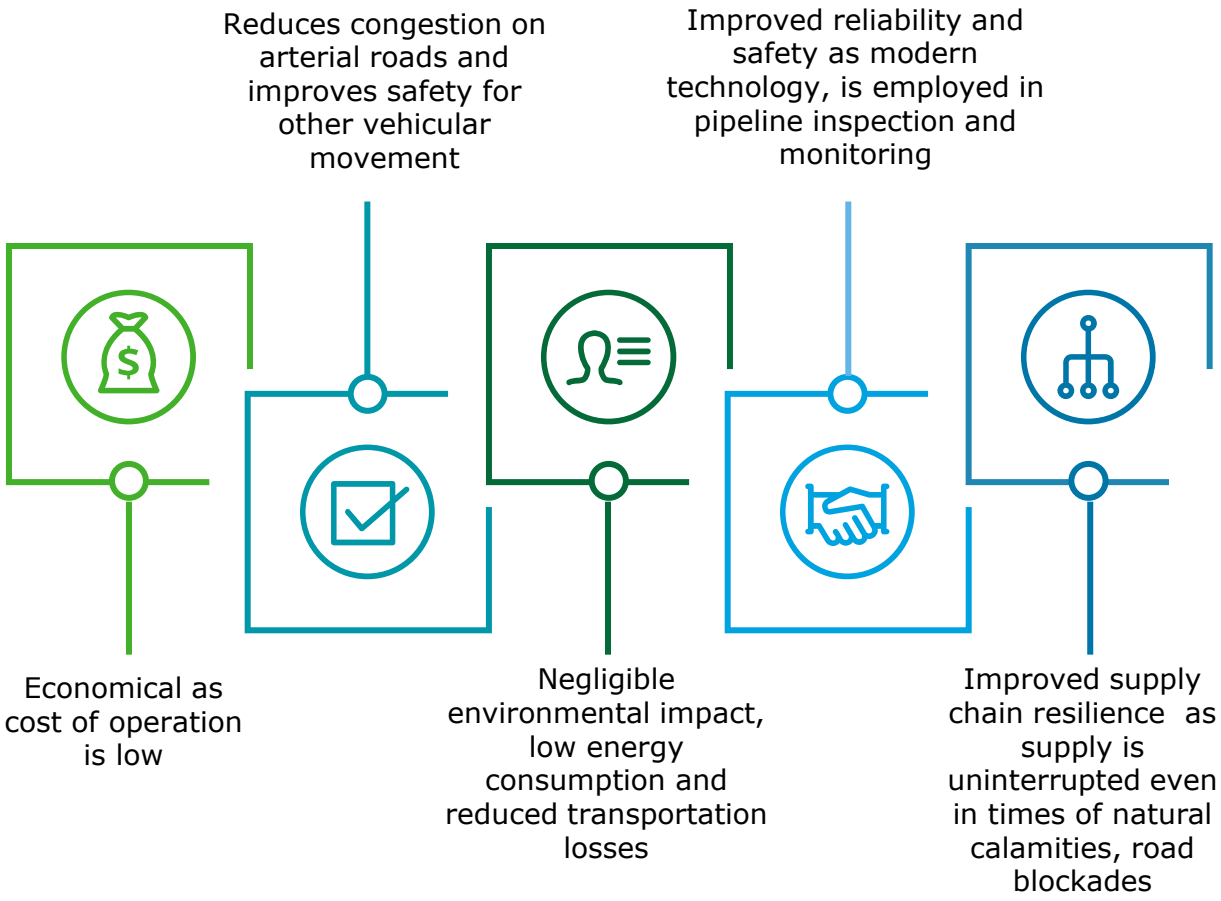
Sources: 1. MoPNG, PNGRB, PPAC, Gati Shakti, OMC Websites,

LPG Pipeline Requirement Analysis

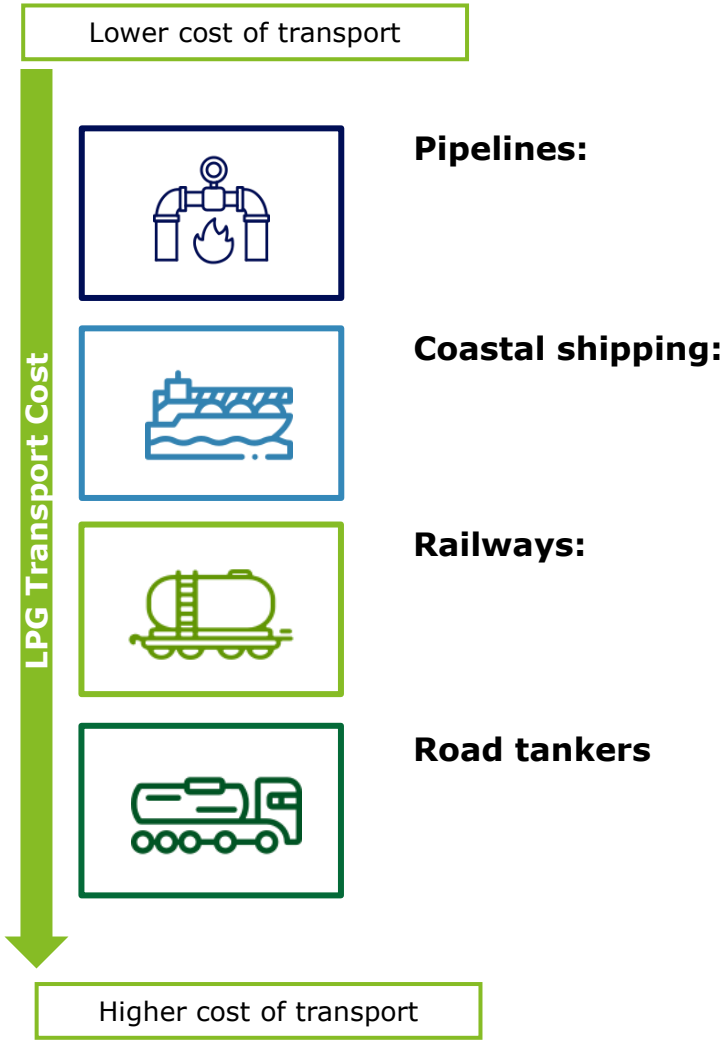
2

Benefit of Pipeline Transport

Movement of bulk LPG through pipelines over long distances instead by road through LPG bullet tankers offers a host of benefits making the former a preferred option.



Typical cost of transportation[1]



Notes: 1. Ranking based on discussions with industry stakeholders.
Sources: 1. IOCL, Deloitte Analysis

Detailed Approach & Methodology for Determining LPG Pipeline Infrastructure

Approach and Methodology combines qualitative and quantitative analysis of data and visual representation on maps to determine the most feasible and beneficial pipelines

1. List and plot route of existing and upcoming LPG pipelines on maps
2. List and plot LPG supply source (refinery, import terminal) on maps

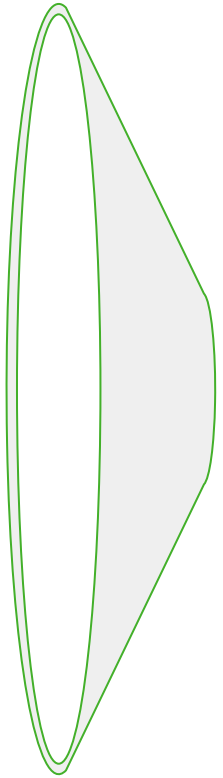
Determine Universe of LPG Bottling Plants not connected by LPG Pipelines

3. List existing LPG bottling plants along with attributes (capacity, owner, state, PPL connectivity)
4. Determine the nearest supply source (refinery/import termina) and calculate the corresponding distance

5. Prioritize states with highest number of unconnected bottling plants
6. Generate potential pipeline routes connecting unconnected bottling plants with refineries/import terminals

Potential routes of new LPG Pipelines

7. Evaluate potential pipelines routes against various parameters – Capacity & No. of BP connected, % own capacity served, redundancy, connecting unserved source, ease of terrain & RoW, spare capacity of source
8. Feedback from LPG Marketers



Proposed LPG Pipelines

Trunk LPG Pipeline

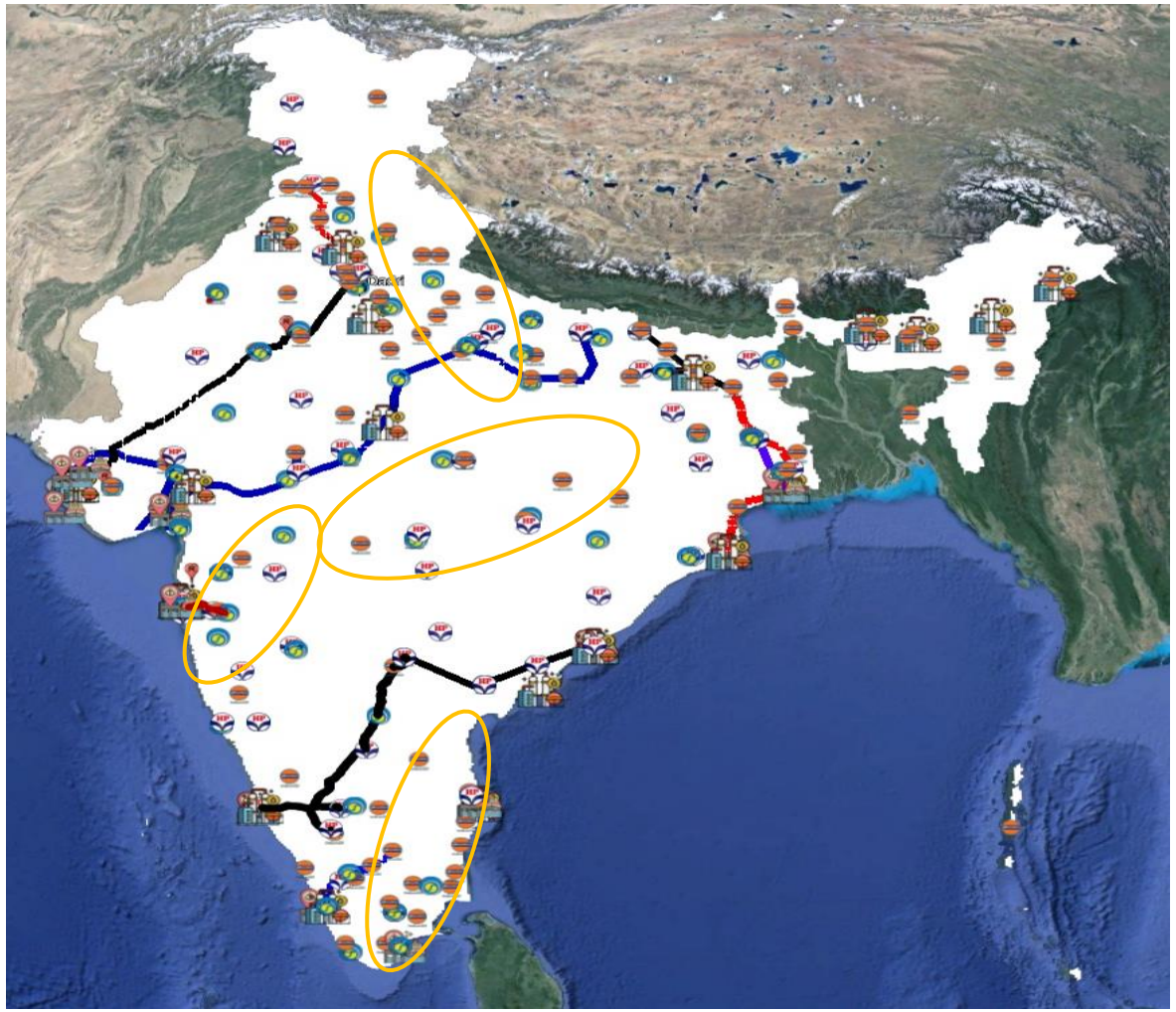
Spur LPG Pipelines

- Origin & Destination of PPL
- Spur and Feeder lines of PPL
- Capacity of PPL
- Length of PPL
- Capex of PPL
- Transportation cost savings
- Emissions Avoided
- Road trips avoided

Notes: 1. Pipeline routes analyzed basis available data and within the ambit of the methodology. Detailed feasibility to be carried out for each proposed pipeline.
Sources: 1. Deloitte Analysis

LPG | Current Bottling Plants and Pipelines

Post completion of the three under-construction LPG pipelines, 120 bottling plants will remain unconnected by direct pipelines, forming the basis for evaluation of potential pipeline routes



Total LPG Bottling Plants	210	22050 TMT
Total LPG Bottling Plants Connected by LPG Pipelines	84	11302 TMT
Bottling Plants for evaluation of pipeline connectivity	126	10748 TMT

Notes: 1. Based on existing and under-construction LPG pipelines

Sources: 1. Gati Shakti Portal, Deloitte Analysis

LPG | Current and Upcoming Pipeline Infrastructure

About 90 bottling plants will be connected via existing and the three under construction LPG pipelines, leaving more than 50% of bottling plants open for consideration for connection via pipelines

S. No	LPG Pipelines	Owner	Length (km)	Capacity (MMT)	Status	Bottling Plants Connected by Pipelines				
						BPCL	HPCL	IOCL	RPML	Grand Total
1	Hassan-Cherlapalli LPG Pipeline	HPCL	650	2.2	Operational	1	1	1		3
2	Jamnagar-Loni pipeline	GAIL	1414	2.5	Operational	4	2	4	1	11
3	Kochi Refinery (Part of Kochi Salem)				Operational	1	1			2
4	Mangalore-Hassan-Mysore Bangalore Pipeline	HPCL	356	3.1	Operational	1	3	1		5
5	Mumbai-Uran pipeline	HPCL	28	.8	Operational	1	1			2
6	Panipat-Jalandhar pipeline	IOCL	280	.7	Operational			3		3
7	Paradip Haldia Barauni Motihari pipeline	IOCL	1468	3.5	Operational	3	2	9		14
8	Uran-Chakan-Shikrapur LPG Pipeline	HPCL	169	1	Operational	1	1	1		3
9	Vizag-Secunderabad pipeline	GAIL	609	1.3	Operational	2	4	4		10
10	GAIL Vijaipur Fractionation Plant Pipeline	GAIL	20	.1	Operational			1		1
	Total Operational					**14**	**15**	**24**	**1**	**54**
11	Haldia-Panagarh LPG Pipeline	IOCL	215	1.45	Under construction		2			2
12	Kochi-Salem LPG Pipeline	IOCL + BPCL	429	1.49	Under construction	1	1	4		6
13	Kandla-Gorakhpur LPG pipeline	IHB	2805	8.25	Under construction	8	6	8		22
	Grand Total (Operational + Under construction)					**23**	**24**	**36**	**1**	**84**

Notes: 1. Based on FY 23 data

Sources: 1. PNG Statistics, Data from OMCs & PNGRB, Deloitte Analysis

Proposed Routes of New LPG Pipelines

LPG Pipelines have been proposed by prioritizing group of bottling plants not served by existing LPG pipelines and requiring large movement of LPG by alternate modes

1 Trunk Pipeline

Connecting large unserved areas and LPG sources

a. Cherlapally – Nagpur LPG Pipeline
b. Shikrapur – Hubli – Goa LPG Pipeline
c. Mumbai - Jalgaon – Aurangabad LPG P/L
d. Paradip Raipur LPG Pipeline
e. Gwalior – Haldwani LPG Pipeline
f. Jalandhar Jammu LPG Pipeline
g. Ennore – Pondicherry LPG Pipeline
h. CPCL CBR – Trichy – Madurai LPG Pipeline

+

2 Spur / Interconnections Pipelines

Leveraging existing network and create redundancy

a. Panipat - Jalandhar Spur P/L to Bathinda
b. Bina Jabalpur Spur
c. Deoria - Bettiah - Motihari (KGPL - Haldia Motihari Interconnection)
d. JLPL – Salempur LPG Spur
e. HPCL Yediyur - BPCL Bangalore Spur.

Tentative

INTERCONNECTION PIPELINES WILL AIM TO CREATE REDUNDANCY IN THE LPG NETWORK.

SPUR PIPELINES WILL LEVERAGE EXISTING PIPELINE INFRASTRUCTURE TO EXTEND PPL CONNECTIVITY

Notes: 1. CPCL CBR Refinery is under - construction
Sources: 1. Deloitte Analysis

Coverage of Additional Bottling Plants

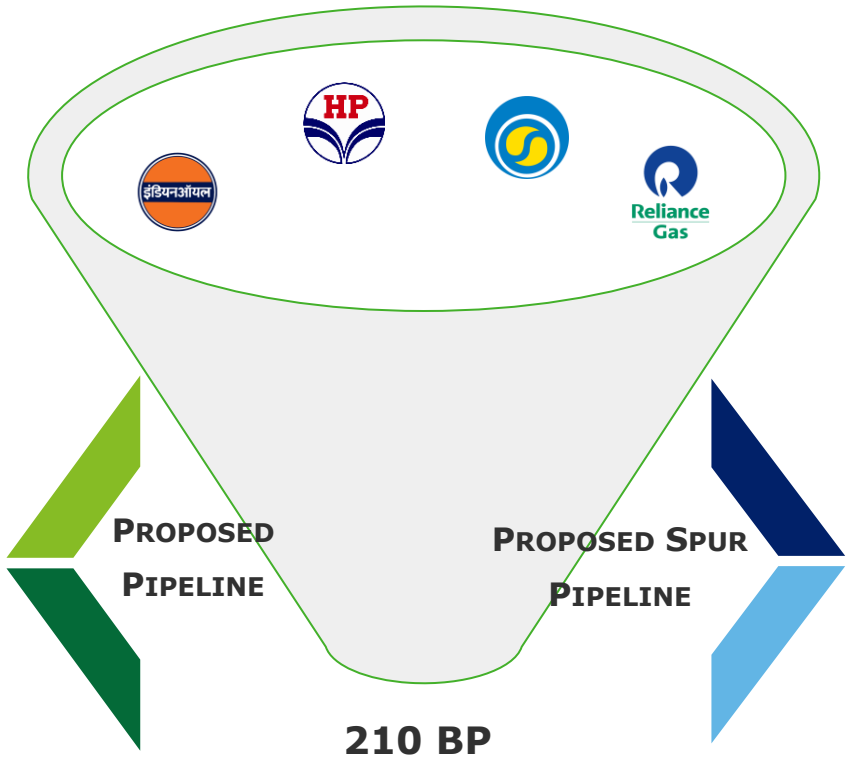
If proposed pipelines are implemented, it will reduce the unserved bottling plants to 68 (60)[1]

210 BP

CONNECTED : 84
NON- CONNECTED : 126

BOTTLING PLANTS CONNECTED: 50

1. Cherlapally – Nagpur LPG PL (6)
2. Shikrapur – Hubli – Goa PL (7)
3. Mumbai Aurangabad Jalgaon (6)
4. Paradip - Raipur LPG PL (6)
5. Gwalior – Haldwani LPG PL (7)
6. Jalandhar Jammu (4)
7. Ennore – Pondicherry (6)
8. CPCL CBR – Trichy – Madurai (8)



210 BP

CONNECTED : 142
NON- CONNECTED : 68

BOTTLING PLANTS CONNECTED: 8

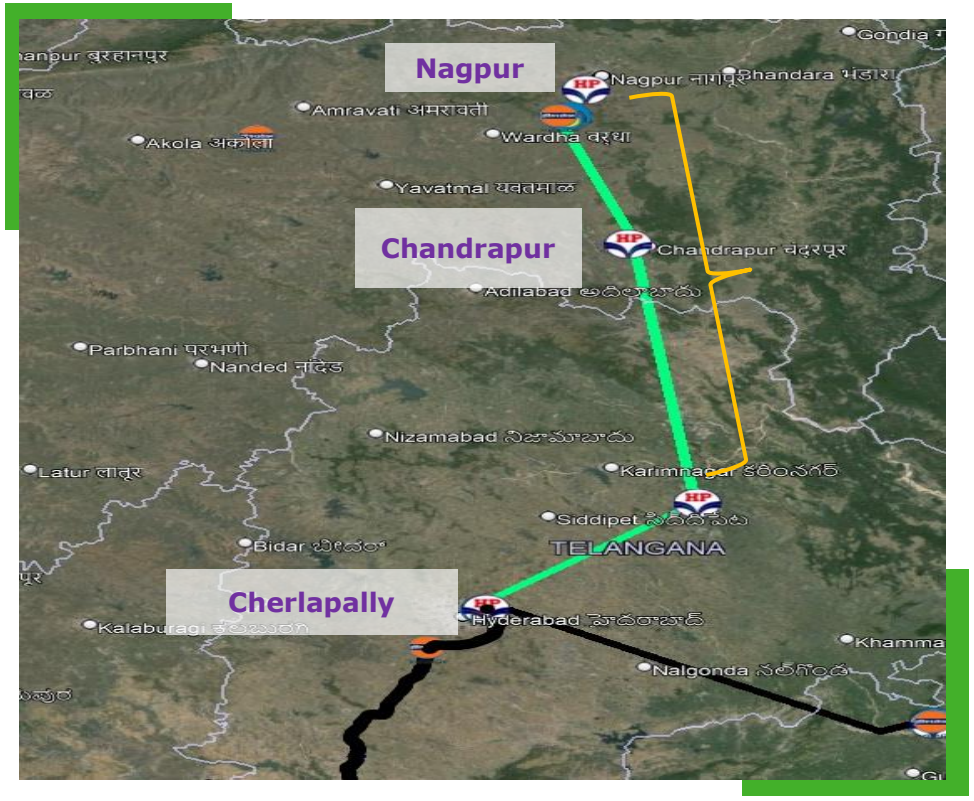
1. Panipat - Jalandhar Spur P/L to Bathinda (2)
2. Bina Jabalpur Spur (3)
3. Deoria - Bettiah - Motihari (KGPL-Haldia Motihari interconnection)(0)
4. HPCL Yediyur - BPCL Bangalore (1)
5. JLPL – Salempur (2)

Notes: 1. Assuming proposed spur pipelines are also implemented
Sources: 1. Deloitte Analysis

Proposed Pipeline | Cherlapally – Nagpur | Overview

Cherlapally – Nagpur pipeline aims to evacuate the LPG from existing Hassan Cherlapally and move the product towards Nagpur in the north via Chandrapur

This pipeline will originate from Cherlapally from existing LPG pipelines (Hassan-Cherlapally) with the northern arm connecting 6 BPs towards Nagpur.



453 km
LPG Pipeline Length

510 TMT
Capacity of Bottling Plant Served

1585 INR cr.
Estimated capex

6 Bottling Plants Connected

1 | 4 | 1

Source

- Hassan Cherlapally pipeline.
- Vizag Secunderabad Pipeline

Route: Cherlapally – HPCL Warangal – HPCL Chandrapur - HPCL Nagpur.

Spur
- No Spur

Emissions avoided:
0.9 Mn tonnes of CO2

Notes: 1. Proposed route is tentative. Map is not to scale. 2. Estimated Capex is based on KGPL capex
Sources: 1. Deloitte Analysis

Proposed Pipeline | Shikrapur – Goa - Hubli| Overview

Shikrapur – Goa - Hubli pipeline aims to evacuate the LPG from existing Uran Chakan Shikrapur pipeline and move the product towards in the Hinterlands of Maharashtra and North Karnataka

This pipeline will originate from existing UCSPL with the product moving to hinterlands of Maharashtra and Northern Karnataka connecting 5 Bottling Plant in main pipeline and 2 Bottling Plant in the Northern Karnataka Spur line.

508 km
LPG Pipeline Length

630 TMT
Capacity of Bottling Plant Served

1778 INR cr.
Estimated capex

07 **Bottling Plants Connected Via PPL**

1 2 3

1

Source

- Uran Chakan Shikrapur pipeline.

Route: Shikrapur– Wai – Hazarwadi – Belgaum - HPCL Hazarwadi- HPCL Hubli– BPCL Goa.

Spur
- Belgaum to Dharwad

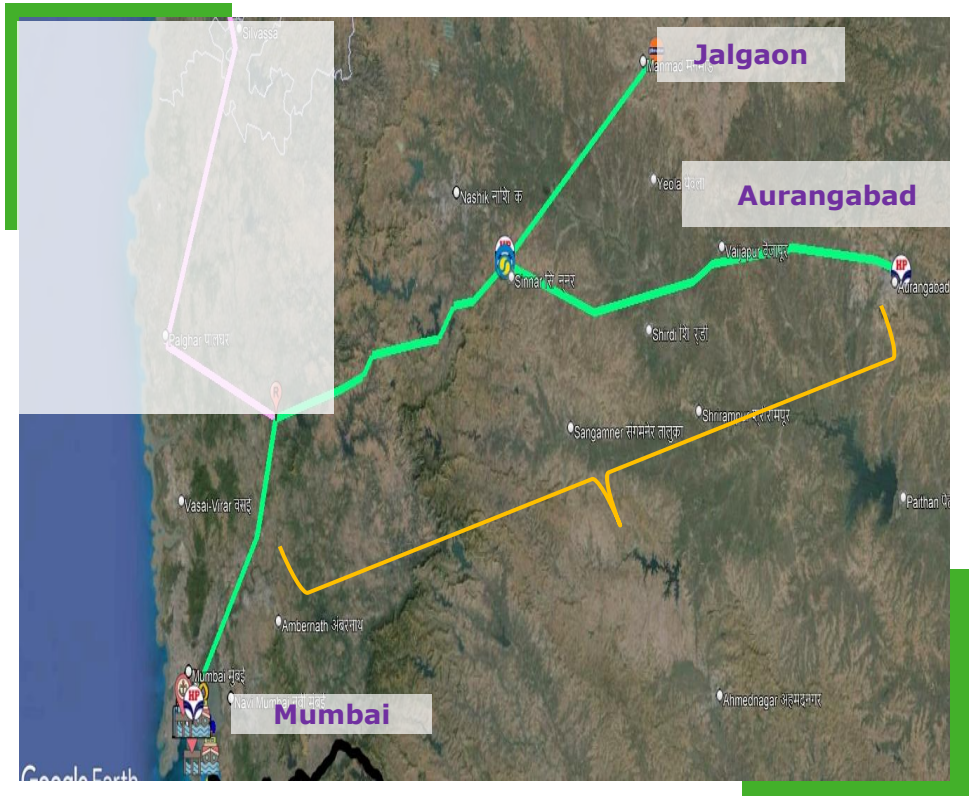
Emissions avoided:
1.4 Mn tonnes of CO2

Notes: 1. Proposed route is tentative. Map is not to scale. 2. Estimated Capex is based on KGPL capex
Sources: 1. Deloitte Analysis

Proposed Pipeline | Mumbai- Jalgaon – Aurangabad | Overview

The Mumbai-Jalgaon-Aurangabad pipeline aims to connect bottling plants in Maharashtra's hinterland, reducing road tanker traffic and alleviating congestion issues originating from Mumbai and onwards

This pipeline will evacuate product from HPCL and BPCL Refineries and Aegis LPG Import terminal in Mumbai and will connect the bottling plants in the hinterlands of Maharashtra in Nashik, Jalgaon and Aurangabad districts.



521 km
LPG Pipeline Length

510 TMT
Capacity of Bottling Plant Served

1823 INR cr.
Estimated capex

6 **Bottling Plants Connected**

इंडियनऑयल 1 | HP 2 | 2 | 1

Source

- HPCL Mumbai
- BPCL Mumbai
- Aegis Terminal

Route: Mumbai– Nashik- IOCL Manmad- BPCL Jalgoan – HPCL Aurangabad

Spur
- Nashik to Aurangabad

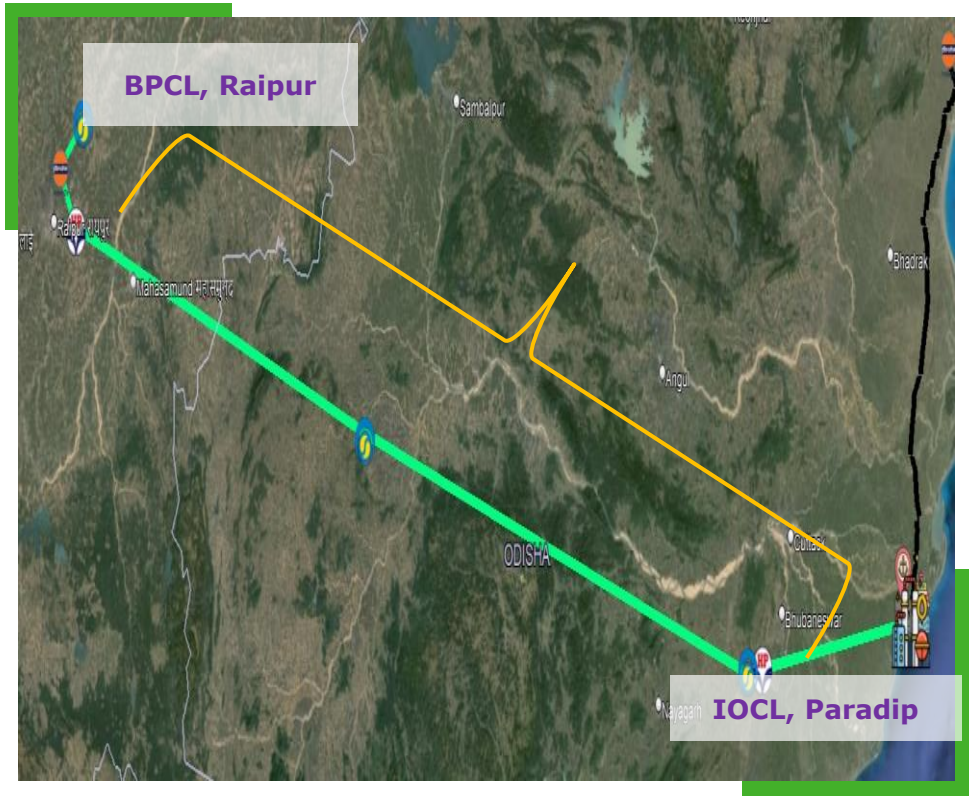
Emissions avoided:
0.7 Mn tonnes of CO2

Notes: 1. Proposed route is tentative. Map is not to scale. 2. Estimated Capex is based on KGPL capex. 3. The pipeline can be connected to Vadhavan Port once port is established

Proposed Pipeline | Paradip Raipur LPG | Overview

Paradip Raipur LPG Pipeline aims to evacuate LPG from IOCL's Paradip refinery and import terminal and serve the bottling plants in the hinterland of Orissa and Chhattisgarh

This 555 KM pipeline will evacuate LPG from IOCL's refinery and LPG import terminal to interior areas of Orissa and Chhattisgarh till Raipur.



555 km
LPG Pipeline Length

540 TMT
Capacity of Bottling Plant Served

1940 INR cr.
Estimated capex

6 Bottling Plants Connected

1 | 0 | 3 | 2

Source

- IOCL Refinery, Paradip

Route: IOCL Paradip Refinery –HPCL Jatni- BPCL Khurda- BPCL Raipur

Spur
- No Spur

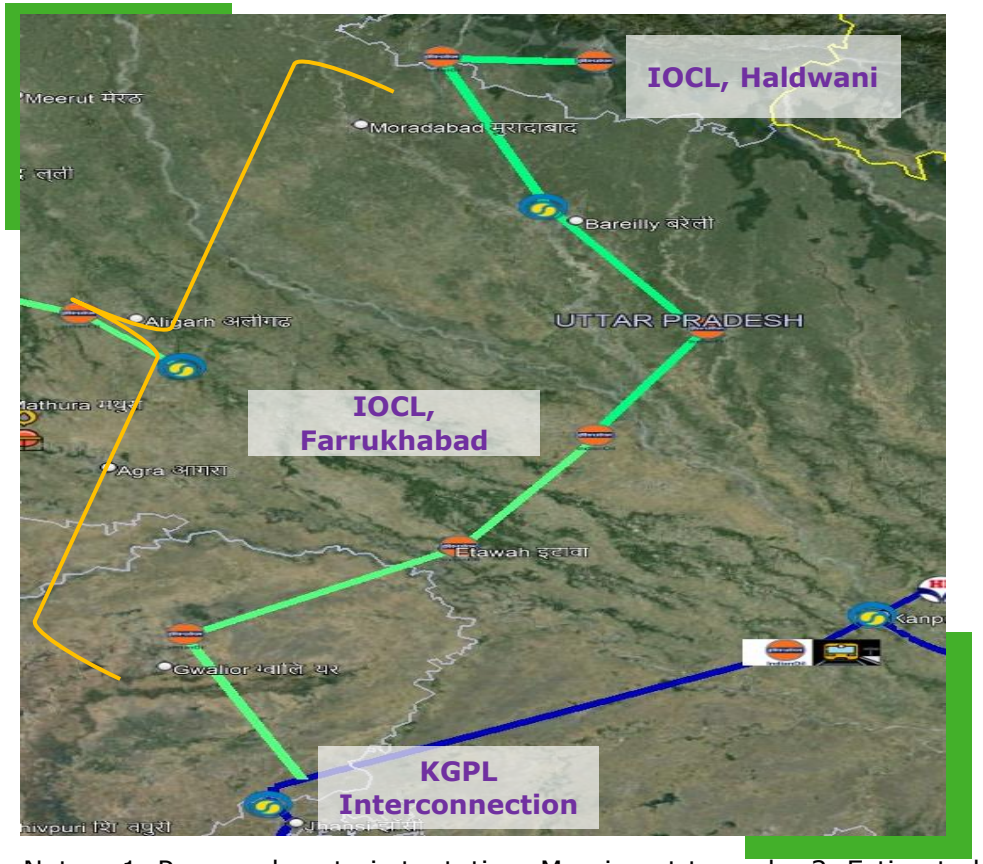
Emissions evaded:
0.93 Mn tonnes of CO2

Notes: 1. Proposed route is tentative. Map is not to scale. 2. Estimated Capex is based on KGPL capex.
Sources: 1. Deloitte Analysis

Proposed Pipeline | Gwalior – Haldwani (Sitarganj)| Overview

Gwalior - Haldwani pipeline aims to create network along the Northern plains and serve BPs in Uttar Pradesh & Uttarakhand. LPG evacuation is planned mainly from KGPL and traverse though hinterland of UP

This pipeline will connect bottling plants in the hinterland of Uttar Pradesh and Uttarakhand with the upcoming KGPL pipeline. This pipeline will evacuate the product in Gwalior, Eatwah, Bareilly, Uttar Pradesh and in Haldwani (Sitarganj), Uttarakhand.



531 km
LPG Pipeline Length

510 TMT
Capacity of Bottling Plant Served

980 INR cr.
Estimated capex

07 **Bottling Plants Connected**

5 | 0 | 2

Source
- Kandla Gorakhpur Pipeline
- Panipat refinery
- Mathura Refinery

Route: KGPL Interconnection – IOCL Gwalior- IOCL Etawah - IOCL Farrukhabad– BPCL Bareilly– IOCL Pattikalan – IOCL Sitarganj.

Spur
- No Spurs

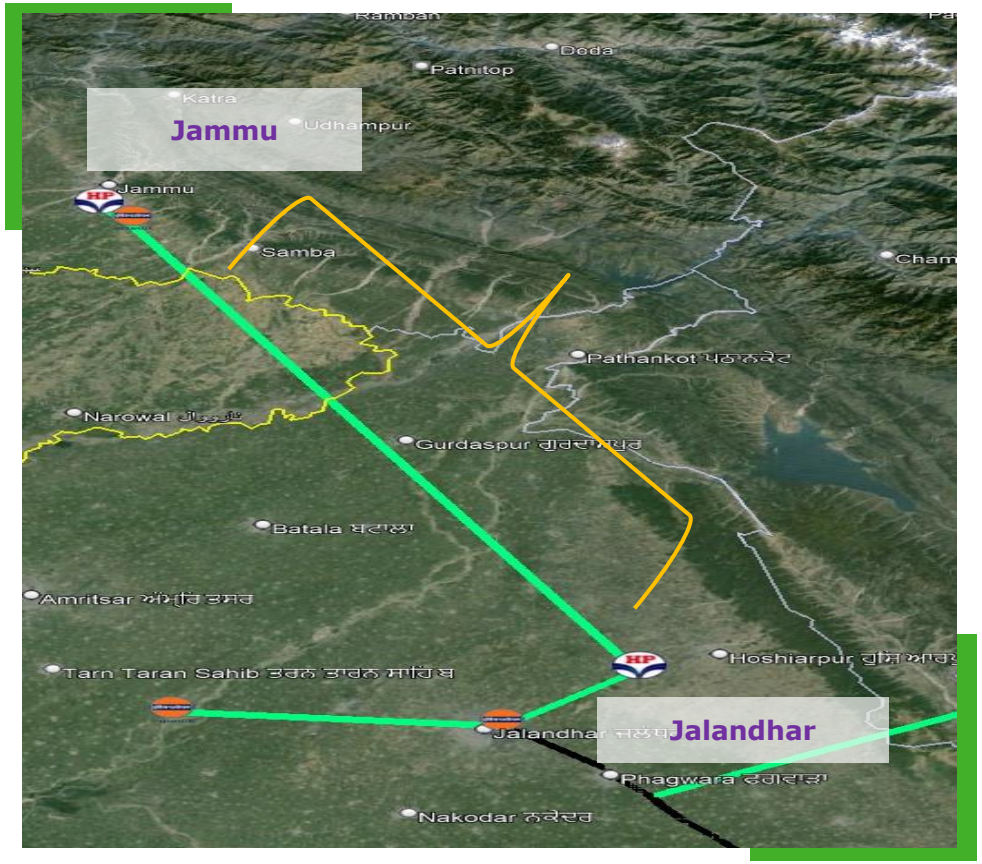
Emissions evaded:
0.9 Mn tonnes of CO2

Notes: 1. Proposed route is tentative. Map is not to scale. 2. Estimated Capex is based on KGPL capex.
Sources: 1. Deloitte Analysis

Proposed Pipeline | Jalandhar - Jammu | Overview

Jalandhar Jammu LPG Pipeline is a extension of Panipat Jalandhar pipeline which aims to transport LPG in the hinterland of Jammu

This pipeline will be an extension of existing Panipat Jalandhar pipeline. It will evacuate the LPG from Panipat refinery and connect the bottling plants in Jammu.



237 km
LPG Pipeline Length

300 TMT
Capacity of Bottling Plant Served

830 INR cr.
Estimated capex

04 **Bottling Plants Connected**

2 **2** **0**

Source

- Panipat Jalandhar pipeline

Route: Panipat Jalandhar– HPCL Jammu

Spur

- Panipat Jalandhar – IOCL Goindwal Sahib

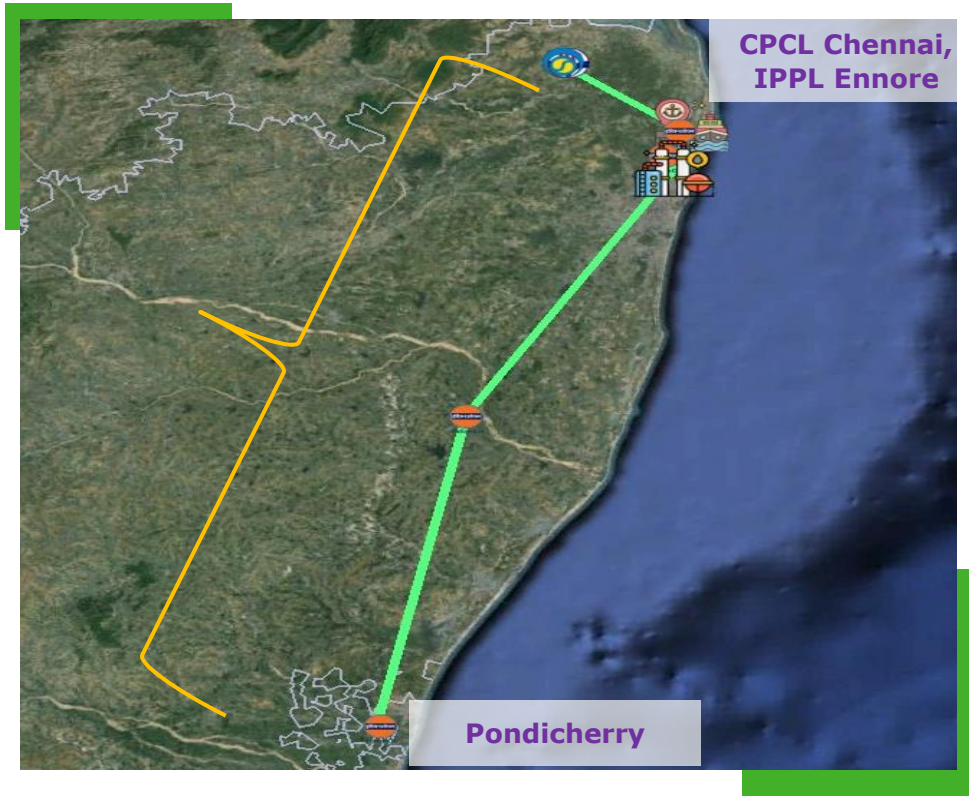
Emissions evaded:
0.42 Mn tonnes of CO2

Notes: 1. Proposed route is tentative. Map is not to scale. 2. Estimated Capex is based on KGPL capex.
Sources: 1. Deloitte Analysis

Proposed Pipeline | Ennore – Pondicherry | Overview

Ennore – Pondicherry pipeline aims to evacuate the LPG from CPCL refinery and IPPL Ennore and push towards down south along the coast connecting 04 bottling plants

This pipeline will originate from CPCL refinery and IPPL Ennore LPG import terminal and aims to connect bottling plants on the coastal belt of northern Tamil Nadu. A small spur will run in northwest direction connecting bottling plants at Chennai and Gummidipoondi



192 km
LPG Pipeline Length

780 TMT
Capacity of Bottling Plant Served

672 INR cr.
Estimated capex

06 Bottling Plants Connected

इंडियनऑयल **4**

HP **1**

1

Source

- CPCL Ennore refinery
- IPPL Ennore

Route: BPCL Chennai - IPPL Ennore terminal – CPCL Ennore Refinery - IOCL Ennore- IOCL Chengelpet - IOCL Pondicherry

Spur

- IPPL Ennore - BPCL Chennai – HPCL Gummidipoondi

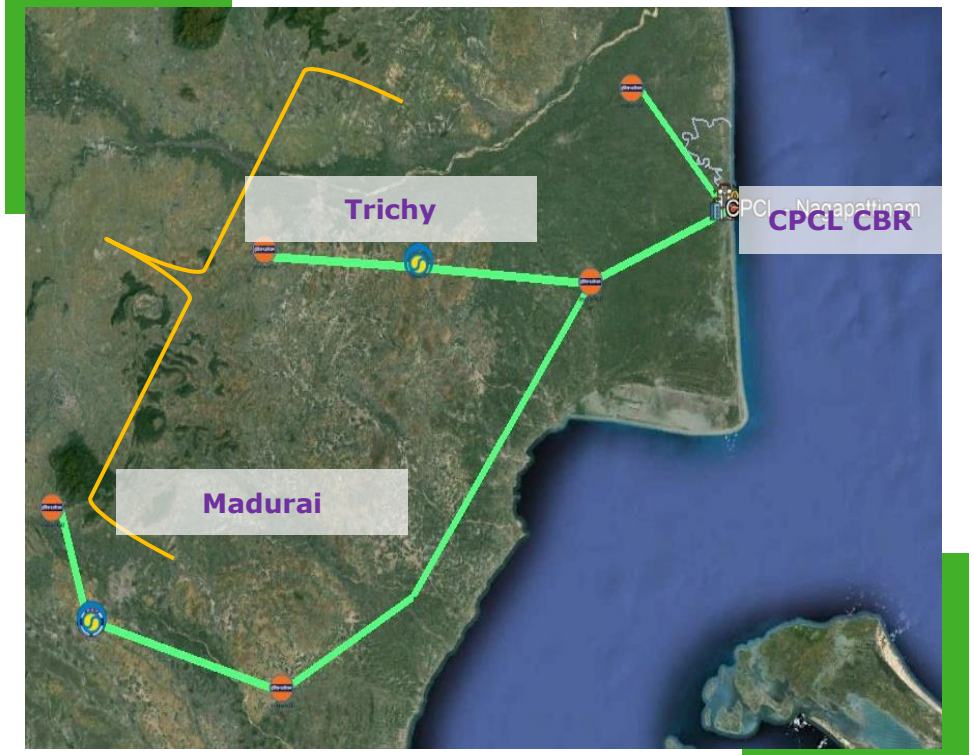
Emissions evaded:
0.2 Mn tonnes of CO2

Notes: 1. Proposed route is tentative. Map is not to scale. 2. Estimated Capex is based on KGPL capex
Sources: 1. Deloitte Analysis

Proposed Pipeline | CPCL CBR – Trichy – Madurai | Overview

CPCL CBR – Trichy – Madurai pipeline aims to evacuate the LPG from upcoming CPCL CBR refinery and push LPG towards Trichy and Madurai and connecting eight bottling plants along the way

This pipeline will originate from CPCL CBR refinery and will have two major arms – one arm will connect bottling plants towards Trichy and the other arm will connect bottling plants towards Madurai. A small north-western spur will also connect bottling plant at Mayiladuthurai



431 km
LPG Pipeline Length

510 TMT
Capacity of Bottling Plant Served

1500 INR cr.
Estimated capex

8 **Bottling Plants Connected**

- **5**
- **1**
- **2**

Source

- CPCL CBR refinery

Route: CPCL CBR Refinery – IOCL Mayiladuthurai- IOCL Mannargudi - IOCL Trichy – IOCL Madurai

Spur

- CPCL CBR to IOCL Mayiladuthurai
- IOCL Mannargudi - IOCL Trichy

Emissions evaded:
0.40 Mn tonnes of CO_2

Notes: 1. Proposed route is tentative. Map is not to scale. 2. Estimated Capex is based on KGPL capex
Sources: 1. Deloitte Analysis

Summary of Proposed LPG Pipelines

Proposed key LPG pipelines will connect additional 59 bottling plants of capacity 5.4 MMT, leading to savings of INR 4,243 cr. and avoided road trips and emissions of 7.4 Mn. And 6 Mn.tonnes of CO2 respectively

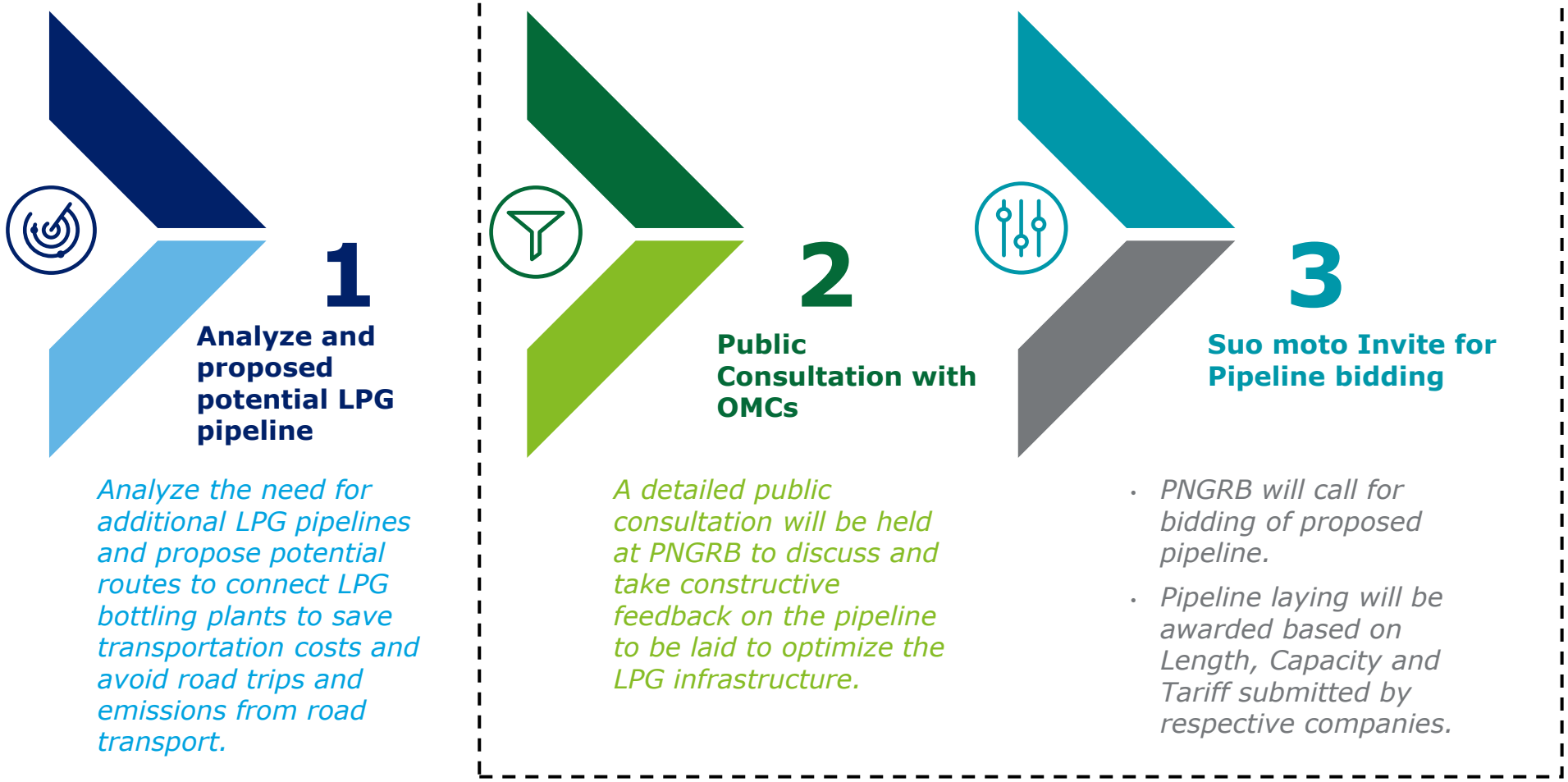
Category	BP Connected	BP Served (TMTPA)	NPV (INR Cr.)[1]	Trips Avoided (Mn)[2]	Emission Saved (in Mn)[2]
Cherlapally - Nagpur	6	510	470	1.01	0.9
Shikrapur – Hubli - Goa	7	630	1030	0.8	1.4
Mumbai - Aurangabad - Jalgaon	6	510	459	0.8	0.7
Paradip - Raipur	6	540	633	0.8	0.9
Gwalior – Haldwani	7	510	507	1.8	0.9
Jalandhar – Jammu	4	300	231	0.4	0.4
Ennore - Pondicherry	6	780	119	1.2	0.2
CPCL CBR - Madurai	8	510	179	0.8	0.4
Total	50	4290	3628	7.61	5.8

Notes: 1. NPV calculated in the year FY 2029. 2. Total road trips and emissions estimated from FY 2029 to FY 2053

Sources: 1. Deloitte Analysis

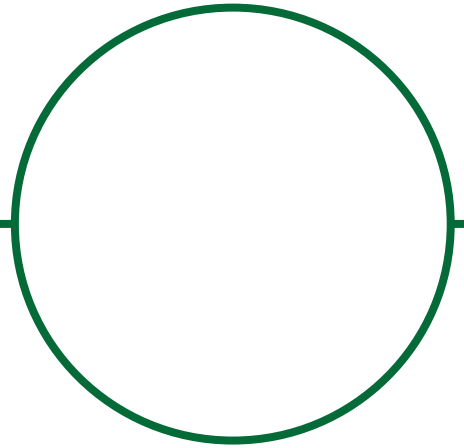
Next steps

A three-step approach is utilized to determine the potential LPG laying entities.



Sources: Deloitte Analysis & PNGRB Regulations

End of the Report



01 ZONAL STUDY ON LPG PIPELINE: POTENTIAL NEW LPG PIPELINES TO BE BID OUT

02 RAPID ASSESSMENT OF "PATHWAYS TO INCREASE SHARE OF NATURAL GAS FROM 6% TO 15%"

03 GLOBAL CASE STUDIES OF TRANSMISSION SYSTEM OPERATOR (TSO)

04 ASSESSMENT OF MATURITY IN NATURAL GAS MARKET

05 MARKET AND REGULATORY FRAMEWORK FOR GAS DISTRIBUTION SECTOR ACROSS THE GLOBE

Report
on
Rapid Assessment of "Pathways to Increase Share of Natural Gas from 6% to 15%"

Prepared For Petroleum And Natural Gas Regulatory Board (PNGRB)
By Deloitte Touche Tohmatsu India LLP (DTTILLP)

July 2024

Study Context

This study report explores the potential for increasing the share of natural gas in India's energy mix

CONTEXT

This study explores the potential for increasing the share of natural gas in India's energy mix. It outlines the benefits, challenges, and policy interventions required to achieve this ambitious target. The study has been conducted to provide inputs to PNGRB on enablers to increase the share of natural gas in the primary energy mix of the country

Demand projection is based on internal analysis and is subject to unlocking of multiple levers and targets. The study lays down the potential sectors to fill up the demand funnel to achieve a 15% share and does not delve into the feasibility of the 15% target

Scope of Work for each of the Modules

1 Overview of Status of Natural Gas and 2030 Goal

- Goal of Gas Based Economy
- Projected Gas Consumption @15% Share in Energy Mix
- Sector Wise Consumption & Challenges Impeding Share of Gas in Energy Mix

2 Projection of Natural Gas Demand & Sectoral Analysis

- Coverage of section
- Global case studies on increase in share of natural gas
- Overall Approach
- Sector overview, projections and enablers of natural gas consumption (Power, Fertilizers, Refining, Steel, CGD, LNG transport, New initiatives and others)
- Additional analysis (Gas RE blend power price, comparison of alternate fuel pricing in refining sector, EV projections, Impact of GST on pricing of CNG)

3 *Summary of Key Enablers*

Overview of Natural Gas in India

1

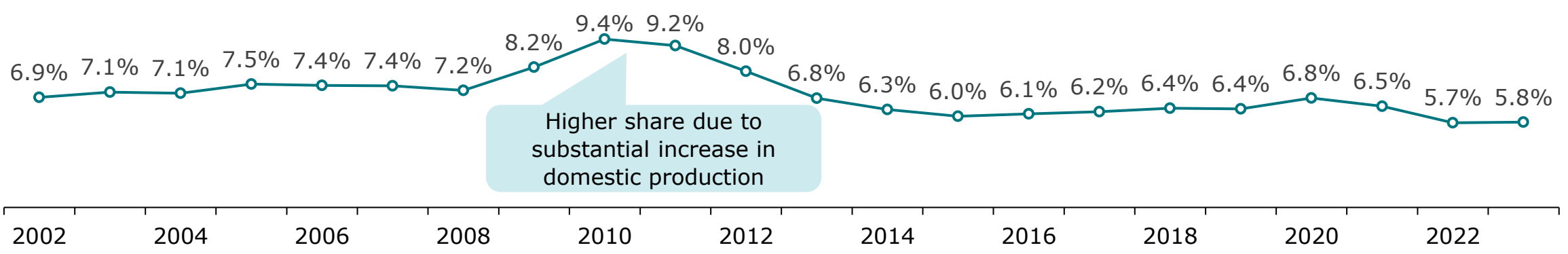
Goal of Gas Based Economy

With six years to go for meeting the 15% target, India faces a steep challenge to raise natural gas consumption whose share has fallen below 6% in 2022 & 2023 in PE mix due to increased gas prices

In 2016, the goal was announced to increase the share of natural gas in the energy mix from 6.3% to 15% by 2030

- Role as bridge fuel in power sector – NG emits ~50% less CO_2 emissions vs coal during combustion
- Improve air quality in urban areas through switch to CNG vehicles in transportation sector
- Critical role in grid balancing as high RE capacity expected to come online by 2030
- Diversify energy mix and stimulate investments in upstream gas exploration & production

Share of natural gas has stagnated at ~6% even after the announcement of 15% target, suggesting practical challenges in raising the gas consumption in various sectors

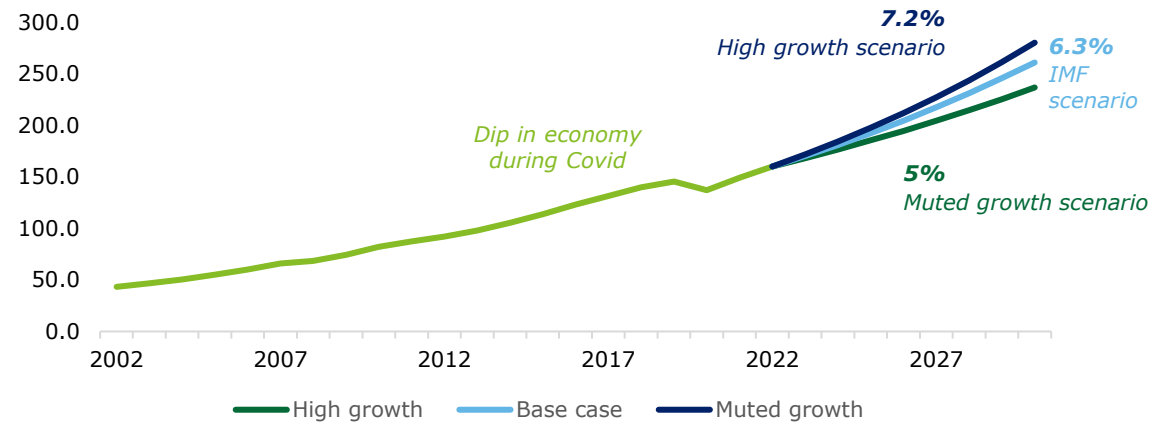


Sources: 1. BP Stats Review 2022, 2. ORF, 3. PIB press releases

Projected Gas Consumption @15% Share in Energy Mix

Growing economy is expected spur demand for energy. With focus on manufacturing and reducing emissions, demand for natural gas demand will go up

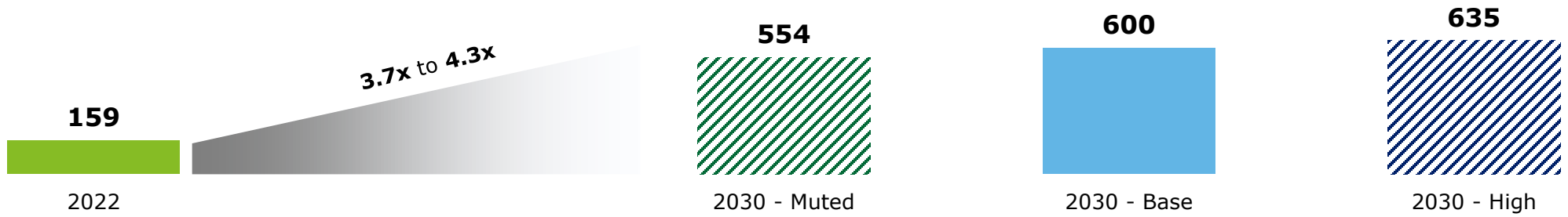
GDP projection (constant prices) INR trillion



- India is in a period of unprecedented opportunity, challenge and ambition in its development.
- Already the world's **third largest economy** in purchasing parity terms, India is expected to surpass Germany and Japan in this decade on nominal basis
- India's long-term GDP growth has become more stable, diversified, and resilient.
- Over the next few years, India is expected to grow at well over **6-8%** per year, with progress being buttressed by dynamic reforms in the macroeconomic, fiscal, tax and business environments.

To reach 15% share, it will require gas consumption to grow at a steep rate of ~17-19% each year to reach at least 600 mmscmd in 2030

Natural Gas Demand Projection @15% share mmscmd



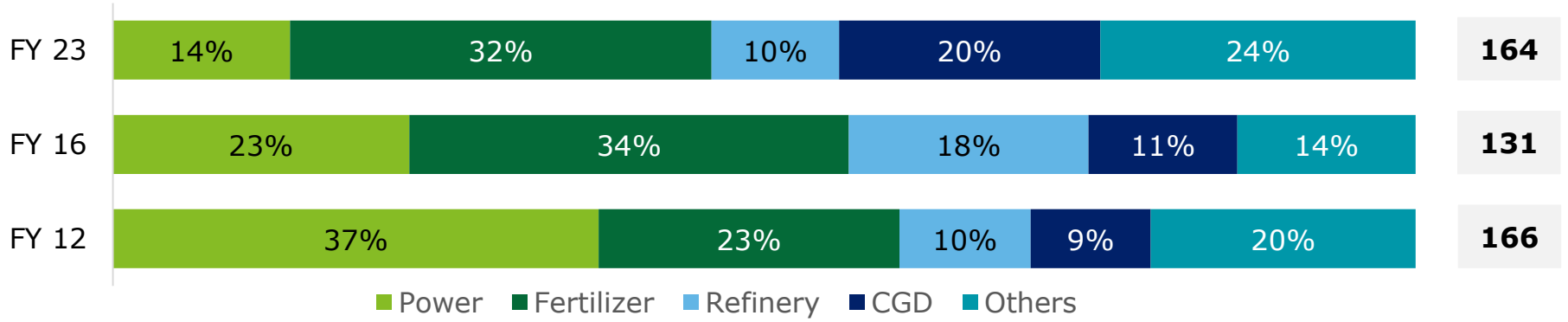
Notes: 1. BP Stats Review 2022, 2. Projected PE(J) based on co-relation with GDP, 3. PE co-related established with GDP. Three scenarios assumed for GDP projects (muted @5%, base @6.3% as per IMF and high growth @7.2%)

Sources: 1. BP Stats Review 2022, 2. ORF, 3. PIB press releases, 4. IMF

Sector Wise Consumption and Challenges Impeding Higher Share of Gas in Energy Mix

Natural gas has positioned itself as the preferred fuel for the transition to net zero, but challenges are on the horizon

Sector wise NG consumption (mmscmd)



- **Demand from fertilizer has remained strong**
- **CGD sector has benefited from allocation policy**
- **Power sector share has dropped due to lack of sufficient domestic gas**

Sector wise challenges

Power

- Declining domestic natural gas allocation
- Lower priority in gas allocation
- High gas price leading to higher power tariff and non dispatching of the plant

Fertilizer

- Volatile natural gas prices puts burden on fertilizer subsidy.
- Pricing of fertilizer is regulated and highly energy intensive process.

CGD

- Lower achievement of MWP targets
- Industrial and commercial consumers are dependent on LNG/deep water gas and are subject to market fluctuations leading to swings in demand/fuel switching by customers
- Litigations challenging regulations /authorizations have surfaced slowing infra development and competition

Refinery

- Dependence on imported LNG
- High cost of gas as feedstock for petchem products puts Indian players at disadvantage

Sources: 1. BP Stats Review 2022, 2. ORF, 3. PIB press releases

Sector Wise Projection of Natural Gas Demand

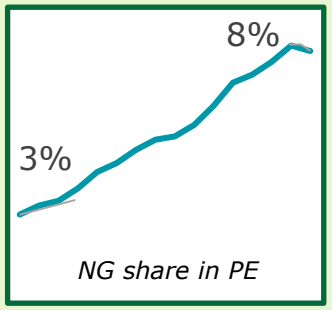
2

Case Study | How has Gas Share Increased in Other Countries?

Globally, increase in gas share has been largely driven by unlocking domestic reserves and market reforms. For India to achieve a higher share of NG, the domestic production needs to ramp up and next phase of reforms needs to kick-in

China

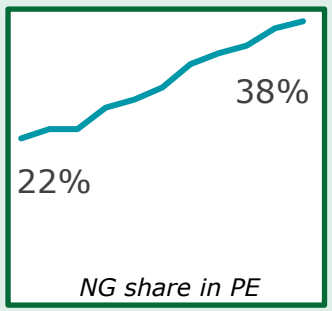
- China's government has incentivized the transition from coal to natural gas to reduce air pollution and meet emissions targets.
- NG consumption was encouraged by expanding gas PPL infrastructure
- Domestic production increased ~3.7x from 60 bcm to 209 bcm btw 2006-22
- LNG imports increased from 1 bcm to 93 bcm
- Period was associated with introduction of pricing reforms aimed at relaxing govt. controls on gas prices



Period: 2007 - 2022

UK

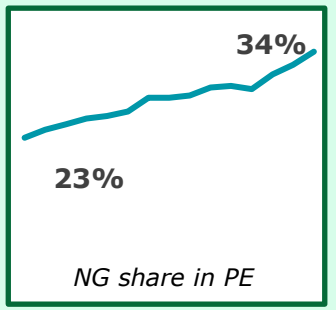
- Post discovery of large reserves of natural gas in North Sea, UK shifted to natural gas for heating in 1970s under govt. led program
- Due to 1973 oil crisis, investments poured into North Sea, tripling O&G production by 1979
- NG production 2.4x between 1990-2000
- Post 1990, NG share exceeded coal as gas fired power plants replaced coal-based power and central gas heating became popular in homes.
- This was aided by privatization of gas supply and opening up of gas markets



Period: 1990 - 2000

USA

- Fracking boom revered production declines post 2005 and has had a dramatic effect on gas supply and prices putting US on pole position
- NG production has nearly doubled (522 bcm to 979 bcm), and more than 100 coal power plants were replaced by gas after 2011, driven by stricter emission standards, low NG prices, and more efficient NG turbine technology
- State-level as well as federal-level environmental policies have pushed gas up in the energy mix while pushing out coal



Period: 2007 - 2022

Sources: 1. SP Global, BP Energy stats, Office of Budget Responsibility, TC Energy, EIA, Forbes

Overall Approach

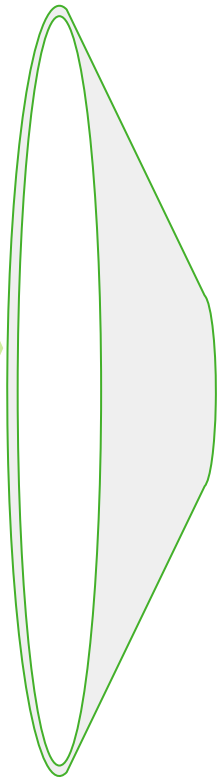
The approach employs quantitative analysis to calculate sector wise natural gas demand tempered with drivers and constraints

As-is sector-wise consumption of natural gas (FY 23)

Sector wise projection of natural gas demand in 2030 (base case, stretch case)

Top Bottom Assessment of Projected Natural Gas Demand @base scenario of economic growth

Bottom-up Assessment of Projected Natural Gas Demand



Sector wise stack-up of natural gas demand projection for 8% and 15% share

Enablers to increase sector natural gas consumption

Projection of natural gas @15% share in primary energy mix: Based on projection of primary energy linked to correlation with GDP forecasted under three different scenario (muted, base, high)

Sector wise **overview, growth drivers and constraints** to build assumptions for NG projection under both scenarios

BASE CASE @8% SHARE

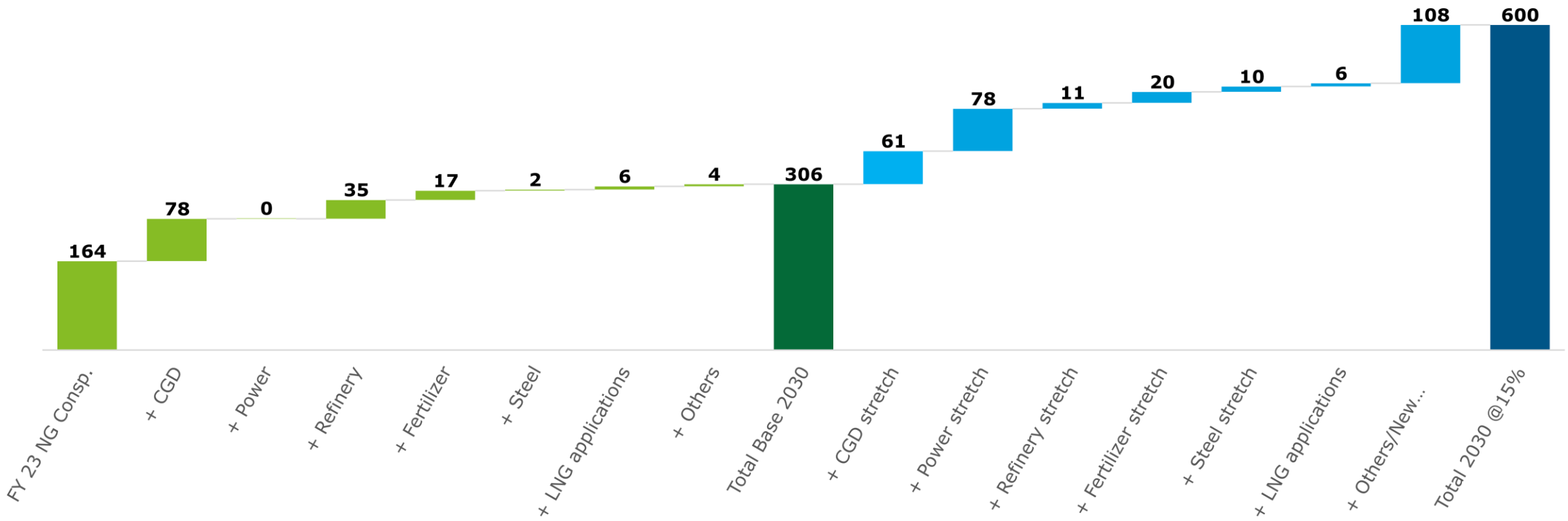
Business as usual scenario under which natural gas demand continues to grow as per existing constraints and drivers

STRETCH CASE @15% SHARE

Stretch scenario requiring additional initiatives and enablers to drive up consumption of natural gas

Projection of Sector-wise Natural Gas Demand @15% Share of Primary Energy Mix

Natural gas consumption is expected to reach ~306 mmscmd ~@8% share in the base scenario. To push the share of natural gas to the desired target of 15%, it will require additional measures and initiatives



Business As Usual (Base) Scenario @8% Share

Stretch Scenario to Target Higher Consumption @15% Share

Demand Projections by Others

Other India and global agencies have also projected a similar range of the natural gas demand by 2030 (FICCI ~300 mmscmd, EIA ~ 311 mmscmd and IEA ~ 315 mmscmd)

Note: 1. Demand projection is based on internal analysis and is subject to unlocking of multiple levers and targets. The study lays down the potential sectors to fill up the demand funnel to achieve a 15% target share

Overview of Natural Gas Consumption (1/2) - Power

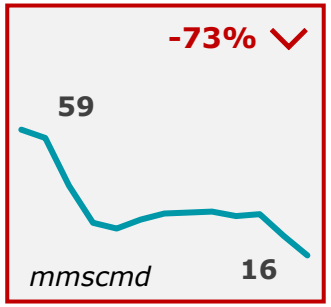
Power generation from gas-based power plants has dropped more than 70% since FY 11 due to challenges around gas availability, pricing and domestic gas allocation policy

Gas power sector in crisis

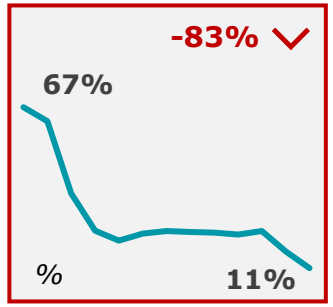
- Out of 23.8 GW installed capacity, 31 plants with 14.3 GW capacity are stranded
- In FY 23, the overall PLF was only 11.4% with 37 plants with 67% capacity share having a PLF of <5%[1]

- Isolated plants fared better with 58% generation share and a PLF of 54% due to better availability of gas and lack of competition
- Gas power plant capacity gas gone up by 43% but generation has reduced by 76% over the same period

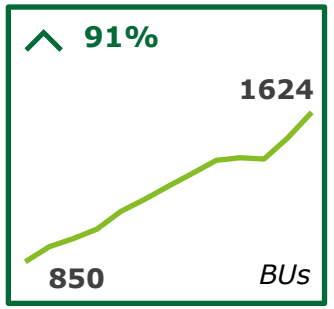
All India power production has increased by 91% (FY11- FY23), but gas sector has seen major reversals, with large drop in gas consumption and subsequently PLF. Gas received vs allotted gas has dropped from 90% to just 17%



Gas consumption - Power



Gas Power Plant PLF



All India Power Generation

Challenges faced by gas-based power plants

1. **Drop in domestic gas production:** Gas production declined drastically from peak of 2011, especially from RIL's KG D6 basin. Many gas plants which became stranded due to lack of gas leading to fall in gas-based power generation

2. **Change in gas allocation policy:** Domestic gas allocation policy was changed in promote CGD over power sector

3. **Increase in RE and coal-based capacity:** There was massive increase in coal and RE capacity which has inherent lower tariffs leading to gas plants losing out in the dispatching power

4. **Volatility in LNG price:** Due to declining availability of domestic gas, plants had to depend on LNG. However, higher prices of LNG coupled with volatility meant, LNG based power was not competitive

Sources: 1. CEA, PPAC

Projection and Enablers of Natural Gas Consumption (2/2) - Power

Gas consumption from power sector can increase 2x-4x if initiatives are taken to improve gas availability and dispatchability recognizing the value provided in integrating RE power and peaking power

Natural Gas Demand Projection in Power sector (mmscmd)

Enablers to increase gas consumption in power sector

1 Blending Gas Power with RE

- **Blend power** produced from domestic gas instead of R-LNG (whose prices will remain high) with renewable energy (solar/wind) as it will result ~ INR 5/unit tariff.
- This will improve utilization of gas power plants

2 Reduce allocation from refinery and fertilizer

- Increase **mandates** for fertilizer and refineries to **use green hydrogen** instead of grey hydrogen from NG
- The freed up domestic gas can be diverted to gas power plants to provide gas at cheaper rates and will help to improve PLF of existing plants.

3 Include emission factor in merit order of dispatch

- Gas power generation emits ~ 50% less CO_2 vs coal plants, however, this is not factored in while considering dispatching power as per Merit Order
- Introduce an **emission factor or a higher carbon tax** to improve ranking and PLF of gas power plants

4 Higher pricing for gas power

- Improve PLF of gas power by valuing the flexibility provided to grid through higher prices and mechanisms such as High Price Day Ahead Market (HP DAM), and higher offtake in peak months

5 Restrict unbated coal power generation

- There are 66 Cat. A and 72 Cat. B plants with 45 GW capacity as per MoEF&CC. Restrict coal power generation in plants closer to large population centres/ critically polluted areas and enforce installation of Flue-gas Desulfurization (FGD) systems as only 8% plants have installed it by end of 2023.

Notes: 1. Installed capacity of gas power plants assumed same as present (23845 MW), 2. Avg. 5Y PLF (FY19-23): 20%, 3. 5Y avg. gas consumption = 1601 MUs/mmscmd
Sources: 1. Deloitte Analysis, IEEFA, CEA, New articles, Ministry of External Affairs – Economic Diplomacy Division, PIB, Down to Earth

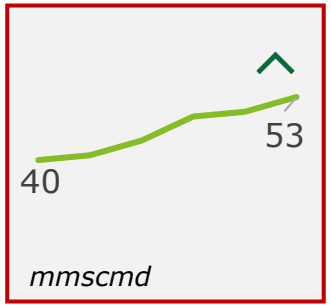
Overview of Natural Gas Consumption (1/2) - Fertilizer

Fertilizer generation from gas-based power plants is growing at a steady pace with the support of subsidies & Direct Benefits Transfer (DBT) and aim to reduce imports

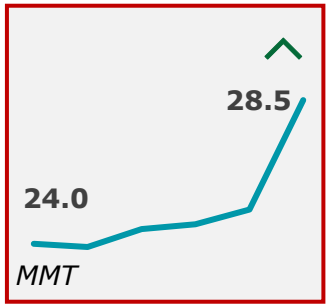
Fertilizer sector aims to increase production and cut on Imports

- Currently there are 36 Gas Based urea units with total capacity of 28.4 MMT.
- In FY 22, plants are running at average utilization of 96.3%, Newly revived plants are expected to curtail imports.[6]
- Revival of closed plants to boost indigenous production and will help in curtailing exports.
- The fertilizer sector faces critical challenges related to food security, harvest losses resulting from overuse of Fertilizers and the imperative of sustainable development.

PAN India Fertilizer production has risen by 65% (FY17- FY22), but lack of modern technology and limited availability of APM gas sector has witness moderate increase in gas consumption. However, with the focus on Indigenous production average capacity utilization of plants has reached 99%.



Gas consumption – Fertilizers (FY17-FY22)



All India Fertilizer Production (FY17-FY22)

Challenges faced by Gas based Fertilizer plants

1. **Subsidies has kept the Sector sailing:** Fertilizer sector growth is riding upon subsidies. Government bears subsidy for 26 fertilizers.
The subsidy bill has fluctuated (~3x between FY 20-23) a lot as per the volatility in prices in the global markets

2. **Highly subjected to price fluctuations of natural gas :** Energy accounts for 90% of the variable costs for ammonia production and NH_3 itself accounts for 80% of the energy production of urea leading to high dependence on prices of natural gas used to produce NH_3

3. **Changes in gas sourcing:** Due to declining domestic production, fertilizer companies have to resort to LNG and are thereby subject to pricing volatility. Under revised gas procurement rules, 40% of gas supplies are now subject to take or pay agreement. Although, it has allowed the companies to buy ~20% of gas through spot markets which will help to take advantage of lower prices.[2]

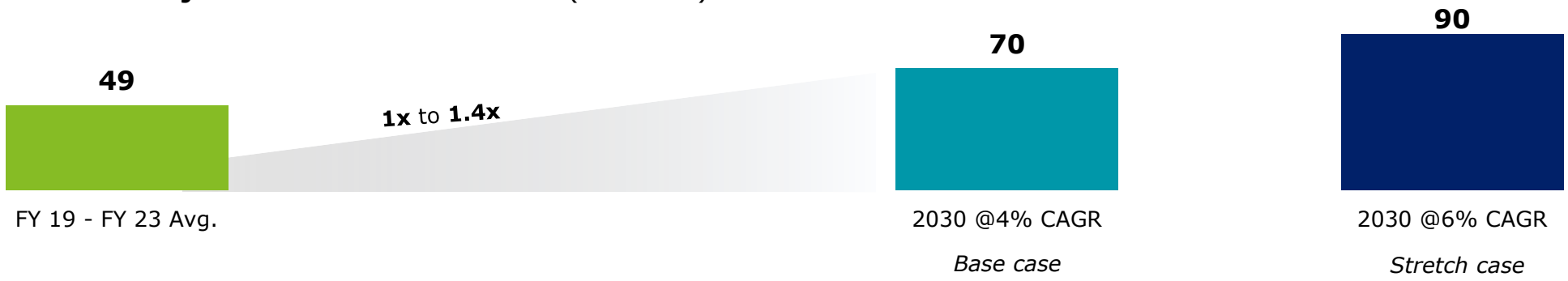
4. **Reduction of fertilizer use:** Introduction of nano urea will impact consumption of tradition urea fertilizers

Sources: 1. Sansad.in 2. Fert.nic.in, 3. Fertilizer Association Of India, 4. News articles, 5. CEEW

Projection and Enablers of Natural Gas Consumption (2/2) - Fertilizer

To reduce imports, revival of fertilizer plants should be expedited and green field capacity to be planned

Natural Gas Demand Projection in Fertiliser sector (mmscmd)



Enablers to increase gas consumption in Fertilizer sector

1 Revival of Gas power Fert. plants

- As per Govt. mandate, existing Plant revival shall be expediated on priority to curtail imports and focus on 'Aatmanirbhar Bharat' (Self-reliant India).
- Upgradation of technology and machinery will help achieve better capacity utilization and increased production.

2 Implementation of gas procurement policy

- Gas sourcing should be done seamlessly from IGX at competitive price.
- Joint sourcing of LNG by pooling gas requirement to reduce gas costs and negotiate as combined entity

3 Increased fertilizer demand from agricultural sector

- India's use of fertilizer is lower than other similar countries with large farming sector. India uses 177 Kg/Ha fertilizer whereas Brazil and China uses 298 Kg/Ha and 319Kg/Ha respectively.[6]
- To improve yield from agricultural land, there will be an increase in fertilizer use, leading to increased demand.
- Balance use of N:P:K. FY 23 ratio was 11.8:4.6:1. Ideal ratio 4:2:1

4 Subsidy allocation

Sufficient and continued budgetary allocation to fertilizer subsidies will ensure production and growth in future.

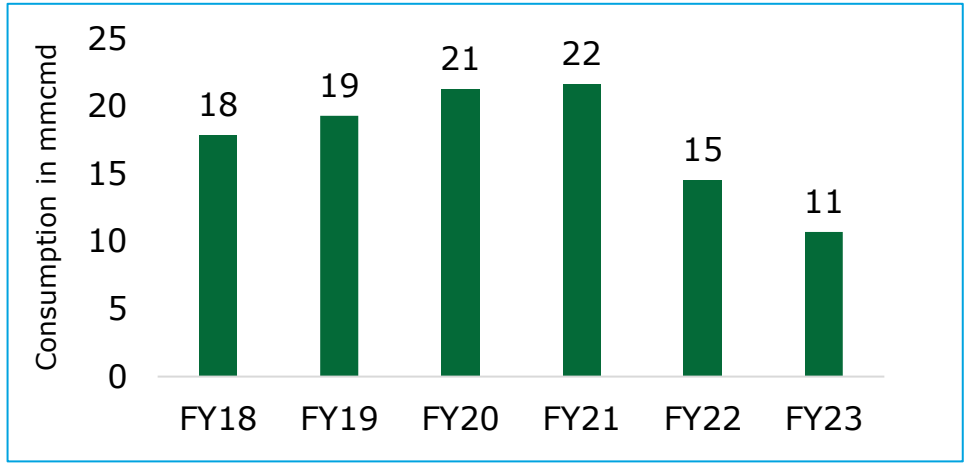
Sources: 1.Sansad.in, 2.Financial Express,3. Livemint, 4. MCF AR, 5.GNFC AR, 6.World Bank

Overview of Natural Gas Consumption (1/2) – Refinery & Petrochemicals

Natural Gas consumption from Refinery has decreased in last few years owing to price of volatile LNG prices

Refinery & Petrochemicals sector

- India has 257 MMTPA of installed capacity, but the total crude processed has been ~2% over its installed capacity i.e. 261.5 MMTPA for FY 23-24[1]
- The consumption of Natural gas has decreased for refinery from 22 to 17 MMSCMD for FY21-23[2]
- The sector is dependent on imported LNG and high volatility in the price of imported LNG contributed to the decline in natural gas by these sectors[3]. The availability of substitutes[4] at more certain price prospects also contributed to the reduction in natural gas consumption by the refining and petrochemicals segments



Challenges faced by the sector

1

Drop in gas sourcing at economical prices: As sector is dependent on imported LNG, high volatility in the price of imported LNG can contribute to the decline in natural gas use by this sector, as is evident in FY22 & FY 23

2

Availability of cheaper substitute: Refineries can increase internal consumption of naphtha, diesel, propane etc. as process fuel to reduce the need for expensive natural gas

3

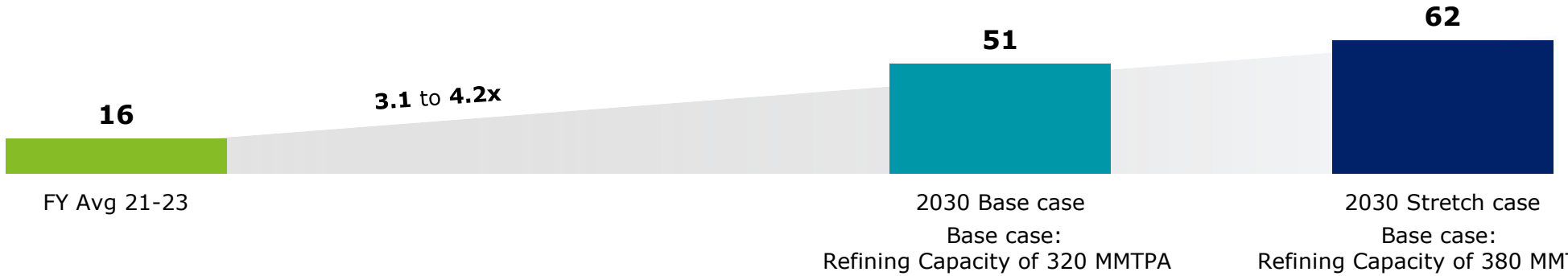
Infrastructure development challenges: Upcoming key projects have been marred by public opposition leading to delays in execution of the major projects like RRPCL, and NG pipeline projects

Sources: 1. PPAC Ready Reckoner March 2024, 2. MoPNG IPNG stats 2022-2023, 3,4. ORF orfonline.org , OMC Websites,

Projection and Enablers of Natural Gas Consumption (2/2) – Refinery & Petrochemicals

Capacity ramp-up primarily geared towards petrochemical integration and emission reductions will push up demand for natural gas in refinery & petrochemicals

Natural Gas Demand Projection in Refinery & Petchem (mmscmd)



Enablers to increase gas consumption in Refinery & Petrochemical sector

1 Target shift to NG by mandating Scope 1 emission targets

- Choice of fuel used in refineries is linked to economics and not emissions.
- Refinery can drive large increase in consumption, and this can be achieved through mandates on increased usage of NG through emission targets

2 Restrict usage of dirty fuels in refinery

- Restrict usage of heavy, residual components forcing switch to natural gas

3 Increase in refining and petchem capacity

- Refining capacity is expected to increase to 300-320 MMTPA by 2030 due to ongoing and announced refinery expansion projects and greenfield HRRL refinery
- Additional 60 MMTPA RRPCL refinery is also under planning

4 Economical Sourcing of Natural Gas

- Implement joint sourcing of gas to negotiate lower gas prices

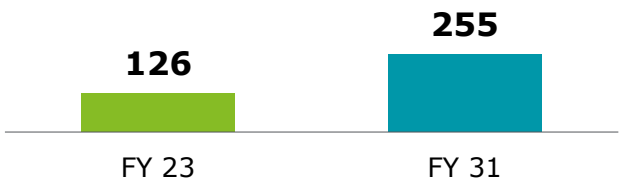
5 Creation of Gas Storages to tackle volatility

Evaluate feasibility of NG storage to cushion the volatility in LNG prices, thereby ensuring increased natural gas uptake

Overview of Natural Gas Consumption (1/2) - Steel

While there will be market for low carbon or green steel, cost economics of gas DRI are unfavorable vs coal

Crude Steel Production (MMT)

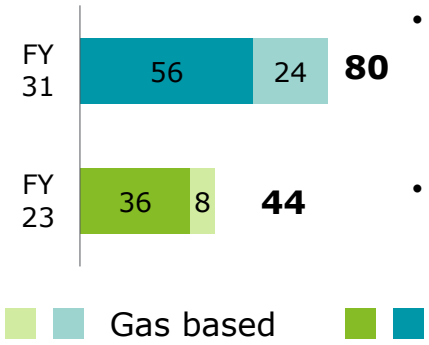


NSP 2017 targets a production of 255 MMT by 2030, an increase of 2x

Drivers

- Per capita consumption of India is lower than world avg. (76 kg vs 233 kg)
- Push on developing infrastructure and manufacturing & GoI schemes such as Gati Shakti, Make in India, Housing for All

Sponge Iron Production (MMT)



- India is **the largest producer** of Direct Reduced Iron (Sponge Iron) and is projected to grow to 80 MMT as per NSP
- Current Production is mainly via coal with **gas-based** production accounting **~ 20%**

Why is coal predominately used in making Sponge Iron in India ?

Coal based rotary kiln furnaces for production of DRI is predominantly found in India and no green field gas-based capacity has come up in India since 1994.

Advantages of Coal based DRI

- Relatively low capital investment costs and operate at smaller scale
- No requirement of coking coal. Non coking coal is used as fuel and as redundant
- Flexibility in location as non coking coal is widely available in India
- Cost advantage vs gas-based DRI process. Gas feed is at-least **1.5x to 3x expensive vs coal feed[1]**

Need for reduction on coal usage in steel making

- Steel sector contributes to ~12% CO_2 emissions of country with each tonne steel production leading to ~2.5 T CO_2 vs global avg. of ~1.9 T CO_2
- Demand for green steel will grow in future
- Regulations about sustainability in advanced countries and the EU are posing challenges for steel exports from India
- Natural gas-based route to desirable for transition to green DRI once green H_2 becomes available at economical rates.
- Coal based DRI plants are highly polluting having adverse impacts on local surroundings

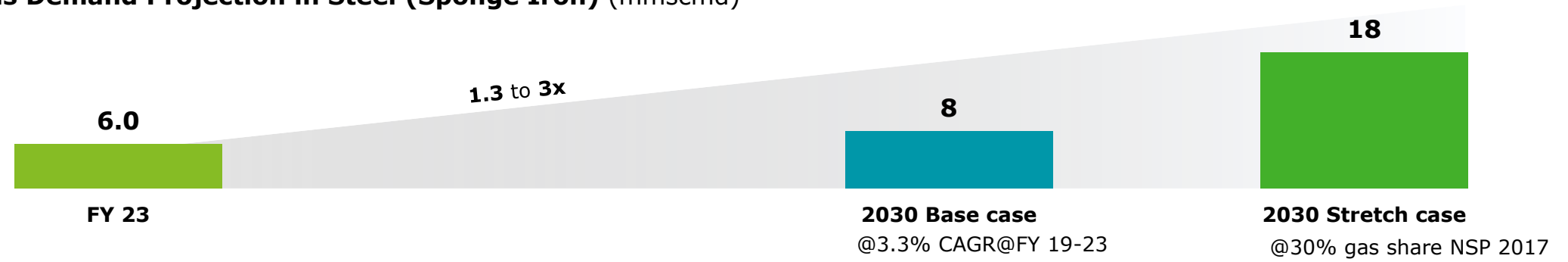
Note: 1. Assumption for 1 tonnes of DRI requires 280 scm of NG or 1100 kg of coal, Coal price ~INR 4500/T and gas price ranging from 7.3 USD/mmBtu for APM gas to 13 USD/mmBtu for LNG @80 USD/bbl

Sources: 1. Ministry of Steel Annual Report, National Steel Policy, Sponge Iron Manufacturers Association, Deloitte Thought Leadership

Projection and Enablers of Natural Gas Consumption (2/2) – Steel

Gas consumption is projected to grow to 8 mmscmd considering historical growth, however accelerated growth of 3x as per NSP 2017 can be targeted if greater emphasis is placed to cut down emissions

Natural Gas Demand Projection in Steel (Sponge Iron) (mmscmd)



Enablers to increase gas consumption in Steel Plants

1 Increased Availability of Domestic Gas for Steel

- MoPNG has to increase supply as production from gas-based plants has stagnated due to lack of domestic gas.
- Greater allocation of deep-water gas which gas higher calorific value

2 Set-up and scale up gas based DRI

- Urja Ganja NGPL (JHBDPL) has brought gas access to the iron & steel belt in JH, OD, WB
- Natural Gas based DRI can be eventually transitioned to green hydrogen to cater to low carbon/green steel emerging market
- Firm supply of natural gas is imperative to boost the confidence and investment in the gas-based steelmaking technology.

3 Reducing emission intensity & Enforcing pollution norms

- Replace LDO for initial start-up of cold kilns
- R&D efforts for technological solutions to substitute part of the coal by NG in existing coal based DRI
- Reducing coking coal usage in integrated plants by NG injection
- Enforcing pollutions norms on the unorganized MSME coal based DRI plants

4 Make price of natural gas economical for steel sector

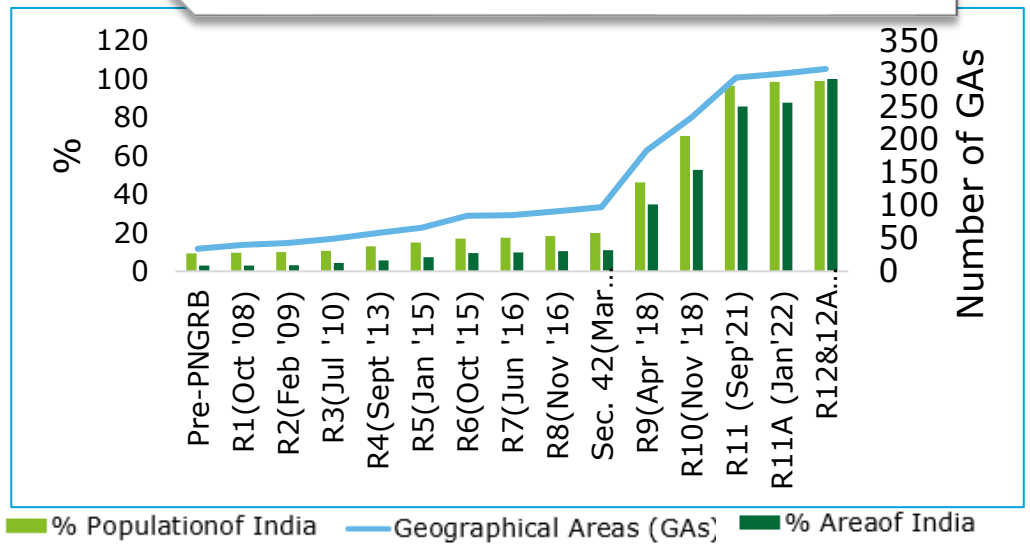
Supply NG at affordable rates ~USD 7/mmBtu, duty waiver on LNG and include NG in the ambit of GST

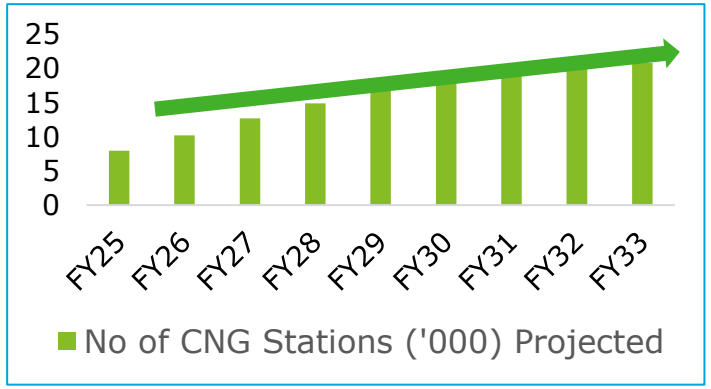
Sources: 1. National Steel Policy, Sponge Iron Manufacturers Association, Argus Media

Overview of Natural Gas Consumption (1/5) – CGD

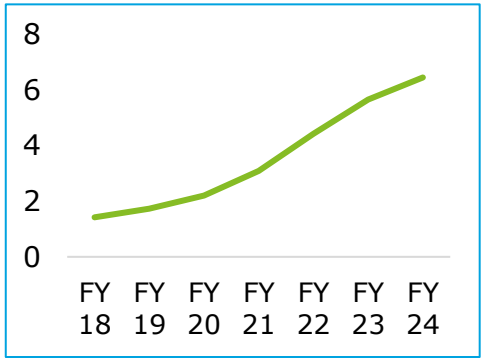
India has witnessed significant growth in authorizations, number of CNG stations, commercial and industrial connections FY 2018 onwards, fueling the demand for NG

Explosive Growth by 3x in Authorizations from 97 to 307 (FY18-FY24)[1]





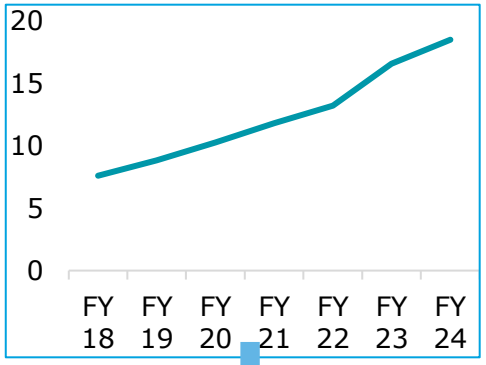
CNG Stations[2] ('000)



Significant Growth by 353% in number of CNG stations from 1424 to 6456 (FY18-FY24)

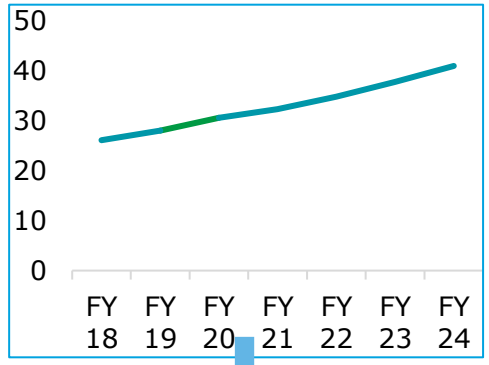
MWP target is set out for completion by 2032

Industrial Conn[2] ('000)



Increase by 108% in no. of Industrial connections from 7601 to 18500 (FY18-FY24)

Commercial Conn[2] ('000)



Increase by 56% in no. of Commercial connections from 26131 to 40,040 (FY18-FY24)

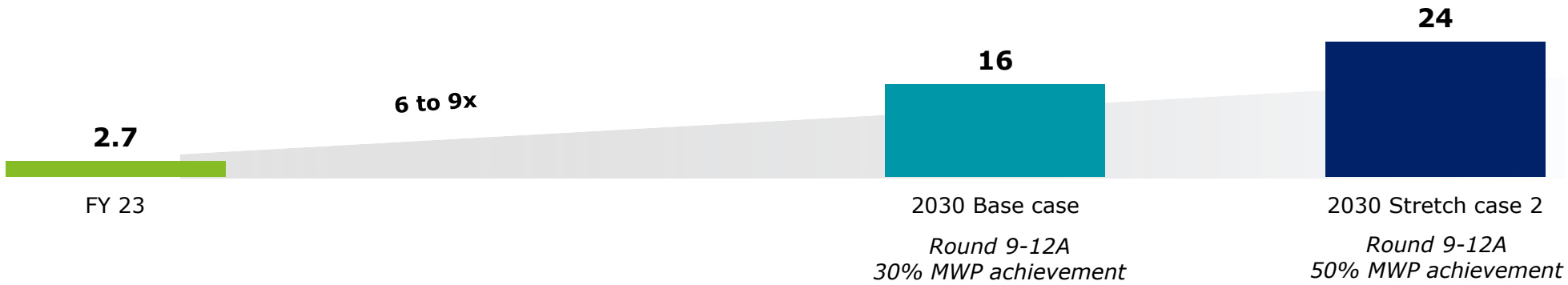
Notes: 1. Projects of CNG stations as per MWP target and growth

Sources: 1. PNGRB 12th CGD Bidding Round Roadshow, 2. IPNG Stats & PPAC Ready Reckoner March 2024

Projection and Enablers of Natural Gas Consumption (2/5) – CGD (PNG)

Increased focus on meeting MWP targets and favourable economics vs LPG should drive up adoption of PNG

Natural Gas Demand Projection in PNG segment (mmscmd)



Enablers to increase gas consumption in PNG segment

1 Focus on completion of MWP targets

- CGD companies are falling behind in meeting MWP targets
- Regulator to ensure CGD companies complete MWP targets within quoted timelines

2 Continuation of existing gas allocation and pricing policy

- Since 2014, D-PNG receives top-most **priority in allocation** of domestic gas
- Policy should be continued in future so that D-PNG receives cheaper domestic gas and is able to maintain pricing competitiveness vs. LPG

3 Mandate gas pipeline in new buildings and rationalize charges and timelines

- Involve central and state level Ministry of Urban Development Departments to mandate gas pipeline as a required utility for permitting new buildings in areas where CGD GA is already authorized or soon to be operational
- Rationalize CGD infra/RoU charges across local govt. bodies

4 Roll out of PNG adoption schemes.
Expedite PNG connections and increase PNG penetration through rollout of Prajwala scheme planned by MoPNG

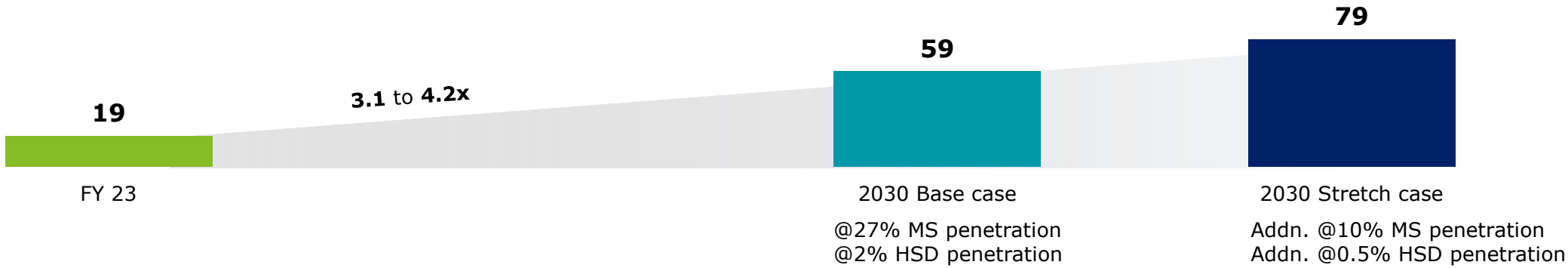
5 ROU Push Single Window Clearance for expediating ROU permissions.

Notes: 1. Avg. consumption 0.4 scmd per domestic connection for R9-12A, 2. MWP targets as quoted for each GA
Sources: 1. PNG statistics 2023, news articles,

Projection and Enablers of Natural Gas Consumption (3/5) – CGD (CNG)

Increased focus on reducing emissions, favorable TCO, and availability of inter-state infrastructure will push adoption of CNG fueled vehicles

Natural Gas Demand Projection in CNG segment (mmscmd)



Enablers to increase gas consumption in CNG segment

1 Continuation of existing gas allocation and pricing policy

- Since 2014, CNG receives top-most **priority in allocation** of domestic gas, Policy should be continued in future so that CNG receives cheaper domestic gas and is able to maintain pricing competitiveness against competing fuels

2 Expanding mandates for use of CNG vehicles

- Expand mandate for use of CNG in public transport across other cities/towns similar to Delhi and Mumbai
- To address pollution concerns, consider introduction of low emission zones which will exempt CNG & EVs and charge other MS/HSD vehicles

3 Reduction in taxes for CNG

- Natural gas in not under GST regime, it is subjected to multiple taxes.
- At present CNG is charged BED of 14% and sales tax as high as 25% in few states
- RSP Savings in range 1%-20% with an average 7% with implications of 18% GST

4 Reduction of GST on CNG vehicles

- Current GST rate of 28% on CNG vehicles is same MS and HSD fueled vehicles despite being a cleaner fuel and should be reduced one step above EV which are taxed at 5%

5 Penalize for non-achievement of MWP

Sources: 1. PNG statistics 2023, news articles,

Projection and Enablers of Natural Gas Consumption (4/5) – CGD (Commercial)

Coverage of CGD across India will enable access of natural gas to commercial users of LPG

Natural Gas Demand Projection in CGD Commercial segment (mmscmd)

Enablers to increase gas consumption in CGD Commercial segment

1 Extend domestic gas for commercial segment

- Demand from commercial segment is not large and availability of domestic gas will ensure lower price for small scale business owners spurring adoption of natural gas

2 Adoption Campaigns

- Marketing of multifaceted benefits - reduction of opportunity costs due to by supply delays, elimination of fuel storage space requirements, safe and reliable transition to commercial PNG connections, uninterrupted supply to sustain business operations

3 Leveraging Technology for Demand Aggregation

- Existing demand aggregation platform, who have commercial outlets listed, like food delivery apps can speed up the reach in each GAs prior to setting up infrastructure in that GA. Example- Commercial chains can lead to demand aggregation from multiple outlets

4 Application of Co-gen and Trigeneration Systems Co-gen and Tri-gen can help hotels, restaurants and hospitals enhance energy efficiency, slashing costs and reducing greenhouse gas emissions. Wider role of district cooling can be explored.

Sources: 1. PNG statistics 2023, news articles, 2. International Institute of Energy Conservation (IIEC)

Projection and Enablers of Natural Gas Consumption (5/5) – CGD (Industrial)

Industrial CGD segment consumption will grow through a combination of inherent conversion and through policy and regulatory measures

Natural Gas Demand Projection in CGD Industrial segment (mmscmd)

At different fuel conversion rates (HSD, LPG, LDO, LSHS, FO, Naphtha, Petcoke)

Enablers to increase gas consumption in CGD Industrial segment

1 Ban polluting fuels through legislation and policy

- Mandate compulsory use of natural gas and ban pollution fuels like (FO, LDO, Naphtha)
- Implement in phased manner targeting industrial clusters and urban areas with high levels of pollution

2 Include natural gas under GST

- Natural gas is outside GST ambit and is subjected to multiple taxes.
- Competing fuels are subject to lower taxes due to inclusion in GST regime

3 Expand infrastructure of CGD network

- Expand CGD transmission and distribution network to reach industrial customers

4 Flexible Contracts

Provision of flexible contracts for dual fuel arrangements can push the adoption and demand in Industrial segment

Notes: 1. HSD bulk sales assumed 12% of total HSD sales (PPAC data)
Sources: 1. PNG statistics 2023, News articles

Enablers Towards 15% Gas Share

3

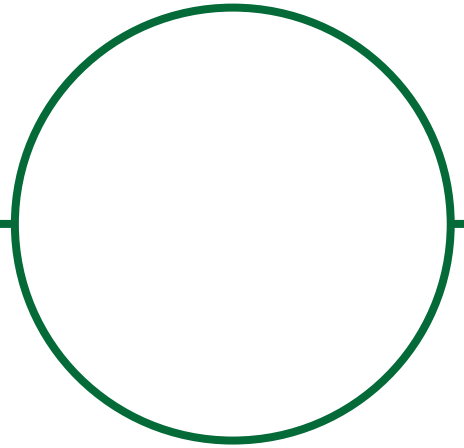
Summary of Key Enablers

Key area specific enablers working in tandem will pull the demand triggers in different segments

Imperatives for India	Levers...		Key Initiatives for 15% Share
Grid balancing with RE power	Pricing	Power	1 Blending Gas Power with RE for affordable pricing from gas-based power plants
		Fertilizer/ Refining	2 Joint sourcing of LNG by pooling gas requirement to negotiate as combined entity and source of gas from spot
		Steel	3 Supply NG at affordable rates to steel sector and consider duty waiver on LNG
Improve air quality	Infra	All Sectors	4 Creation of Gas Storage facilities to tackle LNG price volatility for import dependent sectors
		CGD	5 Meeting MWP targets for CGD will drive consumption in CNG, PNG, Ind. & Com. 6 Expediting ROU permission & resolving hurdles in the ROW
Diversify energy mix	Consumption Policies	Power	7 Restrict unabated generation of coal power in high population centers and critically polluted zones
		Refining/Steel	8 Restricting emissions through targets and mandating use of natural gas
		CGD Ind	9 Ban polluting alternate fuels and allow flexible contracts to increase adoption of NG
Sourcing from domestic/ spot	Gas Sourcing	All Sectors	10 Use of spot market for sourcing of gas to take advantage of lower prices 11 Continuation of preferential gas allocation and pricing policy for CGD sector
Adoption of transition fuels	Taxation Reforms	All Sectors	12 Bringing Natural gas in GST ambit
		CGD	13 Reduction of GST on CNG vehicles, keeping one step above EV

Sources: 1. PPAC, MoPNG, Gati Shakti, OMC Websites,

End of the Report



01 ZONAL STUDY ON LPG PIPELINE: POTENTIAL NEW LPG PIPELINES TO BE BID OUT

02 RAPID ASSESSMENT OF "PATHWAYS TO INCREASE SHARE OF NATURAL GAS FROM 6% TO 15%"

03 GLOBAL CASE STUDIES OF TRANSMISSION SYSTEM OPERATOR (TSO)

04 ASSESSMENT OF MATURITY IN NATURAL GAS MARKET

05 MARKET AND REGULATORY FRAMEWORK FOR GAS DISTRIBUTION SECTOR ACROSS THE GLOBE

Report
on

Global case studies of Transmission System Operator (TSO)

Prepared For Petroleum And Natural Gas Regulatory Board (PNGRB)
By Deloitte Touche Tohmatsu India LLP (DTTILLP)

July 2024

Study Context

The Petroleum and Natural Gas Regulatory Board (PNGRB) is evaluating global markets to understand the liberalization of the natural gas sector

CONTEXT

PNGRB is evaluating unbundling of natural gas market in India.

PNGRB team requires an assessment of global gas markets in implementation of unbundling models for establishment of TSO in that country

Scope of Work for each of the Modules

1 Module 1 – Introduction and Overview of Unbundling

Understand the objectives and need for unbundling and overall approach of the study

- Need for unbundling in Indian gas market
- Objectives and Benefits of Unbundling
- Implementation of Unbundling in European Union (EU)
- Types of unbundling models

2 Module 2 – Global Case Studies

Select and evaluate countries which have implemented unbundling of gas market

- Selection of countries for the study
- Overview and Timeline of Evolution of gas market
- Formation of Transmission System Entity
- Functioning of TSO
- Role of entities in the gas market

3 Module 3 – Assessment and Key Learnings

Assess and draw key learnings from global models

- Global assessment of Market Unbundling (key learnings, Selection of Unbundling Model, Benefits)

Overview of Unbundling

1

Is There A Need For Unbundling In Indian Gas Market?

Lack of transparency in capacity declaration and imbalance management by vertically integrated entities in gas transmission limit open access to infrastructure, restricting competition in price & customer choice

Is there a need for Unbundling?

Transparency

For Better transparency in capacity declaration and imbalance management, as the current mechanism of capacity declaration & booking is decentralized and there are chances of information asymmetry. Hence, an integrated entity (marketing and transportation) might prioritize its own capacity, reducing available capacity to buyers.

Gas Market Liberalization

Currently, presence of an entity engaged in both transportation and marketing leads to right of first use over available capacity in a gas pipeline, limiting open access to shippers on non-discriminatory basis. Hence, unbundling of transportation would reduce barriers to entry for new shippers to gas infrastructure, fully liberalizing the gas market.

Competition in Gas Supply

There are few Suppliers (Refer Notes) of gas in the whole sale gas market, leading to :

- Limited options for customers to choose from considering vast geography of India
- Ineffective market-based price discovery

Notes: 1. Entities engaged in parts of value chain: Producer/Supplier/Transmission with Top 2 entities owing ~66% length[1] of total authorized gas transmission infrastructure and gas volume% ~65% marketed by these top two entities as per FY23 stats

Source: 1. MOPNG/IPNG STATS 2022-2023

Objectives and Mechanism of Unbundling

Protecting interests of end consumers & fostering competition in the market is prime objective of unbundling

Objectives

- To protect interests of the consumers by fostering **trade and competition** in gas supply market
- To ensure **open access** to natural gas transmission pipeline infrastructure on **non-discriminatory basis** by enabling transportation or transmission of gas as a service space not as a space for competition
- To **increase efficiency** in the gas value chain by separating activities
- To **reduce barriers** to entry of new players in the gas supply market

Mechanism

By separation of transportation business unit from other aspects of the business, i.e., production, marketing and distribution, of a vertically integrated entity or an entity present in multiple segments of the value chain in addition to involvement in the transportation of natural gas

EU Directives for TSO and Unbundling mechanism

European Union played a key role in devising an unbundling mechanism

European Union

- European Union (EU) played a key role by defining policy packages to integrate European Market.
- Structural separation of gas transmission system was introduced by EU in their Third Gas Directive. But the entire transition of European Gas Market happened in a phased manner. The main areas of changes were around:
  - Third Party Access
  - Transparency of gas flows
  - Improving integration between markets

Different mechanisms of unbundling

Account Unbundling	Functional Unbundling	Legal Unbundling	Ownership Unbundling
▪ Most basic mechanism of unbundling ▪ Keeping the accounts of various activities separate ▪ It allows regulatory authority to better assess the tariffs proposed and to detect possible instances of cross-subsidy	▪ In addition to the separate accounts, firm is required to re-organize its internal structure. ▪ Separation of operational activities and management ▪ Independent decision making from one another	▪ Establishment of separate legal entities ▪ Legally unbundled entity may be owned by previously vertically integrated firm through a holding company. An interest in discriminating other market players and favoring the parent firm cannot be totally excluded.	▪ Ultimate form of unbundling ▪ A firm owning and operating a network cannot be active in any competitive segment of the supply chain nor have an interest in any company involved in those activities.

EU Directives Timeline and Objective

Three gas directives were passed to reform the Natural gas market

Gas Directives

Third Gas Directive[3] 2009

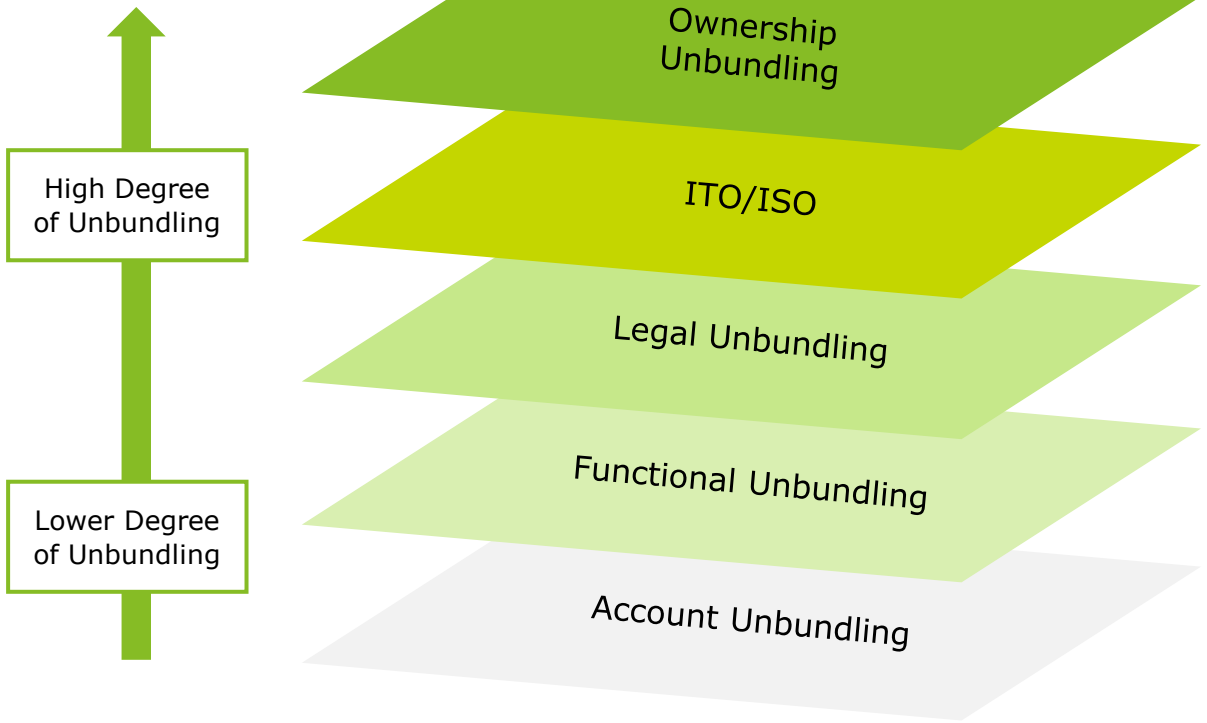
- **Focused on**
  - Introduction of three Unbundling Models- OU, ITO, ISO

Second Gas Directive[2] 2003

- **Focused on**
  - Regulated third party access
  - Legal Unbundling was introduced

First Gas Directive[1] 1998

- **Focused on**
  - Limited Third-Party access
  - Account Unbundling

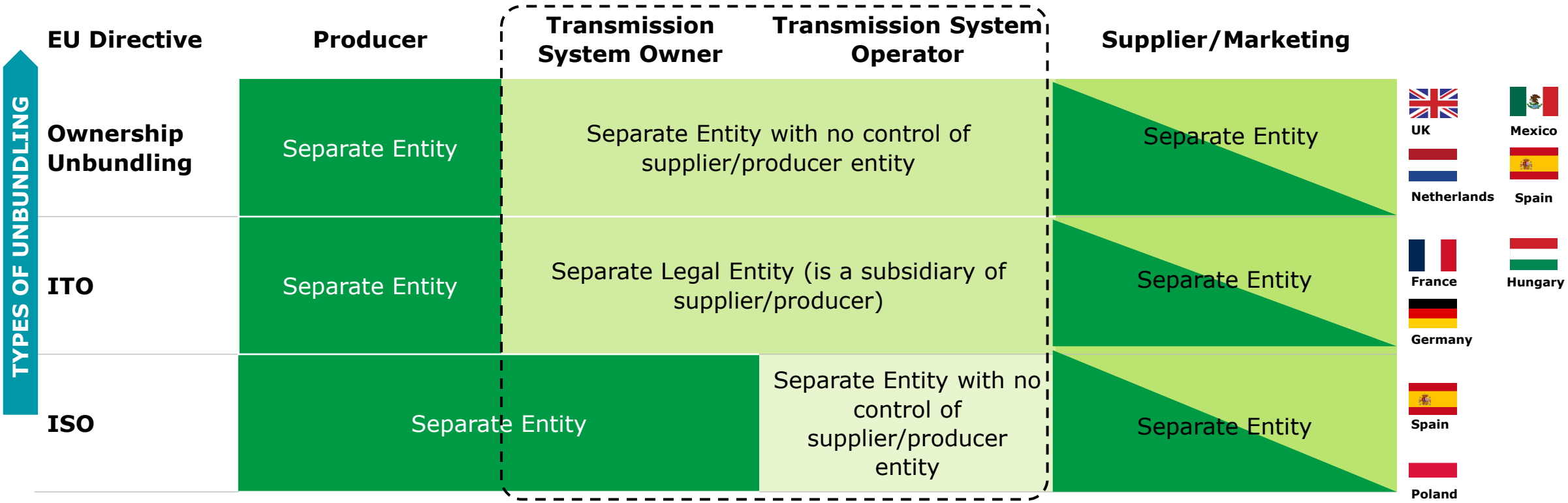


Source: 1. EUR-Lex : European Union Website- Directive 98/30/EC, **2.** EUR-Lex : European Union Website- Directive 2003/55/EC, **3.** EUR-Lex : European Union Website- Directive 2009/73/EC

Types of Unbundling Models as per EU

Different EU unbundling models offer different level of control. Transmission System Operator shall be independent from production & marketing along the value chain

Unbundling Models



Source: 1. Based on Analysis of EUR-Lex : European Union Website- Directive 98/30/EC, EUR-Lex : European Union Website- Directive 2003/55/EC, EUR-Lex : European Union Website- Directive 2009/73/EC

What are the characteristics of Transmission System Operator (TSO)?

TSO was a result of unbundling. Main Objective was to separate the transportation service from production, supply or marketing

TSO Characteristics[1]

TSO is a **Separate legal entity** with no interest in the marketing, supply or production activity in the value chain

- Which **may** or **may not** be a **subsidiary of the parent company**
- Which **may** or **may not own** the **transmission assets**
- Which **operates** and **maintains** the **transmission assets**
- Which **carries** out the **Capacity booking allocation**
- Which provides **third party access of assets** to the shippers
- Which is **responsible** for **Imbalance management**

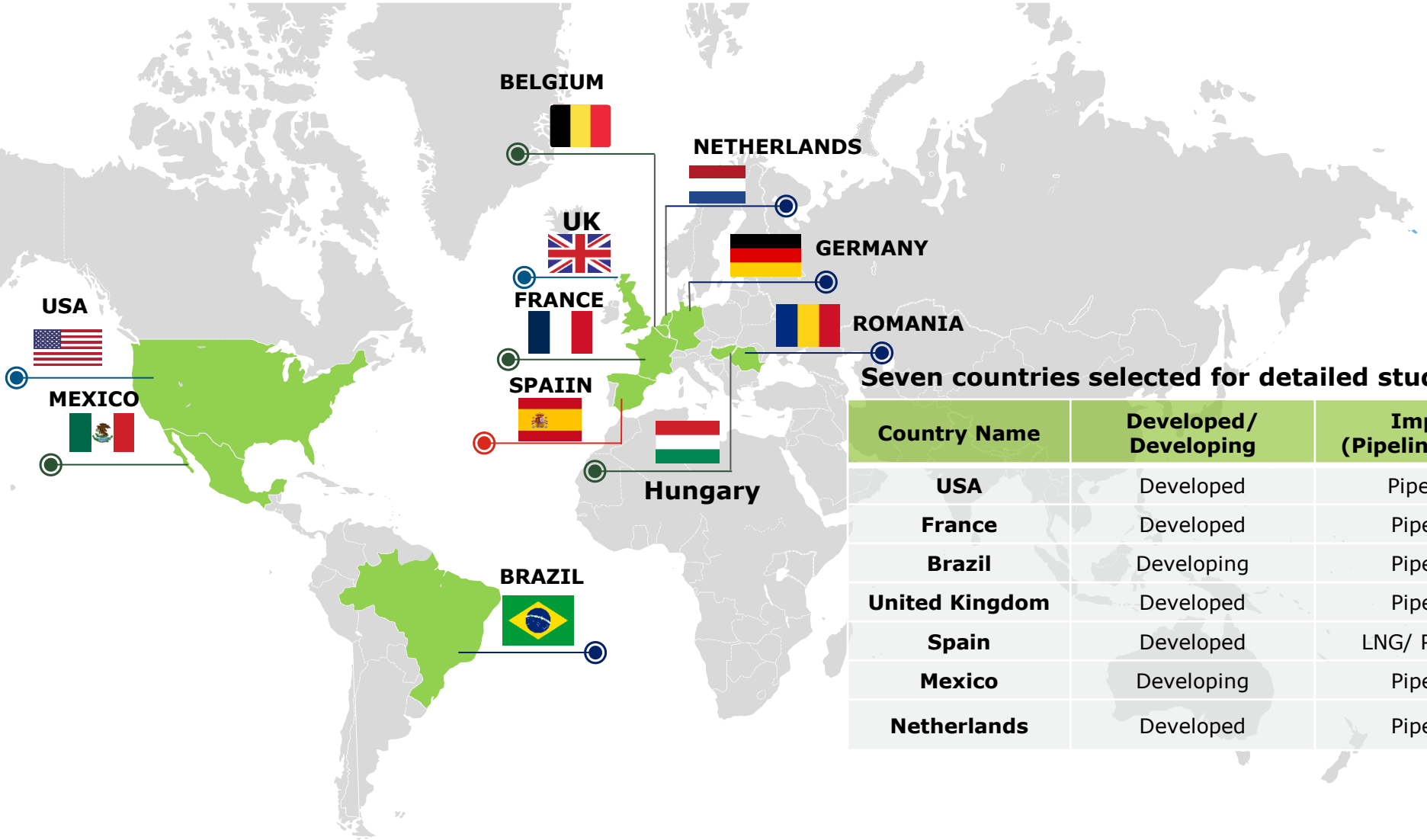
Source: 1. Based on Analysis of EUR-Lex : European Union Website- Directive 98/30/EC, EUR-Lex : European Union Website- Directive 2003/55/EC, EUR-Lex : European Union Website- Directive 2009/73/EC

Global Case Studies

2

Selected Countries

Countries were selected from different parts of the geography basis PE mix, import dependency, geographical area, level of developed economy, and type of unbundling model



Seven countries selected for detailed study

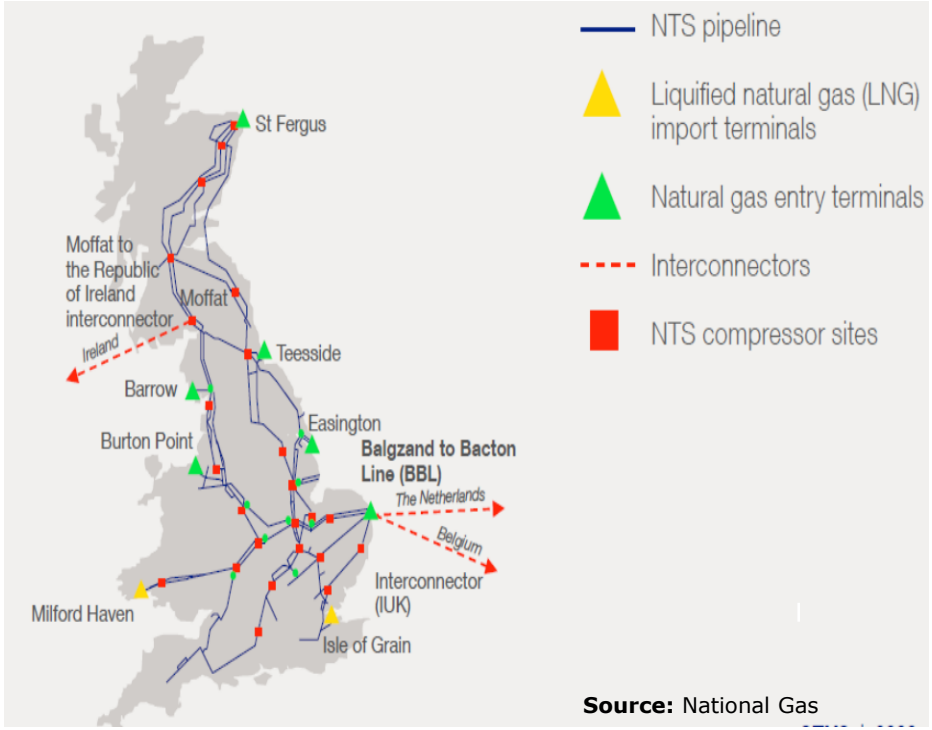
Country Name	Developed/ Developing	Import (Pipeline/ LNG)	Type of Model
USA	Developed	Pipeline	OU
France	Developed	Pipeline	ITO
Brazil	Developing	Pipeline	Legal Unbundling
United Kingdom	Developed	Pipeline	OU
Spain	Developed	LNG/ Pipeline	OU/ISO
Mexico	Developing	Pipeline	OU
Netherlands	Developed	Pipeline	OU

Global Case Study – United Kingdom (1/2)

United Kingdom opted for Ownership Unbundling model

United Kingdom	
COUNTRY	United Kingdom
TSO MODEL	Ownership Unbundling
NO. OF TSO	1 No.
GAS SOURCING	LNG/ Imports through pipeline
PRODUCER/ SUPPLIER	BP/Total Energies/Harbor Energy/Shell/Others
GAS TRANSMISSION PIPELINE OWNER[1]	National Grid Gas also **National Gas**
TRANSMISSION SYSTEM OPERATOR[1]	National Grid Gas also **National Gas**
DISTRIBUTOR[5]	SGN (formerly Scotia Gas Networks) Cadent (formerly National Grid plc/ National Grid Gas Distribution) Wales and West Utilities
REGULATOR[2]	Office of Gas and Electricity Markets

Overview



Source: National Gas

LNG TERMINALS (Nos.)[3]	8
PIPELINE LENGTH (KM)[3]	7666
INTERCONNECTORS (Nos.)[4]	3

Source: 1 National Gas, 2. Ofgem 3. National Gas -Land and Assets 4. Ofgem UK, 5.Climate Change Adaptation Second Round Adaptation Response National Grid Gas July 2016

Global Case Study – United Kingdom (2/2)

Unbundling was triggered due to monopoly of British gas, leading to limited access to gas fields, transmission and distribution infrastructure, thereby limiting competition in the secondary gas market

United Kingdom | **Key Summary**

- **Gas Sector Structure**
  - British Gas was integrated at production, transportation & retail activities and, was a private entity at the time of unbundling
- **Trigger for Unbundling**
  - Unbundling was triggered due to lack of competition in gas market and assumed monopoly by British Gas in UK
  - Unbundling was mandated to resolve the discrimination and difficulties of negotiating access for gas transmission
- **Commodity**
  - **Gas Share in PE Mix:** Natural gas had a share[1] of ~34% in primary energy mix in 1997
  - **Gas Import Dependency:** UK was ~100% supplied from domestic gas production[2] at the time of unbundling but after that import climbed to 7% by 2005
- **Infrastructure**
  - **Gas Network Development :** Pipeline infrastructure was reasonably developed (~65%-5000 kms[3] of current levels 7666 kms) and well spread in the country
- **Regulatory Landscape**
  - Regulations in place for pipeline tariffs and open access at the time of unbundling and there was free market pricing for gas
  - Ownership unbundling aimed to resolve the issues arising from conflict of interest and discrimination due to vertically integration of BG in transmission and trading activities; In 1997, gas trading activities of British Gas was placed under separate ownership, forming Centrica Plc
- **Current Status**
  - **Transportation**: Pipelines are predominantly operated by one large operator, National Gas Grid Plc (earlier by British Gas)
  - **Regulations:** Regulatory framework covering tariff rules, Third Party Access etc. was established along with unbundling initiatives
  - **Enabling Ecosystem**: A virtual capacity booking platform on the gas network, National Balancing Point, is present developed where gas shippers (wholesalers) nominate their buys and sells and where National Grid Gas (NGG), the System Operator, balances the system regularly
  - **Gas exchange at ICE** is also present to facilitate market-based price discovery of gas

Source: 1,2. Stats Review of World Energy 2022 (Energy Institute), 3. Annual Report

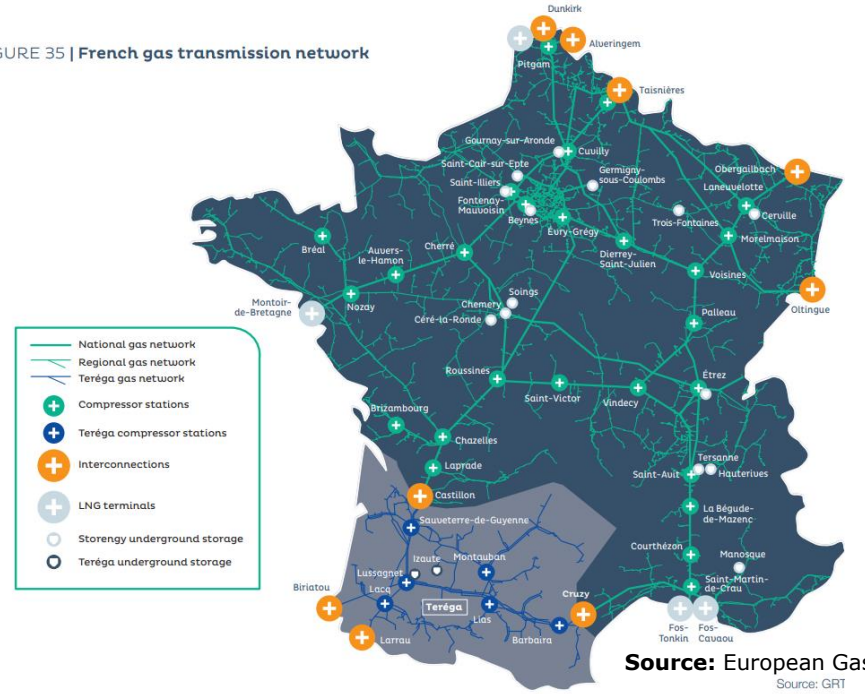
Global Case Study – France (1/2)

France has implemented ITO unbundling model

France	
COUNTRY	France
TSO MODEL	ITO
No. of TSO	2 Nos.
GAS SOURCING	Imports through LNG Terminal and pipelines
PRODUCER/ SUPPLIER	Engie Group (Marketing Entity)
GAS TRANSMISSION PIPELINE OWNER	Engie Group (87%) Total Energies Group (13%)
TRANSMISSION SYSTEM OPERATOR	GRTgaz Terega
DISTRIBUTOR	Gaz Réseau Distribution France (GRDF) (95% distribution grid), Régaz-Bordeaux, R-GDS and 20 others
REGULATOR[3]	Energy Regulatory Commission CRE

Overview

FIGURE 35 | **French gas transmission network**



Source: European Gas Hub

LNG TERMINALS[1] (Nos.)	5
GAS STORAGE[2] (Nos.)	16
PIPELINE LENGTH[2] (KM)	37500
INTERCONNECTORS[2] (Nos.)	7

Source: 1. IEA-France Natural Gas Security Policy and CRE (France) 2. European Gas Hub –French Gas Network Plan 3. CRE-France

Global Case Study – France (2/2)

Gas network maturity and readiness of Regulatory framework were key success factors for France's unbundling initiative

France

Key Summary

- **Gas sector structure**
  - Gas business was integrated i.e. with both transmission and distribution. Hence, both the businesses were separated. Single state-controlled entity, GDF France, held ~87% of gas network in France at the time of initiation of unbundling in 2006
- **Triggers for unbundling**
  - 2nd EU Directive was the primary trigger for unbundling in France
- **Infrastructure**
  - **Gas Network:** Gas network[1,2] was ~97% of length of the current network at time of initiation of unbundling
- **Commodity**
  - **Gas Share in PE Mix:** Natural gas had a share[3] of ~16% in primary energy mix
  - **Gas Import Dependency :** France Natural Gas sector was highly dependent[4]-100% on the imports of natural gas
- **Regulatory Landscape-** Regulator- CRE was formed prior to unbundling
  - Regulatory framework for tariffs, open access etc. was already defined at the time of unbundling
  - Selection of ITO model (Independent Transmission Operator) from the several options of unbundling
- **Current Status**
  - **Transportation**: Transmission Pipelines are operated by two operators, GRTgaz and Terega
  - **Regulations:** Regulatory framework covering tariff rules, Third Party Access (TPA) etc. was established along with unbundling initiatives
  - **Enabling Ecosystem**: A virtual capacity booking platform on the gas network is present developed where gas shippers (wholesalers) nominate their buys and sells and where the System Operator, where market parties & TSOs balances the system on a daily basis.
  - **Gas exchange i.e. PEGAS** is present to facilitate trading and market-based price discovery of gas

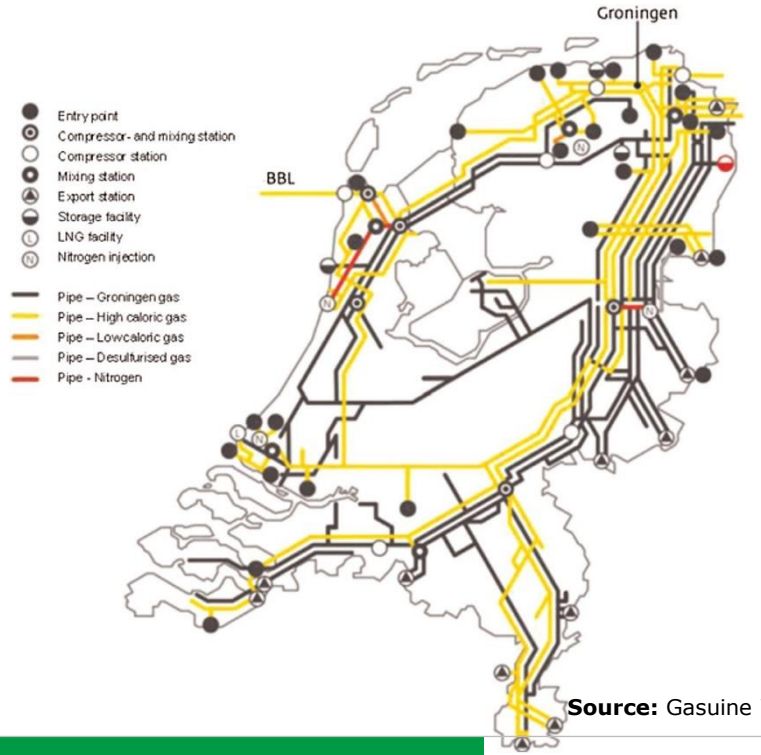
Source: 1. Annual Report Gaz De France & Total Group 2003 & 2004, 2. European Gas Hub –French Gas Network Plan **3,4.-** Stats Review of World Energy 2022

Global Case study – Netherlands (1/2)

Netherland opted for Ownership Unbundling

Netherland	
COUNTRY	Netherlands
TSO MODEL[4]	Ownership Unbundling
No. of TSOs	1 Nos
GAS SOURCING	LNG import, import through BBL Pipeline UK and Germany and production
PRODUCER[4]/ SUPPLIER	Producer- NAM Trader & Supplier-Gas Terra
GAS TRANSMISSION PIPELINE OWNER[1]	Gasuine Transporter Services
TRANSMISSION SYSTEM OPERATOR[1]	Gasuine Transporter Services
DISTRIBUTOR	Other Gas distribution Company DSOs (State-owned)
REGULATOR[5]	ACM

Overview



Source: Gasuine Website

LNG TERMINALS (Nos.)[3]	2 (Static & Floating)
GAS STORAGE (Nos.)[2]	5
PIPELINE LENGTH (KM)[1]	12,000
INTERCONNECTORS (Nos.)[1]	1 (BBL)

Source: 1. Gasuine Website, **2**. Preventive Action Plan 2019 The Netherlands-Ministry of Economic Affairs and Climate Policy, 3. Statista, 4. IEA:2006 Standard Review of the Netherlands, 6. ACM Website

Global Case study – Netherlands (2/2)

The existence of a single chief player in the Netherlands' gas network supply and transmission was a key success factor for the Netherlands unbundling initiative through OU

Netherlands | **Key Summary**

- **Gas sector structure –**
  - Single state-controlled entity, N.V. Nederlandse Gasuine, held ~100% of gas network when compared at current levels in Netherland at the time of initiation of ownership unbundling[5]
  - The share of gas in Netherland's primary energy mix in year 2022, was 27.6%. In year 2004, at the time before legal unbundling, the share of natural gas in primary energy mix was ~37%. Historically, the share of natural gas is on the decline in primary energy mix because of depleting natural gas reserves in Groningen gas field and shift to renewable sources
- **Triggers for unbundling –**
  - As N.V. Nederlandse Gasunie was the only major playe engaged in the supply and transmission of gas, the directive for OU model was passed straightaway in 2006 after legal unbundling through National Unbundling Act 2006 to promote market liberalization & competition in supply
  - Natural gas had a share[3] of ~37% in primary energy mix at the time of unbundling
  - As the existing fields declined, Netherland's natural Gas sector was getting highly dependent on the imports[4] of natural gas. Further, share of natural gas in the energy mix declined to 27% in 2022 from 40% in 2004, raising dependency on imports.
- **Commodity**
  - **Gas Share in PE Mix:** Natural gas had a share of ~37% in primary energy mix in 2006
  - **Gas Import Dependency :** Netherland was ~100% supplied from domestic gas production at the time of unbundling
- **Infrastructure** –
  - **Gas Network :** Pipeline infrastructure was ~94% (11000[1] kms of current levels 12000 kms[2]) and well spread in the country at the time of unbundling
- **Regulation Landscape** –
  - Selection of full Ownership Unbundling after Unbundling Act 2006
  - Before 2013, the Dutch had fragmented regulatory framework that resulted in limited consumer focus and non unified approach to governance

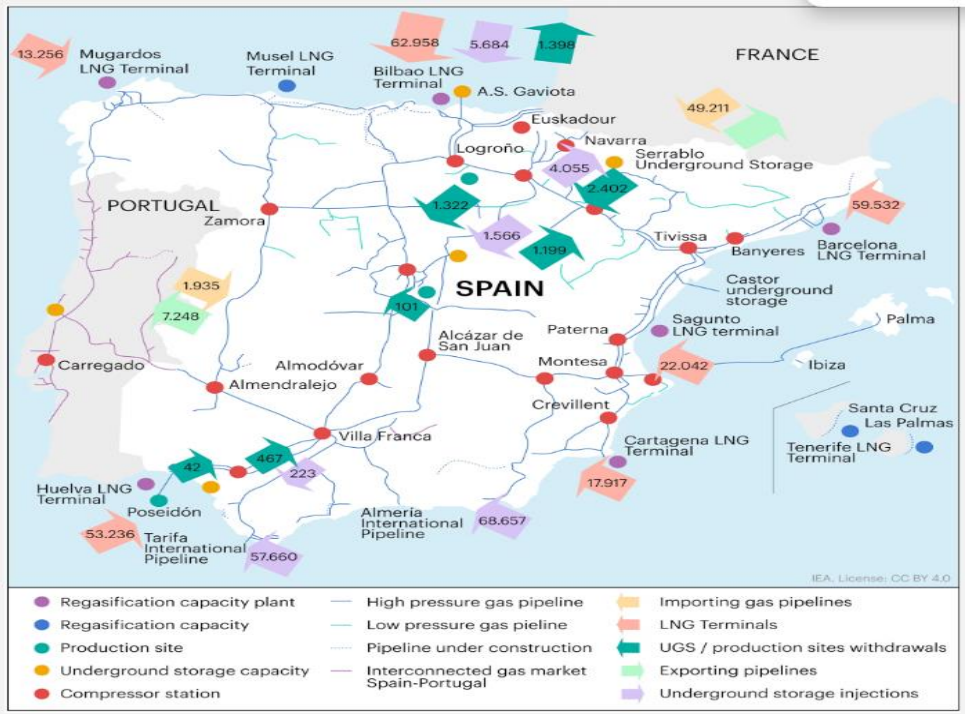
Source: 1.Biosng-Dutch Gas Pipeline network, 2. Gasuine Website, 3,4. Stats Review of World Energy 2022 , **5**.IEA:2006 Standard Review of the Netherlands **6.**Full Ownership Unbundling Act 2006

Global Case study – Spain (1/2)

Enagas Transporte & Reganosa are the TSOs in Spain

Spain	
COUNTRY	Spain
TSO MODEL	Ownership Unbundling and Independent System Operator
NO OF TSO	4 Nos.
GAS SOURCING[1]	LNG/ Imports through pipeline interconnectors
PRODUCER/ SUPPLIER[1]	Algeria/ Spot Suppliers
GAS TRANSMISSION PIPELINE OWNER[4]	Enagas Transporte S.A.U. & Reganosa under OU
TRANSMISSION SYSTEM OPERATOR[7]	Enagas Transporte S.A.U. & Reganosa under OU Small gas companies - ISO
DISTRIBUTOR	Local Distribution Companies
REGULATOR[3]	CNMC
TRADING PLATFORM[2]	Gas exchange - MIBGAS

Overview



LNG TERMINALS[1] (Nos.)	6
GAS STORAGE (Nos.)	4 (underground)
PIPELINE LENGTH[1](KM)	13361
INTERCONNECTORS[1] (Nos.)	2

Sources: 1. IEA Spain Natural Gas Security Policy, 2. MIBGAS website, 3. CNMC, 4. Enagas

Global Case study – Spain (2/2)

Developed Gas network and readiness of Regulatory framework were some of the key success factors for Spain's unbundling initiative

SPAIN | **Key Summary**

- **Gas sector structure**
  - Enagas which was predominantly gas transportation company right from its establishment, maintained accounting and legal unbundling even after Gas Natural acquisition in 1994[4]. But Gas Natural reduced stake in Enagas to comply with EU directives on Ownership unbundling in 2003
- **Triggers for unbundling**
  - Unbundling aimed to remove any conflict of interest of gas transport and increase competition to reduce end user prices and diversify the import sources
- **Commodity**
  - **Gas Share in PE Mix:** Natural Gas contribution in the energy mix[1] was ~17% in 2004 at the time of ownership unbundling
  - **Gas Import Dependency :** Spain was completely 100% dependent on imports (gas with pipeline imports[2] of ~40% and LNG ~60%)
- **Gas Network Maturity:** Pipeline infrastructure was reasonably developed[3] (~90% of current levels) and well spread in the country at the time of unbundling
- **Regulation Landscape**
  - Regulations in place for pipeline tariffs and open access at the time of unbundling and gas prices are indexed to oil prices
  - Unbundling was undertaken by Spain largely to comply with EU directives
- **Current Status**
  - **Transportation**: Pipelines are operated by four operators
  - **Regulations:** Regulatory framework covering tariff rules, Third Party Access etc. was established along with unbundling initiatives
  - **Enabling Ecosystem**: A virtual capacity booking platform on the gas network is present developed where gas shippers (wholesalers) nominate their buys and sells and Network users that are not in balance at the end of the day are charged the corresponding daily imbalance charges and their balancing accounts are set to zero
  - **Gas exchange i.e. MIBGAS** is also present to facilitate market-based price discovery of gas

Sources: 1,2. Stats Review of World Energy 2022 **, 3. 4.** National Report to the European Commission 2018 by CNMC

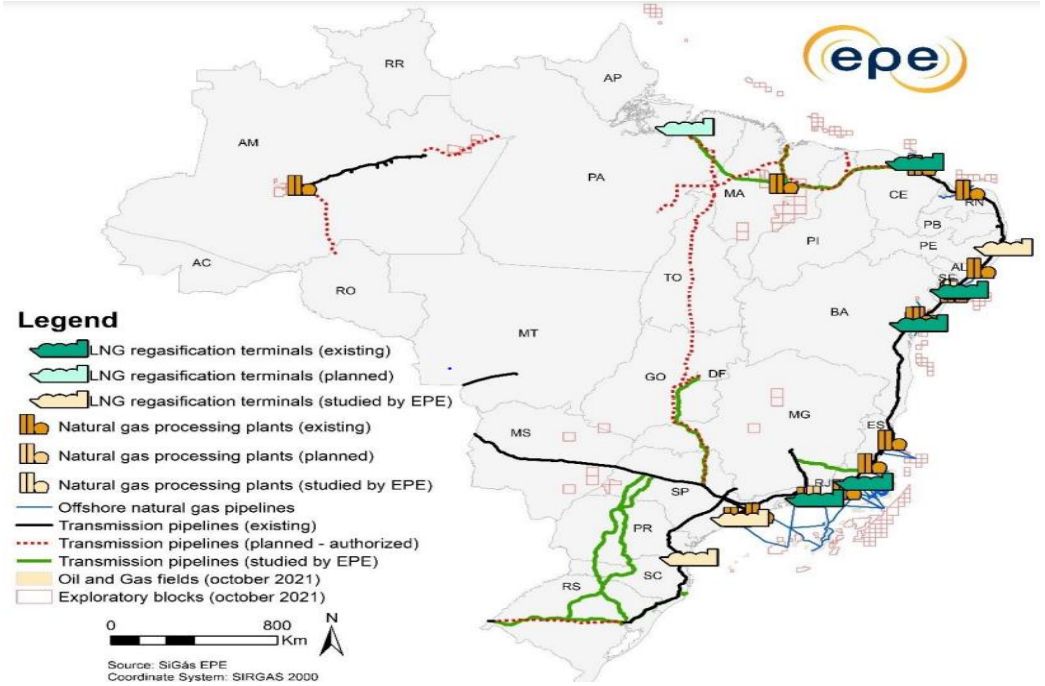
Global Case study – Brazil (1/2)

Transpetro is the TSO in Brazil, while asset ownership rests with TBG, both of which are subsidiaries of Petrobras

Brazil

COUNTRY	Brazil
TSO MODEL	Legal Unbundling
No of TSO	1 Nos
GAS SOURCING	Production/Imports through pipeline/LNG
PRODUCER/ SUPPLIER	Petrobras
GAS TRANSMISSION PIPELINE OWNER[6]	Petrobras owns 1964 KM & TBG Owns 2600 KM
TRANSMISSION SYSTEM OPERATOR[5]	Transportadora Associada de Gás S. A/Transpetro / TBG
DISTRIBUTOR	Local Distribution Companies
REGULATOR[4]	ANP

Overview



Sources: Government of Brazil-2021-Ten Year Energy Expansion Plan

LNG TERMINALS[1] (Nos.)	5 (Static & Floating)
GAS STORAGE[2] (Nos.)	Depleted Onshore fields
PIPELINE LENGTH[3] (KM)	9409
INTERCONNECTORS (Nos.)	0

Sources: 1. Global LNG Hub Report, **2**. Argus Media- Gas Storage makes first sight in Brazil, **3**.2018-Report by IEA: Towards a competitive natural gas market in Brazil, 4.ANP 5. Government of Brazil-2021-Ten Year Energy Expansion Plan 6. Natural Gas Centre of Excellence Project

Global Case study – Brazil (2/2)

Gas network maturity and readiness of Regulatory framework were key success factors for Spain's unbundling initiative

Brazil | **Key Summary**

- **Gas sector structure**
  - Petrobras[2] was controlled by government involved in the production, refining, distribution and enjoyed monopoly in the Brazilian market at the time of unbundling
- **Triggers for unbundling**
  - Unbundling to break Petrobras's monopoly & allowing competition in Brazil's oilfields
- **Commodity**
  - **Gas Share in PE Mix:** Natural Gas contribution[1] in the energy mix has been substantial ~3% in 1997 at the time of legal unbundling
  - **Gas Import Dependency :** Brazil was at 0% import[1] in 1997 but it grew to 21% in 2000
- **Infrastructure**
  - **Gas Network Development:** Pipeline infrastructure was[2] ~15% (1400 Kms of current levels of 9409 Kms) of current length of the network
- **Regulation Landscape**
  - Regulations in place for pipeline tariffs and open access at the time of unbundling and gas prices are indexed to oil prices
- **Current Status**
  - **Transportation**: Pipelines are operated by **Transpetro** as major transmission pipeline operator
  - **Regulations:** Regulatory framework covering tariff rules, Third Party Access etc. was established along with unbundling initiatives
  - **Enabling Ecosystem**: Third Party access, trading hub (in proposal) and imposition of vertical integration
  - **Gas exchange or virtual trading hub** is planned to be established as per New Gas Market Reform Programme

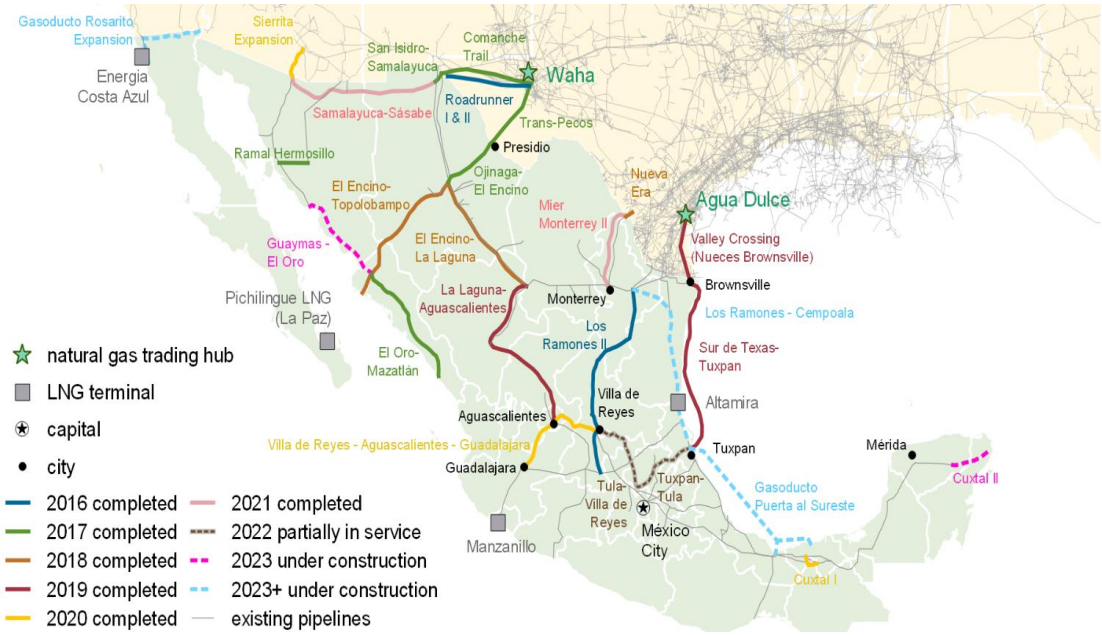
Sources: 1, Stats Review of World Energy 2022 , 2. Brazilian Gas Market and Its Regulatory Overview by Hirdan Katarina de Medeiros Costa, 3. Natural Gas Centre of Excellence Project- March 20, 2005

Global Case study – Mexico (1/2)

There are many TSOs in Mexico's gas market but CENAGAS owns and operates the majority of gas infrastructure

Mexico	
COUNTRY	MEXICO
TSO MODEL	Ownership Unbundling
No of TSO[7]	>5
GAS SOURCING	Production/Imports through pipeline/LNG
PRODUCER/ SUPPLIER	Premex/ international LNG suppliers
GAS TRANSMISSION PIPELINE OWNER[5]	CENAGAS, 10336 KM and other players
TRANSMISSION SYSTEM OPERATOR[6]	CENAGAS
DISTRIBUTOR	Local Distribution Companies (Ecogas, Gasoducto del Noroeste)
REGULATOR[8]	CRE

Overview



Map: Mexico NG Network[1]

LNG TERMINALS (Nos.)[2]	4
GAS STORAGE (Nos.)[3]	SISTRANGAS
PIPELINE LENGTH (KM)[4]	12000
INTERCONNECTORS (Nos.)	17[2]

Sources: 1. Map: EIA-U.S. and CNH, Mexico, 2. IEA Mexico 2015

Global Case study – Mexico (2/2)

Gas network maturity and readiness of Regulatory framework were key success factors for Mexico's unbundling initiative

Mexico — **Key Summary**

Key learnings

- **Industry Structure[4]** – Major gas pipeline & marketing entity(PEMEX) was vertically integrated into production. There were issues around open access of at the time of unbundling.
- **Triggers for Unbundling-**Open gas sector for private investments leading to constitutional reforms
- **Commodity**
  - **Gas Share in PE Mix:** Natural Gas contribution in the energy mix has been substantial[1] ~33 % in 1997 at the time of unbundling
  - **Gas Import Dependency :** Mexico was at 42% import[2] in 2014 at the time of unbundling
  - **Gas Network Maturity:** Pipeline infrastructure was reasonably developed[3] (~90%% of current levels) and well spread in the country at the time of unbundling
- **Regulations**
  - Regulations in place for pipeline tariffs and open access at the time of unbundling and there was regulated market pricing for gas
  - Issues around slow development of pipeline infrastructure and discriminatory access to pipeline led to ownership unbundling
- **Current Status**
  - **Transportation**: Pipelines are operated by **CENAGAS** as major transmission pipeline owner and operator with other players like Engie, Framco
  - **Regulations:** Regulatory framework covering tariff rules, Third Party Access etc. was established along with unbundling initiatives
  - **Enabling Ecosystem**: Third Party access, trading hub (in proposal) and imposition of vertical integration
  - **Gas exchange or virtual trading hub[3]** i.e. Wood Mackenzie is present

Sources: 1.,2. Stats Review of World Energy 2022 , 3. 4. Mexico's Oil and Gas Sector: Background, Reform Efforts, and Implications for the United States

Global Case study – USA (1/2)

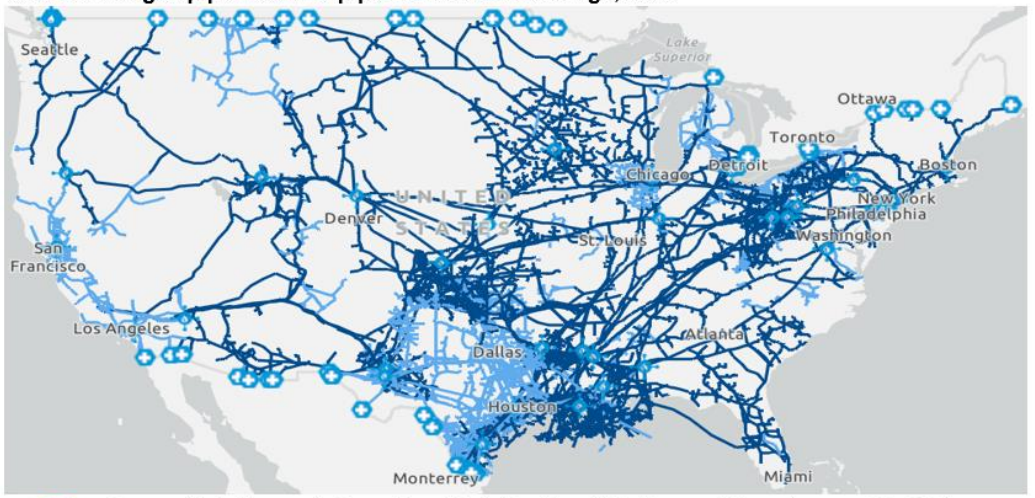
USA has interstate and intrastate pipelines regulated by FERC and state respectively. USA has multiple transmission operators, which are ownership unbundled

USA

Overview

COUNTRY	USA
TSO MODEL	Ownership Unbundled
No of TSO[9]	>35
GAS SOURCING[8]	Domestic
PRODUCER/ SUPPLIER[7]	Chevron, Exxon Mobil,
GAS TRANSMISSION PIPELINE OWNER[5,6]	26 Interstate & 13 intrastate pipeline
TRANSMISSION SYSTEM OPERATOR[5,6]	26 Interstate & 13 intrastate pipeline
DISTRIBUTOR	Local Distribution Companies
REGULATOR[10]	FERC regulate interstate pipelines State regulate intrastate pipelines

U.S. natural gas pipelines and pipeline border crossings, 2023



Source: U.S. Energy Information Administration, U.S. Energy Atlas, January 29, 2024
Note: Light-blue lines are intrastate pipelines, dark-blue lines are intrastate pipelines, and + are border crossings.

LNG TERMINALS[3] (Nos.)	11
GAS STORAGE (Nos.)	Depleted Onshore fields
PIPELINE LENGTH[2](KM)	322000
INTERCONNECTORS[4] (Nos.)	>50

Notes: 1. Interstate Pipeline companies: BHE, DTE, Enbridge Energy, etc

Sources: 1. MAP-EIA 2023, 2 INGAA Climate Report 2024,3. EIA 4. Atlas-EIA 5. INGAA, 6. Rigzone 7. EIA, 8. Stats Review of World Energy 2022 , 9. INGAA, 10. Natural Gas Regulation 2020 pillsburylaw

Global Case study – USA (2/2)

USA successfully introduced phased account and legal unbundling at a federal level between 1985 and 1992

USA | **Key Summary**

Key learnings

- **Gas sector structure**
  - Entities are not vertically integrated in USA - separate entities for gas production, transmission/marketing and distribution
  - Oil producers are separate from the oi transportation and marketing companies. There are interstate pipelines that cross state boundaries. The interstate companies provide transportation and storage services. The intrastate pipelines remain within the state boundaries and supply to distribution companies, which further distribute to customers.
- **Triggers for unbundling**
  - To open market for consumers and promote competition
- **Commodity**
  - **Gas Share in PE Mix:** Natural Gas contribution in energy mix[1] was ~23% in 1985 and 1992 at time of Account and legal unbundling
  - **Gas Import Dependency :** USA was at 4% import[2] in 1985 and 11% in 1992
- **Regulation Landscape**
  - **Gas Network Development[3]** - Pipeline infrastructure was reasonably developed (~100% of current levels) and well spread in the country at the time of unbundling
- **Regulations**
  - Regulations in place for pipeline tariffs and open access at the time of unbundling and there was free market pricing for gas
  - Issues around discriminatory access to pipeline led to legal unbundling. However, USA did not implement ownership unbundling as there were digital platform to book capacities, multiple contracting allowed for pipeline capacities along different pricing mechanisms and emergence of gas hubs which ensured market efficiency and transparency

Sources: 1,2. Stats Review of World Energy 2022

Assessment and Key Learnings from Global case studies

3

Global Assessment – Key Conclusions from Global Study

Overall market readiness & key insights from Global case study at the time of unbundling & post unbundling have been summarized

Key Conclusions

1	Markets which got unbundled, may not necessarily demonstrate higher share of gas in their Primary Energy Mix or stagnation in growth of gas infrastructure	*For example, Brazil share of gases were only 3%[1] in PE mix at time of legal unbundling. Brazil still has envisaged expansion of gas transmission pipeline[4] ~20% over its existing length*
2	Markets which are not so ready for unbundling, but have undertaken changes in regulations for open access, pricing, tariff mechanisms have shown market growth post unbundling	*For example, post unbundling, Brazil allowed open access on pipelines, upstream pricing freedom with certain Gas Laws which led to increase in share of NG in mix to 12[2]%.*
3	There have been other important mechanisms like Enforcement of environmental regulation which have led to significant increase in gas offtake	*For example, in Mexico, growth in gas consumption was contributed by Power Alliance Coal 2017[3] which decided to not open any coal-based power plants.*
4	Unbundling led to vibrancy and provided more choices to consumers, but it has taken over 6-10 years for evolution of gas market in terms of increase in number of shippers & decrease in market concentration	*For example, in UK, Netherlands, Austria, Spain there were increase in number of gas shippers & decrease in market concentrations post unbundling which led to increased choices for consumers*
5	Countries with 100% import dependency has unbundled at even at the time of least share of gas in PE mix	*For example, Spain had 100% dependency[1]. Brazil had ~100% domestic production but only 2.9% share of natural gas in PE mix at time of unbundling*

Source:1, 2. Stats Review of World Energy 2022 , 3. Climate Transparency 2021- Mexico, 4. PGJ online News

Global Assessment - Benefits of Market Liberalization and Unbundling

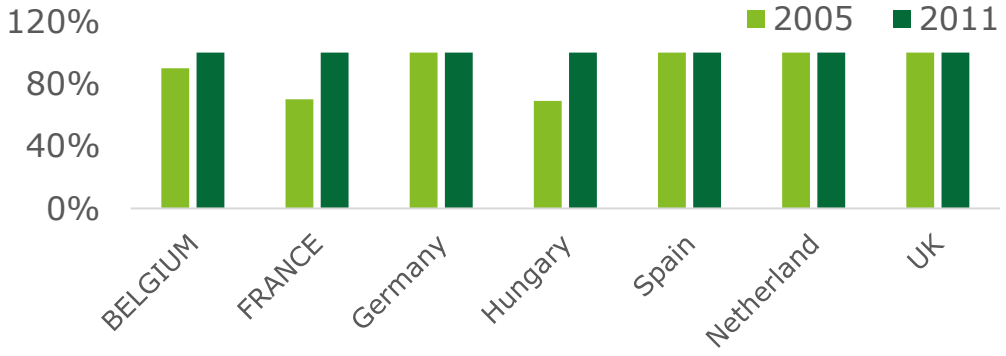
Market has witnessed a decrease in market concentration and increase in switching rates for customers

Country	Unbundling	TPA Status[1] (2005)	TPA Status[1] (2011)	TSO Model	Supplier[1](HHI) (2008)	Supplier[1] (HHI) (2014)
Belgium	2001	90%	100%	OU	5600	4000 ↓
France	2004	70%	100%	ITO	6200	4700 ↓
Germany	2005	100%	100%	ITO	1900	1886 ↓
Hungary	2000	69%	100%	ITO	3200	1494 ↓
Spain	2001	100%	100%	OU/ISO	2000	2399 ↑
Netherland	2006	100%	100%	OU	7200	6455 ↓

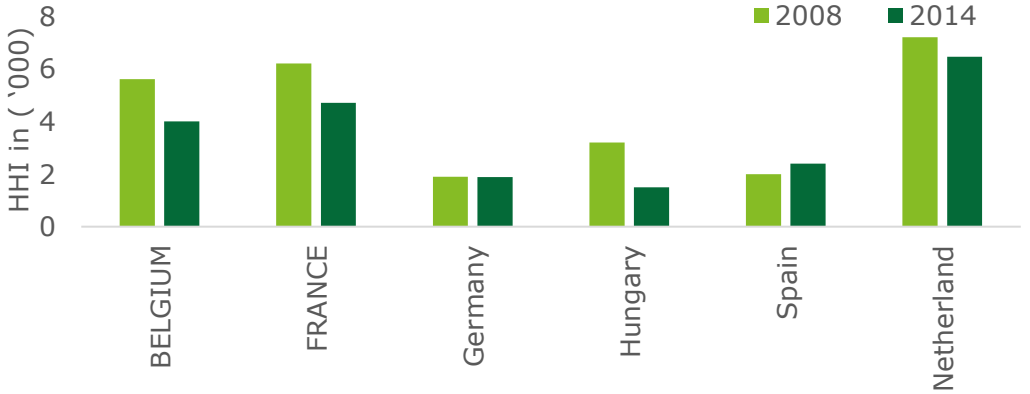
Market concentration for gas suppliers has overall witnessed a decrease after market opening and Unbundling

Customer avg. switching rates have increased from 0% to 20% for EU Union, with UK accounting for switching rate[1] from 47% to 85% for segmental consumers

Opening of Market[1]



Market Concentration for Gas Supplier[1]



Notes: HHI: The Herfindahl-Hirschman Index (HHI) is a common measure of market concentration that is used to determine market competitiveness. Higher is HHI, lesser is the market concentration. TPA Status is in terms of access to gas infrastructure. Access may be limited due to existing legacy contracts in place, limited capacity access on gas infrastructure.

Source:1: Report on progress in creating the internal gas and electricity market 2004-2020, 2. Primary Research-Provided by CREG- Belgium as benefit of implementing TSO with new model of operation

Global Assessment-Benefits of Market Liberalization and Unbundling

Countries have witnessed an increase in market competition with more choice of suppliers for end consumers

Country	Unbundling	Switching Rates[1,2]		TSO Model	Number of Gas Suppliers[3,4,5]		
		Before 2004	2008		2004	2008	2014
Belgium	2001	9%	11% ↑	OU	8	8	18 ↑
France	2004	0%	4.50% ↑	ITO	8	13	20 ↑
Germany	2005	0%	10.68% ↑	ITO	9	NA	38 ↑
Hungary	2000	2%	1.50% ↓	ITO	6	14	20 ↑
Spain	2001	2%	4%-20% ↑	OU	4	34	18 ↑
Netherland	2006	5%	12.30% ↑	OU	5	14 ↑	NA
UK	1997	47% ↑	11%* ↓	OU	8	24 ↑	23

Key Takeaways

1. *Overall Customer switching rates have witnessed an increase after unbundling coupled with open access as number of gas suppliers entered the market, creating more choices for end customers*
2. *Number of Natural Gas Suppliers has witnessed an increase, increasing competition in the gas supply market*

Notes: *For UK, customer switching rates have been as high as 90% around 2004 after unbundling in 1997, indicating competition in gas supply market. The switching rates have been less compared to 2008 levels, owing to market stabilization after 10 years of unbundling, but it had significant switching rates comparable to other countries in Europe in 2008.

Source: 1. Report on progress in creating the internal gas and electricity market 2004-2020

Global Assessment-Reason for selection of Given Model

Fundamental rights and Preserving national interest in assets were chief reasons for adoption of ITO Model

Country	Model	Reason for selection of Given Model
France[1]	ITO	• Law required delivery services as public companies[1], hence the provision stopped the privatization. Also, Government wanted to protect the national interest in the energy sector
Germany[2]	ITO	• The fundamental rights (right to property) as per constitutional law induced barriers to EU legislation of OU and hence, the ITO model was adopted
Netherlands[3]	OU	• The government wanted to separate network managers completely from the commercial activities and wanted to ensure the network remains publicly owned
Spain[4]	OU+ISO	• The Govt wanted to open-up competition with highest level of unbundling, hence separated the Enagas through legislation from Gas Natural company, today known as Naturgy
UK[5]	OU	• BG was privatized under Gas Act 1986, and later competition law required to release gas to other players to introduce competition, hence, business separation led to OU adoption
Brazil[6]	Legal	• Legal unbundling to break Monopoly of State-owned company along the value chain. Further, to introduce competition government has recently launched New Gas Law for OU
Mexico[7]	OU	• To Open Gas sector for private investment and hence, formed through constitutional reforms by separation of transportation asset & its operations under separate Ministry
Hungary[8]	ITO+OU	• Push from Private sector to protect the assets, as the biggest company was private and owned gas pipeline transmission and operation. Hence, ITO was adopted to protect the interests of MOL
USA[9]	OU	• To introduce competition among the local distribution companies with private players.
Romania[10]	ITO	• As per Governmental Decision No. 334 / April 28th, 2000, TransGaz separated from Romgaz(VIU), to restructure the National Gas company into five independent business to break the monopoly of production companies
Belgium[11]	OU	• OU, the highest degree of unbundling was adopted to introduce competition in the secondary gas market for industry players and end consumers.

Sources: 1. France-USAID Sept 2019(pg 51), 2. European Review of Energy Markets, May 2008 3. CMS Expert Guide on Netherlands, 4.PNGRB Meeting with Spain, 5. National Gas Website-Privatization of BG 6. Brazilian Gas Market and Its Regulatory Overview by Hirdan Katarina de Medeiros Costa, 7. Mexico's Oil and Gas Sector: Background, Reform Efforts, and Implications for the United States, 9. Costs, Benefits and Concerns related to FERC Order 636, 10. CASE AT.40335 – Romanian gas interconnectors, 11. Discussion with CREG, Belgium Energy Regulator

Annexure

3

Understanding Modes of Unbundling (1/3)

Account unbundling calls for separation of accounts along the value chain

Unbundling

	Account Unbundling	Legal Unbundling
UNBUNDLING	**Account Unbundling**	**Legal Unbundling**
PRINCIPLE	**Separation of all the accounts** across the value chain i.e. for **supply, transportation and distribution**	**Operation/asset ownership** will be done by separate legal entity which may or may not be subsidiary of the parent company
OBJECTIVE	It allows regulatory authority to better assess the tariffs proposed and to detect possible instances of cross-subsidy	It allows regulatory authority to better separate the transmission from other parts of value chain
PRODUCER/ SUPPLIER	Parent Company	Parent Company
GAS TRANSMISSION PIPELINE OWNER	Pipeline Asset ownership remains with **the parent company**(vertically integrated company)	Pipeline Asset ownership may remain with **the parent company** (vertically integrated company)
GAS TRANSMISSION PIPELINE OPERATOR	**Parent Company**(Vertically Integrated Company) operates the pipeline transmission system	**Separate legal entity**, which may or may not be subsidiary of parent company
OPERATIONS & MAINTENANCE	Parent company carries out O&M of the pipeline asset	Separate Legal Entity carries out O&M
PIPELINE ASSET AUGMENTATION	Parent Company carries out the asset augmentation as and when needed based on the capacity augmentation request by separate legal entity post approval by Regulator	Parent Company carries out the asset augmentation based on the capacity augmentation request by separate legal entity post approval by Regulator

Understanding Modes of Unbundling | Ownership Unbundling & ITO (2/3)

In OU, asset ownership & operations is owned by the full independent legal entity. It cannot be a subsidiary of VIU entity. While asset ownership is retained in ITO by VIU entity but operations are transferred.

Unbundling

	Ownership Unbundling	ITO
UNBUNDLING	**Ownership Unbundling**	**ITO**
PRINCIPLE	**Pipeline Asset ownership with operations** is separated along the value chain with no direct or indirect control of parent entity	**Operation & asset ownership** will be owned by separate legal entity which will be a subsidiary of the parent company
PRODUCER/ SUPPLIER	Parent Company	Parent Company
GAS TRANSMISSION PIPELINE OWNER	Ownership of transmission asset is separated from **the parent company** (vertically integrated company) **Pipeline operator is the asset owner**, which is a separate legal entity from parent company (not a subsidiary of parent company)	Pipeline Asset ownership remains with **the newly formed separate legal entity that carries out operations** (vertically integrated company)
GAS TRANSMISSION PIPELINE OPERATOR	**Pipeline operator, who is the asset owner,** operates the pipeline transmission system	**Separate legal entity (Pipeline Operator)**, which is a **subsidiary of parent company**
OPERATIONS & MAINTENANCE	**Pipeline operator** carried out O&M of the pipeline asset	Separate Legal Entity carries out O&M
PIPELINE ASSET AUGMENTATION	**Pipeline Operator** carries out the asset augmentation based on the capacity augmentation approval by Regulatory authority after proper validation is made.	**Pipeline Operator** carries out the asset augmentation based on the capacity augmentation approval by Regulatory authority, thereafter the investment to be approved by Asset Owner

Understanding Modes of Unbundling | ISO (3/3)

Independent system operator is responsible for operations of the assets. It has no shares in asset ownership. It cannot be a subsidiary of the parent VIU company

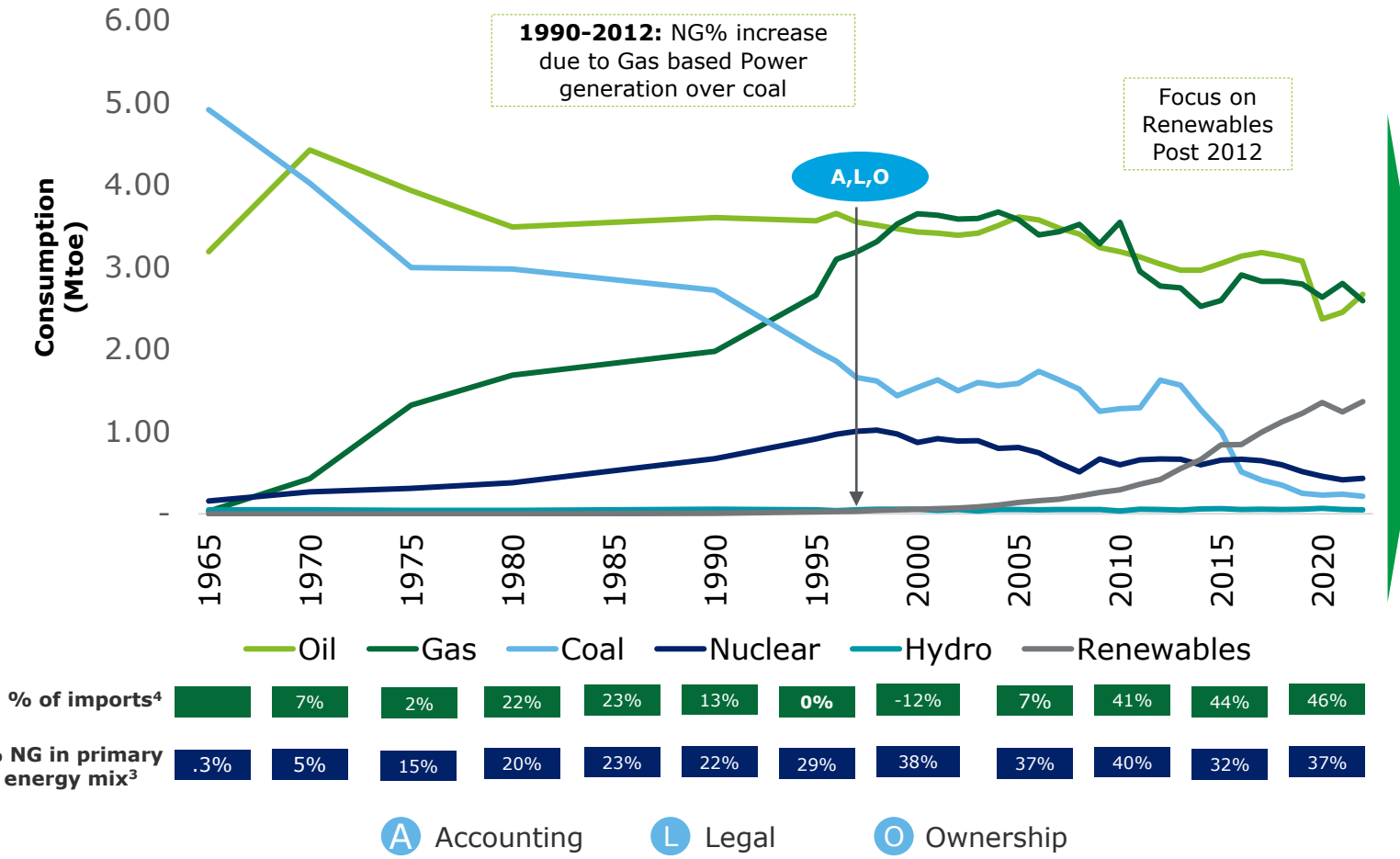
Unbundling

	ISO
UNBUNDLING	**ISO**
PRINCIPLE	Asset ownership is retained by parent entity
PRODUCER/ SUPPLIER	Parent Company
GAS TRANSMISSION PIPELINE OWNER	Pipeline Asset ownership remains with **the parent company** (vertically integrated company)
GAS TRANSMISSION PIPELINE OPERATOR	**Separate legal entity**, which is a not a subsidiary of parent company, operates the pipeline transmission system
OPERATIONS & MAINTENANCE	**Pipeline operator** carries out O&M of the pipeline asset
PIPELINE ASSET AUGMENTATION	**Pipeline Operator** carries out the asset augmentation based on the capacity augmentation approval by Regulatory authority, thereafter the investment to be approved by Asset Owner

Global Case Study – United Kingdom (1/10)

Natural Gas share in the primary energy mix increased because of coal phase out policy and increase in consumption from gas fired power generation

United Kingdom



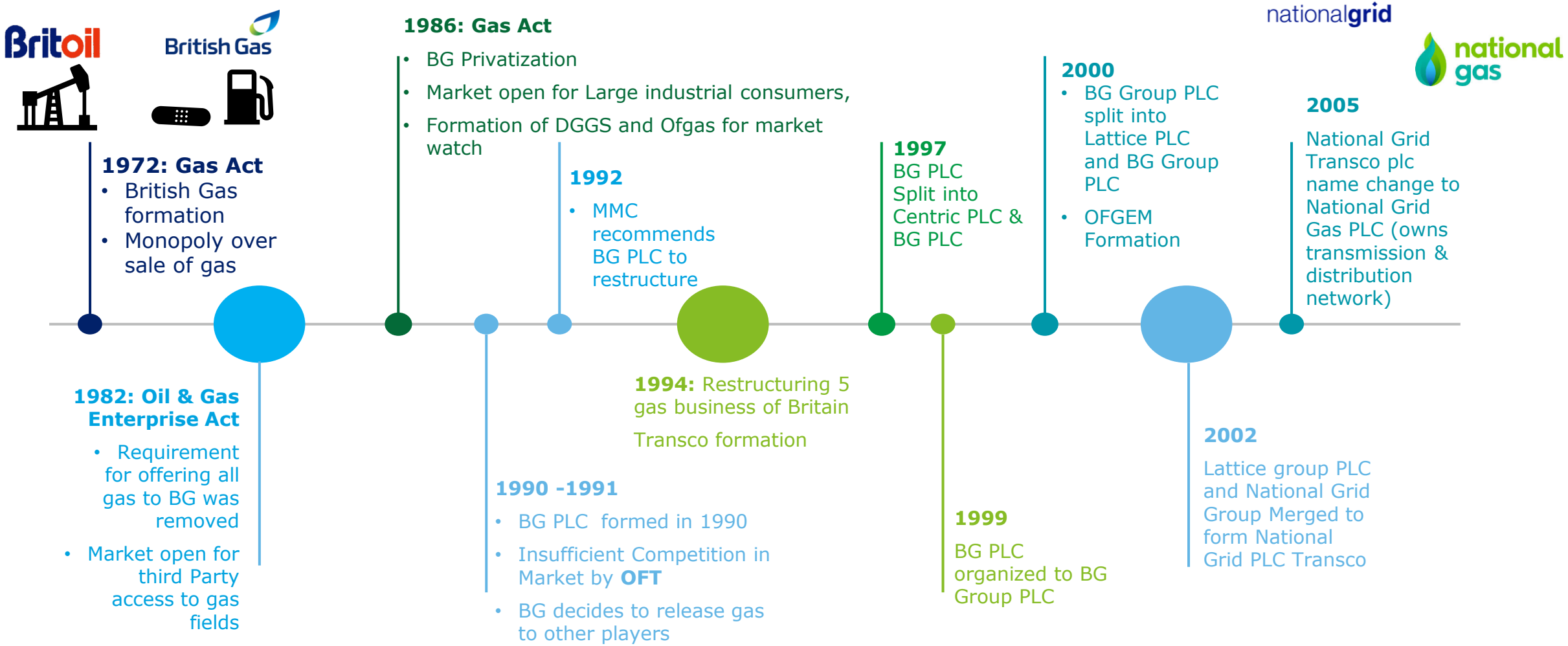
Key Historic Timeline

Key Points in History

- **From 1990-2012[1],** the Natural Gas consumption increased due to gas fired Power generation over coal.
- The gas contribution increased nominally from ~34% in 1997 to ~40% in 2010 primarily as gas replaced coal in the electricity generation
- Ownership unbundling was initiated in 1997 when gas sector had achieved sufficient development and completed in 2000
- **However, post 2010**, Gas consumption reduced due to combination of
  - ✓ Overall economic slowdown
  - ✓ Rising gas prices
  - ✓ Energy efficiency measures and renewable energy
- **In 2012[2],** coal became cheaper than gas, hence consumption increased for that year. Since, 2012, coal has fallen back due to the increased availability of other forms of generation including nuclear and wind

Source: 1. UK Energy Outlook, 2. Govt of UK-Long Term trends in energy 3,4. Stats Review of World Energy 2022

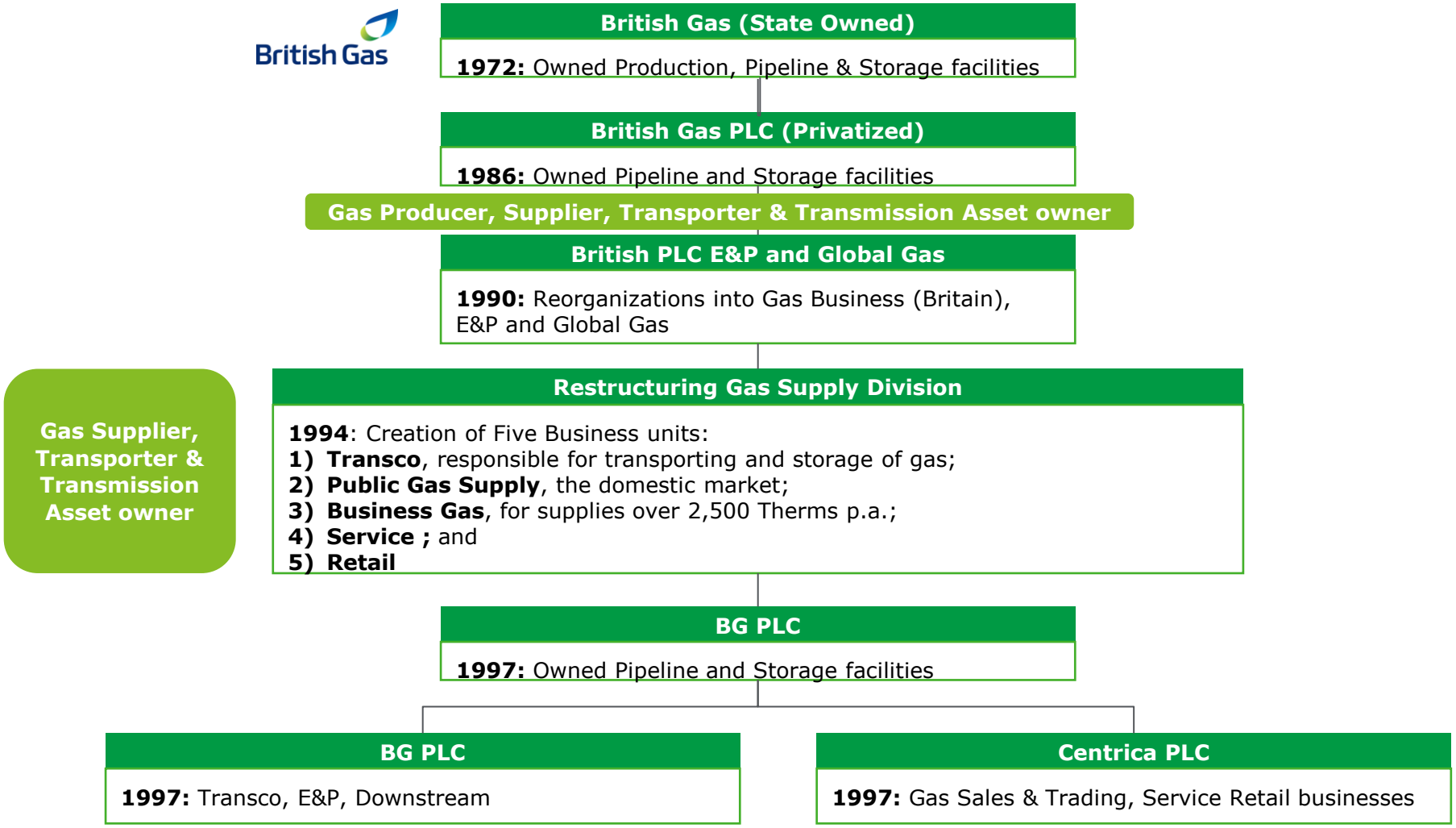
Global Case Study – United Kingdom | Timeline[1] (2/10)



Source: 1. National Gas(Website): Privatization of BG to National Gas

Global Case Study – United Kingdom |TSO formation[1] from entities (3/10)

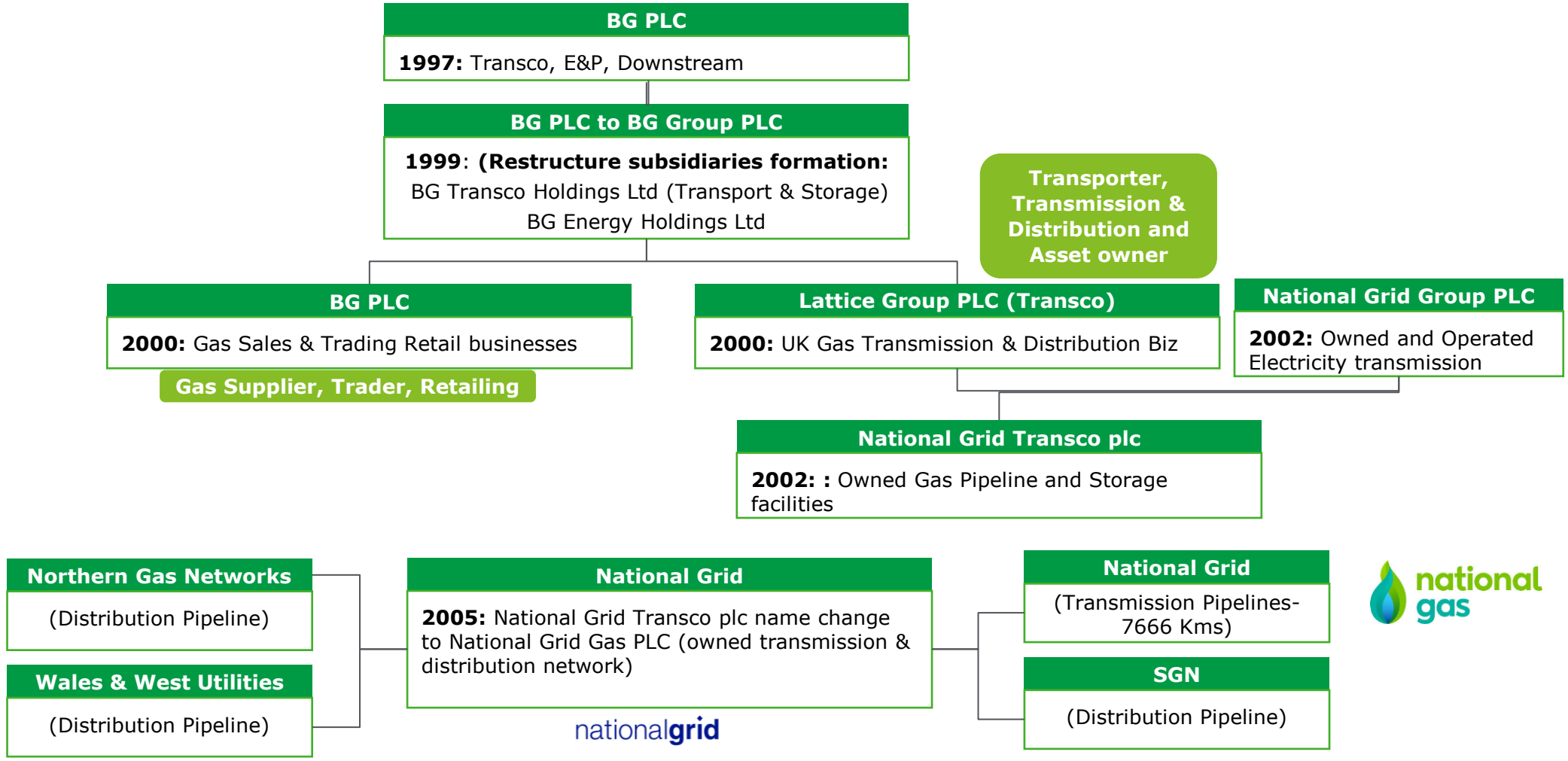
British Gas, which was state-owned, privatized, and later restructured into multiple functional business units under the direction of Office of Fair Trading and Monopolies & Mergers commission. Later, BG business units separated to form National Grid Group that owned and operated Natural gas transmission assets



Source: 1. National Gas(Website): Privatization of BG to National Gas

Global Case Study – United Kingdom |TSO formation[1] from entities (4/10)

National Grid is the owner of Transmission assets and National Gas in the TSO



Source: 1. National Gas(Website): Privatization of BG to National Gas

Global Case Study – United Kingdom (5/10)

Monopoly of the British Gas Corporation and insufficient competition pushed the Government to privatize BG. Thereafter, Office of Fair trading & MMC restructured BG, leading to ownership Unbundling of the BG in United Kingdom

- **Before Privatization[1]** –
  - Under the Gas Act 1972, British Gas Corporation was established by amalgamation of Gas Council and 12 Area Boards. It assumed monopoly over the sale of gas in United Kingdom. It also enjoyed monopoly with respect to any gas reserves from UK Sector of the North Sea. In 1982, under Oil and Gas Enterprise Act, the requirement of offering all the gas to British Gas Corporation was removed and hence the market was open for **third party access**
- **1986[1] – Privatization of British Gas Corporation**
  - Under the Gas Act 1986, provisions were made to privatize the British Gas Corporation and formation of British Gas Plc. (BG) First Director General of Gas Supply (DGGS) and the Office of Gas Supply (Ofgas) were set up in 1986 to carefully watch the market
  - Under the Gas Act 1986, the market for large industrial customers (consumption more than 25000 therms per annum) was open for competition. BG retained franchise monopoly over the remaining market (consumption less than 25000 therms per annum).
- **1991-1997[1] – Ownership unbundling happened in 1997**
  - Thought the large industrial customers were open to competition, new entrants faced obstacles such as, existing gas fields were still committed to British Gas and new entrants had to access British Gas pipelines and storage facilities which gave British Gas chance to take commercial advantage and approach large customers.
  - In 1991, British Gas came under scrutiny of **Office of Fair Trading** (OFT) and insufficient competition found. BG decided to reduce its market share and release some gas to other players.
  - In 1992, MMC (Monopolies and Merger Commissions) recommended to reorganized BG PLC into 03 main divisions and in 1994 BG created Transco (For gas transport and storage),
  - Gas Act 1995, made provision for the separate licensing of gas suppliers, gas shippers and public gas transporters and opened the full market to competition

British Gas was a private entity which mandated for unbundling to resolve competition issue and open market for new entrants

Source: 1. National Gas(Website): Privatization of BG to National Gas

Global Case Study – United Kingdom (6/10)

Ownership Unbundling Model was implemented for UK as a result of assets and operation separation from the Gas sales and trading business

United Kingdom

- In 1996, the Network Code was established with rules for Third-Party Access to British Gas network and introduced Daily Balancing and National Balancing Point (NBP) – A virtual platform where gas shippers nominate their buys and sells. National Gas Grid (NGG) started as a System Operator.
- In 1997, British Gas Plc split into two separate entities (Ownership Unbundling) – BG Group (took over upstream business) and Centrica PLC (responsible for gas supply business). Transco was sold to National Grid
- In 2000, BG Group PLC (BG) was further broken up into two new businesses, BG Group PLC and Lattice Group PLC. Transco, the high-pressure gas transmission pipeline business, remained part of Lattice.
- In 1999, the Review of Gas Trading Arrangements introduced the on-the-day commodity market (OCM) to spot trading
- The Office of Gas and Electricity Markets (Ofgem) was formed through the merger of the Office of Electricity Regulation and the Office of Gas Supply.
- In 2005, the previous code was replaced with the Uniform Network Code (UNC) to set up an operating framework for the industry.

Ofgem ensures gas market of UK is competitive and it regulates transmission & distribution networks in UK

- **National Transmission System (NTS)[2] – Systems of pipeline network in UK is known as NTS.**
  - It transports high pressure natural gas around Great Britain via 7,666 Km of pipeline
  - **National Grid Gas (NGG) plc Group** owns and operates the UK Gas Transmission system and low pressure distribution network. **Group is composed of :**
    - National Grid (Transmission Pipelines-7666 Kms)
    - Northern Gas Networks (Distribution Pipeline)
    - SGN (Distribution Pipeline)
    - Wales & West Utilities (Distribution Pipeline)

UNC is developed to be a legal & contractual framework to supply & transport gas

Source: 1. National Gas(Website): Privatization of BG to National Gas, **2**. Climate Change Adaptation Second Round Adaptation Response National Grid Gas July 2016

Global Case Study – United Kingdom (7/10)

UNC as per EU regulations defines the capacity booking, imbalance management and tariff mechanisms

United Kingdom

- **UNC (Uniform Network Code)[1] –**
  - The UNC defines the rights and responsibilities for users of gas transportation systems and provides for all system users to have equal access to transportation services. The major concepts underlying the Uniform Network Code are that:
    - Gas transportation services should meet market requirements.
    - System security and safety should be assured.
    - Pricing should reflect the real costs of the services concerned.
    - Robust computer systems should be developed and maintained.
    - Daily energy balancing should be operated.
    - Gas Shippers (Shippers) should be incentivized to balance their own supply and demand
- **Transportation price control Formulae[2]**
  - Transportation charges are derived in relation to price control formulae set by Ofgem
  - These formulae determines maximum revenue National Gas NTS can earn from transportation business
  - If National Gas NTS earns more or less revenue than the maximum permitted revenue, a compensating adjustment is made in the future year
  - The allowed revenue for NTS is divided into Transportation Owner (TO) and System Operator (SO) allowances

Source: 1. National Gas- UNC on Capacity Products, 2. National Gas UNC on Gas Transportation Charges

Global Case Study – United Kingdom | Functioning of TSO (8/10)

Prisma and Gemini are the capacity booking platform used by the shippers

United Kingdom	Functioning of TSO
TRANSMISSION SYSTEM OPERATOR	National Gas Grid owns the National Gas Transmission system
MODE OF BOOKING[3]	Online Joint Capacity booking platform managed by TSO such as **PRISMA and Gemini**
CAPACITY BOOKING GOVERNANCE CODE[1]	Capacity Network Code by European Union Regulation-(EU) 2017/459
LEVERS FOR FOSTERING COMPETITION IN GAS MARKETS	• Unbundling TSOs and DSOs • TPA-Capacity Booking Platform • Title Transfer[2] at National Balancing Point, which are made via OCM trading system, managed by ICE Index • Gas Exchange
CAPACITY BOOKING PLATFORM	• Introduction of Entry-Exit Regimes (**Physical and Virtual)** • At (virtual) interconnection points, capacity is offered via auctions. • CAM Network Code with provision for bundled capacity for adjacent TSOs • Capacity booking through algorithms target to different time periods • Incremental capacity addition & approval by regulatory authorities • Governance of TSO for Regulation implementation by ENTSOG • ENTSOG submit reports to CEER

Source: 1. Regulation (EC) No (EU) 2017/459, **2.** National Gas on Title transfer, **3.** National Gas Capacity Booking Guidelines June 2022

Global Case Study – United Kingdom | Functioning of TSO (9/10)

Price control financial model for transmission tariffs is set by Ofgem

United Kingdom | **Functioning of TSO**

IMBALANCE MANAGEMENT[1,2]	• The commercial framework requires users of the system (gas shippers) to balance supply into and demand from the network. If this balance is not expected to be achieved on any given day, then the Gas System Operator, as Residual Balancer, will enter the market and undertake trades (buys or sells) to seek to resolve any imbalance on the system. • The National Balancing Point, commonly referred to as the NBP, is a virtual trading location for the sale and purchase and exchange of natural gas in the United Kingdom. It is the pricing and delivery point for the ICE Futures Europe (Intercontinental Exchange) natural gas futures contract. It is the second most liquid gas trading point in Europe and has a major influence on the price that domestic consumers pay for their gas[citation needed]. Gas at the NBP trades in pence per therm. • **Correction Based Mechanism**: The balancing market, which is called the On-the-day Commodity Market (OCM), is operated by the ICE Index exchange, as appointed by National Gas. The OCM is the market we use in our role as residual balancer.
TARIFF[3]	• The Transportation tariffs are determined through price control financial model set by Ofgem • The allowed revenue for the NTS is divided into Transportation Owner (TO) and System Operator (SO) allowances. • These formulae determine the maximum revenue National Grid NTS can earn from the transportation of gas. Should National Grid NTS earn more or less than the maximum permitted revenue in any formula year, a compensating adjustment will be made in the relevant future year as described in the NTS License

Source: 1. Regulation (EC) No 715/2009 2. National Gas 3. National Gas on Tariffs 4. Residual Balancer

Global Case Study – United Kingdom (10/10)

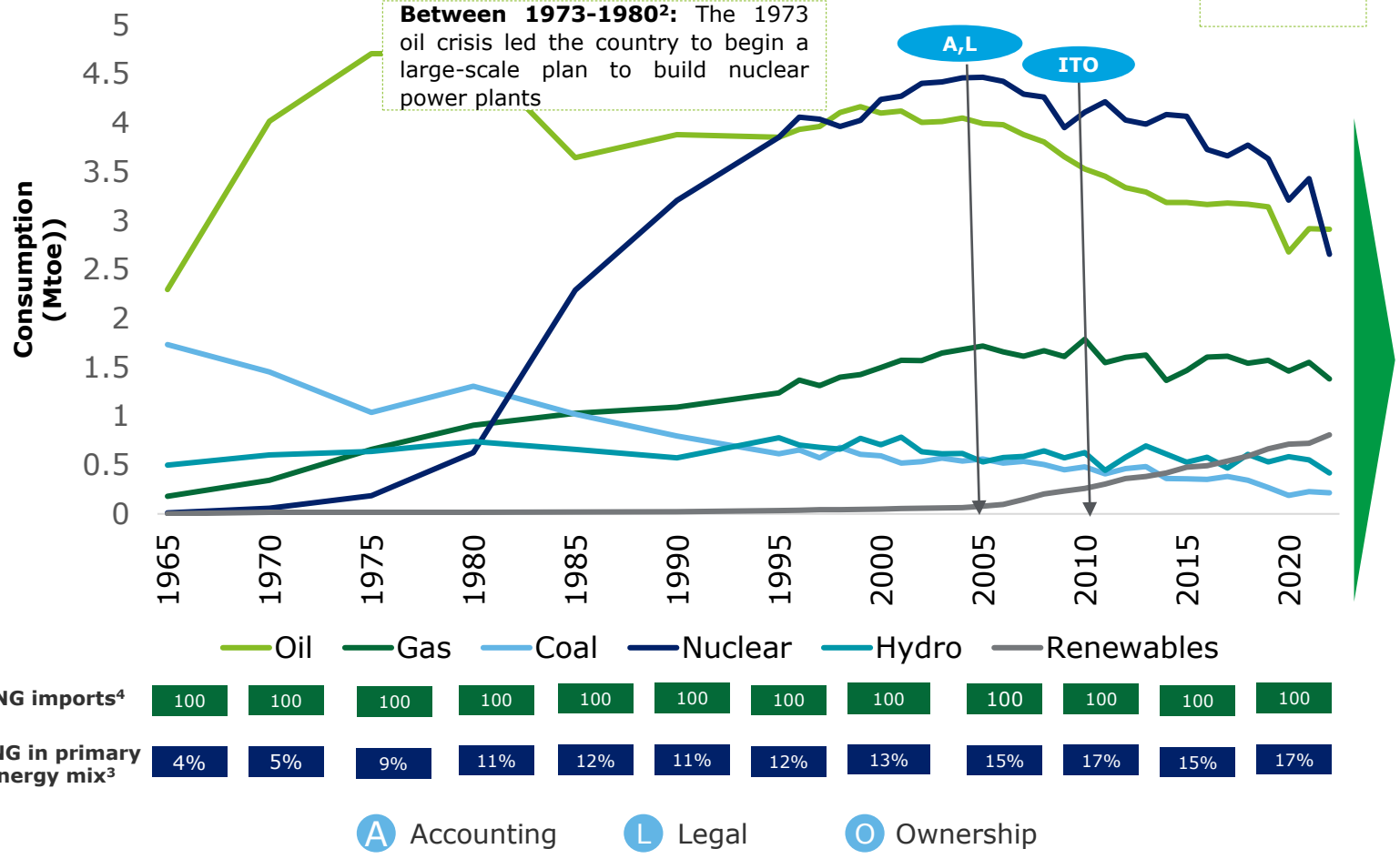
Various parties in the Gas Market play a key role in providing transportation, capacity booking, imbalance management, regulation of TSO, monitoring & implementation of Network code and cooperation of

United Kingdom	Roles
TSO	• Provides Third Party access to National Gas Grid-**(Regulation (EC) No 715/2009)** • Manages the online capacity Booking Platform-PRISMA and entry-exit regime (**Regulation-(EU) 2017/459)** • Capacity Conversion, Release of additional capacity and Bundling capacity through Harmonization (**NG Capacity guidelines**) • Imbalance Management is done by TSO by buying and selling of gas-on-Gas Exchange within Day Market. (Unbalancing Behavior code regulation (**Regulation (EU) No 312/2014)** • Executing Capacity Augmentation based on approval of Market Parties request by Regulatory Authority
MARKET PARTIES	• Responsible for booking capacity at entry-exit regimes • Market parties share responsibility for maintaining the balance of the transport network • Market Parties can carry Title Transfer of the gas in the secondary market i.e. at TTF • Capacity Augmentation Request to TSO
REGULATORY BODY	• Provides certification for TSO as per the defined code • The Ofgem sets the price control tariff model • National Regulatory Authority approves the imbalance charges
ENTSOG	• The ENTSOG for Gas shall monitor & analyze the implementation of the network codes and the Guidelines (Regulation (EC) No 715/2009). It acts as a bridge between European gas TSOs and promotes open communication within the market. • Capacity at IPs is sold through auctions that take place simultaneously across Europe in accordance with a harmonized auction calendar published by ENTSOG.
CEER **Council of European Energy Regulators**	• Promote cooperation between national energy regulators and contribute to the development of a well-functioning internal energy market • Create a standardized regulatory environment across Europe

Global Case Study – France (1/7)

Oil and Nuclear were the primary energy sources in France. Gas consumption increased nominally post 1997 to 2010 owing to energy conservation measures and focus on renewable after 2005

France



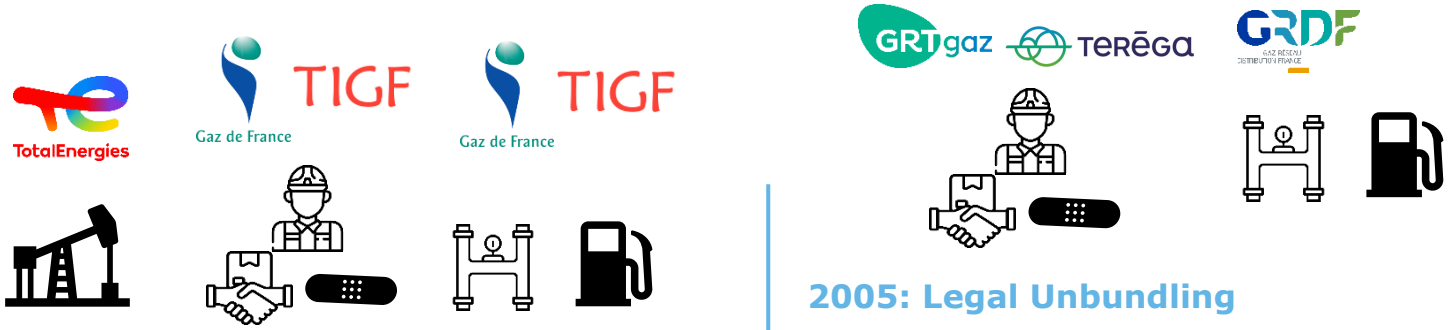
Key Historic

Key Points in History

- **Prior 1970[1],** the France was primarily dependent on oil for electricity production
- **Post 1970-1980:**
- The oil crisis sent shockwaves across the world's markets due to rising prices and shortages.
- The gas contribution[3] nominally from ~12% in 1997 to ~15% in 2010
- The gas contribution remained stable with ~16% in 2005 to ~15% in 2016 primarily due to
  - ✓ Energy conservation measures
  - ✓ Overall slowdown of economy
  - ✓ Focus on renewable started increasing after 2005 onwards
- **2005:** Legal unbundling was initiated in 2005 when gas sector had sufficient maturity
- **2009 – Post 3rd EU Directive**, options for different unbundling models were provided. France selected to ITO model.
- Coal Consumption has halved since 2013 due to power plant closure.

Source: 1. EIA: Energy Overview for France, 2. Emag- Nuclear Power **3,4.-** Stats Review of World Energy 2022

Global Case Study – France | Timeline (2/7)



Prior to 2005:

GDF France & Total Group's Entity were into Gas transmission and distribution

2003:

EU 2nd Directive

2005: Legal Unbundling

GRTGaz, a subsidiary of GDF (transmission) and, TIGF (transmission) a subsidiary of Total Group were formed in 2005 to achieve legal unbundling

2009:3rd EU Directive

Options for different unbundling models were provided. France selected to ITO model

2011: ITO Model

Implementation of ITO model on GRTgaz started in 2011

2012:

The final certification of French transmission operator by the CRE was issued in 2012 with approval from European Commission

Source: 1. USAID EIA Report on Unbundling of Natural Gas Market in BiH, September 2019

Global Case Study – France (3/7)

Legal unbundling was initiated in 2005 with a matured gas network and significant % of gas share in energy mix

France

- **Prior to unbundling –**
  - **GDF France** was a leading state-controlled entity in France operating into transportation and distribution. GDF holding approximately[1] ~87% of gas network in France.
  - Remaining 13% of gas network was controlled by Total Group's entity
- **2005 – Initiation of Legal Unbundling -**
  - Legal unbundling[0] was initiated in France in year 2005.
  - The length of gas network at time of legal unbundling in France was[1] ~36,490 Km. The current gas network length in France[2] is ~37,500 Km. Therefore, at the time of unbundling, the gas network of France was ~97% of the current gas network.
  - In year 2022, the natural gas contributed[3] to 15.6% of the France primary energy mix. In year 2005, at the time of legal unbundling, the share of natural gas in primary energy mix was ~16%. Historically, the share of natural gas in France's primary energy mix is almost constant and substantial to the level of ~16%
  - As it can be observed, the gas network length did not increase to a greater extent post legal unbundling in 2005 as the network was sufficiently matured at the time of unbundling
  - GRTGaz[4], a subsidiary of GDF and, TIGF a subsidiary of Total Group were formed in 2005 to achieve legal unbundling
  - **2009 – Post 3rd EU Directive**, options for different unbundling models were provided. France selected to ITO model.
  - France does not have any significant gas exploration and production infrastructure; the transmission network is logically seen as the only gas industrial asset. The major motivation to opt for ITO model can be seen as French Government being the majority owner of GDF with a conviction of keeping its role in strategic sectors of the economy.
  - **2011** – The practical implementation of ITO model on GRTgaz started in 2011. The final certification of French transmission operator by the CRE was issued[5] in 2012 with approval from European Commission.

~97% of current gas network was available when legal unbundling was initiated

France adopted ITO model for unbundling based on 3rd EU Directive

Source: 0. USAID EIA Report on Unbundling of Natural Gas Market in BiH, September 2019 **1.** Annual Report Gaz De France & Total Group 2003 & 2004, 2. European Gas Hub – French Gas Network Plan **3.-** Stats Review of World Energy 2022 , 4. CRE Activity Report 2011

Global Case Study – France | TSO formation from entities (4/7)

GDF France unbundled into GRTGaz & GRDF (Both subsidiary of GDF France). TIGF unbundled into Terega (subsidiary of TIGF)

Transporter, Distributor and Transmission & Distribution Asset owner

TIGF TRANSPORT ET INFRASTRUCTURES GAZ FRANCE

Supply, Transporter, Distributor and Transmission & Distribution Asset owner

Gaz de France **2005** | GDF SUEZ **2006** | ENGIE **2015**

Transmission & Distribution Asset owner

Total's Group Entity

Till 2004: (Transportation & Distribution assets & Ops)
Post 2005: Owned only assets but ops is looked after b
separate legal entity

GDF France (Govt)

Till 2004: (Transportation & Distribution assets & Ops)
Post 2005: Owned only assets but ops is looked after by separate legal entity
2006: GDF France and Suez merged to form GDF Suez
2015: GDF Suez changed name to Engie

Marketing /Supply

Terega (TIGF)	GRTGaz (subsidiary of GDF France, now Engie)	GRDF (subsidiary of GDF France, now Engie)
Post 2005: (Transportation only, with Total's Group as asset transmission asset owner)	**Post 2005:** (Transportation only, with GDF as asset transmission asset owner)	**Post 2005:** (Distribution only, with GDF as asset distribution asset owner)
Transporter	**Transporter**	**Distributor**

TEREGA | GRTgaz | GRDF GAZ RÉSEAU DISTRIBUTION FRANCE

Source: 1. USAID EIA Report on Unbundling of Natural Gas Market in BiH, September 2019

Global Case Study – France (5/7)

ITO model was adopted by France with two TSOs- GRTgaz and Terega using Prisma as a capacity booking platform

France	Functioning of TSO
TRANSMISSION SYSTEM OPERATOR[1]	**ITO Model**: GRTgaz and Terega (TIGF)
MODE OF BOOKING	Online Capacity booking platform managed by TSOs and powered by PRISMA[2]
CAPACITY BOOKING GOVERNANCE CODE	Capacity Network Code by European Union Regulation-(EU) **2017/459**
LEVERS FOR FOSTERING COMPETITION IN GAS MARKETS	• Unbundling TSOs and DSOs • TPA-Capacity Booking Platform • Title transfer Facility and Gas Exchange (listed on ICE Index): PEG[3] • PEGEX (Gas Index)[3]
CAPACITY BOOKING PLATFORM BY CAM	• Introduction of Entry-Exit Regimes (**Physical and Virtual)** • At (virtual) interconnection points, capacity is offered via auctions. • CAM Network Code with provision for bundled capacity • Capacity booking through algorithms target to different time periods • Incremental capacity addition & approval by regulatory authorities • Governance of TSO for Regulation implementation by ENTSOG • ENTSOG submit reports to CEER

Source: 1. USAID EIA Report on Unbundling of Natural Gas Market in BiH, September 2019(Page 51), **2**. Capacity Booking at Terega, GrtGaz **3.** ICE.COM -Gas Exchange-PEG,

Global Case Study – France (6/7)

Creation of Single market area-TRF, which is the single gas marketplace area in France to minimize the balancing zones and to ensure security of supply, guarantee a single price

France — **Functioning of TSO**

Governing Codes and Bodies	
IMBALANCE MANAGEMENT	• By Market Parties and TSOs as per the Balance NC, which came into force in 2015 • Creation of Single market area-TRF[1], which is the single gas marketplace area in France to minimize the balancing zones and to ensure security of supply, guarantee a single price • Rules for TSO balancing actions on the market to incentivize shippers to be balanced by applying a marginal price to cash out imbalances. • As part of its balancing system, both TERÉGA and GRTgaz sell and buy quantities of gas via Powernext's PEGAS platform.[2] • **Correction Based Mechanism**: TSO execute that mechanism by buying and selling gas on Gas Exchange (PEGAS) with day market called within-day balancing action (WDBA)[3]
TARIFF	• Tariff are of two types[4] : the regional network term and the delivery term. An exit capacity term relative to the main network also applies. • The NTR (regional tariff level)[5] is set by the CRE for each consumer delivery point (PLC), each regional network interconnection point (PITD) and each transport distribution interface point (PITD). It is established as a function of the cost of transmission of the gas from the main network to the relevant delivery point, but excludes connection.

Source: 1.CRE-Madrid Forum-Creation of Single Market Area, **2, 3.** Acer Europe-Balancing Regime 10th Sept 2018, **4,5**. Grt Gaz-Downstream Network Transmission Tariff principles

Global Case Study – France (7/7)

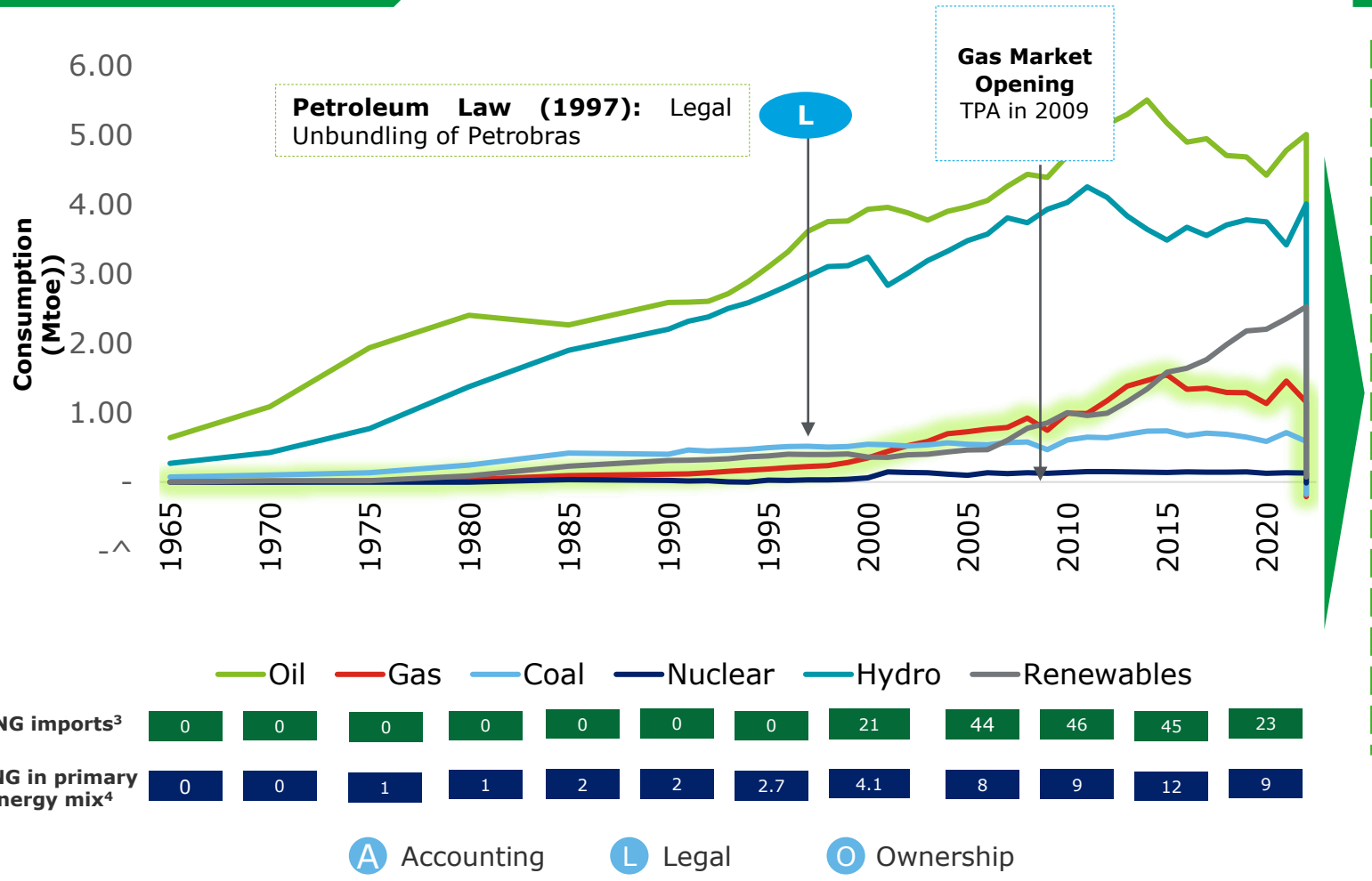
Various parties in the Gas Market play a key role in providing transportation, capacity booking, imbalance management, regulation of TSO, monitoring & implementation of Network code and cooperation of

France	Roles
TSO	• Provides Third Party access to National Gas Grid-**(Regulation (EC) No 715/2009)** • Manages the online capacity Booking Platform-PRISMA and entry-exit regime (**Regulation-(EU) 2017/459)** • Imbalance Management is done by TSO by buying and selling of gas-on-Gas Exchange within Day Market. (Unbalancing Behavior code regulation (**Regulation (EU) No 312/2014)** • Executing Capacity Augmentation based on approval of Market Parties request by Regulatory Authority
MARKET PARTIES	• Responsible for booking capacity at entry-exit regimes • Market parties share responsibility for maintaining the balance of the transport network • Market Parties can carry Title Transfer of the gas in the secondary market i.e. at PEGAS-FR • Capacity Augmentation Request to TSO
REGULATORY BODY	• Provides certification for TSO as per the defined code • The CRE sets tariffs for each entry and exit point • National Regulatory Authority approves the imbalance charges • Unbalancing Behavior code regulation by regulator for market parties and penalty
ENTSOG	• The ENTSOG for Gas shall monitor & analyze the implementation of the network codes and the Guidelines **((EC) No 715/2009)** • it acts as a bridge between European gas TSOs and promotes open communication within the market.
CEER **Council of European Energy Regulators)**	• Promote cooperation between national energy regulators and contribute to the development of a well-functioning internal energy mkt • Create a standardized regulatory environment across Europe

Global Case study – Brazil (1/6)

In 1997, after the implementation of petroleum law, which required to separate ownership and operation of natural gas transmission assets from Petrobras (Vertically integrated entity), gas consumption rose

BRAZIL



Key Historic

Key Points in History

1970-2010[1]

- In the 1970s and 1980s, realizing the massive potential of Brazil's rivers, the government began large-scale investments in hydropower

1997[2]

- **Petroleum Law:** Leading to creation of two subsidiaries-TAG (Pipeline Owner) and Transpetro (Operator)

2009[2]

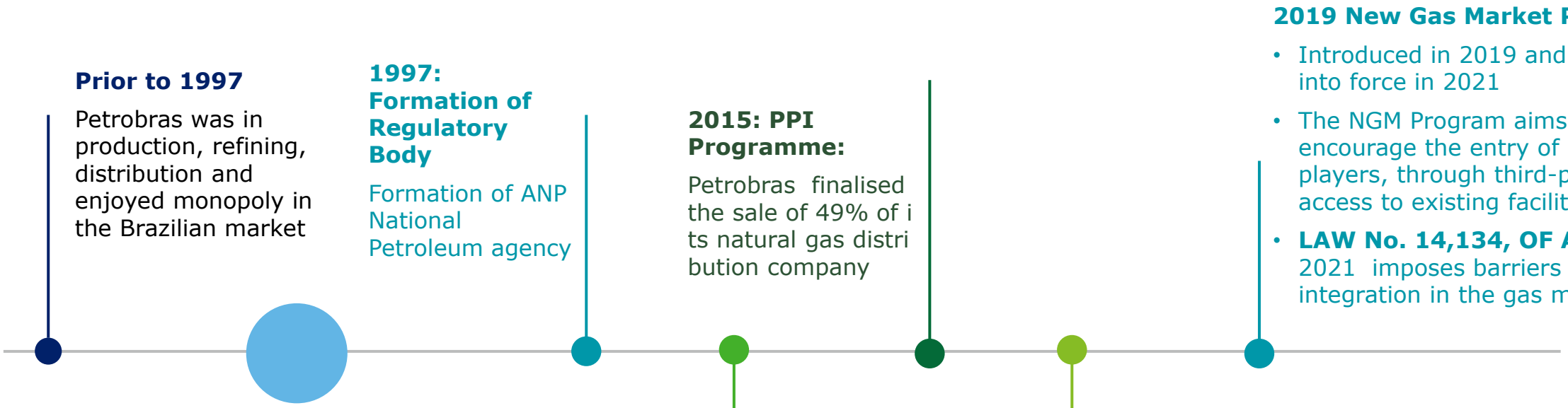
- **Natural Gas Law:** Enabling Third Party access to transmission networks

2012 onwards

- Natural gas-powered thermal generation has seen a rapid increase, as it is being increasingly used (together with non-hydro renewables) to compensate for variation in hydropower generation
- Biomass forms the major portion of the renewable source of energy

Sources: 1. Oxford Energy Brazil 2. IEA Implementing Gas Market Reform in Brazil 3, 4. Stats Review of World Energy 2022

Global Case study – Brazil | Timeline (2/6)



Prior to 1997

Petrobras was in production, refining, distribution and enjoyed monopoly in the Brazilian market

1997: Formation of Regulatory Body

Formation of ANP National Petroleum agency

2015: PPI Programme:

Petrobras finalised the sale of 49% of i ts natural gas distri bution company

2019 New Gas Market Program

- Introduced in 2019 and came into force in 2021
- The NGM Program aims to encourage the entry of new players, through third-party access to existing facilities.
- **LAW No. 14,134, OF APRIL** 8, 2021 imposes barriers to vertical integration in the gas market.

1997

- In 1997, Government approved Law 9.478/1997, with Petrobras creating 2 wholly-owned subsidiaries:
- Transportadora Associada de Gás S.A. (TAG), **(pipeline owner)**
- Transpetro, **(Pipeline operator)**

2009

- Brazil approved the Gas Law (Law 11.909/2009)
- Established guidelines for open access to the natural gas transportation network

2016

- Gas Grow programme launched
- Targeted increasing competition in the natural gas sector by guaranteeing TPA to essential infrastructure & the transmission system

Sources: 1,Brazilian Gas Market and Its Regulatory Overview by Hirdan Katarina de Medeiros Costa, 2.2018-Report by IEA: Towards a competitive natural gas market in Brazil

Global Case study – Brazil (3/6)

In 1997, Government implemented the petroleum law, which required to two create subsidiaries for ownership & operation of Natural gas transmission assets from Petrobras, which was a VIU

Brazil

Prior to 1997[1]

- Petrobras was controlled by government involved in the production, refining, distribution and enjoyed monopoly in the Brazilian market
- Natural Gas share[2] in the primary energy mix was 2% in 1991.

1997[1] : Open access to oil fields: Legal Unbundling

- In 1997, Government approved **Law 9.478/1997**, breaking Petrobras's monopoly & allowing competition in Brazil's oilfields
- The 1997 Petroleum Law mandated that Petrobras create a subsidiary to build and operate its pipelines, maritime terminals and vessels to carry hydrocarbons and its products.
- In compliance with the legal requirement, Petrobras set up two wholly-owned subsidiaries: Transportadora Associada de Gás S.A. **(TAG),** which owned the pipelines, and **Transpetro,** which operated them.
- Creation of National Petroleum agency Agência Nacional do Petróleo (ANP) in 1997,who was responsible for the regulation and supervision of the petroleum industry, and the National Council of Energy Policies, a public agency responsible for developing public energy policy.
- Natural Gas share[2] in the primary energy mix was approximately ~2.9% in 1997

1999[1]

- The National Petroleum Agency (ANP) signed agreements with other companies, ending the company's monopoly
- Natural Gas share[2] in the primary energy mix was approximately ~4.1 % in 2000

2009[1] : Open access to gas infrastructure

- In 2009, Brazil approved the Gas Law (Law 11.909/2009), which was issued because of the very limited increase in the number of participants in the natural gas market when Petrobras' monopoly was ended.
- The Gas Law introduced a concession regime for the transportation of natural gas and regulated the access to the pipeline transportation system.

In 2009, Open access to Gas infrastructure was granted as per Gas Law

Transpetro was operator and TAG owned the gas transmission assets

Sources: 1,Brazilian Gas Market and Its Regulatory Overview by Hirdan Katarina de Medeiros Costa, 2. Stats Review of World Energy 2022

Global Case study – Brazil (4/6)

PPI programme of 2015 was aimed at selling of distribution assets by Petrobras to new players

Brazil

- **2009[1] : Third Party Access to gas infrastructure continued**
  - This law specifically addresses the natural gas sector in Brazil, particularly the transportation, storage, and commercialization of natural gas. Does not cover exploration and production of natural gas, which is regulated by the 1997 Petroleum Law.
  - Established guidelines for open access to the natural gas transportation network. This promotes competition among gas suppliers and benefits consumers, allowing consumers to switch suppliers.
  - Through its subsidiaries TAG and Petrobras Logística de Gás S.A. (Logigás), Petrobras has controlled most of the country's transmission infrastructure. Petrobras had stakes in over 95% of the transport network and all LNG import terminals
  - Petrobras operated 69% of country's transport network well as all regasification capacity through Petrobras Transporte S.A. (Transpetro). The remainder is mainly operated by TBG, where Petrobras owns a 51% stake.
  - **Limitation:** It only applies to customers with very large consumption volumes.
  - The law contained provisions to ensure TPA, but, in practice, alternative market participants did not even reach the point of access due to difficulties in accessing gas processing plants and upstream pipelines. Also, the legal framework established the concept of free consumers, but this was never effectively introduced in most states
- **Petrobras PPI Programme 2015[2]: Gas Distribution**
  - At the end of 2015, Petrobras finalised the sale of 49% of its natural gas distribution company, Gaspetro, to Mitsui & Co., Ltd. Taking into account that Gaspetro controls Petrobras's stakes in 19 state-run natural gas distributors, this was an important step in the process of opening the market to new players.

PPI programme of 2015 was aimed at selling of distribution assets by Petrobras to new players

Petrobras operated 69% of the country's transport network through Transpetro

Sources: 1,Brazilian Gas Market and Its Regulatory Overview by Hirdan Katarina de Medeiros Costa, 2.2018-Report by IEA: Towards a competitive natural gas market in Brazil

Global Case study – Brazil (5/6)

As per the New Gas market programme, there is a legal requirement to move from legal unbundling model to ownership unbundling.

Brazil

Gas Grow programme[1] launched in 2016

- In 2016, the Gas to Grow (Gás para Crescer) programme targeted increasing competition in the natural gas sector by guaranteeing TPA to essential infrastructure and the transmission system and establishing market-oriented rules.
- This programme engaged several stakeholders and produced policy recommendations
- **Trigger for establishment:** Gas demand in Brazil has historically been constrained by factors such as market structure and network access as a result of the de facto monopolistic position of the state-controlled company Petrobras, limited transparency in price formation, slow deployment of new distribution networks, limited development of secondary markets and different regional taxation regimes.

2019[2]: New Gas Market Programme was introduced for ownership Unbundling implementation and third-Party access

2021[2]: New Gas Market Programme came into force, (Novo Mercado de Gás):

- The NGM Program aims to encourage the entry of new players, both through new projects that can make natural gas available to the market, and through third-party access to existing facilities.
- New Gas Law No. 14,134, OF APRIL 8, 2021 imposes barriers to vertical integration in the gas market

New Gas Market Programme was launched in 2021. The focus is to adopt OU model

Petrobras operated 69% of the country's trans port network through Transpetro

Sources: 1.2018-Report by IEA: Towards a competitive natural gas market in Brazil, 2. IEA Report on ovo-mercado-de-gas

Global Case study – Brazil | TSO Formation from Entities (6/6)

Petrobras was the vertically integrated entity that separated the ownership & operations of gas transmission assets in Brazil.

TSO Formation[1]

Gas Production, Supplier, Transporter & Transmission Asset owner

Petrobras

Before 1997 : (Supply and Transportation assets & Ops)
Post 1997 : Petrobras created two subsidiaries

Transporter & Transmission Asset owner

Transportadora Gasoduto Bolívia-Brasil (TBG)

1999: Owned Transportation assets & Ops

Transportadora Associada de Gás S.A. (TAG)

Post 1997: A subsidiary of Petrobras**,** which owned the Pipeline
Post: A subsidiary of Engie Group

Asset owner

Transpetro

Post 1997: A subsidiary of Petrobras**,** which Operates the Pipeline

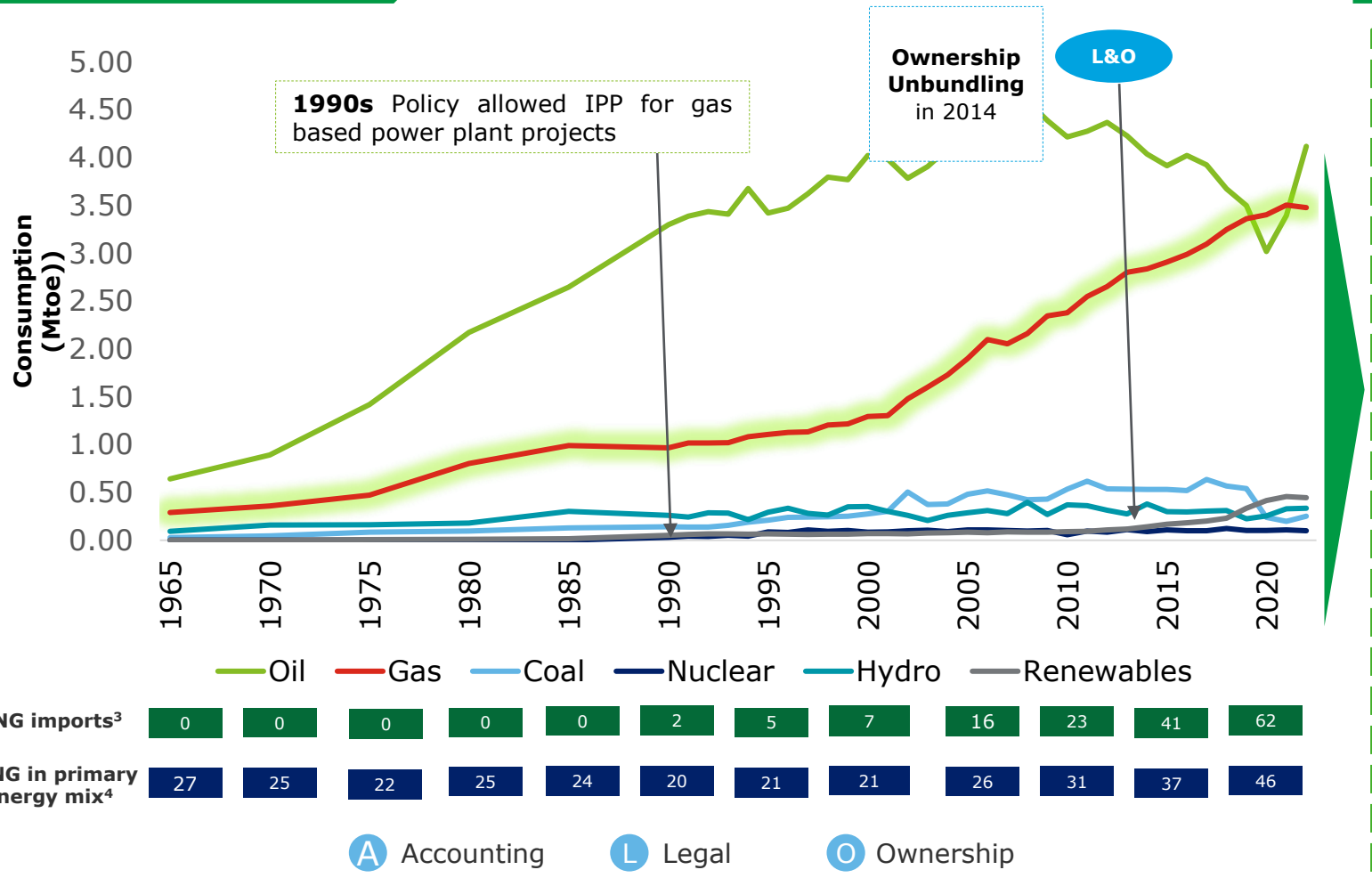
Transporter

Sources: 1,Brazilian Gas Market and Its Regulatory Overview by Hirdan Katarina de Medeiros Costa,

Global Case study – Mexico (1/4)

1990s Policy allowed private investor to invest in power generation using gas, leading to IPP for gas based power plants

MEXICO



Key Historic

Key Points in History

1990

- **1990s** Policy allowed, private investors to invest in power Generation using gas, leading to IPP Independent Power Producer for gas-based power plants

2014

- Unbundling of Pemex (state owned oil Company)
- Gas contributed to 56%[1] of total electricity generated (300TWH) followed by Hydro, coal and oil. Mexico is the major consumer of Oil and Gas.

2017

With Powering Past Coal Alliance in 2017[2], the govt of Mexico decided not to open any more coal based power plants, as the contribution by coal in electricity generation is minimal

2023

- In May 2023, CRE extended the "clean" label to gas-fired CHP plants considered to be efficient cogeneration

Sources: 1. Mexico Energy Outlook 2013,2017, 2. Climate Transparency 2021, 3, 4. Stats Review of World Energy 2022

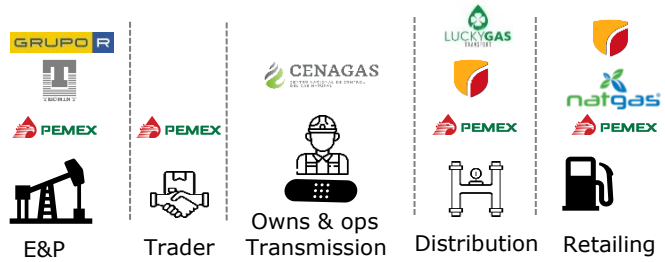
Global Case study – Mexico | Timeline (2/4)

Prior to 2013

PEMEX, a state-owned vertically integrated entity from exploration to distribution, Pemex retained a monopoly over Mexico's oil and natural gas sector

2014 Energy Reforms:

- Secondary Laws Approved in August 2014. Key provisions dealing with the hydrocarbons sector not mentioned in 2013 Constitutional Reforms
- CRE was established as energy regulator



2013: Constitutional Energy Reforms

- Maintaining state ownership of subsoil hydrocarbons resources
- Provision for opening refining, transport, storage, natural gas processing, and petrochemicals sectors to private investment

2014: Ownership Unbundling

CENAGAS was created in 2014 to assign capacity rights for pipelines that were previously owned and operated by Petróleos Mexico (PEMEX)

Sources: 1. Mexico's Oil and Gas Sector: Background, Reform Efforts, and Implications for the United States

Global Case study – Mexico (3/4)

Constitutional Energy Reforms of 2013 and 2014 primarily drove the ownership separation of PEMEX, which was vertically integrated entity

MEXICO

Prior to 2014[1]
- PEMEX, a state-owned vertically integrated entity from exploration to distribution, Pemex retained a monopoly over Mexico's oil and natural gas sector. It was the monopoly owner of Mexico's pipeline assets.

2013: Constitutional Energy Reforms[1]
- Maintaining state ownership of subsoil hydrocarbons resources, but allowing companies to take ownership of those resources once they are extracted and to book reserves for accounting purposes
- Provision for opening refining, transport, storage, natural gas processing, and petrochemicals sectors to private investment

2014[1]: Energy Reforms in Mexico
- Secondary Laws Approved in August 2014. Key provisions dealing with the hydrocarbons sector not mentioned above include:
  - Pemex's monopoly on retail gasoline and diesel sales ends in 2016

  The institutional framework has been updated with new specialized bodies like
  - **Ministry of Energy (SENER)** develops Mexico's upstream policy, determines areas to be made available and the schedule for public bidding, chooses between contract models, and approves the non-fiscal terms of the contract.
  - **Ministry of Finance (SHCP)**determines the fiscal terms to apply to each contract and participates in audits.
  - **National Hydrocarbons Commission (CNH)**interfaces with Pemex and private companies, conducts and manages contracts, and oversees the industry.
  - **Energy Regulatory Commission (CRE)** grant permits for transportation, storage, distribution, compression, liquefaction, decompression regasification, marketing, and sale of crude oil, oil products, and natural gas.
  - **National Agency for Industrial Safety and Environmental Protection** regulates environmental and safety concerns.
  - **National Natural Gas Control Center (CENAGAS):** manages system for gas distribution and storage.

2014[2]: Ownership Unbundling
- **CENAGAS** was created in 2014 as the public entity entrusted with assigning capacity rights for pipelines that were previously owned, operated, and largely used by Mexico's national energy company, Petróleos Mexico (PEMEX)
- **CENAGAS[2]** manages Mexico's Integrated National Natural Gas Transportation and Storage System, also known as SISTRANGAS, which currently has 6,256 miles of pipeline and a total transportation capacity of 6.3 billion cubic feet per day (Bcf/d).

Constitutional Energy Reforms of 2013 and 2014 primarily drove the formation of TSO -CENAGAS

CENAGAS also manages SISTRANGAS as part of its assets

Sources: 1. Mexico's Oil and Gas Sector: Background, Reform Efforts, and Implications for the United States, 2 EIA- Reforms in Mexico Gas Market

Global Case study – Mexico | Value chain (4/4)

CENAGAS is the transmission system operator, which is an ownership unbundled entity

Mexico — **Structure**

Producer, trader, Transporter & Transmission Asset owner, Transporter & Distribution Asset owner, Retailing

Pemex

Before 2013 : (Exploration, Supply, Transportation & distribution assets & Ops)
Post 2014 : Separated from Pemex

Transporter & Transmission Asset owner

CENAGAS

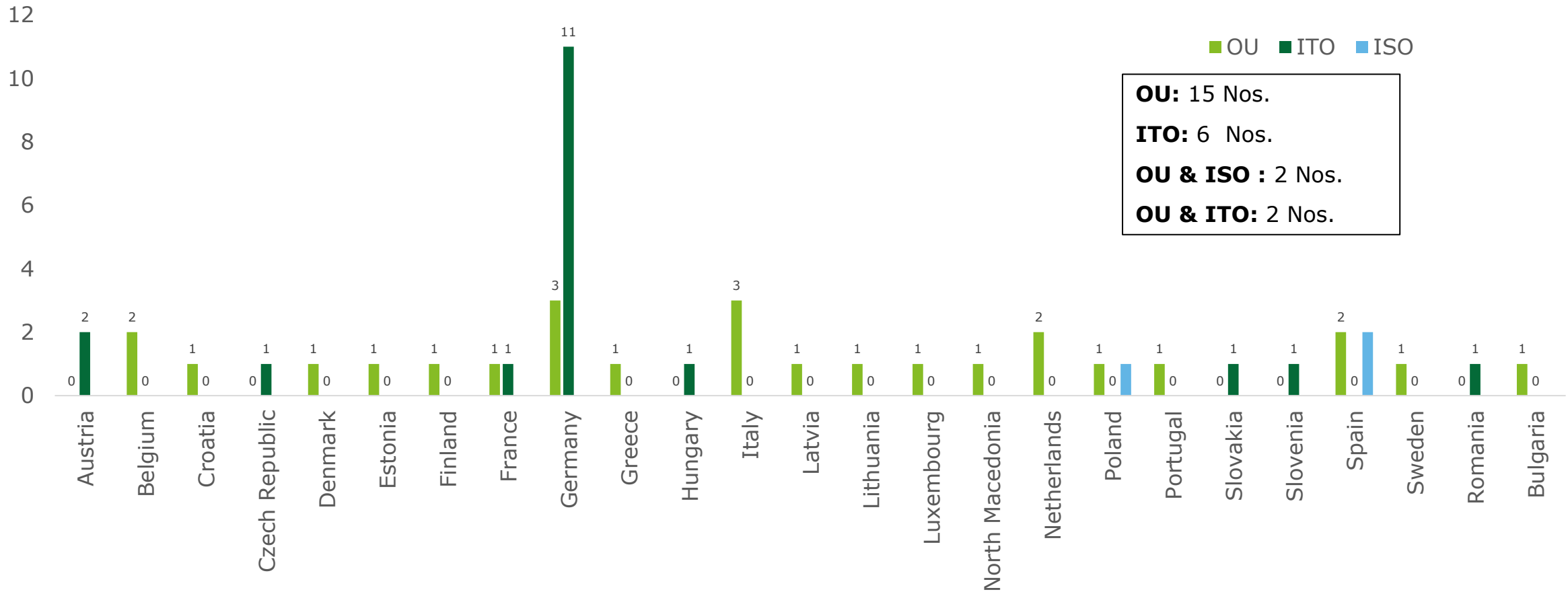
Post 2014: CENAGAS was created in 2014 to assign capacity rights for pipelines that were previously owned and operated by Petróleos Mexico (PEMEX),

Sources: 1. Mexico's Oil and Gas Sector: Background, Reform Efforts, and Implications for the United States

Unbundling Models in different EU Countries

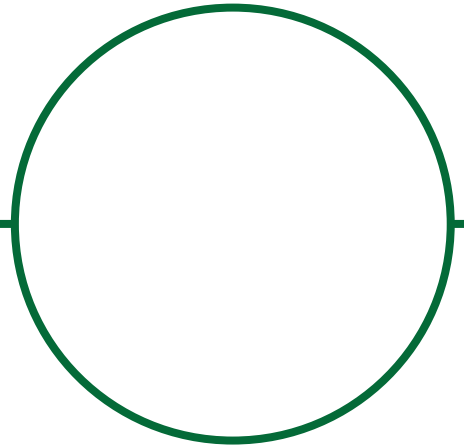
Out of 25 countries, 15 EU countries have Ownership Unbundling (OU) only, 6 have Independent Transmission Operator (ITO) only, and 2 each have adopted both OU & ITO or OU & ISO models

EU Countries



Source: 1. CEER Report TSO/DSO unbundling status 2024

End of the Report



01 ZONAL STUDY ON LPG PIPELINE: POTENTIAL NEW LPG PIPELINES TO BE BID OUT

02 RAPID ASSESSMENT OF "PATHWAYS TO INCREASE SHARE OF NATURAL GAS FROM 6% TO 15%"

03 GLOBAL CASE STUDIES OF TRANSMISSION SYSTEM OPERATOR (TSO)

04 ASSESSMENT OF MATURITY IN NATURAL GAS MARKET

05 MARKET AND REGULATORY FRAMEWORK FOR GAS DISTRIBUTION SECTOR ACROSS THE GLOBE

Report
on
Assessment Of Maturity In Natural Gas Market

Prepared For Petroleum And Natural Gas Regulatory Board (PNGRB)
By Deloitte Touche Tohmatsu India LLP (DTTILLP)

September 2024

Study Context

The Petroleum and Natural Gas Regulatory Board (PNGRB) has undertaken a study to define and assess the key parameters of maturity and development in the natural gas sector

CONTEXT

The Petroleum and Natural Gas Regulatory Board (PNGRB) has undertaken a study to define and assess the key parameters of maturity in the natural gas sector during the unbundling of transportation and marketing of natural gas. The study has identified the gas market situation in terms of infrastructure, gas share in the primary energy mix of the country, supply diversification, liquidity in the market, robustness of the regulatory framework, and the transparency in pricing that exists in countries where unbundling took place in the natural gas sector.

Scope of Work for each of the Modules

1. **Objective of the Study**
2. **Introduction**
3. **Section I – Parameters of Mature/Developed Natural Gas Markets**
4. **Section II – Analysis of development in natural gas sector of India (2015-24)**
5. **Section III – Status of various parameters during and after unbundling in selected countries**
6. **Section IV – Analysis of Power sector in India where unbundling occurred and benefits**
7. **Section V – Realized Benefits of Separating Marketing and Transportation Activities Globally**
8. **Conclusion**

Objective of the Study

The objective was to define and assess the key parameters of maturity and development in the natural gas sector in India

The **Petroleum and Natural Gas Regulatory Board (PNGRB)** has undertaken a study to define and assess the key parameters of maturity in the natural gas sector during the unbundling of transportation and marketing of natural gas. The study has identified the gas market situation in terms of infrastructure, gas share in the primary energy mix of the country, supply diversification, liquidity in the market, robustness of the regulatory framework, and the transparency in pricing that exists in countries where unbundling took place in the natural gas sector.

The Government of India's target to raise the share of natural gas in the energy mix to 15% by 2030[1] underscores the critical role of unbundling in facilitating this transition. Unbundling is expected to enhance market efficiency, attract investment, and support the expansion of infrastructure necessary to meet these ambitious goals.

Additionally, India has committed under international climate agreements, such as the Paris Agreement (COP 21) to reduce emissions intensity per unit of GDP by 33-35% from 2005 levels and to achieve 40% of installed capacity from non-fossil energy resources by 2030. India has already achieved the same and now under the Glasgow Convention (COP 26), India has committed to cutting total projected carbon emissions by 1 billion tonnes by 2030, reducing the carbon intensity of its economy by less than 45% by the end of the decade, achieve 50% of installed capacity from non-fossil energy resources and achieving net-zero carbon emissions by 2070[2].The unbundling of the natural gas sector plays a crucial role in meeting these climate targets by fostering a more competitive, transparent, and efficient gas market that supports the transition to cleaner energy sources.

Sources: 1. PIB India- Natural Gas Target for India by 2030 2. India’s Updated Nationally Determined Contribution to be communicated to the UNFCC

Introduction (1/9)

Unbundling

Unbundling refers to the separation of activities of an industry involved in multiple parts of value chain-trading, producing, transporting, distributing, that was previously integrated.

Unbundling in Natural Gas Sector

In the context of the natural gas sector, unbundling typically involves separating the ownership and operation of gas transportation (pipeline infrastructure) from the marketing and sale of gas. This separation ensures that pipeline operators (who manage the physical infrastructure) and gas marketers (who sell the gas to consumers) operate independently, promoting competition, transparency, and fairness in the market. The primary goal of unbundling is to prevent conflicts of interest, enhance market efficiency, and create a level playing field for all market participants.

Unbundling may or may not be the first step in liberalizing a market. In some cases, it happens when the market has reached a certain maturity level in terms of development of Natural gas ecosystem (all aspects of supply, trading or marketing, transmission, distribution) in a country or when competition is hindered by presence of monopolies or infrastructure bottlenecks.

In cases where infrastructure monopolies hinder competition (in terms of access or transparency in accounting, pricing, competition) or innovation, unbundling becomes a corrective mechanism, which restores the market to healthy competition levels.

In the USA, unbundling in the natural gas sector came after regulatory reforms aimed at increasing competition in the interstate pipeline business (FERC's Orders 436 and 636). This unbundling was a response to the complexities and inefficiencies within the market, ensuring open access to pipelines and allowing for more dynamic price formation. It wasn’t necessarily a starting point of liberalization but rather a step required to keep pace with market growth, technological advancements and when the ecosystem has evolved.

Sources: 1. FERC

Introduction (2/9)

Unbundling in Natural Gas Sector: Global Perspective

Unbundling has been a significant part of regulatory reforms aimed at liberalizing the market, improving access to infrastructure, and fostering competition. As countries-initiated unbundling at different stages of gas market development, the factors determining market maturity varied accordingly basis their as-is status. Consequently, the specific circumstances at the time of unbundling depended on whether a country was already operating in a mature market or was still developing towards that goal. The intent of unbundling was to promote fair access to infrastructure, increased competition through a larger number of market participants, and greater number of consumer choices.

From the global perspective, there are different stages of unbundling in the gas sector with lower degree of unbundling to higher degree of unbundling.

1) **Account Unbundling**: It is the lowest form of unbundling, which requires an entity involved in various parts of the value chain to keeping separate accounts of various activities.
2) **Legal Unbundling:** It is lower form of unbundling, which requires an entity involved in more than one part of the value chain (production, marketing, transmission & distribution) to reorganize its activities into separate legal entities. Legally unbundled entity is owned by the previously vertically integrated firm through a holding company.
3) **Ownership Unbundling**: It is the highest form of unbundling. It requires an entity involved in more than one part of value chain to ownership unbundle all its activities. A firm owning and operating a activity cannot be active in any other competitive segment of the supply chain nor have an interest in any company involved in those activities.

Status of Unbundling in Natural gas sector: Global

Globally, countries have undertaken initiated unbundling implementing lowest form of unbundling, and then moving to higher forms of unbundling in a phased manner i.e. account separation, followed by legal unbundling and then finally to ownership.

Below is the list of few countries, which have implemented unbundling in their natural gas sector and have foreseen benefits:

Sources: 1. EU

Introduction (3/9)

Country Name	Developed/ Developing	Year of Unbundling
USA	Developed	1992: Ownership Unbundling
France	Developed	2005: Legal Unbundling
Brazil	Developing	1997: Legal Unbundling
United Kingdom	Developed	1997: Ownership Unbundling
Spain	Developed	2014: Ownership Unbundling
Mexico	Developing	2014: Ownership Unbundling
Netherlands	Developed	2005: Legal Unbundling 2006: Ownership Unbundling

Sources: 1. EU

Introduction (4/9)

How Unbundling was enforced globally?

The European Union's (EU) energy sector unbundling process is a powerful example of how regulation, legislation, and legal enforcement can drive market liberalization. The process unfolded over several decades through three key energy market directives, each addressing specific challenges in the sector's liberalization.

The unbundling of energy companies (specifically separating generation and supply from transmission) was a critical component of this transformation.

Here's an analysis of how each directive was enforced, why it was important, and the role of courts in resolving legal challenges.

1. **First EU Gas Directive[1] (1998)** – Initial Steps Toward Market Liberalization

Context and Motivation:

The First EU Gas Directive (1998) aimed to break down national energy monopolies in gas, initiating the move towards a competitive EU energy market. Before this, vertically integrated companies-controlled generation, transmission, and distribution in many EU member states, resulting in inefficiencies, high prices, and limited competition.

Key Provisions:

- **Third-Party Access (TPA):** The directive introduced negotiated access for third parties (new entrants) to the gas transmission networks. However, access to these networks was subject to negotiation with incumbent network operators, and there were no strong legal guarantees of non-discriminatory access.
- **Market Opening:** The directive mandated the partial opening of the energy markets i.e. certain % of consumers can choose their energy suppliers.

Sources: 1. Based on Analysis of EUR-Lex : European Union Website- Directive 98/30/EC

Introduction (5/9)

Why It Was Important:

This directive was the EU's first step toward liberalizing its energy markets, allowing for some level of competition. However, it lacked robust mechanisms for unbundling and regulatory oversight, leading to limited market impact.

Limitations:

- **No Full Unbundling:** There was no clear requirement for separating network activities (transmission and distribution) from generation and supply, so vertically integrated companies continued to dominate.
- **Negotiated TPA:** Since access to networks was subject to negotiation, incumbents could still limit access to new competitors, maintaining their dominance.

2. Second EU Gas Directive[1] (2003) – Introducing to Legal Unbundling

Context and Motivation:

By the early 2000s, it was clear that the First Directive had not gone far enough to ensure market competition. Vertically integrated companies were still dominating the market, and new entrants struggled to gain non-discriminatory access to essential network infrastructure.

Key Provisions:

- **Legal Unbundling:** The Second Gas Directive (2003) introduced the concept of legal unbundling, requiring the separation of transmission and distribution activities from generation and supply within vertically integrated energy companies. This meant that companies had to create legally distinct subsidiaries for network operations.
- **Regulated TPA:** The directive introduced regulated third-party access, ensuring that tariffs for network access were regulated by independent national authorities, reducing the ability of incumbents to unfairly block competitors.
- **Market Opening:** The directive required a higher percentage of the market to be open to competition, with full market opening in gas by 2007.

Sources: 1. EUR-Lex : European Union Website- Directive 2003/55/EC

Introduction (6/9)

Why It Was Important:

The Second Directive marked a significant step forward in the liberalization process. By mandating legal unbundling, it ensured that network operators were legally separate entities, reducing the conflict of interest between network operation and energy production. This helped improve transparency and competition.

Limitations:

- **No Ownership Unbundling**: Despite legal separation, many vertically integrated companies still owned both generation/supply and transmission/distribution assets, leading to potential conflicts of interest.
- **Varying Implementation:** Some member states were slow to implement the directive, and the quality of unbundling varied across countries, leading to uneven market liberalization.

3. Third EU Gas directive Package[1] (2009) – Full Ownership Unbundling

Context and Motivation:

The shortcomings of the Second Directive, particularly the continued influence of vertically integrated companies, prompted the EU to take further steps with the Third Energy Package (2009). The goal was to complete the liberalization process and create a fully competitive energy market across the EU.

Key Provisions:

- **Ownership Unbundling:** The Third Energy Package introduced the requirement for full ownership unbundling. This meant that energy companies could no longer control both production/supply and transmission networks. Transmission System Operators (TSOs) had to be completely independent of companies involved in generation and supply.

Sources: 1. EUR-Lex : European Union Website- Directive 2009/73/EC

Introduction (7/9)

- **Three models for unbundling were introduced:**
    - **Full Ownership Unbundling:** Complete separation of ownership of generation/supply and transmission.
    - **Independent System Operator (ISO):** A third-party operator could manage the transmission system, but ownership of the assets could remain with the energy company.
    - **Independent Transmission Operator (ITO):** Vertically integrated companies could still own transmission systems, but strict rules were imposed to ensure independence in decision-making.
- **National Regulatory Authorities:** Independent national regulators were empowered to oversee market activities, ensuring transparency and fairness in access to networks.
- **Agency for the Cooperation of Energy Regulators (ACER):** A new EU-wide regulator, ACER, was established to oversee cross-border energy market activities and harmonize rules between member states.

Why It Was Important:

The Third Energy Package was crucial because it finally tackled the root of the problem—ownership of transmission assets by vertically integrated companies. This was the most significant step towards ensuring a level playing field in the EU energy market. By separating ownership, it was possible to foster true competition, reduce conflicts of interest, and promote transparency.

Benefits of unbundling have been in-terms of increase in competition levels, increase in number of gas suppliers, increase in third party access to infrastructure, and also in terms of decrease in transportation tariffs for pipeline networks due to efficient operations. Refer Section V of detailed benefits experienced in different countries and refer section IV for assessment of different parameters at the time of unbundling in different countries from global cases.

Introduction (8/9)

Status of Unbundling in Natural gas sector: India

- Currently, in India as per the PNGRB affiliate code of conduct[1], 2008, Entities have implemented account separation but the compliance towards legal separation as per clause 5A of the PNGRB affiliate code of conduct, 2008 is pending. Under PNGRB's affiliate code of conduct 2008, entities engaged in transportation and marketing are required to legally separate the two functions into two separate legal entities. There is also a provision to require an entity to unbundle the ownership.

- Largely, in India, the status of entities complying with affiliate code of conduct is as follows:

Entity Name	Status of Unbundling
GAIL	Not legally unbundled
GSPL	Legally Unbundled but control of vertically integrated entity
PIL	Ownership Unbundled
GTIL	Legally Unbundled
GIGL	Legally Unbundled
IGGL	Legally Unbundled
IOCL	Not Legally Unbundled

Note:

1. GSPL is legally unbundled but its shareholder is GSPC, which has 37% stake in GSPL. Hence, in this arrangement, promotor can influence decision of the transportation entity

2. PIL was earlier owned by RIL and now its being owned by Brookfield Asset Management. PIL does not carry out any gas marketing

Sources: 1. PNGRB Affiliate code of conduct 2008- Amendment 2015

Introduction (9/9)

Approach

The note is divided into five sections:

- Parameters constituting market maturity for a Natural gas sector
- Analysis of development in natural gas sector of India from 2015 to 2024 in terms of different parameters required for a mature natural gas market
- Status of various parameters at the time of unbundling in natural gas sector of the selected countries
- Benefits of unbundling in natural gas sector from global case study scenario
- Analysis of power sector in India where unbundling has occurred two decades ago

Methodology

Assessment methodology is based on the analysis of the data and information collected through primary and secondary research by PNGRB.

- Secondary research is based on the data & information retrieved from publicly available reports and information available on websites of governments, regulators, and transmission system operators. Supporting sources of the data have been enclosed in the endnote
- During the primary research phase, PNGRB has interacted with energy regulators from France, Belgium, Netherlands, Spain, and United Kingdom

Sources: 1. PNGRB Affiliate code of conduct 2008- Amendment 2015

Section I: Parameters of Mature Natural Gas Markets (1/4)

Section I: Parameters of Mature Natural Gas Markets

A mature natural gas market, in the context of unbundling transportation and marketing activities in both developed and developing markets, may be characterized by the following parameters. These parameters, derived from an assessment of global case study of natural gas markets, present the situation or circumstance at the time of unbundling in various countries around the world. These parameters are as follows:

1. Demand
2. Supply
3. Infrastructure
4. Market Structure or Ecosystem
5. Regulations
6. Commercial mechanism
7. Net Zero Emission
8. Energy Security

Details of the respective parameter are mentioned below:

1. Demand

Firm demand in a natural gas market is evaluated by:

- Evolving consumption and requirement of natural gas across various sectors such as City Gas Distribution (CGD), power, refinery, fertilizers, steel, transportation, bunkering etc.
- Presence and creation of new demand centers and also new areas of application such as Compressed Natural Gas (CNG) stations, industrial and commercial connections in CGD in Geographical areas, domestic connections via Piped Natural Gas (PNG), in new initiatives-bunkering, fishing, LNG transportation

Section I: Parameters of Mature Natural Gas Markets (2/4)

- Analyzing dependency on natural gas, which is demonstrated through share of natural gas in primary energy mix of a country and also established by existing & upcoming infrastructure that enable consumption of gas (equipment, machines, plants) in sectors mentioned above

2. Supply

Robust gas supply in a natural gas market is evaluated by analyzing:

- Production of natural gas from domestic fields
- Supply of natural gas volume from firm LNG contracts and spot markets
- LNG storage and regasification capacity

3. Infrastructure

Robust Infrastructure in a natural gas market is evaluated by presence of:

- **Transmission Pipelines:** Extensive, well-maintained & interconnected transmission pipeline forming a gas grid i.e., interconnected pipeline network with sufficient capacity to transport gas across different regions of the country
- **LNG terminals:** Terminals with adequate capacity, strategically located across the country, connected by pipelines to efficiently transport natural gas
- **CGD infrastructure:** It is covered by presence of number of CNG stations, and PNG connections in domestic, industrial and commercial segment in different geographical areas
- **CGD Connectivity:** Number of Geographical Areas connected by natural gas transmission pipeline and other modes of supply
- **Gas Grid connectivity to supply sources:** Interconnected pipelines to supply sources i.e., domestic fields and LNG terminals

Section I: Parameters of Mature Natural Gas Markets (3/4)

4. Market Structure or Ecosystem

In a gas market structure, an ecosystem is created by **presence of multiple market participants**. A competitive landscape with a variety of market participants in different parts of Natural gas value chain include:

- Gas Producers
- Gas Marketers & Traders
- Gas Transporters
- Gas Distributors
- Gas Consumers
- LNG Terminal Operators
- Gas Exchange Platform

5. Regulations

This is demonstrated by the presence of control through coded standards and guidelines, which establish, operationalize, and regulate the petroleum and natural gas market ecosystem—covering participants and infrastructure. These controls promote infrastructure expansion, ensure safe operations, protect consumer and company interests, and foster competition. It is enabled through:

- Presence of standards & regulations governing market operations and safety
- Presence of regulations and guidelines to enable third party access to infrastructure
- Presence of independent regulatory bodies to oversee and enforce market rules
- Policies supporting competition and preventing monopolistic practices
- Authorization of pipelines through competitive bidding mechanism to promote market-driven tariff discovery.
- Presence of tariff Regulation, establishing fair mechanisms for tariff determination, attracting investments in infrastructure and optimizing logistics.
- Presence of regulations around account unbundling and legal unbundling of transportation and marketing functions in natural gas sector

Section I: Parameters of Mature Natural Gas Markets (4/4)

6. Commercial Mechanism

Resilience of the commercial mechanism is evaluated by presence of:

- Standardized contracts and trading practices
- Active markets for capacity booking and balancing services
- Revenue settlement mechanism among the gas transporters

7. Net Zero Emission

A mature natural gas market would facilitate the integration of natural gas into country’s broader decarbonization strategy, supporting industrial sectors, transport, and households in reducing emissions. The market should enable easier access to clean fuels like natural gas, while regulatory and policy frameworks would ensure compatibility with country's emission reduction goals.

8. Energy Security

The ability to balance domestic production with imports via a well-developed pipeline infrastructure and LNG import terminals ensures supply stability. Market maturity also implies strategic reserves, transparent market signals, and pricing mechanisms that reflect global conditions.

Section II: Analysis of development in natural gas sector of India (2015-24) (1/9)

2015	2024
Demand	
Consumption: 131 mmsmcd[1]	**Consumption**: 188 mmcmd[2]

Key Highlights

- **Growth:** Gas demand has increased by 43% in 9 years, with ~12% y-o-y increase[3] in FY24
- **Drivers of demand:**
  - Gas demand rose in CGD sector from 15 to 38 mmscmd[4] by 150% within 9 years through increase in CNG stations , PNG - domestic, industrial and commercial connections in various Geographical Areas (GAs) after twelve rounds of bidding and authorization covering entire India.
  - **Demand in Fertilizer sector** has risen by 33% in 9 years from 44 to 58.8 mmscmd[5] (FY16 -FY24)
  - Although demand in the Power and Refinery sectors in 2024 did not reach 2015 levels, it has picked up in FY2024, increasing by 11% compared to FY2023, driven by the availability of affordable RLNG.

FICCI projects annual gas demand of 300 MMSCMD by 2030 and 450 MMSCMD by 2040 in its report-Transition Journey to Clean Energy[6]. EIA has projected annual gas demand increase to 300-310 MMSCMD by 2030[7] So we, see the expected demand is in the range of 300 MMSCMD.BP energy outlook projects an increase of natural gas consumption to 485 MMSCMD (net zero case) and 643 MMSCMD (accelerated) respectively by 2050[8]

With the successful completion of Minimum Work Program (MWP) targets and the establishment of pipeline connectivity in City Gas Distribution (CGD), gas demand is expected to be primarily driven by CNG, domestic, and industrial & commercial (I&C) connections. Additionally, demand is likely to increase in other sectors such as Power, Refinery, and Petrochemicals, alongside new initiatives like LNG transportation and bunkering. This growth is being supported by the economic availability of RLNG and the expansion of refining and petrochemical capacities.

Sources: **:** 1. MOPNG IPNG statistics 2014-2015; 2. PPAC May 2024; 3. MOPNG IPNG Statistics 2022-2023 & PPAC Ready Reckoner May 2024; 4. PPAC Natural gas consumption Sector-wise India 2023-2024; 5. PPAC Natural gas consumption Sector-wise India 2009-2024; 6. FICCI- Transition Journey to clean energy; 7. EIA ; 8. BP energy outlook

Section II: Analysis of development in natural gas sector of India (2015-24) (2/9)

Supply	
Domestic: 70 MMSCMD[1] **LNG import:** 61 MMSCMD	**Domestic:** 99 MMSCMD[2] **LNG import:** 89 MMSCMD

Key Highlights

- LNG supply from long-term contracts and the spot market has increased by 47% over the past nine years, highlighting the strength of global LNG supply contracting. In contrast, supply from domestic gas fields has grown at a slower rate of 15% during the same period

Hence, India's Gas supply is being strengthened basis renewal and addition of new long-term LNG supply contracts by entities such as PLL, GAIL, IOCL in gas portfolio. Delivery of LNG is being strengthened by capacity addition at LNG import terminals and commissioning of new LNG terminals in western and eastern part of India.

The domestic supply is projected to increase[3] to a peak of 113 MMSCMD in 2026 and is expected to be around 90-100 MMSCMD by 2030

Sources: 1. PPAC Natural gas consumption Sector-wise India 2009-2024; 2.PPAC Natural gas consumption Sector-wise India 2009-2024; 3. Institute for Energy Economics and Financial Analysis

Section II: Analysis of development in natural gas sector of India (2015-24) (3/9)

Infrastructure (Transmission Pipeline, LNG Terminal, City Gas distribution)	

• **Transmission Pipeline[1]**: 16,231 Km with total capacity of 345 mmscmd
• **LNG Terminals[2]**: 4 LNG terminals (Dahej, Hazira, Dabhol, Kochi) with 21.7 MMTPA
• **CGD[3]:** Domestic connections-31,63,588, Industrial (23,304) & Commercial (6225)
  ○ 1081 CNG stations across GAs 84 authorized till FY 2016
	• **Transmission Pipeline[4]**: 24,881 Km with operational capacity of 379 mmscmd and 10,494 km with capacity of 118 mmscmd under construction
	• **LNG Terminals[5]**: 7 LNG terminals (Dahej, Hazira, Dabhol, Kochi, Mundra, Dhamra, and Ennore) with 52.7 MMTPA & 3 upcoming (Chahra,Jafrabad, Gopalpur) with total capacity expected to increase to 73.7 MMTPA by 2030
	• **CGD[6]:** Domestic connections-1,31,18,891, Industrial (44,471) & Commercial (19,211)
	  ○ 6959 CNG stations across 307 GAs authorized till June 2024
	  ○ 100% Geographical area coverage achieved in terms of CGD authorization
	  ○ 287[7] out of 307 GAs have been made operational either via pipeline or via other modes
	  ○ 195 GAs[8] have achieved connectivity via gas transmission pipeline

Sources: 1.MOPNG IPNG statistics 2015-2016; 2.MOPNG IPNG statistics 2015-2016; 3. MOPNG IPNG statistics 2015-2016; 4. PNGRB NGPL Status March 2024; 5,6. PPAC Ready Reckoner May 2024; 7. PNGRB; 8. PNGRB

Section II: Analysis of development in natural gas sector of India (2015-24) (4/9)

Infrastructure (Transmission Pipeline, LNG Terminal, City Gas distribution)

Key Highlights

- **Network Expansion with Gas Grid connectivity:** Gas transmission network increased by 53% in 9 years with gas grid connectivity across several demand centers in India
- **LNG Import Capacity Boost:** Total LNG import capacity surged by 119% from 21.69 MMTPA in 2015 to 47.7 MMTPA in 2024, creating robust infrastructure for importing and processing LNG. Further, capacity expansion has been proposed at existing LNG terminals (Dahej (+5), Dabhol (+7) and Dhamra (+5)).
- **CGD Proliferation:** Domestic and Industrial & Commercial connections have increased by 314% and 115% respectively with number of CNG stations witnessing an increase by 543% in 9 years (2015-2024)

Hence, India's gas delivery has been adequately strengthened by addition of transmission & distribution pipeline network and development of GAs and LNG terminals in the country.

Section II: Analysis of development in natural gas sector of India (2015-24) (5/9)

Market Structure or Ecosystem through Presence of Market Participants	
• **Gas Transporters[1]**: 7 Nos • **Gas Distributors[2]**: 21 Nos • **LNG Terminal Operators:** 4 LNG terminals by 3 Entities (PLL, Shell, and JV of GAIL & Ratnagiri) • **Gas Exchange** did not exist in 2015 • **Major Gas Marketer:** GAIL, IOCL, BPCL, and GSPC	• **Gas Transporters[3]:** 8 Nos • **Gas Distributors[4]:** 43 Nos • **LNG Terminal Operators:** 7 LNG terminals with 3 upcoming facilities by 7 entities (PLL, Shell, JV of GAIL & Ratnagiri, GSPC LNG, IOCL, Adani, HPCL, and Swan LNG) • **Gas Exchange[5]** was established in 2020 with annual volume of gas traded accounting to 1030 MMSCM with 998 trades in 2024 • **Major Gas Marketer:** GAIL, IOCL, BPCL, and GSPC

Key Highlights

- Currently in 2024, there are 8 gas transporting, 4 gas supplier or marketing, and 43 gas distribution entities present in the ecosystem
- Gas Exchange has been operationalized by PNGRB in 2020 to provide market-based price discovery of gas, access to domestic and global LNG suppliers across 9 delivery points & 6 regional gas hubs in domestic market

India's gas market encompasses all the essential elements of a robust ecosystem. To fully enable this ecosystem, it is crucial to enhance transparency, improve operational efficiency, and foster competition to provide end consumers with greater choice. This could be done by bringing efficiency in different business activities of the gas sector i.e. by separation of marketing and transportation functions.

Sources: 1.PNGRB Authorized Natural Gas Pipeline; 2. PNGRB Authorized GAS; 3. PNGRB Authorized Natural Gas Pipeline ; 4. PNGRB Authorized GAs; 5. Indian Gas Exchange Annual Presentation 2023-2024

Section II: Analysis of development in natural gas sector of India (2015-24) (6/9)

Regulations	
• There was no mechanism to set zonal unified tariff for customers • Regulations around LNG terminals, imbalance management services and gas exchange were non-existent in 2015	• Unified Tariff[1] was established by PNGRB in 2023 with moto of one-Nation, One-Grid and One- Tariff • PNGRB has expanded its regulatory oversight to include the regulation of LNG terminals[2] (2018 & 2024), the provision of imbalance management services (2016) in gas transportation, and the operationalization of a gas exchange (2020) in 2024

Key Highlights

- Unified tariff mechanism has been established by PNGRB to provide benefit to end consumer with motto-one nation, one grid & one tariff.

Comprehensive regulations in gas sector has truly made the market to move towards maturity

Sources: 1. PNGRB Tariff Regulations for Natural Gas Pipeline ; 2. PNGRB Regulations for T4S-LNG terminals, Imbalance management etc.

Section II: Analysis of development in natural gas sector of India (2015-24) (7/9)

Commercial mechanism	
• In 2015, there was no unified revenue settlement mechanism in place, as each pipeline operated under its own individual tariff structure • In 2015, there was no commercial settlement mechanism in place for the imbalance management in gas transport operations	• A revenue settlement mechanism[1] was introduced in 2023 with the implementation of the unified tariff system • Mechanism for providing Imbalance management services in gas transportation was established in 2016

Key Highlights

- Commercial terms & conditions and mechanisms for revenue entitlement & tariffs have been defined by PNGRB and have been operationalized by Industry settlement committee

This demonstrates the stability in the trade practices through established regulatory mechanisms evolved in the gas sector of India.

Sources: 1. PNGRB Tariff Regulations for Natural Gas Pipeline

Section II: Analysis of development in natural gas sector of India (2015-24) (8/9)

Net Zero Emission: India has been pursuing aggressive pollution reduction agendas

- In 2015, India submitted its Intended Nationally Determined Contribution (NDC) to UNFCCC on October 2, 2015
- The 2015 NDC comprised eight goals; three of these had quantitative targets up-to 2030:
- cumulative electric power installed capacity from non-fossil sources to reach 40%
- reduce the emissions intensity of GDP by 33 to 35 percent compared to 2005 levels
- creation of additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover.

- In **2022**, India now stands committed to reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level.
- India to achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030.

Key Highlights

- India's commitment to climate goals (under the Paris Agreement) is also becoming a central part of policy, and natural gas can serve as a transition fuel from coal and oil to renewable energy.

This demonstrates the focus and commitment of India, enabled by the intervention of PNGRB and ecosystem enablers, in fostering growth within the gas sector ecosystem through technological advancements in India.

Section II: Analysis of development in natural gas sector of India (2015-24) (9/9)

Energy Security	
• In 2015, RLNG import was 61 mmscmd where as the domestic production was 70 mmscmd in India	• In 2024, the RLNG import has grown to 90 mmscmd, where as the domestic production has grown to 99 mmscmd

Key highlights

- Energy security is crucial as India remains dependent on imports for its energy needs, especially oil and gas. A mature natural gas market should promote diverse supply sources (domestic and international) and infrastructure resilience.
- As RLNG import going to increase in the future with marginal increase in domestic production to cater to the growing demand, Unbundling would enable various players to participate in the supply chain, increasing the diversity of suppliers and competition, which would enhance energy security. It would also attract private investment into infrastructure development, contributing to a more resilient supply network.

LNG import infrastructure has evolved to cater to the import needs of India. Further, fostering competition and making efficient market is the way forward.

Section III: Status of various parameters during & after unbundling in selected countries (1/8)

Section III: Status of various parameters during and after unbundling in selected countries where unbundling occurred

The key conclusions out of the global study are as follows:

1. **Markets which got unbundled, did not necessarily exhibit a specific threshold share of natural gas in their primary energy mix; rather, unbundling occurred in countries with varying levels of gas share in their energy mix. Further, in some countries, the gas transportation infrastructure was already well-established at the time of unbundling, while in others, it expanded significantly after the unbundling process.**

   a. **Global Context**

      i. Natural Gas share in the primary mix has ranged from 2.9% to 37% for the global gas markets where unbundling took place.
      ii. Brazil's (with an area[1] of 85,15,770 sq km) share of gas[2] was only 2.9% (~17 MMSCMD of NG) in PE mix at time of legal unbundling in 1997 whereas other countries - UK, Spain, France, and Mexico had gas[3] share ranging from 14% to 38%.
      iii. Brazil had[4] approximately 1,400 kilometers of natural gas pipeline infrastructure in 1997, which expanded to around 9,409 kilometers[5] by 2023. In contrast, other countries had already developed more extensive gas transmission infrastructure at the time of unbundling, compared to current levels of 2024.Countries such as UK had 65% (~5000Kms) in 1997 of today's(2024) gas transmission infrastructure[6] (7666 Kms)

   b. **Indian Context:** Currently, India's share of Natural gas consumption has touched 5.8[7]% with absolute consumption rising to 188 MMSCMD. With authorization of 307 GAs, there is a demand growth expected in the CGD sector as only 191[8] GAs are connected via pipeline. Further, completion of MWP targets would add to the demand of natural gas. Demand in power sector and refinery & petrochemical is picking up with availability of affordable RLNG. Brazil, having an area 2.6 times that of India, unbundled at only 2.9% share of gas in the PE mix.

Sources: 1. CIA; 2. Statistical Review of World Energy Data; 3. Statistical Review of World Energy Data; 4.GASBOL Pipeline in 1999; 5. 2031 Ten year Expansion Plan; 6.National Gas UK Transmission Length, 7. Statistical Review of World Energy Data; 8. PNGRB

Section III: Status of various parameters during & after unbundling in selected countries (2/8)

2. Countries with 100% import dependency, 100% domestic supply, and a mix of domestic and import dependency have undergone unbundling of transportation and marketing function in natural gas sector. This demonstrates that domestic supply sufficiency is not the only factor to consider for gas market maturity prior to unbundling; rather, the robustness of firm contracts and stable availability through various mechanisms are also crucial.

a. Global Context

i. For example, Spain and France, which had 100% import dependency[1], got unbundled in 2013 and 2006 respectively.
ii. UK, Brazil, Netherlands had ~100% domestic supply of gas at the time of unbundling[2]. (UK (1997) & Netherlands (2006)- ownership & Brazil (1997)- legal). Gradually, these countries developed dependency on LNG impots, with share of LNG imports increasing in its gas supply portfolio.
iii. Mexico, which went ahead with ownership unbundling in 2014, had 35% import and 65% domestic supply dependency.

b. Indian Context

i. Currently, India has a diversified supply of gas from domestic fields and LNG imports[3], accounting for 52% and 48%, respectively, in FY24. This diversified supply, supported by the robustness of firm contracts and stable availability, enhances the overall gas consumption portfolio.

Sources: 1. Statistical Review of World Energy Data; 2. Statistical Review of World Energy Data; 3. PPAC Natural gas consumption Sector-wise India 2023-2024

Section III: Status of various parameters during & after unbundling in selected countries (3/8)

3. Unbundling led to multiple benefits and provided more choices to consumers, but it took over 6-10 years for evolution of gas market in terms of increase in number of shippers, customer switching rates, decrease in market concentration (increase in competition)

a. Global Context

i. For example, in UK, Netherlands, Hungary, Austria, Spain, France and Belgium, there was an increase in number of gas shippers[1] (from 2004 to 2014: UK-8 to 23, Hungary- 6 to 20, Germany- 6 to 20, France-8 to 20, Belgium- 8 to 18); decrease in market concentrations (Hungary- 3200 to 1494, Germany- 1900 to 1886, France-6200 to 4700, Belgium- 5600 to 4000); and increase in choice for customers (switching rates: UK-upto-47%, Hungary- 4 to 20%, Germany- 0 to 10.6%, France-0 to 4.5%, Belgium- 9 to 11%) after unbundling which led to increased choices for consumers. Post unbundling, the evolution of market was being monitored by European commission, which generated report on progress in creating the internal gas and electricity market for entire European countries. The results of this study in detail is highlighted in section IV of this paper

b. Indian Context

i. In India, the natural gas market is predominantly served by four major entities: GAIL, IOCL, GSPC, and BPCL, with each handling significant volumes and major volume share[2] (54%) handled by GAIL. However, there is a need to increase the number of gas suppliers to enhance competition and provide more choices for end consumers. This would facilitate better price discovery both domestically and globally, particularly through LNG supply contracts and competition.

Sources: 1. Report on progress in creating the internal gas and electricity market (2004-2014); 2. GAIL

Section III: Status of various parameters during & after unbundling in selected countries (4/8)

4. Markets, which got unbundled, undertook changes in policies & regulations for third party access, pricing, tariff mechanisms and for acceptability of natural gas as a cleaner source of fuel to drive consumption and growth gas infrastructure in the market post unbundling.

a. Global Context

i. China's government incentivized the transition from coal to natural gas to reduce air pollution and meet emissions targets with focus on expanding gas pipeline infrastructure with gas share[1] rising from 3% to 8% from 2007 to 2022. This period was associated with introduction of pricing reforms aimed at relaxing govt. controls on gas prices.
ii. Post unbundling in 1997, Brazil allowed third party access on pipelines and upstream pricing freedom with certain Gas Laws which led to increase in share of NG in mix[2] to 12% in 2015.
iii. In Mexico, growth in gas consumption (11.8% in Primary Energy mix[2]) in 1990s, prior to unbundling in gas sector, was driven by gas-based power generation. Further, Power Alliance Coal[3] in 2017 decided not to open any coal-based power plants, accepting gas a cleaner source of fuel.

b. Indian Context

i. In India, the PNGRB (Petroleum and Natural Gas Regulatory Board) has enabled third-party access to pipelines through the common carrier concept. To incentivize customers and transporters, PNGRB has also been deliberating on efficient tariff mechanisms through tariff reforms. Additionally, there is a need to enhance operational efficiency in the movement of gas molecules and to increase the diversity of LNG and gas suppliers, providing more options for end consumers.
ii. As globally, countries have achieved efficiency in moving a gas molecule and created a more competitive and transparent gas market through its policies and reforms. Clear separation between the supply and transport of gas has led to improved efficiency, greater supplier diversity, and better price discovery, ultimately benefiting the end consumers.

Sources: 1. Statistical Review of World Energy Data; 2.Statistical Review of World Energy Data; 3.Climate Transparency 2021

Section III: Status of various parameters during & after unbundling in selected countries (5/8)

5. Markets, which got unbundled, had interconnected transmission pipeline network of gas from source of supply-domestic or LNG import facilities

a. Global Context

i. Countries such as UK, France, Netherlands, Brazil had developed sufficient network of pipelines (UK-~5,000 Km, France ~36,000 Kms, Netherlands~11,000 Km, Brazil~1,411 Km, Mexico~10,800 Km) which were interconnected to gas supply sources- either LNG terminal or domestic gas fields to enable the seamless movement of gas molecule.

a. Indian Context

i. Currently, India has gas transmission pipeline of length[1] 24,881 Km and with length of 10,494 Km under construction. The pipelines are interconnected to form a gas grid for transmission of gas from one part of country to another from source of supply to demand centers. Total operational capacity (cumulative) of the natural gas pipeline is 379 mmscmd with 118 mmscmd under construction as per FY 24

6. Markets, which got unbundled, demonstrated regulatory readiness in terms of operational services, tariff reforms and safety standards

a. Global Context

i. **Regulatory readiness for operational services:** Global countries have demonstrated regulatory readiness in terms of governance of gas market operations-capacity booking mechanism, imbalance management and tariff regulation. Countries such as UK, Spain, France, Netherlands, Belgium had regulatory readiness and framework defined by European Union Commission.

Sources: 1.PNGRB

Section III: Status of various parameters during & after unbundling in selected countries (6/8)

ii. Independent Regulatory Bodies: Markets of countries had independent energy regulator prior to unbundling to frame regulatory policies and develop market operation framework to promote fair access to infrastructure, competition and prevent monopolistic practices. List of countries with energy regulators at time of unbundling:

1. UK- DGGS and Ofgas[1] (established in 1986)
2. Spain-CNMC[2] (established in 2007)
3. France-CRE[3] France (established in 2000)
4. Netherlands- Dte[4] Netherlands (established in 1998)
5. Brazil-ANP[5] (established in 1997)

iii. Tariff Determination: In Europe, European commission[1] set out a EU regulation[6] 2017/460 as per the defined methodology (capacity based tariff, price reference methodology, commodity based etc.) to promote fair pricing.

b. Indian Context

i. Regulatory readiness for operational services[7]: PNGRB (Petroleum & Natural Gas Regulatory Board) has demonstrated regulatory readiness in terms of governance of gas market operations services across petroleum product pipeline and natural gas sector through its various regulations & codes. PNGRB has notified regulations around Authorization, Tariff, third party access, Technical Standards and Specifications including Safety Standards:

1. **Petroleum and Natural Gas Regulatory Board (Authorizing Entities to Lay, Build, Operate or Expand Natural Gas Pipelines) Regulations, 2008 (as amended):** Mechanisms for establishment of natural gas pipeline under different regulation mechanisms (Regulation 5, 17, 18,19,21, Section 42 of PNGRB Act 2006)
2. **Petroleum and Natural Gas Regulatory Board (Access Code for Common Carrier or Contract Carrier Natural Gas Pipelines) Regulations, 2008 (as amended):** Mechanism for access to gas infrastructure (Clause 12), declaration of common carrier capacity on pipeline (Clause 5), system imbalance management (Clause 13), interconnection of two or more pipelines (Clause 11) etc.

Sources: 1. National Gas UK; 2. CNMC –Spain; 3. CRE France-Who are we?; 4. ACM Netherlands; 5. World Bank - Brazil; 6. Commission Regulation (EU) 2017/460 of 16 March 2017 ; 7. PNGRB

Section III: Status of various parameters during & after unbundling in selected countries (7/8)

ii. **Independent Regulatory Bodies:** India has PNGRB (Petroleum & Natural Gas Regulatory Board), which was formed under PNGRB ACT 2006. It was established by an Act of Parliament in 2006 by **Government of India** with an objective to regulate the refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas so as to protect the interests of consumers and entities engaged in specified related activities and to ensure uninterrupted and adequate supply of petroleum, petroleum products and natural gas in all parts of the country and to promote competitive markets.

iii. **Tariff Determination:** In India, PNGRB has established tariff reforms to benefit end consumers (through unified tariff) and entities (through Cost plus DCF tariff for reasonable returns on investments). This has benefited consumers in terms of single zone based tariff and entities in terms of creating opportunities for reasonable returns on investments.

7. Globally Gas Markets, which witnessed unbundling, established platforms for the purpose of trading gas, capacity booking & imbalance management in transmission pipeline to create a liquid gas market.

a. **Global Context:** Globally, countries established Gas exchange platform arrangement to facilitate trading of gas and achieve price discovery mechanism. For Example:

i. **UK:** On-the-day Commodity Market (OCM) was introduced[1] in 1999, as part of new gas trading arrangements, two years post unbundling.
ii. **France:** Gas Exchange Point (PEG) exists with name TRF[2] (Traded Region France)
iii. **Spain:** MIBGAS - Gas exchange platform was established in year 2015 after adoption of unbundling$_3$ in year 2013 and 2014
iv. **Netherlands:** TTF (Title transfer Facility) was established in 2003, prior to legal unbundling[4]. It has become one of the largest international gas trading platforms in Europe with trade have risen from 153 MMSCMD in 2008 to 12873 MMSCMD in 2020.
v. Centralized Capacity Booking platforms are being used in European countries for booking capacities on natural gas pipeline. Platform such as Prisma is used to transparently declare the capacity to all the buyers and shippers. These centralized platforms have been established gradually with unbundling of transportation functions in these countries in Europe.

Sources: 1. Ofgem; 2. European Traded Gas Hubs: German hubs about to merge: Oxford Studies; 3. MIBGAS Platform ; 4. Gasuin- TTF ; 5. European Traded Gas Hubs: German hubs about to merge: Oxford Studies

Section III: Status of various parameters during & after unbundling in selected countries (8/8)

b. Indian Context: India currently has a fully operational gas exchange platform, IGX, which was established in 2020. IGX offers a range of contracts, from short-term to long-term. In 2024, the annual trading volume on IGX reached 1,030 MMSCM (2.8 MMSCMD) across 998 trades. However, there is still a need to develop greater liquidity in trading. Additionally, in India, capacity booking platforms have been facilitated through capacity declarations made by transporters on their respective websites. Hence, PNGRB has taken aggressive measures to evolve gas trading and access to infrastructure through capacity booking on natural gas pipeline.

Sources: 1. IGX

Section IV: Analysis of the Power Sector in India: Unbundling and Demonstrated Benefits (1/3)

Section IV: Analysis of the Power Sector in India: Unbundling and Demonstrated Benefits

Historical Developments in Power sector developments in Power sector is mentioned below:

- **1970: Challenges in Power sector-** In 1970s, SEBs started incurring losses due to reasons such as operations inefficiency, mismanagement, pilferage, leakage etc.
- **1975: Central Government created centralized generation entities-** Due to poor performance of State Electricity Boards during 1970s, Central Government set up two central public sector utilities for Power Generation: NTPC and NHPC in **1975.**
- **1989: PGCIL as Transmission System Operator with fully ownership unbundled-** In **1989,** NPTC-National Power Transmission Corporation (PGCIL) was created to take over operations of transmission and later took over assets from NTPC and NHPC. Hence, it was established as a fully ownership unbundled entity.
- **2003: Unbundling in State electricity Boards**- In 2003, under Section 131 of Electricity Act 2003, it was mandated to reorganize the State Electricity Boards in India to separate entities of Generation, Transmission and Distribution segments.
- **2003:** After unbundling, open access to transmission and distribution system was enabled.
- **2008: Independent System operator for PGCIL-** POSOCO was formed as 100% subsidiary of PGCIL, with objective to take over operations, managing load despatch centers across the region in India.
- **2008:** Indian Electricity Exchange (IEX) was formed in 2008
- **2017:** POSOCO got fully separated in 2017 from PGCIL with objective to separate the operations from transmission assets. The decision was to separate POSOCO from Power Grid Corp, as PGCIL want to focus on competing with private companies for setting up transmission network but not at the same time operating the grid.
- **2022:** Name of POSOCO changed to Grid Controller of India Limited (Grid-India)

Sources: 1. Turning around the power distribution sector

Section IV: Analysis of the Power Sector in India: Unbundling and Demonstrated Benefits (2/3)

Reasons for unbundling in Power sector

- To enable open access for buyers of capacity
- To bring efficiency in operations-generation, transmission, and distribution
- To restrict losses and prevent cross subsidization of businesses
- To focus on transmission and distribution infrastructure development
- To fully institutionalize the focus of entities in their own business function- generation, transmission, distribution
- To attract investments by private companies
- To create a competitive market-place and increase choices for procurers of electricity by third party access, capacity booking and power purchase contracts

Benefits of Unbundling in Power sector

- **Increase in Private Investment**: Private participation has increased in the power sector in all parts of value chain.
- **Reduction in Transmission and Distribution Losses:** Transmission and distribution losses have significantly reduced, bringing efficiency in operations and saving costs.
- **Efficiency improvements** have been observed in power generation, transmission and infrastructure creation.
- **Enhanced Consumer Choice**: Unbundling has allowed consumers to choose their electricity suppliers, leading to competitive pricing and better service quality. This has resulted in cost savings for consumers.
- **Enhanced Competition:** With participation of private entities, a competitive marketplace has developed leading to increased choices for end consumers
- **Price Discovery on IEX:** The unbundling of the electricity sector, particularly the separation of generation, transmission, and distribution, has significantly transformed the market dynamics, creating an open and competitive environment.

•

Sources: 1. Turning around the power distribution sector

Section IV: Analysis of the Power Sector in India: Unbundling and Demonstrated Benefits (3/3)

- **By allowing multiple players to enter the market**, unbundling has dismantled monopolistic control, fostering a more competitive landscape. This has enabled competition on electricity exchanges leading to more efficient price discovery, as prices are now determined by market forces rather than being set by a single entity. The increased competition has also encouraged innovation, improved service quality, and provided consumers with more choices, ultimately driving the sector towards greater efficiency and sustainability.
- Further, tariff determination through bidding on electricity exchanges has led to effective price discovery.

Sources: 1. Turning around the power distribution sector

Section V: Realized Benefits of Separating Marketing and Transportation Activities Globally (1/2)

Section V: Realized Benefits of Separating Marketing and Transportation Activities Globally

Benefits of unbundling has been assessed globally across several parameters. For example, European Commission published reports on "**progress in creating the internal gas and electricity market for entire European countries[1]**".

a. Competition levels: Competition level in the gas market is accessed by several factors. Such as change in market concentration, increase in customer switching rates, increase in number of gas suppliers etc.

I. Countries like Belgium, France, Germany, Hungary, Netherlands witnessed a decrease in HHI i.e. increase in number of market players, increasing market competitiveness. (HHI: The Herfindahl-Hirschman Index (HHI) is a common measure of market concentration that is used to determine market competitiveness. Higher is HHI, lesser is the market concentration)

II. Countries, which got unbundled, witnessed an increase in number of gas suppliers

III. Globally, Gas Markets witnessed an increase in Customer switching rates as more number of choices were available to customers in the market after unbundling.

Progress in creating the internal gas and electricity market for entire European countries 2004-2014

S.N	Subject	Belgium	France	Germany	Hungary	UK	Netherland
1	**Market Concentration**	**5600** (2008) to **4000** (2014)	**6200** (2008) to 4700 (2014)	**1900** (2008) to **1886** (2014)	**3200** (2008) to **1494** (2014)	Not available	**7200** (2008) to **6455** (2014)
2	**Number of Gas Suppliers**	**8** (2004) to **18** (2014)	**8** (2004) to **20**(2014)	**9** (2004) to **38** (2014)	**6** (2004) to **20** (2014)	**8** (2004) to **23**(2014)	**5** (2004) to **14** (2008)
3	**Switching Rate of customers**	**9%** to **11%**	**0%** to **4.5%**	**0** to **10.6%**	**4** to **20%**	Up-to **47%**	**5%** to **12.3%**

Sources: 1. Report on Progress in creating the internal gas and electricity market for entire European countries 2004-2014

Section V: Realized Benefits of Separating Marketing and Transportation Activities Globally (2/2)

b. Market Opening[1]: Countries like Belgium, France, Hungary witnessed an improvement in level of access to infrastructure Post unbundling with market opening.

S.N.	**Subject**	**Belgium**	**France**	**Germany**	**Hungary**	**Netherland**
1	**Market Opening**	90% (2005) to 100% (2011)	70% (2005) to 100% (2011)	100% (2005) to 100% (2011)	69% (2005) to 100% (2011)	100% (2005) to 100% (2011)

c. Optimization of transportation Tariffs: Unbundling of gas transportation from gas marketing has resulted in optimization of transportation tariffs. During an interaction with CREG, the Belgian energy regulator, it was revealed that Belgium[2] has not experienced a single increase in gas transmission tariffs over the past 10 years (2014-2024). This stability is attributed to increased efficiency and network optimization following the unbundling process.

d. Gas Market Opening & liberalization: Unbundling of transportation from marketing function has resulted in creation of liberalized ecosystem through open-access.in different countries with countries moving to more liberalized gas market, creating opportunities for customers by introducing competition in gas supply and increased choices Refer Point V (a) and V (b).

Sources: 1. Report on Progress in creating the internal gas and electricity market for entire European countries 2004-2014; 2. Primary Research with International Regulators.

Section VI: Conclusion (1/3)

Conclusion

Natural gas can play a pivotal role in India's decarbonization strategy by acting as a transitional fuel. It emits significantly lower carbon dioxide compared to coal and oil, making it a cleaner alternative for power generation and industrial use. By integrating natural gas into the energy mix, particularly in sectors like transportation and manufacturing, India can reduce its carbon footprint while gradually shifting towards renewable energy sources considering the carbon emission targets.

The government has announced plans in 2023 to develop the Indian Carbon Market[1] (ICM) where a national framework will be established with an objective to decarbonize the Indian economy by pricing the Green House Gas (GHG) emission through trading of the Carbon Credit Certificates. Natural gas can enhance India's participation in the carbon credit trading market by lowering overall greenhouse gas emissions, thus generating carbon credits. By substituting higher-emission fuels like coal with natural gas, industries can earn carbon credits, which can be traded to offset emissions or support further investments in cleaner technologies.

Assessment on India’s Market Development

India’s gas sector has adequately evolved and has seen expansion in terms of demand, infrastructure, supply, regulatory intervention, commercial practices, adding to maturity in this sector.

Learnings from Global case study

India demonstrates market & ecosystem readiness with respect to parameters that existed in different countries at the time of unbundling. Further, global countries mentioned above have demonstrated development of competition in the gas market post bundling.

Sources: 1. ICM Market

Section VI: Conclusion (2/3)

Learnings from Power Sector

Similar to power sector, the gas sector aims to achieve several key benefits, including attracting private investments through open access, fostering competition, expanding consumer choices for gas, and enhancing business efficiency by unbundling functions.

The unbundling of the electricity sector, particularly the separation of generation, transmission, and distribution, has significantly transformed the market dynamics, creating an open and competitive environment.

- **By allowing multiple players to enter the market**, unbundling has dismantled monopolistic control, fostering a more competitive landscape. This has enabled competition on electricity exchanges leading to more efficient price discovery, as prices are now determined by market forces rather than being set by a single entity. The increased competition has also encouraged innovation, improved service quality, and provided consumers with more choices, ultimately driving the sector towards greater efficiency and sustainability.

- Further, tariff determination through bidding as per Electricity Act 2003 on electricity exchanges has led to effective price discovery.

For India, Unbundling in the gas sector, similar to the electricity sector, can significantly enhance the functioning of the Indian Gas Exchange (IGX) by creating an open and competitive market environment. By separating the infrastructure (transmission and distribution) from gas marketing and supply, unbundling removes the monopolistic control of vertically integrated companies, allowing multiple players to enter the market. This promotes competition among suppliers, leading to more dynamic price discovery on the IGX as prices are determined by market forces rather than by a few dominant players.

Hence, basis above detailed assessment from global and sectoral outlook, India's gas market is mature in comparison to levels in 2015. It has achieved high level of maturity in all the parameters mentioned -demand, supply, infrastructure, regulatory intervention, commercial mechanism.

Section VI: Conclusion (3/3)

Supply side: Substantial increases from domestic production sources have not been projected in the future hence, the future gas supply is expected from LNG long term contracts.

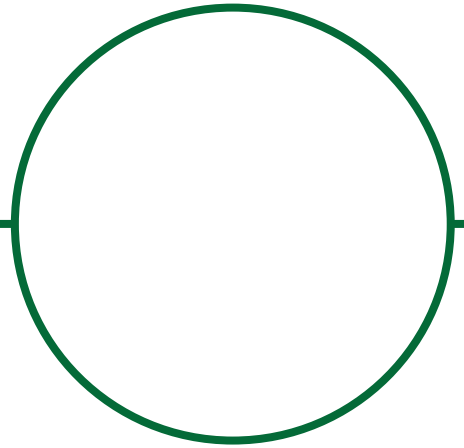
As India uses LNG for its 48% of its gas, which is priced based on market conditions, the increasing consumption means that most of the gas will be LNG based, with prices determined by the market. This requires elimination of risk at LNG entry points with LNG volumes marketed by only few suppliers and hence, there is need to increase more open access in terms on the supply front to tackle such risks. Hence, unbundling would create opportunities for open access to infrastructure.

Demand Side: Key demand centers (majority of fertilizers and power plants) are connected to the national gas grid and more consumption centers are expected to come online once the CGD GAs, which were recently authorized, commence operations. As the demand for natural gas increases and it begins to replace LPG, it will provide significant benefits to the exchequer by potentially lowering subsidies.

Regulatory: Regulatory mechanisms are well in place to tackle all functions of gas market, hence it is required to fully liberalize the gas market through unbundling to take benefits of the regulatory interventions and reforms envisaged by the regulator.

These are visible signs of fully functional natural gas market, showing deep level of maturity in the country.

End of the Report



01 ZONAL STUDY ON LPG PIPELINE: POTENTIAL NEW LPG PIPELINES TO BE BID OUT

02 RAPID ASSESSMENT OF "PATHWAYS TO INCREASE SHARE OF NATURAL GAS FROM 6% TO 15%"

03 GLOBAL CASE STUDIES OF TRANSMISSION SYSTEM OPERATOR (TSO)

04 ASSESSMENT OF MATURITY IN NATURAL GAS MARKET

05 MARKET AND REGULATORY FRAMEWORK FOR GAS DISTRIBUTION SECTOR ACROSS THE GLOBE

Report
on

Market and Regulatory Framework for Gas Distribution Sector across the Globe

Prepared For Petroleum And Natural Gas Regulatory Board (PNGRB)
By Deloitte Touche Tohmatsu India LLP (DTTILLP)

January 2025

Study Context

The Petroleum and Natural Gas Regulatory Board (PNGRB) has undertaken a comparative analysis of gas distribution exclusivity frameworks across the globe

CONTEXT

The Petroleum and Natural Gas Regulatory Board (PNGRB) The Petroleum and Natural Gas Regulatory Board (PNGRB) has undertaken a comparative analysis of gas distribution exclusivity frameworks across the globe

This study assesses the market and regulatory framework for gas distribution sector across the globe

Scope of Work for each of the Modules

1 **Indian CGD Sector**

Status of exclusivity (infrastructure and marketing) in India

2 **Global Case Studies**

Regulatory frameworks in gas distribution across globe

- *How do entities operate in the market for gas marketing and distribution to end consumers?*
- *Is unbundling of gas distribution operations and marketing required for entities?*
- *Are there any mandates for Third-Party Access (TPA) to gas distribution infrastructure?*

Exclusivity (infrastructure & marketing)

- *Is there any exclusivity (infrastructure operation & construction or marketing of gas molecule) for a specific geographic area granted to gas distribution companies?*
- *What is the duration and scope of exclusivity in different countries?*
- *What happens when the exclusivity period ends, considering if provision exists?*
- *What is the regulatory framework for enabling exclusivity, if it exists?*

3 **Conclusion**

Indian CGD Sector

1

What is Exclusivity in CGD?

Section 20 of the PNGRB Act, 2006 provides provision for exclusivity for CGD networks

Exclusivity

CGD exclusivity refers to the rights granted to a CGD entity to exclusively develop and operate gas distribution networks within a specific Geographical Area (GA) for a defined period.

Infrastructure

For laying, building or expansion of CGD network

The Board may allow an entity exclusivity for laying, building or expanding of CGD Network over the economic life of the project

Marketing/Sale

From Purview of common carrier or contract carrier

The Board may provide exclusivity to an entity proposing to lay, build, operate or expand a CGD network from the purview of common carrier or contract carrier for a period of specific (3,5,8) years from the date of authorization

- **Under Section 20 of the PNGRB Act 2006,** The Board may decide on the **period of exclusivity** to lay, build, operate or expand a city or local natural gas distribution network for such number of years as it may by order, determine in accordance with the principles laid down by the regulations made by it, in a transparent manner while **fully protecting the consumer interests**

Rationale

"Exclusivity is envisaged with a view to facilitate the development of a planned and integrated CGD network with appropriate priorities for end-use of natural gas as also the network spread besides providing incentive to the entity for investing in such project"

Source: PNGRB

Regulation by PNGRB on CGD Exclusivity

Section 20 of the PNGRB act provides provision for exclusivity for CGD networks

What PNGRB Act 2006 Say?

Section 20(4) of PNGRB Act and 61(q)

*The Board may decide on the **period of exclusivity** to lay, build, operate or expand a city or local natural gas distribution network for such number of years as it may by order, determine in accordance with the principles laid down by the regulations made by it, in a transparent manner while fully protecting the consumer interests.*

What CGD Authorization & Guiding Principle on common carrier & contract carrier Regulation say?

Regulation 12 of PNGRB CGD Authorization Regulation

*The **exclusivity period** to lay, build, operate or expand a city or local natural gas distribution shall be as per the provisions in the Petroleum and Natural Gas Regulatory Board (**Exclusivity for City or Local Natural Gas Distribution Networks) Regulations, 2008.***

Regulation 6 of CGD Guiding Principles on common carrier & contract Carrier, 2024

The principles for the declaration of common carrier and contract carrier for the CGD network is governed as per this regulation

What CGD Exclusivity Regulation say?

Regulation 6 of CGD Exclusivity

Purview of common or contract carrier

*The Board may provide exclusivity to an entity proposing to lay, build, operate or expand a CGD network from the purview of common carrier or contract carrier for a period of **five years** from the date of authorization 1 **[or as extended in terms of proviso to regulation 12 of the Petroleum and Natural Gas Regulatory Board** (Authorizing Entities to Lay, Build, Operate or Expand City or Local Natural Gas Distribution Networks) Regulations, 2008 as directed by PNGRB subject to the conditions that the entity meets the service obligations as stipulated under regulation 8.*

Regulation 5 of CGD Exclusivity

Infrastructure

*The Board may allow an entity exclusivity for laying, building or expanding of CGD Network over the economic life (**normally 25 years**) of the project subject to the following terms and conditions*

*Depending on satisfactory compliance, the exclusivity can be extended for block of **10 years***

PNGRB was required to establish formal procedure for declaration of common or contract carrier for the network

Source: PNGRB

Expiry of Exclusivity (Marketing) – (1/2)

PNGRB has been instructed by the court to complete the process for declaring the end of exclusivity for 73 GAs but has put on hold the final declaration

	Till 2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Pre PNGRB	25	7	2		3					
R1	6									
R2	3									
R3	5									
R4	9									
R5	8									
R6	16	1								
R7	1									
R8		6								
R9					51	4	31			
R10						38	10	2		
R11							39	21	6	1
R12									7	
Total (302)	73	14	2	0	54	42	80	23	13	1

1. ***PNGRB notified new CGD Guiding principles for common carrier & access code regulation in 2020 to address the legal cases filed on account of automatic declaration for end of exclusivity***

2. ***In 2024, PNGRB has initiated the process for declaration of end of exclusivity for 73 GAs***

3. ***As per the order of stay in the court regarding declaration of CGD network of MGL and IGL due to filed cases, PNGRB has been advised to complete the procedure but hold final declaration***

Note: Anand(Gujarat), Assam and Tripura authorized in 2015 but doesn't have expiration dates for exclusivity from perspective of common or contract carrier.

Source: PNGRB

Expiry of Exclusivity (Infrastructure) – (2/2)

Infra exclusivity has ended in Three GAs and two GAs have been awarded with No Infra exclusivity

	2021	2023	Till 2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2047	2048	2049	2050
Pre PNGRB	1	1	9	1	1	3	5	1	4	1		7	1		1	3		
R1			6															
R2							2	1										
R3							1	3	2									
R4									9									
R5									8									
R6										17		1						
R7											1							
R8												6						
R9												75	2		8			
R10													47	1	3			
R11															44	22		1
R12																	7	
Total (307)	1	1	15	1	1	3	8	5	23	19	1	89	50	1	56	25	7	1

1. ***PNGRB via public notice in March 2024 informed that Infrastructure exclusivity has expired in Greater Mumbai & Vadodara***
2. ***Geographical area of Upper Assam and Agartala has been awarded with No Infrastructure Exclusivity.***
3. ***Infrastructure exclusivity of NCT of Delhi is due to expire in May 2025***
4. ***Infrastructure exclusivity of Surat-Bharuch-Ankleshwar expired in 2024***

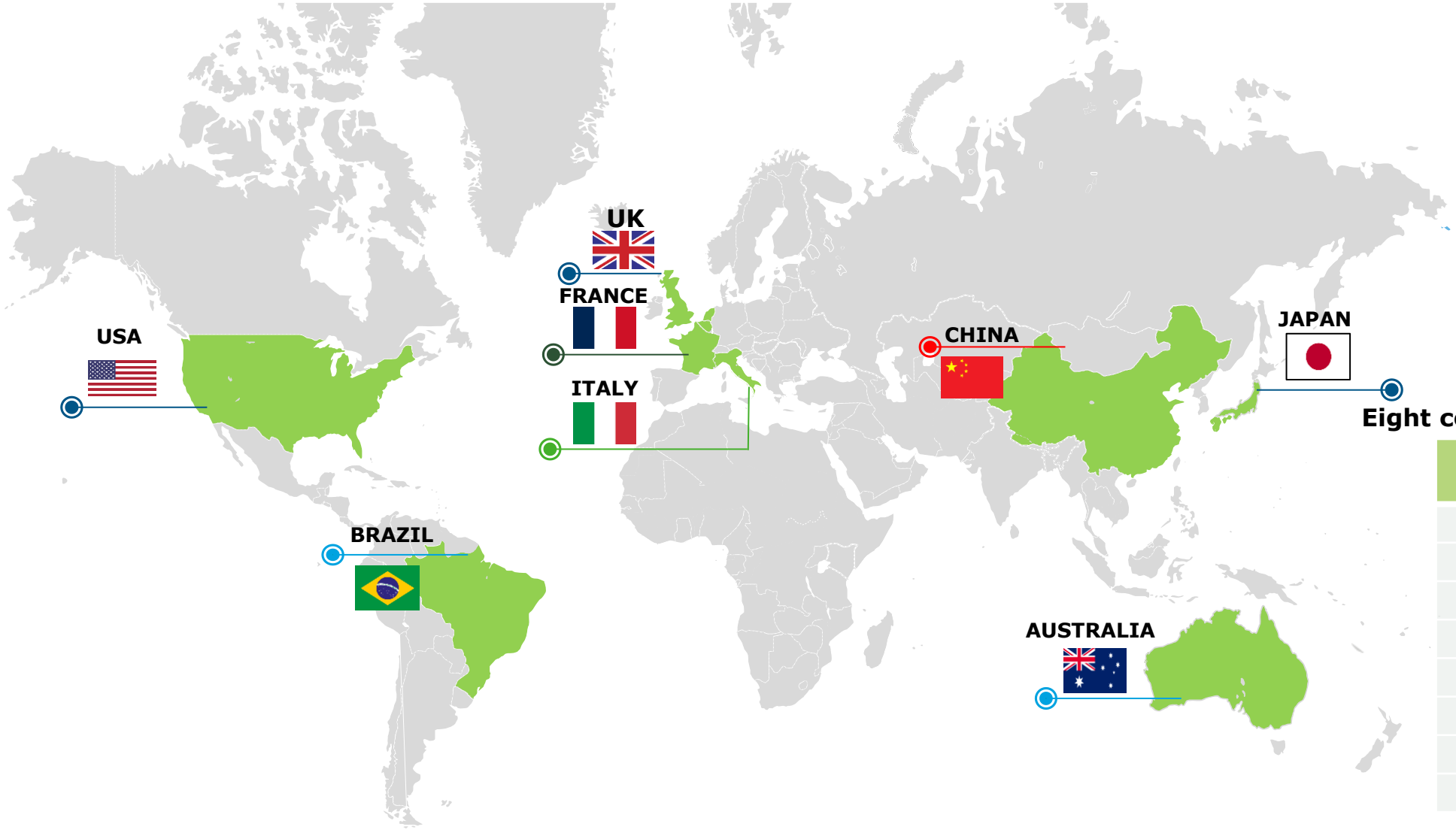
Source: PNGRB

Global Case Studies

2

Selected Countries

Countries were selected from different parts of the geography basis level of developed economy and regulatory framework for bundled/unbundled entities



Eight countries selected for study

Country Name
Italy
France
United Kingdom
Australia
China
Brazil
Japan
USA

European: History & As is Status for Gas Distribution

DSOs have to comply with legal form of unbundling in Europe except few country specific mandates

2nd Gas Directive

- Legal Unbundling of distribution activity from other parts of the vertically integrated Undertaking (No obligation to separate ownership of distribution assets from the VIU
- Concept of Combined operators (transmission, storage, distribution) but separate legal form
- Member state was given a choice not to apply provisions of legal unbundling of DSOs to VIU with less than 1,00,000 connected customers
- Third Party access to eligible customers based on some volume thresholds initially by Member states. Criterias were revised each year. Post 2007 all customers were eligible

- Gas distribution across Europe was largely monopolistic, with national or regional incumbents holding exclusive rights to distribute and supply gas within specific territories.

1st Gas Directive

- Unbundling and transparency of **accounts** in all activities of VIU
- Member state had option to decline authorization of new distribution infrastructure creation if existing/proposed infrastructure was not saturated
- Eligible customers were specified based on volume thresholds

3rd Gas Directive

- No change from 2nd directive

Note: VIU – Vertically Integrated Undertaking, DSO - Distribution System Operators
Source: 1.Directive 2003/55/EC, Chapter IV, Article 11, Page L176/64-65; 2. Directive 2003/55/EC, Chapter IV, Article 11, Page L176/65; 3. Directive 2003/55/EC, Chapter VI, Article 18, Page L176/67

Market framework in gas distribution sector in Europe as per EU Gas Directives

In Europe, Gas distribution is legally unbundled from gas marketing with third party access to gas distribution infrastructure

1 How do entities operate in the market for gas sale and distribution to end consumers?

- *As per **2nd** EU gas directive 2003/55/EC, member states[1] are required to designate Distribution system operators (DSOs) for a period of time.*
- *Each DSO is responsible for operating, maintaining and developing under economic conditions a secure, reliable and efficient system in its area. They do not carry out any sale of gas but operations only under Gas Transporter license.*
- *DSOs are eligible for Regulatory Allowed Revenue that covers their investments in assets.*
- *Revenue for DSO is driven by transportation charges (to recover our Regulatory Allowed Revenue) which are levied on gas shippers, who will then recover these costs from energy suppliers, who in turn recover these costs through consumers' energy bills.*

2 Is unbundling of gas distribution operations and sales required for entities?

- *As per **2nd** EU gas directive 2003/55/EC, the entities[2] are required to legally unbundle distribution activity from other parts of the vertically integrated Undertaking (VIU) but there is no obligation to separate ownership of distribution assets from the VIU*
- *Entities serving less than 0.1 million customers are excluded from this requirement.*

3 Is there any mandate for Third-Party Access (TPA) to gas distribution?

*As per EU gas directive 2003/55/EC and 2009/73/EC, Member States are required to ensure the implementation of a system of third-party access to the transmission and **distribution** system.*

4 Is there any exclusivity for gas sale or distribution?

There is no exclusivity on sale of gas however, DSOs operate in specific geographical areas based on concession contracts signed between the local municipality/government and the distribution system operator or license provided by regulator. It varies from country to country.

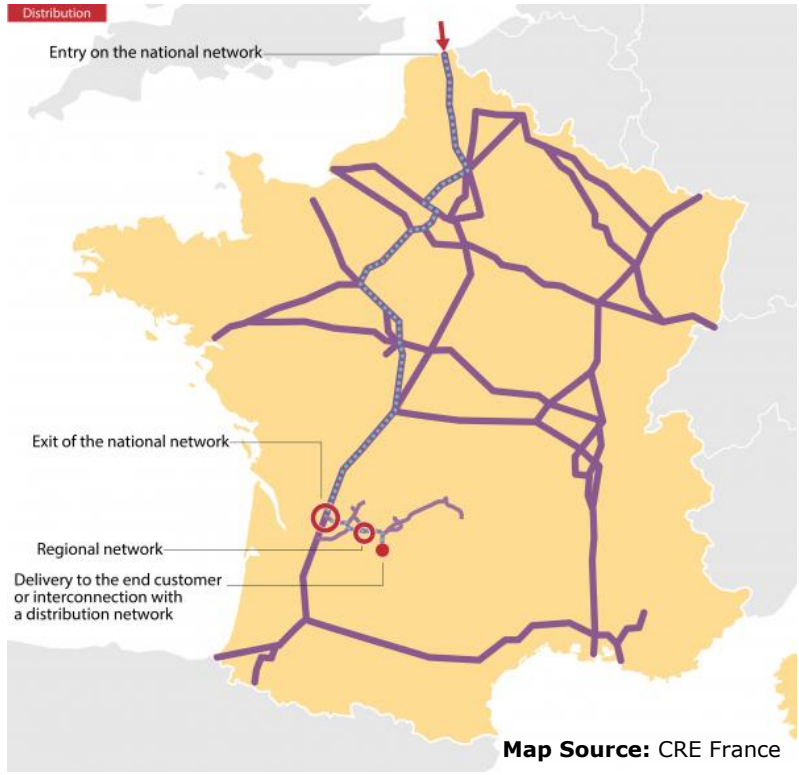
Source: 1.Directive 2003/55/EC, Chapter IV, Article 11, Page L176/64-65; 2. Directive 2003/55/EC, Chapter IV, Article 11, Page L176/65; 3. Directive 2003/55/EC, Chapter VI, Article 18, Page L176/67

Regulatory Frameworks in Gas distribution of Europe- France (1/3)

Legal form of unbundling is present for gas distribution sector in France

Agenda

COUNTRY	France
DSO MODEL	Legal Unbundling*
NO OF DSO[1]	23
Name of DSO[1]	GRDF, Régaz-Bordeaux, R-GDS and 20 others
Gas Supply	100% Import (LNG terminals/ Pipeline imports)
PRODUCER/ SUPPLIER	BP/Total Energies/Harbor Energy/Shell/Others
Gas Distribution Pipeline Owner[1]	Engie (Public ~57%, State~23.64%)
Gas Distribution System Operator[1]	GRDF, 22 small DSOs-Régaz-Bordeaux, R-GDS and 20 other DSOs
REGULATOR[2]	CRE France



Map Source: CRE France

LNG TERMINALS[1] (Nos.)	5
GAS STORAGE[2] (Nos.)	16
DISTRIBUTION NETWORK LENGTH[2] (KM)	1,94,000

Note: *Small distribution companies are not mandated to legally unbundle because of their small customer base <100000
Source: 1. CRE France

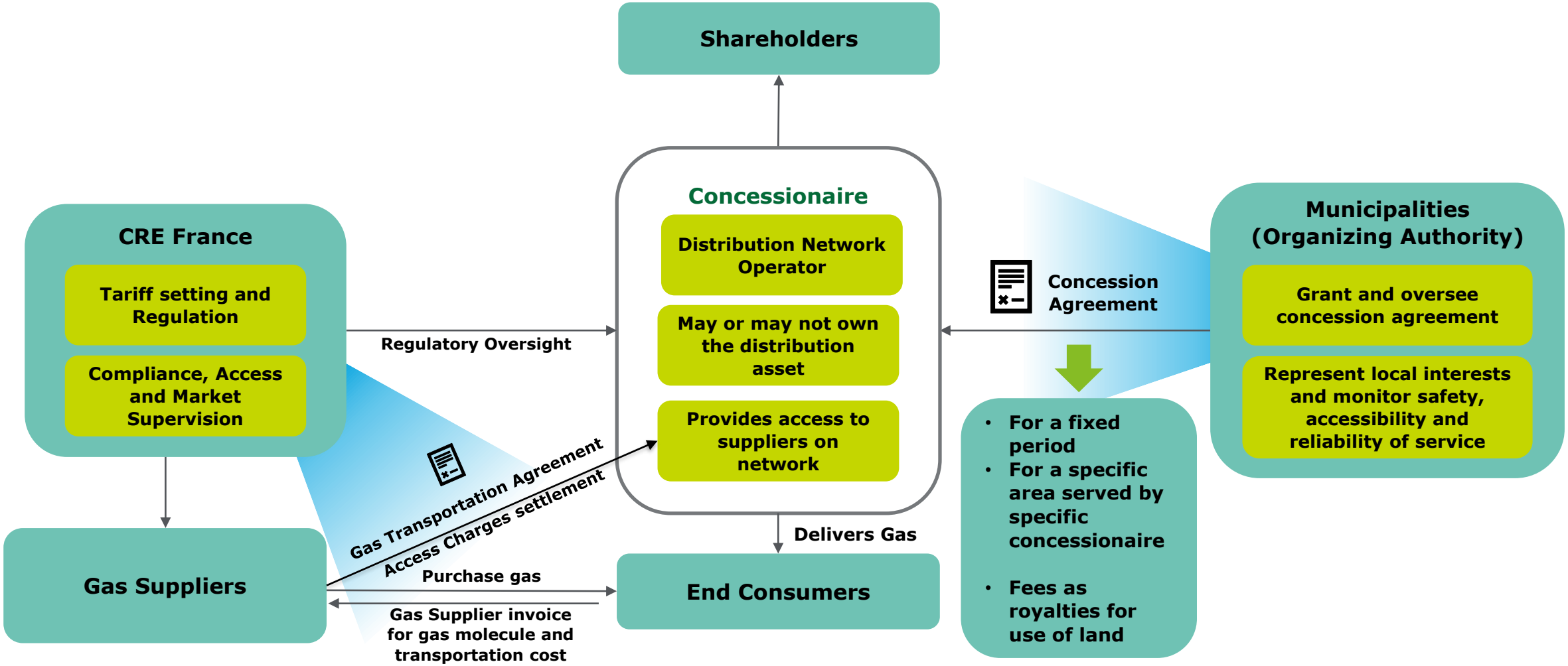
Regulatory Frameworks in Gas distribution of Europe- France (2/3)

In France, there is no exclusivity on sale of gas for a specific area however concession agreements are signed between DSOs & municipalities for operation, maintenance and development of gas distribution infra

Country	Regulator	Mechanism	Areas defined as	Infrastructure Exclusivity	Operator	Marketing Exclusivity	Exception
France	CRE France	Concession Agreement	Referred as **concession area** but mainly with municipal boundaries	• Valid is Upto-20 years in a specific area	Known as DSO and has authorized concession area	Non-existent	
				• **Example** – GRDF for 50 municipalities, RGDS for 50 neighboring municipalities	**Example** – GRDF, Regaz Bordeaux, RGDS and 20 small DSOs	**Example**: Global Energy Management & Sales (GEMS) - Gas marketing	
				• Infrastructure owners & operators cannot sell the gas (legally unbundled) • DSO is allowed revenue on return over Regulated Asset Base • No other Entity can set-up parallel network in the authorized area • The entity has continued doing infra **post exclusivity end period through renewal of concession agreements**	Provides **Third Party access** to infrastructure	• **License** is required for gas supply but validity of license is not defined • An entity not directly involved in gas distribution is eligible for marketing of gas • French Energy secretary issues license • Gas supplier has obligations to uninterrupted gas supply and access to gas sources for availability • No specific margin for the players - not regulated	--

Operating Model of the Distribution System Operator in France (3/3)

The gas distribution operator functions under a concession agreement within a designated area and time frame, subject to regulatory and service quality oversight by the CRE and Municipality



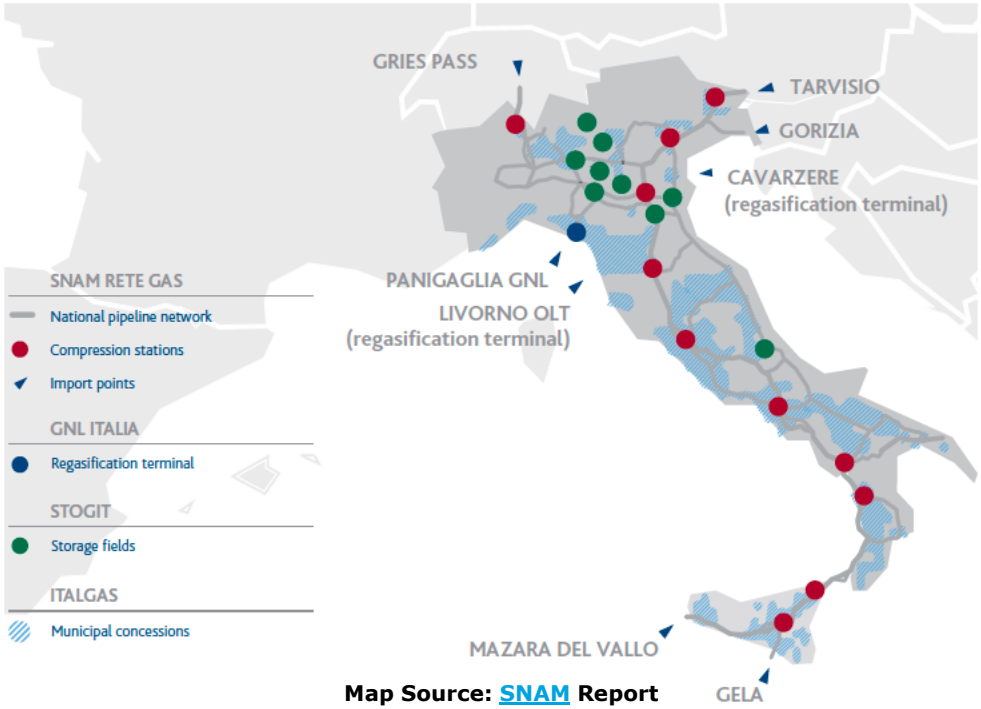
Note: *Small distribution companies are not mandated to legally unbundle because of their small customer base less than 100000
Source: 1. CRE France **2** Regaz-Infravia capital; 3. RGDS; 4.Infravia capital-Regaz

Regulatory Frameworks in Gas distribution of Europe- Italy (1/2)

Legal form of unbundling is present for gas distribution sector in Italy

Agenda

COUNTRY	Italy
DSO MODEL	Legal Unbundling*
NO OF DSO[1]	>206 but Top 6 has more than 70% Mkt share DP
Name of DSO[1]	Italgas, 2i Retegas, Hera, A2A, Iren, Toscana Energia
Gas Supply[2]	95% Import (LNG terminals/ Pipeline imports)
PRODUCER/ SUPPLIER	Enel Energia/Edison/Hera comm (Hera group)
Gas Distribution Pipeline Owner[1]	Gas distribution network operator
REGULATOR	The Italian Regulatory Authority for Energy, Networks and Environment (ARERA)



Map Source: SNAM Report

LNG TERMINALS[3] (Nos.)	3
GAS STORAGE[4] (Nos.)	13
DISTRIBUTION NETWORK LENGTH[5] (KM)	2,68,000

Note: *Small distribution companies are not mandated to legally unbundle because of their small customer base less than 100000
Source: 1. Market Report by AD little; 2.World Energy Institute 2023; 3. Adriatic LNG Italy;IEA; 4.IEA 5. Proxigas

Regulatory Frameworks in Gas distribution of Europe- Italy (2/2)

In Italy, there is area specific service concession contract for gas distribution by an authorized entity valid for 12 years with sale of gas performed by multiple gas supplier licensees in an area

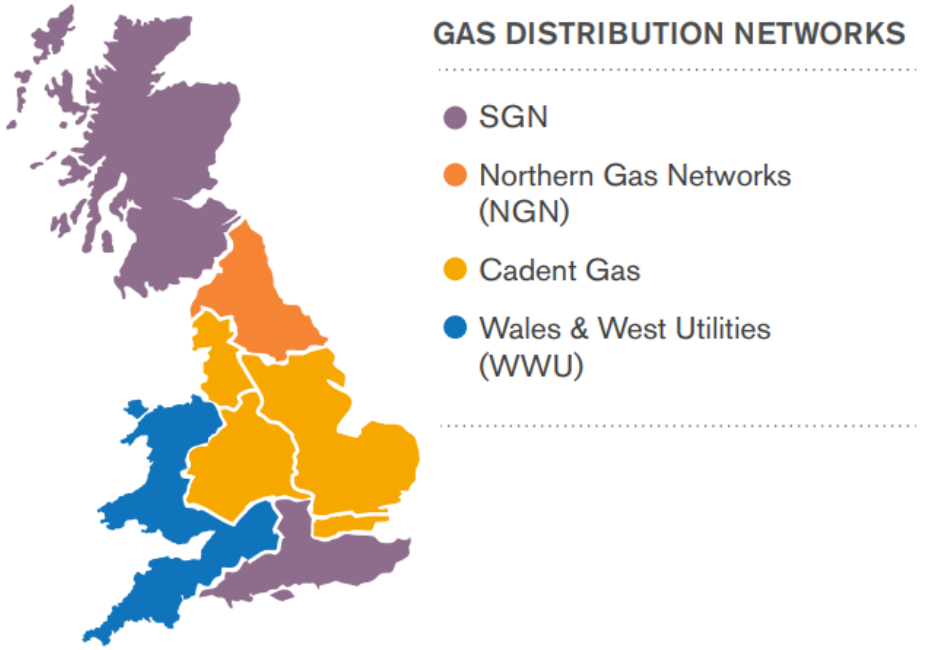
Country	Regulator	Mechanism	Areas defined as	Infrastructure Exclusivity	Operator	Marketing Exclusivity	Exception
Italy	The Italian Regulatory Authority for Energy, Networks and Environment (ARERA)	Service concession contracts	Referred as **concession area** but mainly with municipal boundaries	• Valid is Up-to 12 years in a specific area	Known as DSO and has authorized concession area	Non-existent	
				• **Example** – Italgas, 2i Retegas, Hera, A2A, Iren, Toscana Energia	**Example** – Italgas, 2i Retegas, Hera, A2A, Iren, Toscana Energia	**Example**: Enel Energia/Edison/Hera comm (Hera group)	
				• Infrastructure owners & operators cannot sell the gas (legally unbundled) • DSO is allowed returns on Regulated Asset Base • No other Entity can set-up parallel network in the authorized area • **Post exclusivity end period,** there is **retendering** for bidding of service concessions	• Provides **Third Party access** to infrastructure • Tariff Regulated by ARERA	• **License** is required for gas supply, but validity of license is not defined • An entity not directly involved in gas distribution is eligible for marketing of gas • ARERA issues gas supply license • Gas supplier has obligations to uninterrupted gas supply and access to gas sources for availability • Earlier price were regulated for small consumers but 2024 onwards it is phased out	Retendering is being done after exclusivity and assets are transferred on redemption value to new concessionaire

Regulatory Frameworks in Gas distribution of Europe- UK (1/2)

Legal form of unbundling is present for gas distribution sector in UK

Agenda

COUNTRY	UK
DSO MODEL	Legal form of unbundling . Distribution only with no sale of gas
NO OF DSO[1]	4
Name of DSO[1]	SGN (formerly Scotia Gas Networks) Cadent (formerly National Grid plc/ National Grid Gas Distribution), Southern Gas Networks with IGTS Wales and West Utilities, National Grid
Gas Supply[2]	46% LNG Imports
PRODUCER/ SUPPLIER[3]	Supplier- British Gas (Centrica), E.ON UK, SSE Energy Supply Limited, BP Gas (More than >50)
Gas Distribution Pipeline Owner[1]	Gas distribution network operators
REGULATOR	Ofgem



Map Source: Ofgem

LNG TERMINALS[4] (Nos.)	3
GAS STORAGE[5] (Nos.)	9
DISTRIBUTION NETWORK LENGTH[6] (KM)	2,74,000

Note: IGTS : Independent Gas Transporters
Source: 1.Power Compare UK; 2. Data by World Energy Institute-2023; 3. Ofgem Gas License; 4.Govt. of UK 5.Govt. of UK

Regulatory Frameworks in Gas distribution of Europe- UK (2/2)

In UK, there is no exclusivity on sale of gas however there is area specific designated concessionaire for gas distribution

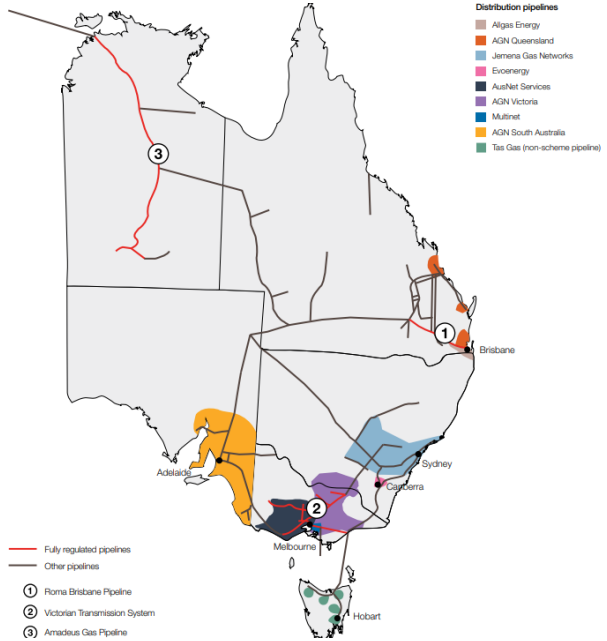
Country	Regulator	Mechanism	Areas defined as	Infrastructure Exclusivity	Operator	Marketing Exclusivity	Exception
UK	Ofgem	concession contracts as per Utilities Act 2000	Gas distribution regions	• Concession contracts can be more than 5 years, but current arrangement does not specify any period	Known as DSO and has authorized concession area	Non-existent	
				Example – SGN, Cadent, Southern Gas Networks with IGTS, Wales and West Utilities, National Grid	**Example** – SGN, Cadent, Southern Gas Networks with IGTS, Wales and West Utilities, National Grid	**Example**: British Gas (Centrica), E.ON UK, SSE Energy Supply Limited, BP Gas (More than >50)	
				• Infrastructure owners & operators cannot sell the gas (legally unbundled) • DSO is allowed returns on Regulated Asset Base • No other Entity can set-up parallel network in the authorized area • There is no expiry of licenses for gas distribution however, performance is monitored for continuity of license	• Provides **Third Party access** to infrastructure • Charges for gas connections and transportation • Allowed Revenue with incentive through incentive framework efficiency improvements	• **License** is required for gas supply, but validity of license is not defined • An entity not directly involved in gas distribution is eligible for marketing of gas • Ofgem issues gas supply license • Ofgem monitors performance and license compliance • Ofgem sets a price cap for gas, which limits the amount that utility providers can charge.	--

Regulatory Frameworks in Gas distribution of Australia (1/2)

Separation with ring fencing requirements is present for gas distribution sector in Australia

Agenda

COUNTRY	Australia
DSO MODEL	Separation with ring fencing requirement
NO OF DSO[1]	9
Name of DSO[1]	Jemena Gas Network, Multinet Gas, AusNet Services, APA Group, Australian Gas Networks (AGN), ATCO Gas Australia etc.
Gas Supply[2]	Domestic Production is 3.8x of the consumption
PRODUCER/ SUPPLIER[3]	Origin Energy, AGL Energy, Energy Australia, Alinta Energy
Gas Distribution Pipeline Owner[1]	Gas distribution system operator
REGULATOR[2]	Australian Energy Regulator



Map Source: AER

LNG TERMINALS (Nos.)	-
GAS STORAGE[3] (Nos.)	6
DISTRIBUTION NETWORK LENGTH[4] (KM)	74,492

Source: 1.State of energy market 2023: ; 2. Data by World Energy Institute-2023; 3.AEMC; 4.State of the energy market 2023

Regulatory Frameworks in Gas distribution of Australia (2/2)

There exists infrastructure exclusivity for license holders in specific area designated under license while there is no exclusivity over sale of gas

Country	Regulator	Mechanism	Areas defined as	Infrastructure Exclusivity	Operator	Marketing Exclusivity	Exception
Australia	AER/ACC	Area specific Licensing	Supply Area	• License Identified up to 21 years	Known as DSO and has authorized concession area	Non-existent	
				Example – Jemena Gas Network, Multinet Gas, AusNet Services, APA Group, Australian Gas Networks (AGN), ATCO Gas Australia etc.	**Example** – Jemena Gas Network, Multinet Gas, AusNet Services, APA Group, Australian Gas Networks (AGN), ATCO Gas Australia etc.	**Example**: Origin Energy, AGL Energy, Energy Australia, Alinta Energy	There is provision in regulation to grant exclusive license for one or more supply areas as per energy coordination act 1994
				• Infrastructure owners & operators cannot sell the gas (legally unbundled) • DSO is allowed returns on Regulated Asset Base • No other Entity can set-up parallel network in the authorized area • There is no expiry of licenses for gas distribution however, performance is monitored for continuity of license	• Provides **Third Party access** to infrastructure • Network tariffs are regulated • Essential Services comm issues gas supply license	• **License** is required for gas supply with validity of license is up-to 10 years • An entity not directly involved in gas distribution is eligible for marketing of gas • Essential Services comm issues gas supply license • AER monitors performance and license compliance • Market driven gas prices while network tariffs are regulated	-

Regulatory Frameworks in Gas distribution of China (1/2)

Gas sale and distribution is performed by a single bundled entity in a specific region in China

Agenda

COUNTRY	China
DSO MODEL	Bundled Gas distribution entity (Gas sale and distribution)
NO OF DSO[1]	>5, but Major 5 distributors
Name of DSO/Distribution Entity[1]	ENN Energy Holdings Limited, China Gas Holdings Limited, Towngas China Company Limited, Kunlun Energy Company Limited, Beijing Gas Group Co., Ltd. etc.
Gas Supply[2]	43% Imports and 57% Domestic Production
PRODUCER/ SUPPLIER[3]	China National Petroleum Corporation (CNPC), China National Offshore Oil Corporation (CNOOC), Sinopec
Gas Distribution Pipeline Owner[1]	Gas Distributors /Gas Distribution Entity
REGULATOR[2]	National Energy Administration (NEA)

Map Source: Baker Institute

LNG TERMINALS[4] (Nos.)	14
GAS STORAGE (Nos.)	-
DISTRIBUTION NETWORK LENGTH[5] (KM)	1,047,260.050

Source: 1.S&P 2. Statistical Review 2023-Energy Institute; 3. Secondary Research; 4. S&P; 5. CEIC Data

Regulatory Frameworks in Gas distribution of China (2/2)

China has area specific concession contracts for gas sale and distribution by bundled entity with area specific exclusivity

Country	Regulator	Mechanism	Areas defined as	Infrastructure Exclusivity	Operator	Marketing Exclusivity	Exception
China	National Energy Administration (NEA)	Area specific concessions	Geographical Area	• Present up-to 30 years	Gas distribution and sale is done by a single entity only	• Present up-to 30 years	
				Example: ENN Energy Holdings Limited, China Gas Holdings Limited, Towngas China Company Limited, Kunlun Energy Company Limited, Beijing Gas Group Co., Ltd. etc.	**Example**: ENN Energy Holdings Limited, China Gas Holdings Limited, Towngas China Company Limited, Kunlun Energy Company Limited, Beijing Gas Group Co., Ltd. etc.	**Example**: ENN Energy Holdings Limited, China Gas Holdings Limited, Towngas China Company Limited, Kunlun Energy Company Limited, Beijing Gas Group Co., Ltd. etc.	**Same entity(Bundled)** is responsible for gas sale and operation of the gas distribution infrastructure
				• Infrastructure owners & operators can sell the gas • No other Entity can set-up parallel network in the authorized area • Since private and foreign investments in gas distribution began in 2002 and the exclusivity period extends up to 30 years, the expiry of any concession is yet to happen	Third party is non-existent as on date	• An entity directly involved in gas distribution is eligible for marketing of gas • Local government is involved in area specific concession rights • Prices are regulated for residential customers	-

Regulatory Frameworks in Gas distribution of Brazil (1/2)

There is no mandate for unbundling of gas marketing from gas distribution in city gas distribution

Agenda

COUNTRY	Brazil
DSO MODEL	No mandate for unbundling of gas marketing from gas distribution
NO OF DSO[1]	Local Distribution companies(>5)
Name of DSO[1]	Bahia Gas Company (Bahiagas), Companhia de GÃis de SÃ£o Paulo (ComgÃis), Companhia Paraibana de GÃis, Naturgy Energy Group S.A., PetrÃ³leo Brasileiro S.A., Potiguar Gas Company (Potigas), Santa Catarina Gas Company (SCGÃS).
Gas Supply[2]	22% Imports/78% domestic production
PRODUCER/ SUPPLIER	Petrobras, Bolivian
REGULATOR	National Agency of Petroleum, Natural Gas and Biofuels (ANP)

Map Source: Typical in 2015-Efficiency and performance in gas distribution. Evidence from Brazil

LNG TERMINALS[3] (Nos.)	5
GAS STORAGE[4] (Nos.)	-
DISTRIBUTION NETWORK LENGTH[5] (KM)	40,000

Source: 1.SPER Market Research; 2.World Energy Institute 2023; 3. IEA; 4.ARGUS MEDIA;

Regulatory Frameworks in Gas distribution of Brazil (2/2)

Brazil has area specific concession contracts for gas sale and distribution by bundled entity with area specific exclusivity

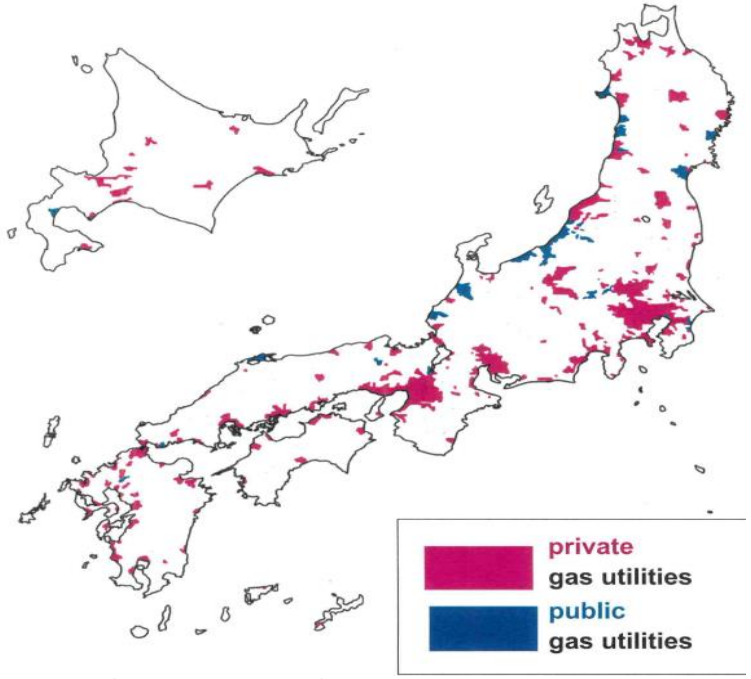
Country	Regulator	Mechanism	Areas defined as	Infrastructure Exclusivity	Operator	Marketing Exclusivity	Exception
Brazil	National Agency of Petroleum, Natural Gas and Biofuels (ANP)	Concession contract	Municipalities	• Present up-to 30 years extendable by 20 years for a predefined area	• Gas distribution and sale is done by a single entity only	• Present up-to 30 years for domestic and commercial[2] customers • Up-to 12 years for industrial[1] and thermoelectric consumers	
				Example: Bahia Gas, Companhia de GÃis de SÃ£o Paulo (ComgÃis), Companhia Paraibana de GÃis, Naturgy Energy Group S.A., Potigas, Santa Catarina Gas Company	**Example**: Bahia Gas, Companhia de GÃis de SÃ£o Paulo (ComgÃis), Companhia Paraibana de GÃis, Naturgy Energy Group S.A., Potigas, Santa Catarina Gas Company	**Example**: Bahia Gas, Companhia de GÃis de SÃ£o Paulo (ComgÃis), Companhia Paraibana de GÃis, Naturgy Energy Group S.A., Potigas, Santa Catarina Gas Company	• Same entity **(Bundled)** is responsible for gas sale and operation of the gas distribution infrastructure • Industrial consumers meeting certain volume thresholds can contract directly with gas producers or marketers, rather than relying on local distribution companies (LDCs) • State Regulatory agencies issues licenses for distribution and retailing
				• Infrastructure owners & operators can sell the gas • No other Entity can set-up parallel network in the authorized area • Concession contract establishes expansion goals which include achieving additional customers and new networks within the first 5-year period and a additional customers within 10 years	• State-level regulation permits natural gas distributors to pass on supply prices to end-users & charge a distribution margin	• An entity directly involved in gas distribution is eligible for marketing of gas • Local government is involved in area specific concession rights • Regular price adjustments taking into account inflation, distribution margins and tariffs	

Regulatory Frameworks in Gas distribution of Japan (1/2)

Post Liberalization in 2017, there is 100% open access on gas distribution infrastructure

Agenda

COUNTRY	Japan
DSO MODEL	Legal Unbundling
NO OF DSO[1]	~190
Name of DSO[1]	Osaka Gas Network Co., Ltd., Tokyo Gas Network Co., Ltd., Toho Gas Network Co., Ltd, Saibu Gas Network Co., Ltd
Gas Supply[2]	100% Imports
SUPPLIER	Osaka Gas Network Co., Ltd., Tokyo Gas Network Co., Ltd., Toho Gas Network Co., Ltd, Saibu Gas Network Co., Ltd
REGULATOR	Ministry of Economy, Trade and Industry (METI)



Map Source: Japanese Gas Association

LNG TERMINALS[3] (Nos.)	37
GAS STORAGE[4] (Nos.)	-
DISTRIBUTION NETWORK LENGTH[5] (KM)	224604

Source: 1.SPER Market Research; 2.World Energy Institute 2023; 3. IEA; 4.ARGUS MEDIA

Regulatory Frameworks in Gas distribution of Japan (2/2)

Japan has service areas where there is infrastructure exclusivity for gas distribution by a single entity in the authorized service area but there is no exclusivity on sale of gas as there is 100% open access

Country	Regulator	Mechanism	Areas defined as	Infrastructure Exclusivity	Operator	Marketing Exclusivity	Exception
Japan	Ministry of Economy, Trade and Industry (METI)	• City gas utility, referred as General gas Utility, is required to obtain license[1] to supply gas to service area • Post liberalization[2] in 2017, there is no exclusivity on gas sale in any particular area. There could be more than one retailer in service area	Service Area[1]	• There is infrastructure exclusivity for a service area but no fixed period of exclusivity	• Gas distribution and sale are done by two separate legal entities as there is mandate for legal unbundling[2]	• There is no marketing exclusivity for a service area for a period. There is 100% open access to infrastructure post liberalization	
				• **Example**: Osaka Gas Network Co., Ltd., Tokyo Gas Network Co., Ltd., Toho Gas Network Co., Ltd, Saibu Gas Network Co., Ltd	• **Example**: Osaka Gas Network Co., Ltd., Tokyo Gas Network Co., Ltd., Toho Gas Network Co., Ltd, Saibu Gas Network Co., Ltd	**Example:** Osaka Gas Co., Ltd., Tokyo Gas Co., Ltd, Toho Gas Co., Ltd, Saibu Gas Co., Ltd	• Separate legal **(unbundled)** entity is responsible for operation of the gas distribution infrastructure and is known as General pipeline service provider. It has no role in gas retailing.
				• Infrastructure owners & operators cannot sell the gas • No other Entity can set-up parallel network in the authorized service area	• Government regulates the gas transportation rates for General gas utility pipeline service provider • Ministry of Economy, Trade, and Industry (METI) issues license under the Gas Business Act.	• An entity directly involved in gas distribution is not eligible for marketing of gas • Ministry of Economy, Trade, and Industry (METI) issues license under the Gas Business Act.	

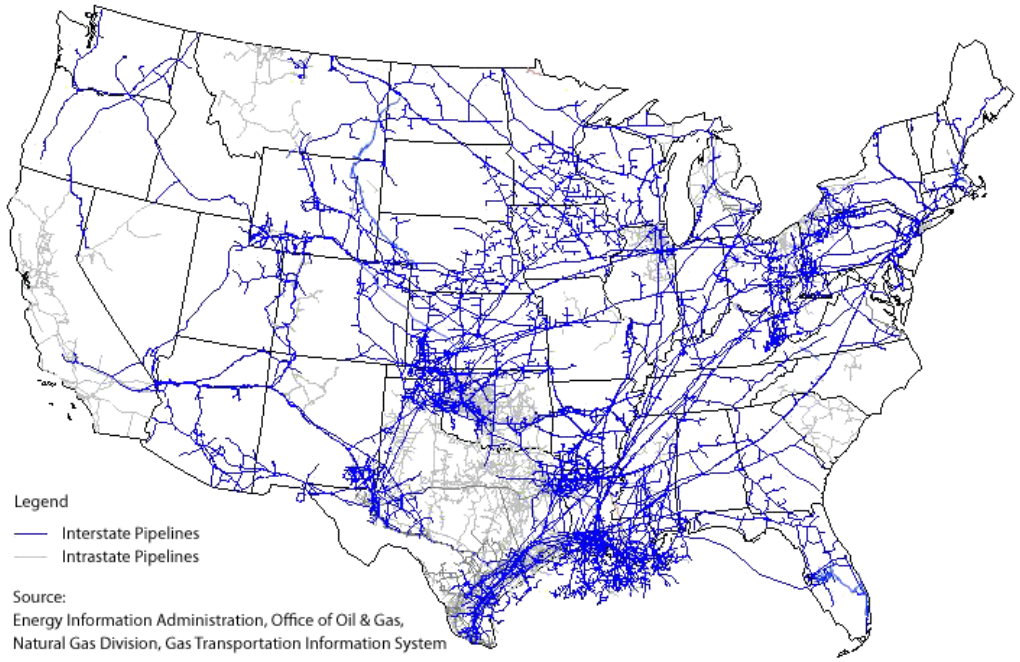
Source: 1. Japanese Gas Law; 2.Presentation by Japanese Gas Association

Regulatory Frameworks in Gas distribution of USA (1/3)

USA follows a mix of regulated and deregulated market models for different regions, with state-level regulations determined by individual states

Agenda

COUNTRY	USA
DSO MODEL[1]	Regulated Regions (LDCs are responsible for transportation and gas sale at regulated rates while gas sale is also performed by retail marketers) Deregulated Regions (LDCs are responsible for transportation only while gas sale is performed by retail marketers)
NO OF DSO[1]	One in each region
Name of DSO[1]	Deregulated LDCs-Atmos Energy, Consolidated Edison, Nicor Gas; Regulated-CenterPoint Energy Mississippi, Louisville Gas & Electric
Gas Supply[2]	100% domestic production
SUPPLIER	Direct Energy, Just Energy and Reliant Energy
REGULATOR	FERC



Map Source: AFDC Energy

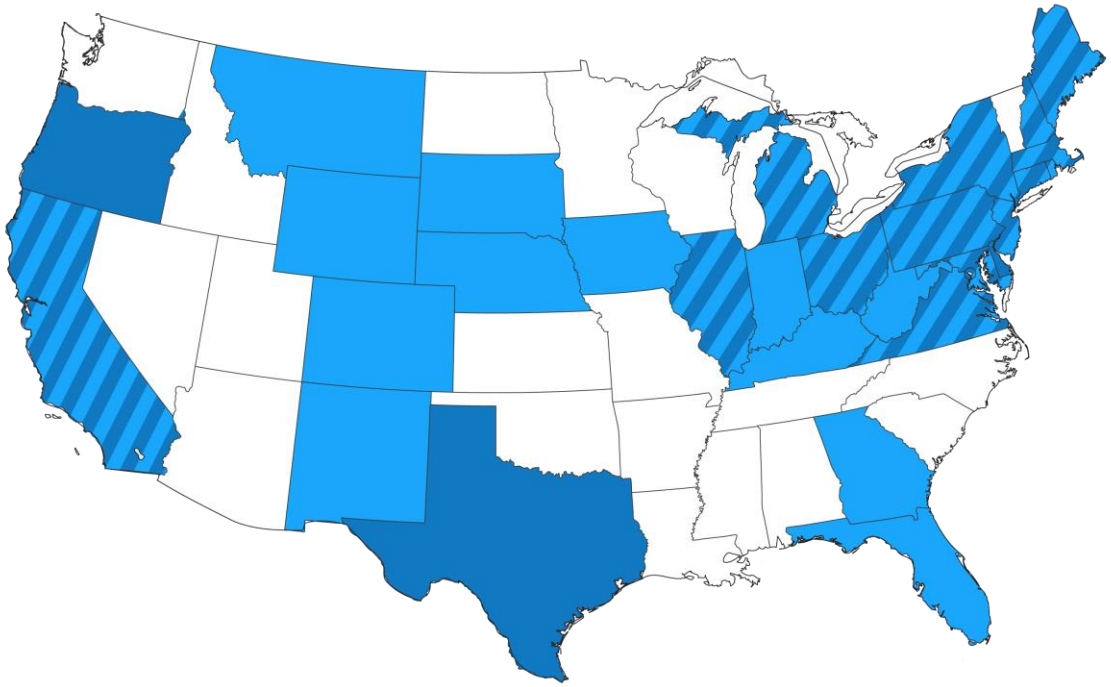
LNG TERMINALS[3] (Nos.)	170
GAS STORAGE[4] (Nos.)	~400-
DISTRIBUTION NETWORK LENGTH[5] (KM)	3.5 x 10^6

Source: 1.World Bank; 2.World Energy Institute 2023; 3. FERC; 4.EnergyInfrastructure-API; 5. AFDC

Note: LDCs stands for Local Distribution Companies

Regulatory Frameworks in Gas distribution of USA (2/3)

In USA, there are states with regulated and deregulated gas markets



Map Source: Diversegy

Regulated Markets In USA

- *Integrated Gas utilities are responsible for the delivery and supply of gas.*
- *Energy consumers in regulated energy markets don't have the power to switch to another energy provider*
- *Example-Alaska, Albama, Missipi etc.*

Deregulated Markets in USA

- *Gas utilities are responsible for the delivery of gas. Marketers perform commercial activities related to sale of gas*
- *The customer's gas bill is split into two parts: delivery and supply. If a customer elects to purchase gas from a supplier, then the supply portion of their invoice is billed by the supplier.*
- *Energy consumers in deregulated energy markets have the power to switch to another energy provider*
- *Example-California, Montana, virginia etc.*

Source: 1. Diversegy

Regulatory Frameworks in Gas distribution of USA (3/3)

USA has infrastructure and market exclusivity in regulated states while there is only infrastructure exclusivity in deregulated states

Country	Regulator	Mechanism	Areas defined as	Infrastructure Exclusivity	Operator	Marketing Exclusivity	Exception
USA	Federal Energy Regulatory Commission (FERC)		Regulated and Deregulated Market	• There is infrastructure exclusivity in a specific territory for regulated and deregulated region • **Example**: Deregulated LDCs- Atmos Energy, Consolidated Edison, Nicor Gas; Regulated- CenterPoint Energy Mississippi, Louisville Gas & Electric	• **Regulated Region**: Integrated gas utility act as operator in a specific state • **Deregulated Region**: Gas Utility act as transporter only without any engagement in gas sale in a specific state	• **Regulated Region**: There is marketing exclusivity over sale of gas by a single utility • **Deregulated Region**: There is no marketing exclusivity over sale of gas • **Example:** Direct Energy, Just Energy and Reliant Energy	
				• Infrastructure owners & operators cannot sell the gas in deregulated state • No other Entity can set-up parallel network in the authorized service area	• **Regulated Region**: Government regulates the gas transportation and supply rates • **Deregulated Region**: Market based price discovery for gas sale prices. Network tariffs regulated, but unbundled from commodity costs	• **In Deregulated state**, an entity directly involved in gas distribution is not eligible for marketing of gas. • State public utility commissions issues license for gas supply and distribution	• Deregulated: Separate legal **(unbundled)** is responsible for operation of the gas distribution infrastructure. • Large Industrial can buy gas from producers/marketers

Source: 1. Diversegy ; 2. World Bank ; Natural Gas.org

Key Learnings based on Global Case Studies for exclusivity in Gas Distribution

Key takeaways

a Regulatory Framework for Market operations

- *There exists restrictions to hold license for both activities of gas distribution and gas sale by the same entity in developed countries like Australia, UK, Italy, France and in developing countries like Japan*
- *There exists provision for separation of activities in terms of unbundling or separation of transportation activity from gas sale with ring fencing arrangement for gas distribution in developed countries*
- *In developing countries like China and Brazil, bundled entities are responsible for gas distribution and sale of molecule in authorized area but in Japan, separate legal entities perform gas sale & distribution*
- *There is observed to be price regulation for small consumers (low volume) in county like China while such regulations has been observed to be phased out in Italy*
- *In USA, there are regulated regions where there are bundled services offered for gas sale and transportation while in deregulated regions there are unbundled services offered by entities*

b Exclusivity

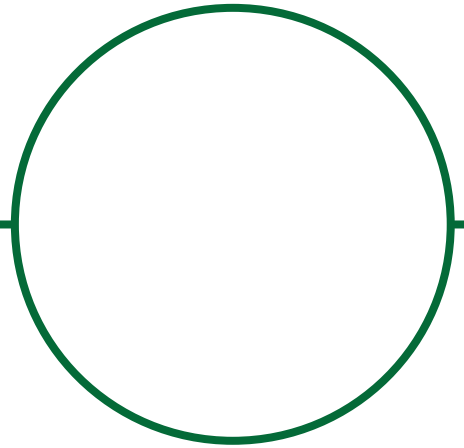
- *There is no exclusivity for sale of gas to geographical area i.e. end consumers are free to choose from the pool of gas suppliers existing in the market while there is also long-term exclusivity in countries like Brazil and China for 30 years*
- *Gas transporters (also know as DSO/DNO) enter into a concession agreements/contracts with local government/municipalities that offers them exclusive rights to operate, maintain and develop infrastructure in an authorized geographical area*

c Third Party access

- *There exists third party access arrangement on gas infrastructure, enabling non-discriminatory access*

Source: Analysis based on Global learnings

End of the Report



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