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Transforming Mobility Through Natural Gas

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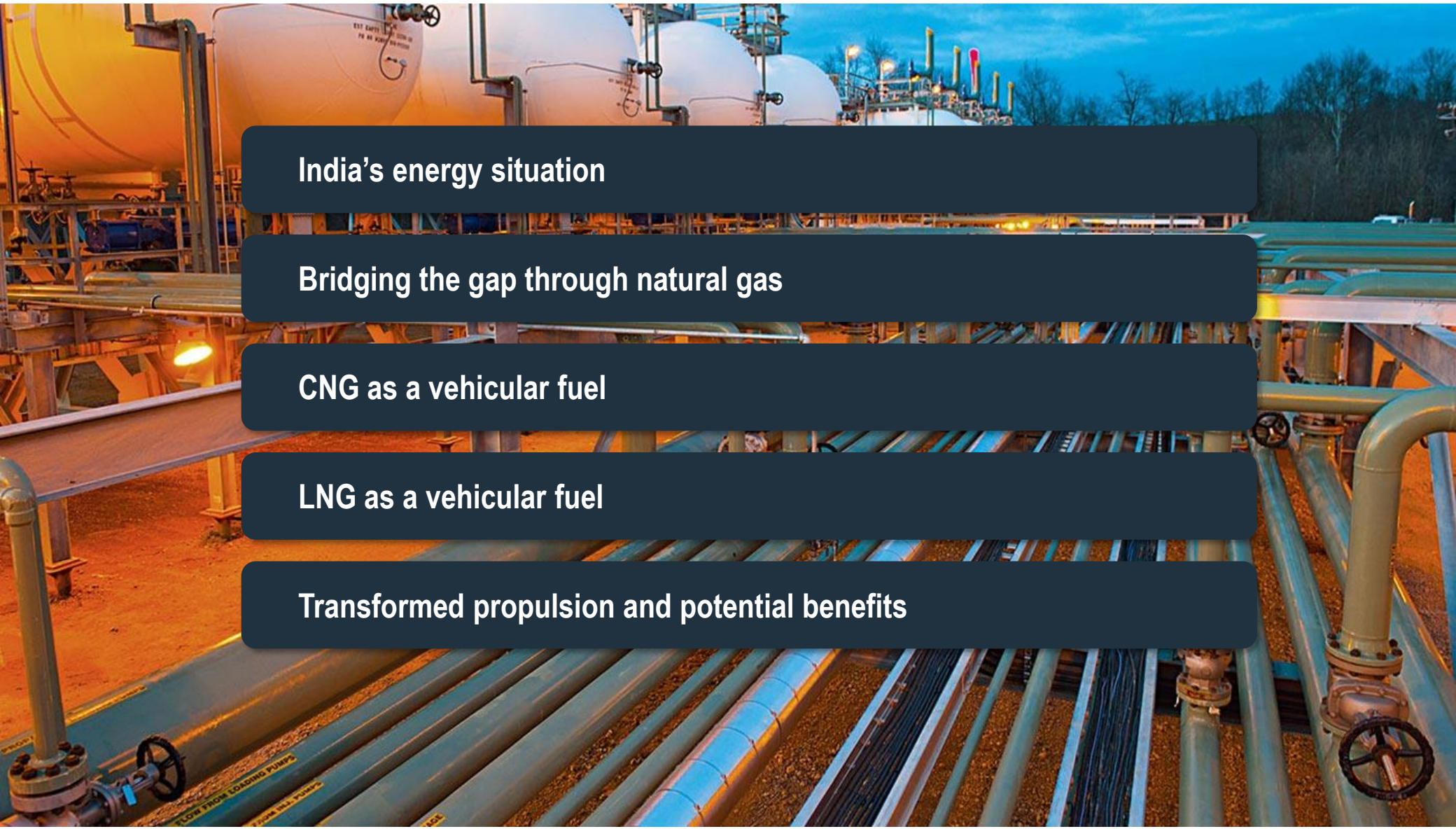

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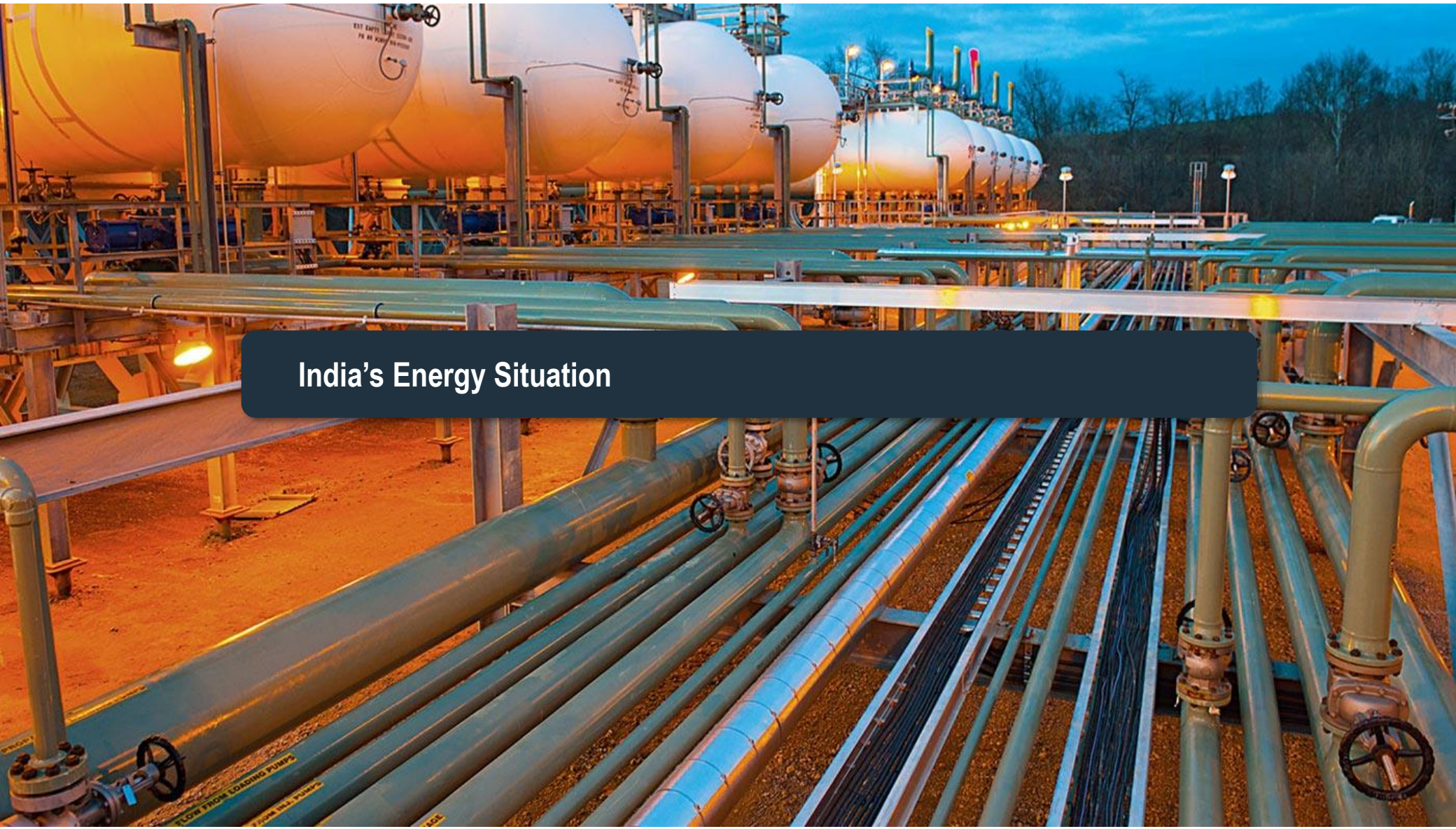

India's Energy Situation

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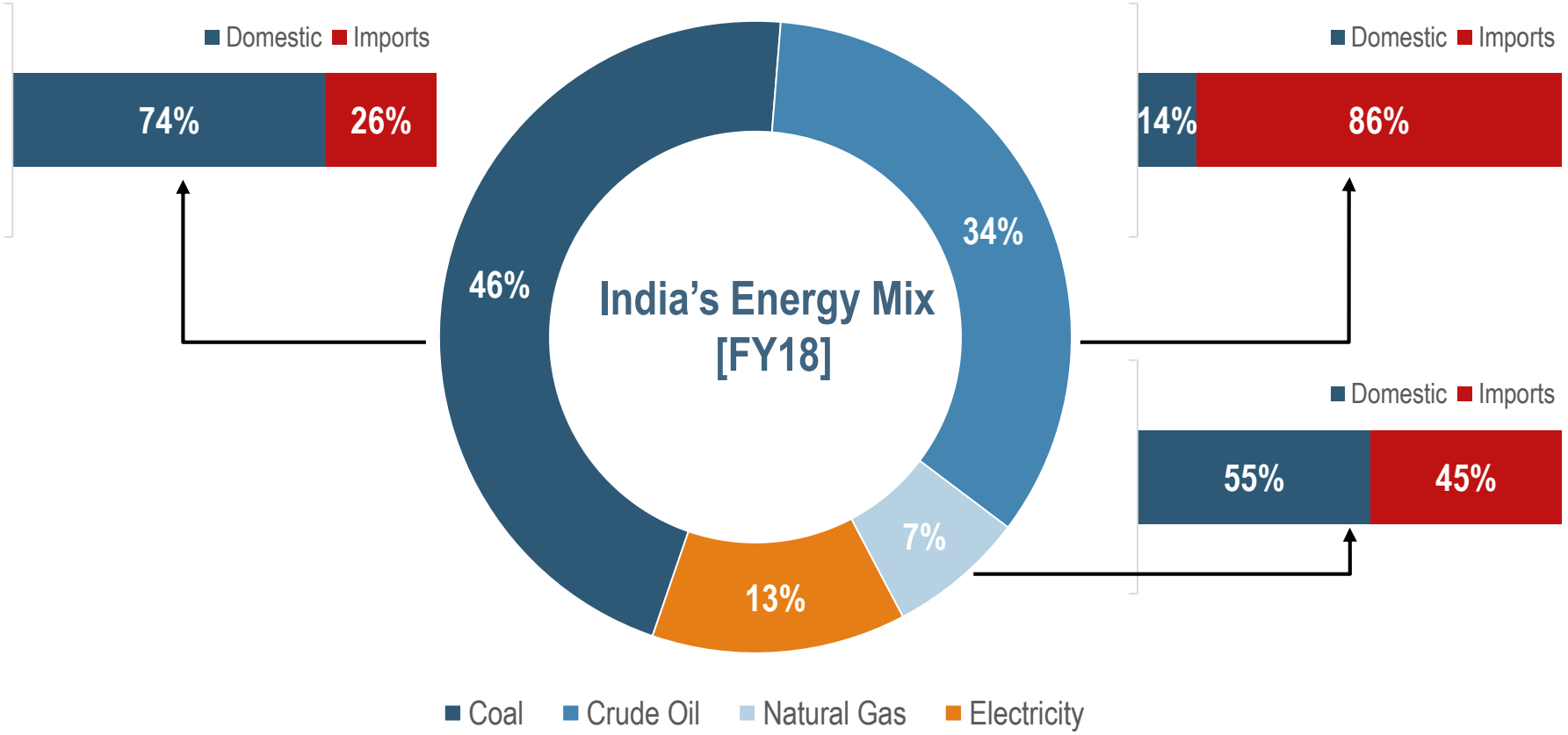
Primary energy consumption of the country is largely dependent on coal and imported crude oil



- **India imports ~50% of its primary energy** needs; import dependence is severe for crude oil with 86% imports
- Despite having vast untapped deposits of Natural Gas, **only 7% of India's primary energy needs are met by it**

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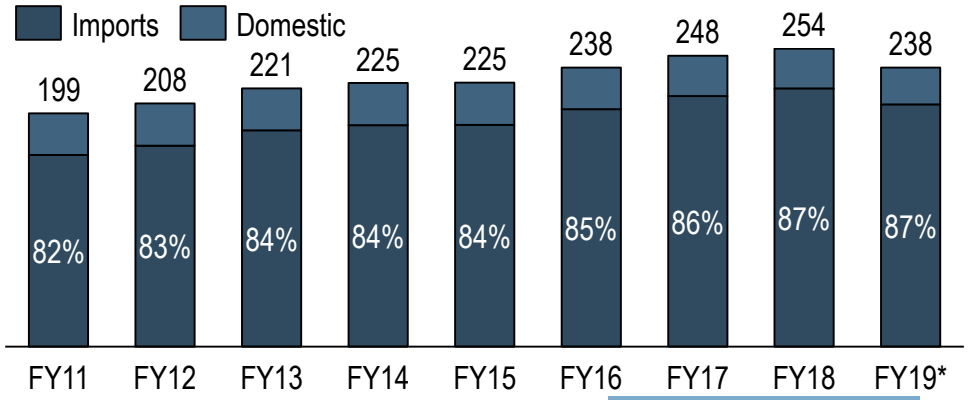
Source: MoSPI, PPAC

The current oil import situation poses a monetary as well as a strategic burden on the Indian economy; imminent need to reduce import dependence

India's Crude Oil Consumption [MMT]

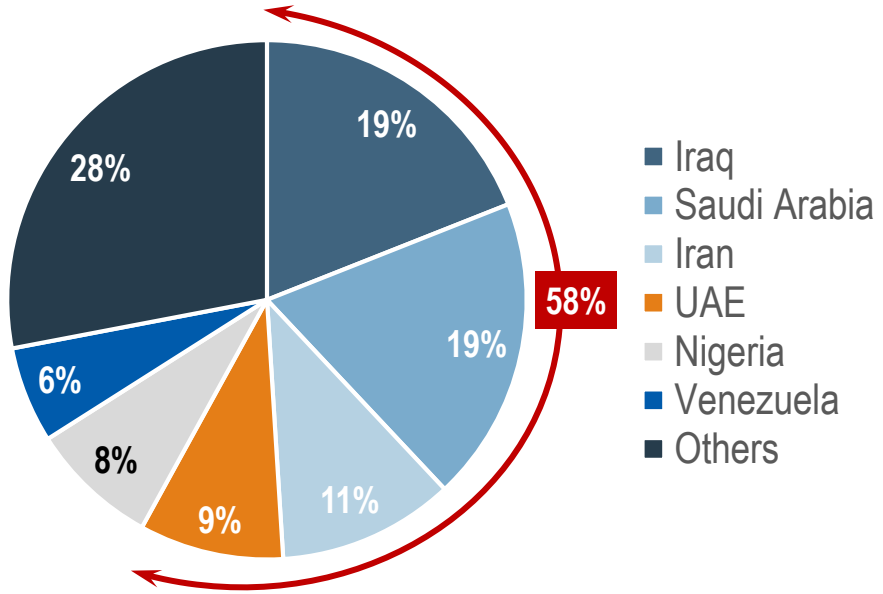


Total oil imports in FY19*		103 Billion USD
Total import bill in FY19*	22%	464 Billion USD
Total forex reserves in FY19	26%	401 Billion USD

Crude oil import bill as a percentage of total imports / forex reserves

*Apr-Feb

Sources of Crude Oil Imports [FY19**]



**Apr-Jan

- Crude oil import is a major source of foreign exchange outflow for India and has considerable impact on the Current Account Deficit
  - India's CAD in Q3 FY19 was 16.9 Bn USD
  - Equals to ~16% of oil import bill

- More than 50% of India's crude oil imports come from the Middle Eastern countries
- Rising instability in the region might result in supply shocks in future, risking India's energy requirement
- There is a strategic need to reduce our dependence

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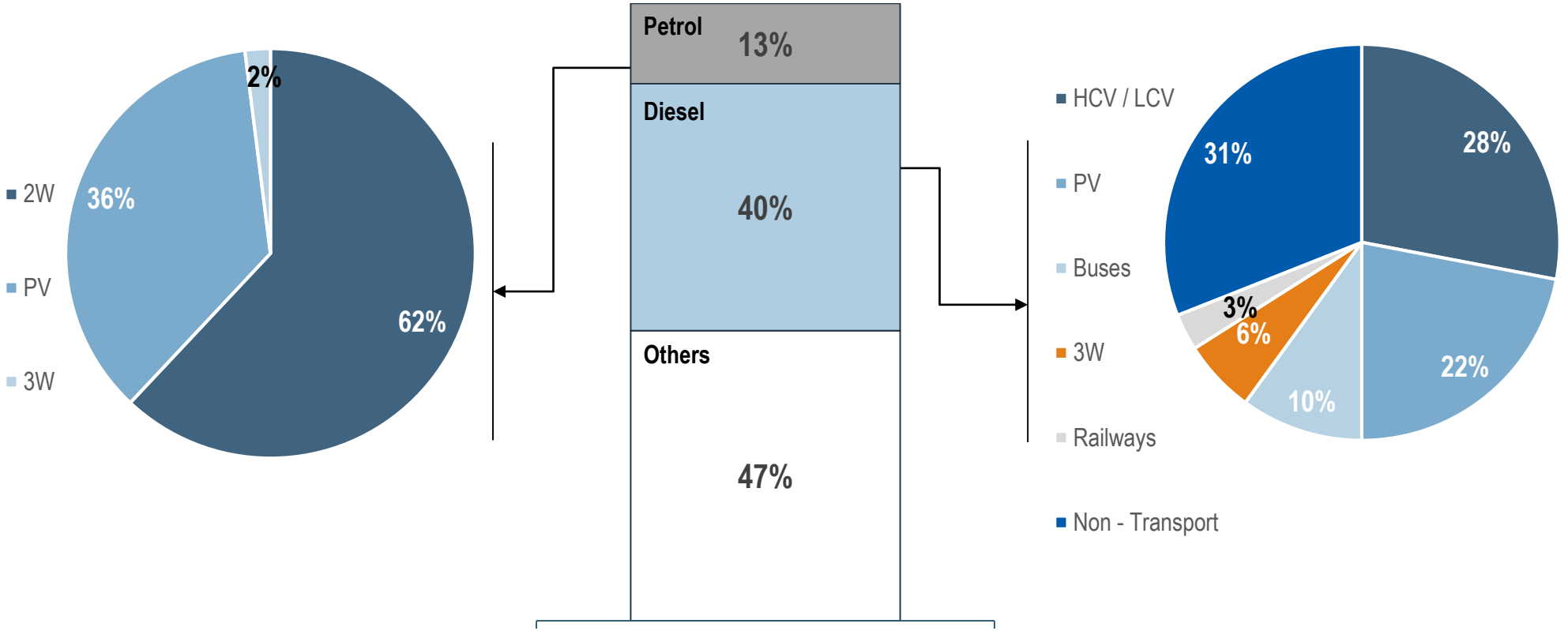
Source: EXIM Data, RBI, PPAC, NRI Analysis

Transport sector is one of the major contributor to the crude oil burden as it makes up for ~53% demand of petroleum products

Consumption of Petroleum Products

- 2W and CV account for highest consumption of petrol and diesel respectively
- Need to target all vehicle segments for oil usage reduction



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Source: PPAC, NRI analysis

EV adoption can resolve this issue, but pace of adoption & financial viability varies drastically across segments; NGVs & EVs can yield huge benefits

Segment	2-Wheelers	Buses	Passenger 3-Wheelers	Trucks	Cars	Cargo 3Ws	LCVs
Electrification	✓	✓	✓		✓		✓
Alternative Fuels		✓	✓	✓	✓	✓	✓

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Source: NRI Analysis

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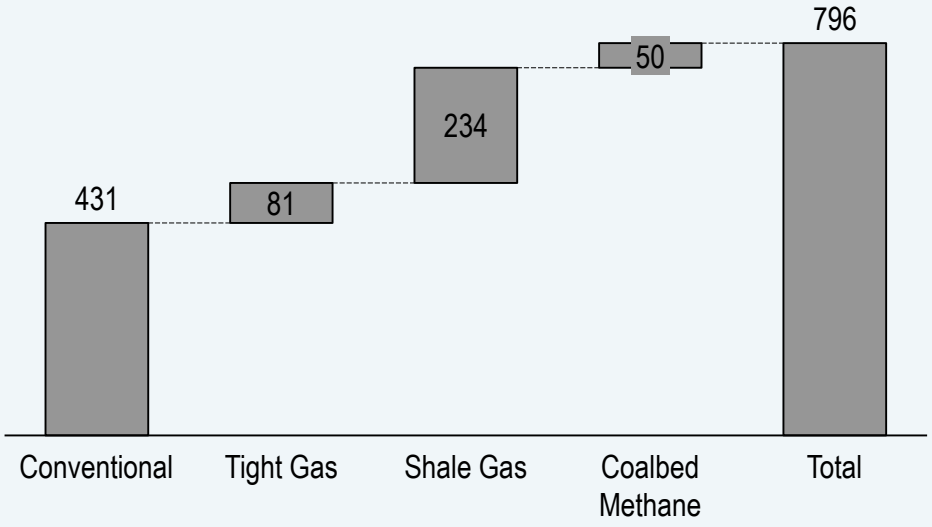
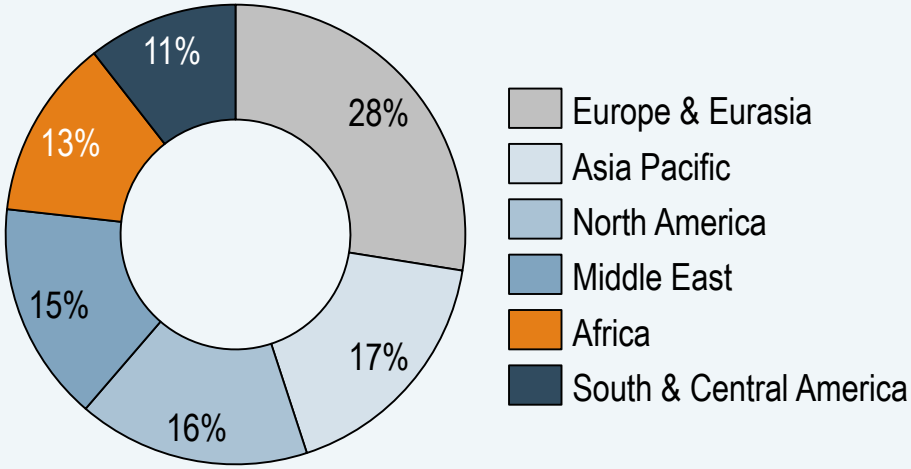
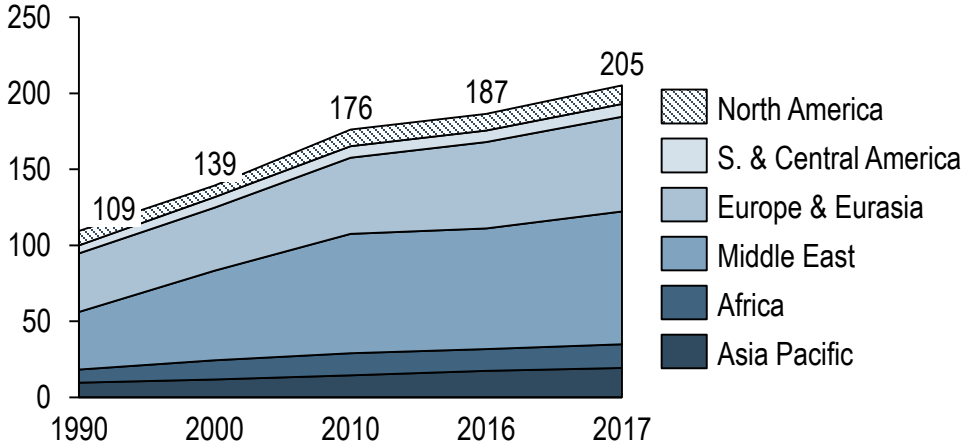
Global natural gas resources are in abundance (796 TCM) in the world and are geographically dispersed; India holds 4 TCM of gas reserves

Global Resources [TCM, 2016]

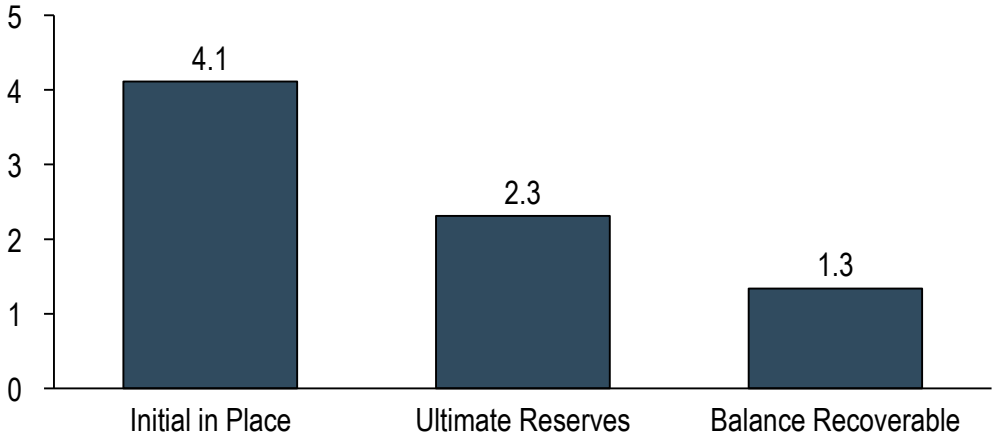




Global Reserves [TCM]



Natural Gas Resources in India [TCM, 2018]



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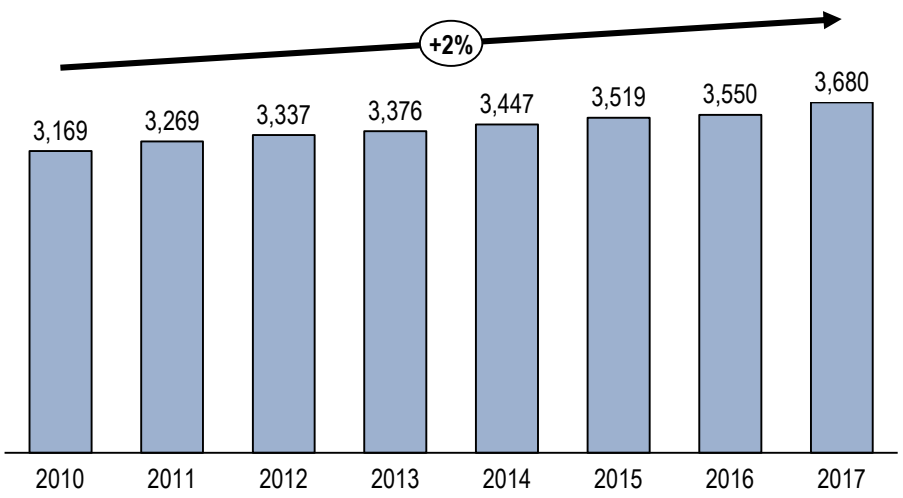
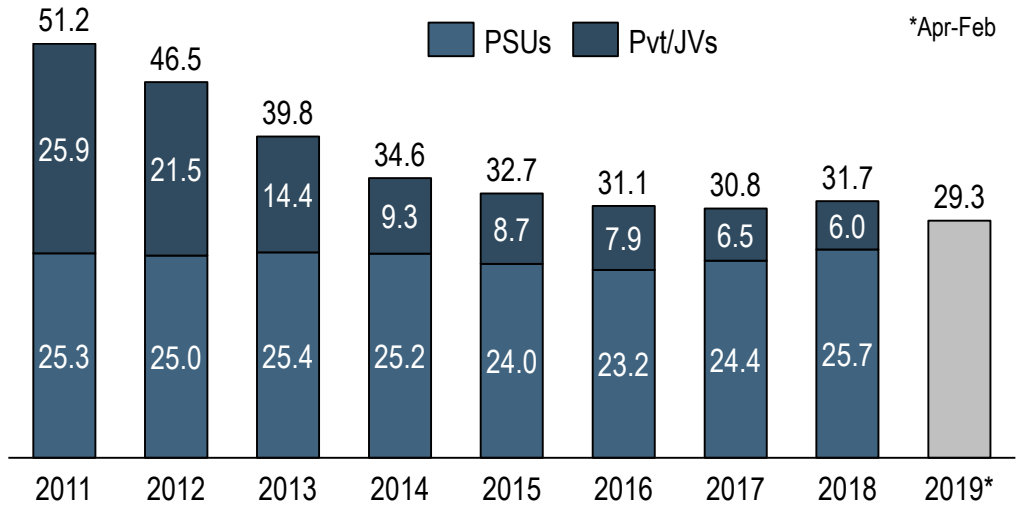
Source: BP Energy Outlook, MoPNG, DGH

Global production of NG has risen steadily over the years, while in India NG production has declined since 2011 due to reduced production from KG basin

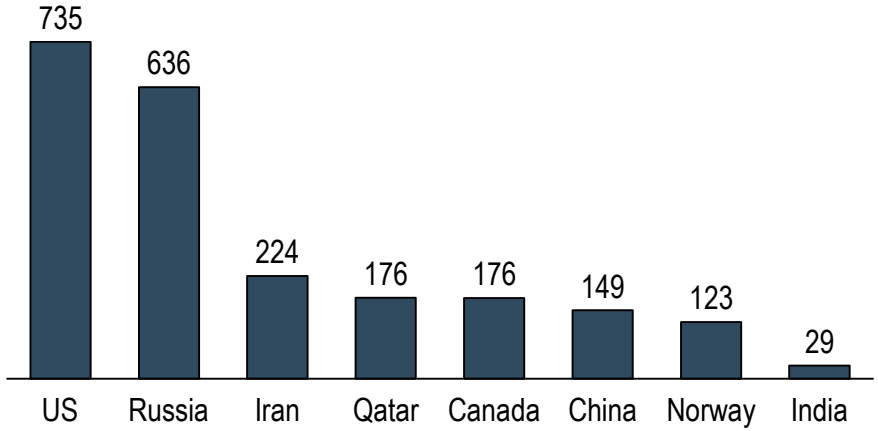
Global Natural Gas Production [BCM]



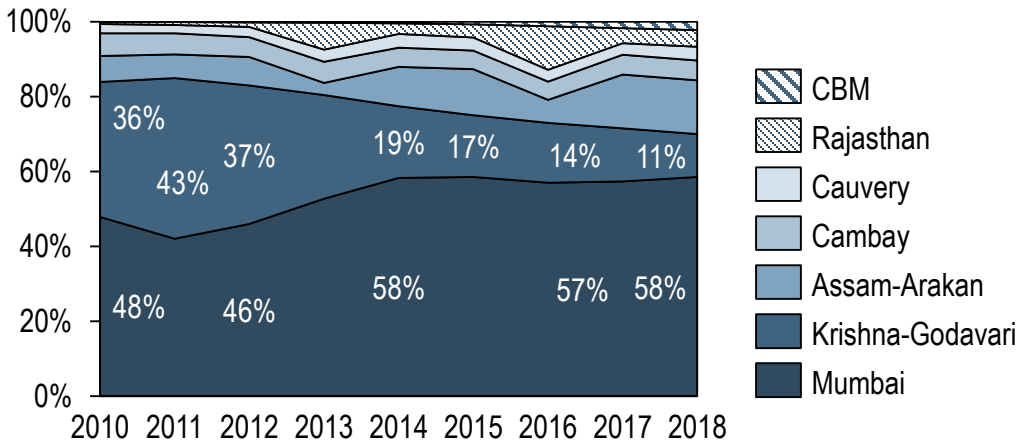
Natural Gas Production in India [BCM]



Top Natural Gas Producers [BCM, 2017]



Natural Gas Production by Basin - India [%]



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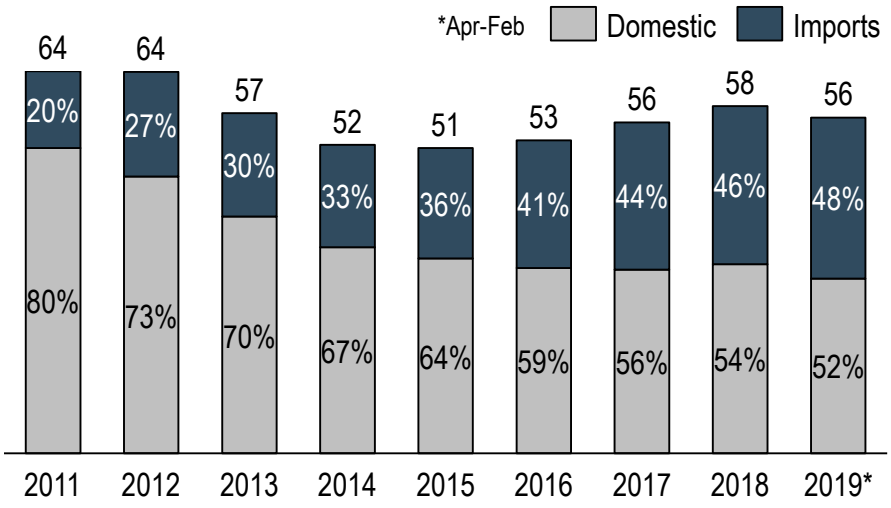
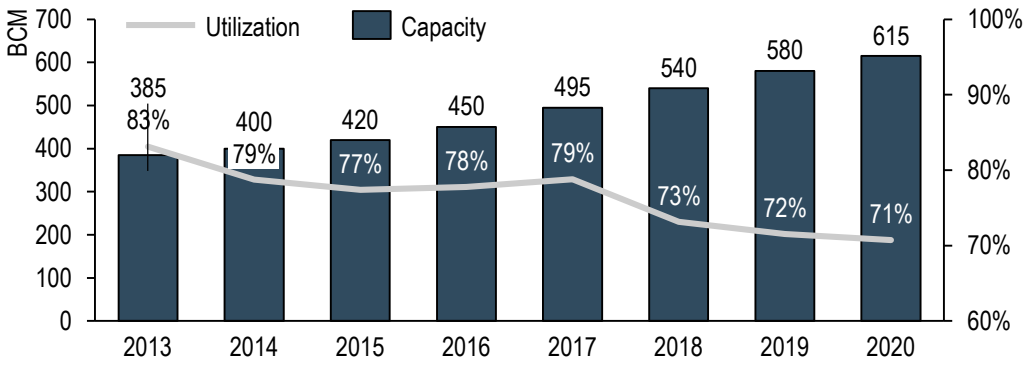
Source: BP Energy Outlook, MoPNG, DGH

Though ~50% of Natural Gas is imported, per unit energy import is 44% cheaper than crude oil and is expected to remain the same

Natural Gas Imports Contribution [MMSCM]



World LNG Liquefaction Capacity & Utilization



Worldwide, LNG export projects are expected to add 75BCM liquefaction capacity in 2018-20 period

Crude Oil vs Natural Gas Pricing*

Price of crude (Indian basket, in $ per MMBTU)	11.12
Landing price of LNG ($/MMBTU)	6.25
% discount in natural gas as compared to crude oil	**44%**

*Feb 2019

Changing Mix of Spot, Short & Long term Contracts

- US exports with flexible destination and gas linked pricing can provide a better alternative to traditional oil linked, fixed delivery supply contracts
- Ample supply of LNG market will lead to more spot purchases or short term contracts providing more flexibility for buyers

Increased LNG production and export capacity, flexible contracts will lead to increased competition among LNG suppliers making natural gas prices attractive for the end consumers in the short term

Source : PPAC, EIA, IIEJ

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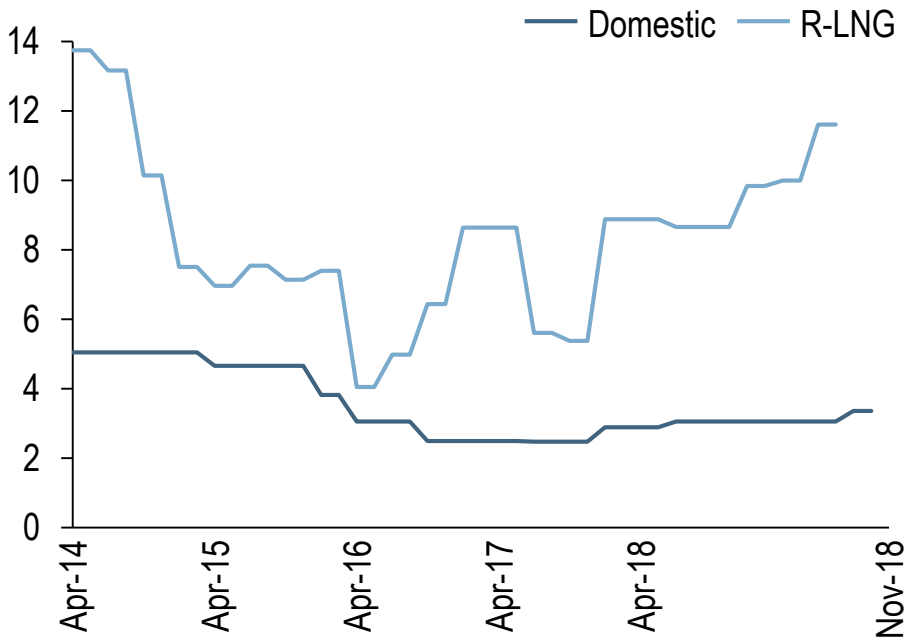
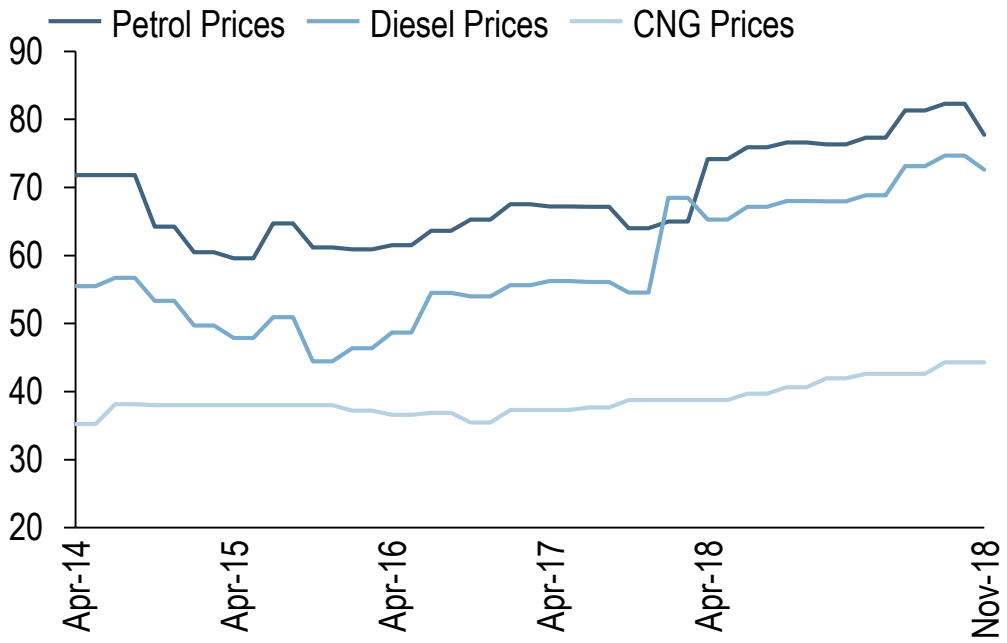
Domestic gas price of natural gas is regulated by the government to make CNG attractive for the retail consumers

Domestic NG Vs R-LNG Price ($/MMBTU)



Retail Fuel Price Trend in Delhi (Rs./Litre, Rs/Kg)



- ✓ Domestic gas price is regulated by the government
- ✓ Domestic gas is allocated to priority sectors which includes CGD

- ✓ CNG prices are kept lower than petrol and diesel making CNG attractive as compared to traditional fuels

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Source : IOCL, Secondary Research

CNG as a vehicular fuel

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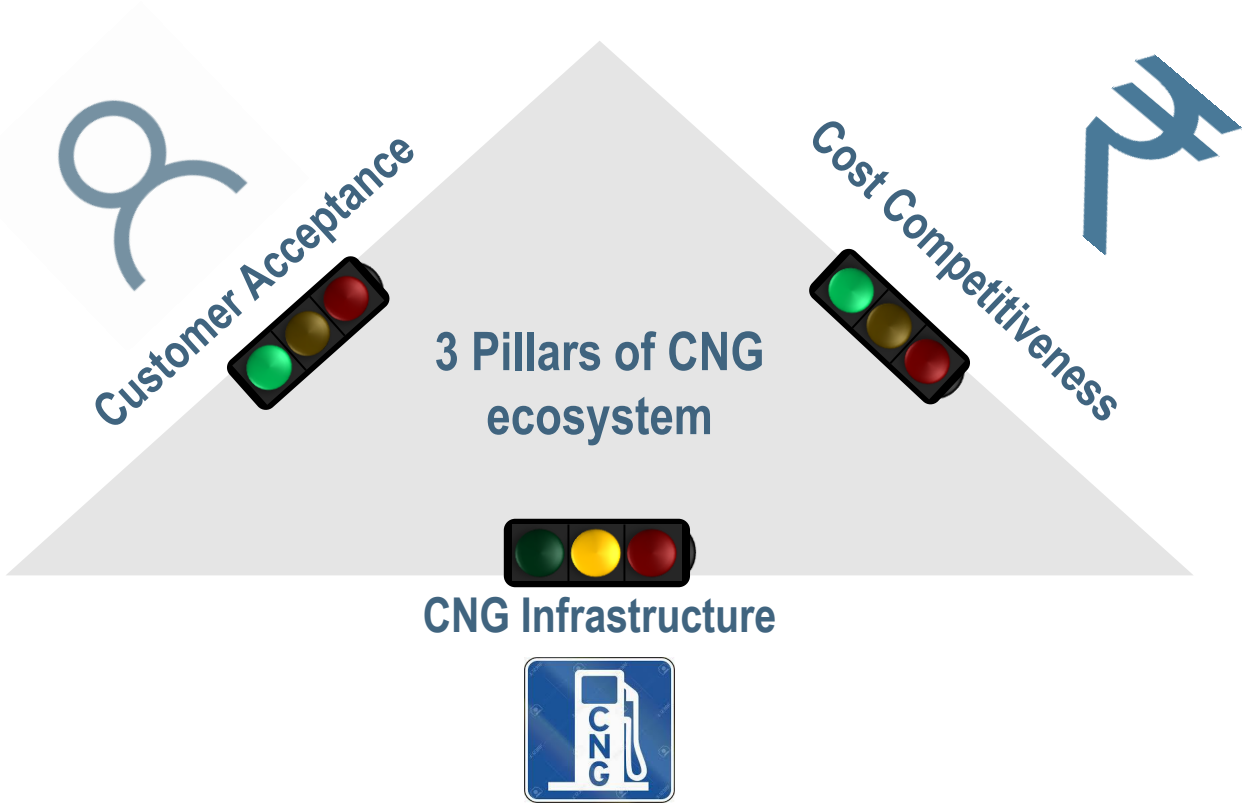
High customer acceptance, cost competitiveness and developing infrastructure can make CNG a viable alternative fuel for mass adoption



Conducive policy environment for market creation, technology development and setting up of a widespread infrastructure for CNG vehicles

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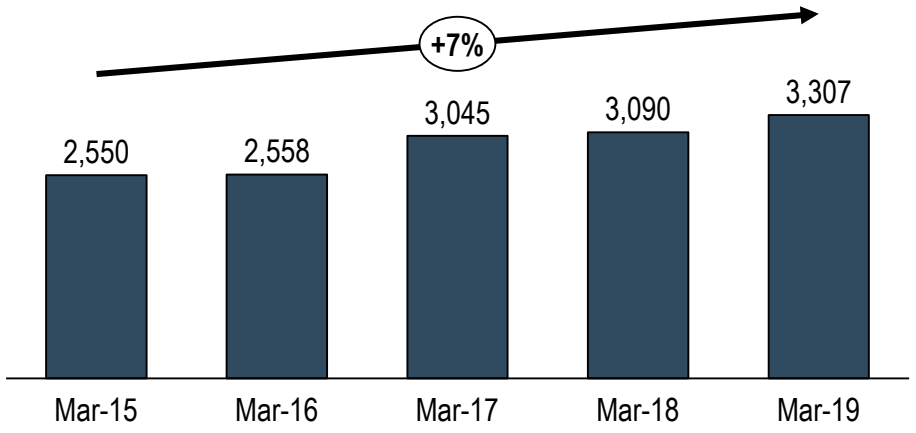
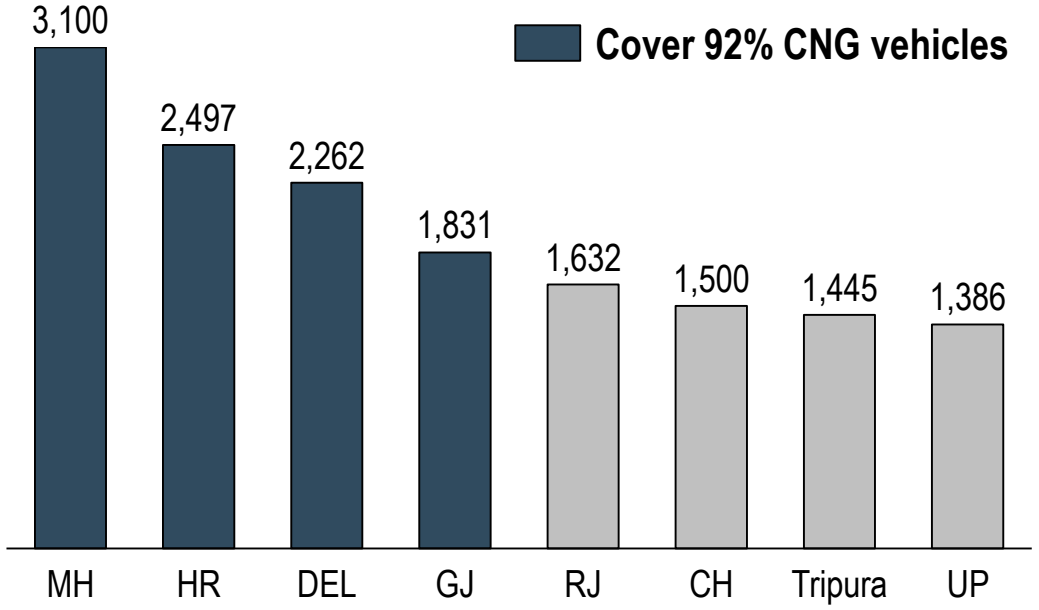
CNG vehicles in India have increased over the years; CNG infrastructure acts as the main driver for CNG vehicle demand

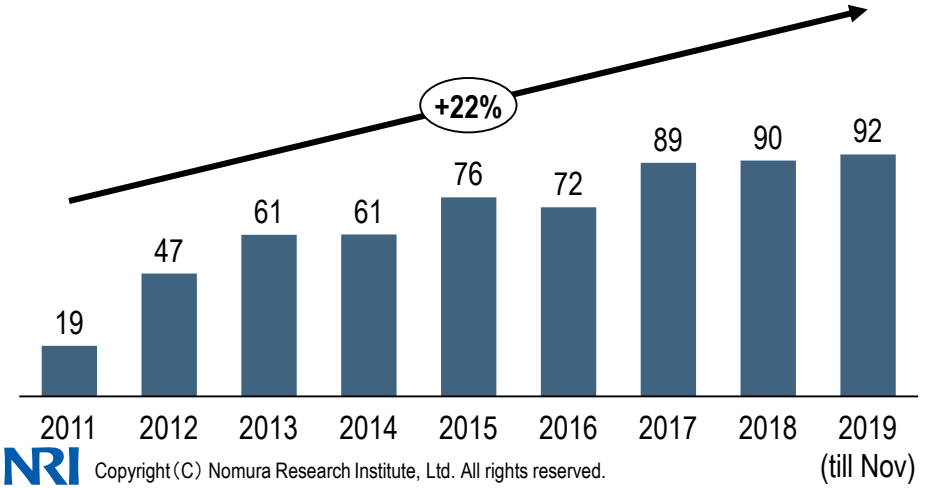
CNG Vehicles in India [000's]



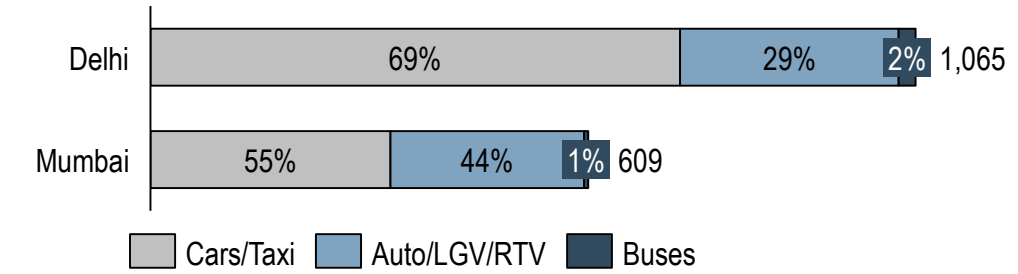
Number of CNG vehicles per station [Mar'2019]



OEM CNG Vehicle Sales in India [000's]



CNG Vehicles by Type [000's, 2017]



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Source: MoPNG, IGL, MGL

OEMs are increasingly offering CNG variants in passenger, commercial and goods vehicle segments

Passenger Vehicles

Number of models offered 13

PV Sales share 29%

Maruti Suzuki	Desire Tour | Eco | Ertiga | Celerio | Wagon R | Alto
Hyundai	Santro | Grand i10 | Xcent
Ford	Aspire | Figo
Honda	Amaze
Mahindra	KUV Trip
Volkswagen	To be launched in 2020

3Ws and LCVs

Number of models offered 20

Mahindra	Supro | Jeeto | Bolero Maxi Bolero Pickup| Optimo | Jayo
Tata	Ace | Ace Zip| Ace Magic
Piaggio	Ape City | Auto Dx | Ape City Xtra
Bajaj	RE Compact| RE Maxima| Qute
Atul	Gempaxx | Gemini
Ashok Leyland	Dost CNG
Maruti Suzuki	Super Carry
TVS	TVS King

M&HCVs

Number of models offered 23

Tata	LP 407| LP 909 | Low entry | Tarmac | LP 407 CNG | LP 709 | LP 909 CNG
Ashok Leyland	LYNX Smart | LYNX Strong| Janbas | MIDI | 12M FESLF
Eicher	Starline | Pro 1059 | Pro 1095 | Pro 1075
SML Isuzu	S7 Staff | S7 XM | Samrat | Sartaj
Mahindra	Excelo | Cosmo
Force Motors	Traveller CNG

Source: SIAM, OEM Websites

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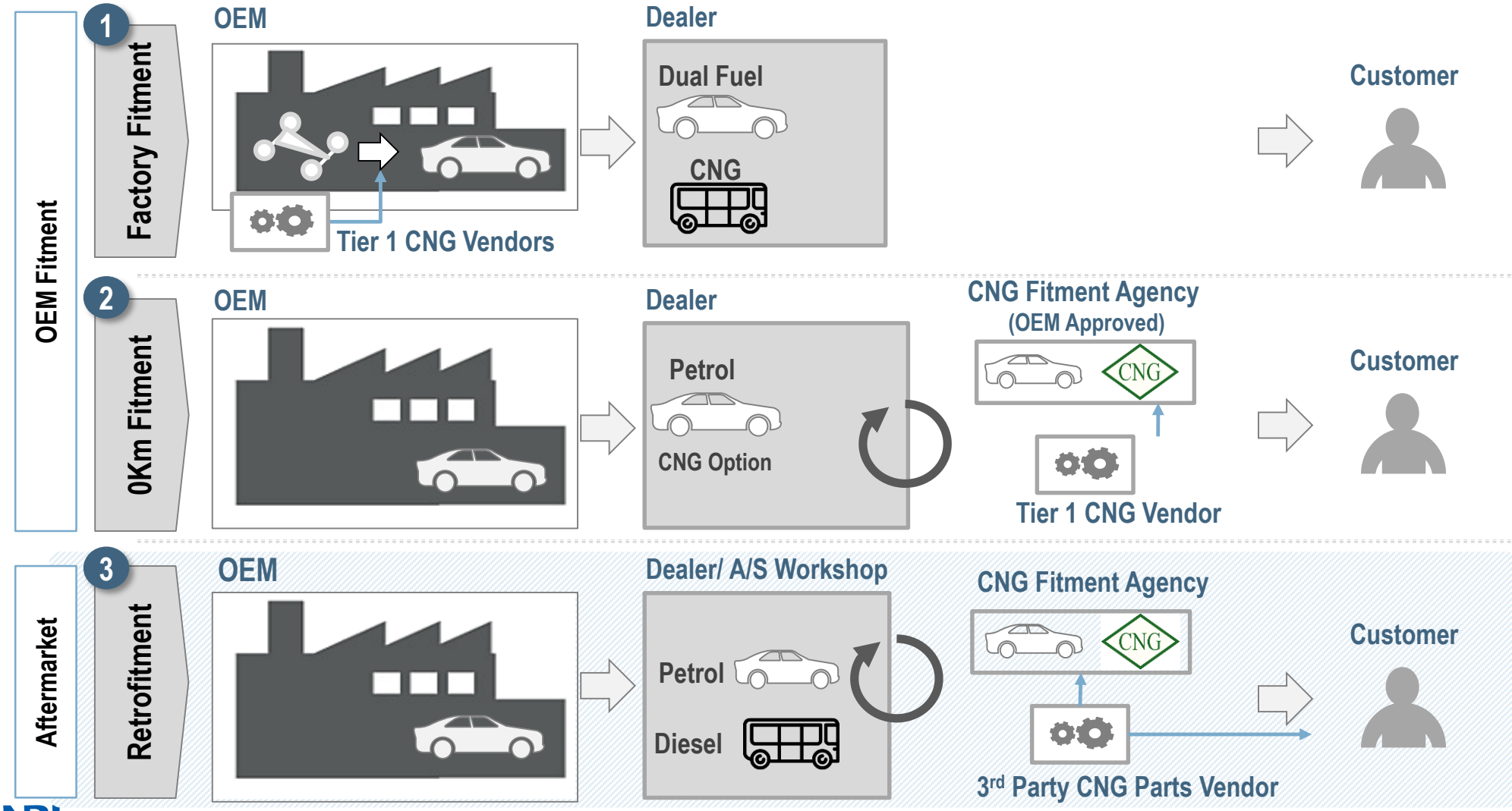
CNG retro fitment technology can be leveraged to convert existing vehicles running on conventional fuels



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Source: Primary, Secondary Research

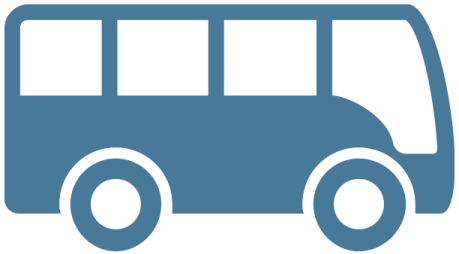
High customer acceptance has been seen across all the vehicle segments due to savings in TCO

Passenger 3W
Annual Savings : ₹ ~1,00,000

LCV
Annual Savings : ₹ ~70,000

Taxi
Annual Savings : ₹ ~40,000

Personal Car
Annual Savings : ₹ ~16,000



Bus
Annual Savings : ₹ ~3,90,000

Truck
Annual Savings : ₹ ~2,60,000

*Annual savings for 5 years on the basis of 5-year TCO (Total Cost of Ownership)

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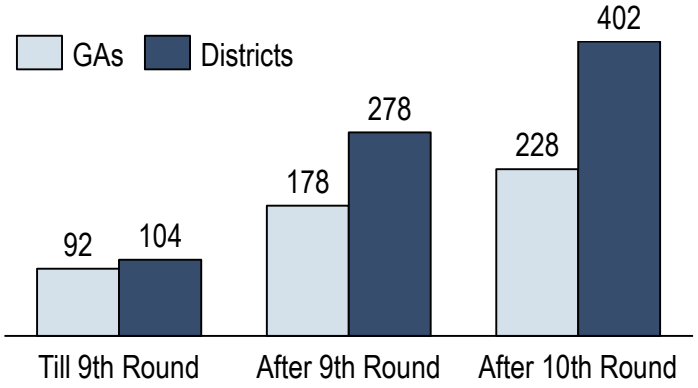
Source: NRI Analysis

After 9th & 10th round, CGD infrastructure will cover 52% area & 72% population and will make natural gas accessible across the country

Developing CGD Infrastructure



70%
Population

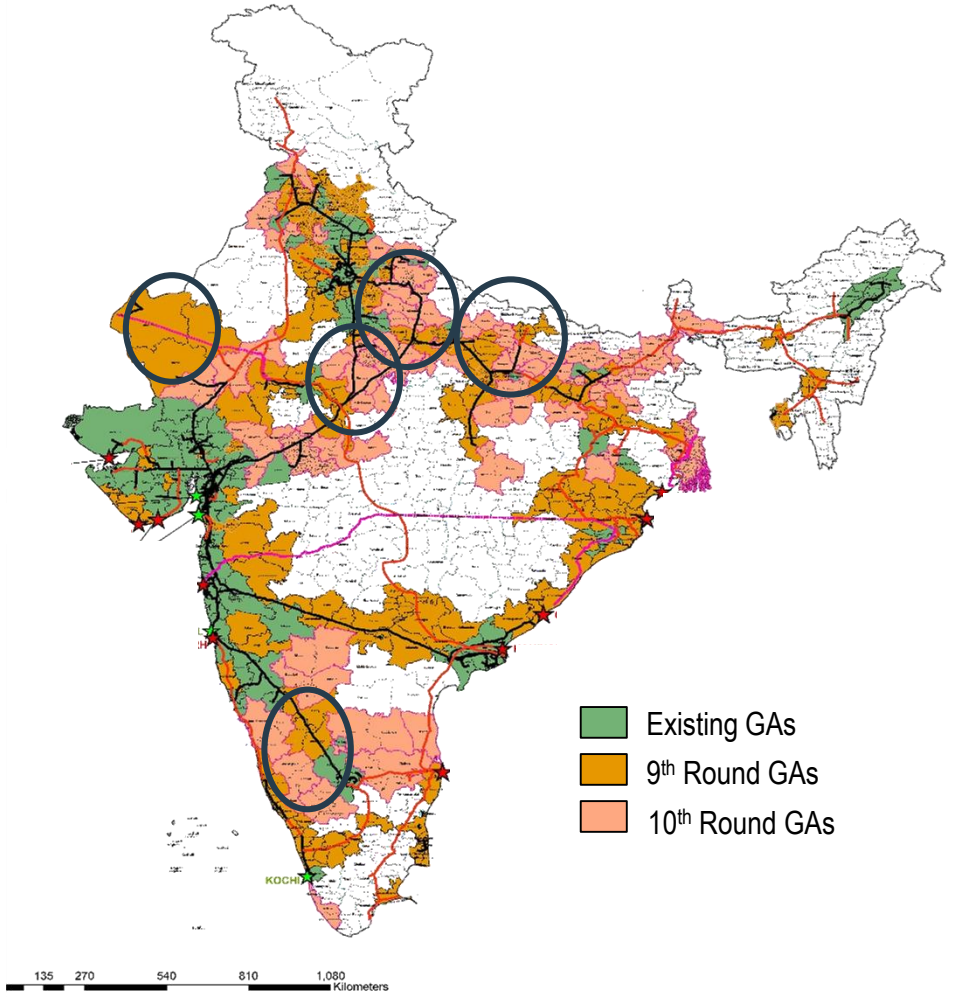
52%
Area

State-wise Districts covered in 9th & 10th Round

Sr.	State	No of Districts	% Vehicle Sales FY 2018
1	Uttar Pradesh	50	9%
2	Bihar	27	3%
3	Madhya Pradesh	25	4%
4	Karnataka	23	7%
5	Rajasthan	20	5%
	Total	**145**	**28%**

Top 7 states benefited after 10th CGD round make up 55% of the total vehicle sales in the country as of FY2018

CGD Infrastructure After 10th Bidding Round



Source : PNGRB, Secondary Research

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LNG as a vehicular fuel

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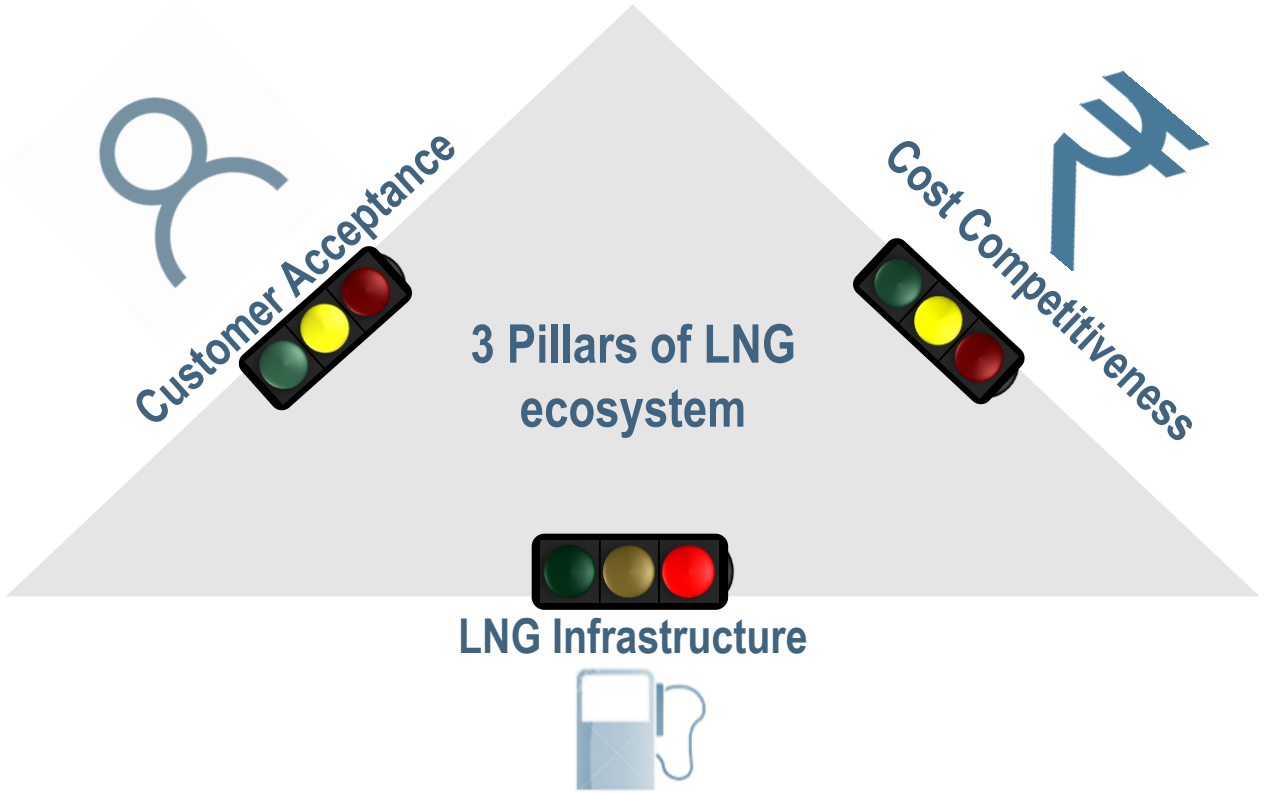
Cost competitiveness, infrastructure development & domestic manufacturing will make LNG a promising alternative for long haul trucks and intercity buses



Conducive policy environment for market creation, technology development and setting up of a widespread infrastructure for LNG vehicles

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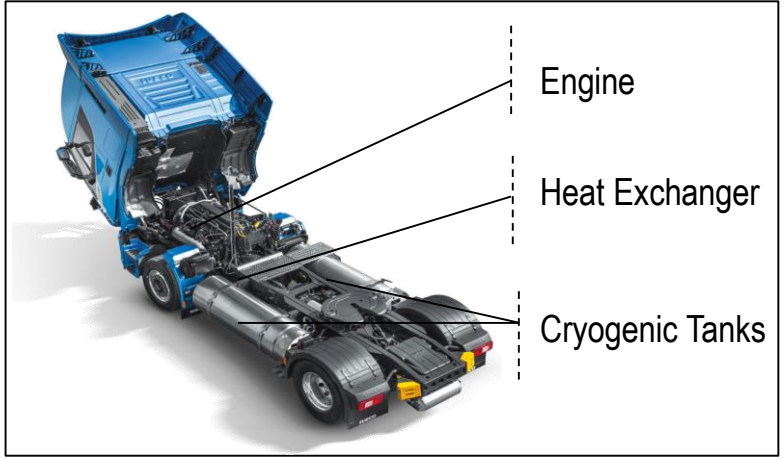
Due to higher energy density of LNG, these vehicles have longer driving range than CNG but cryogenic tanks are needed to store the fuel at -162° C

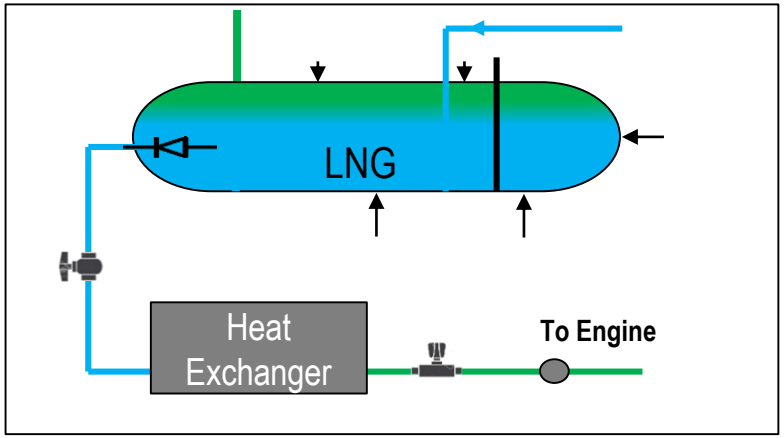
What are LNG Vehicles ?



- The main difference between LNG & CNG vehicles is fuelling system - which is modified to store LNG at sub-zero temperature of **-162° C**
- Cryogenic tanks are used to maintain the LNG at this temperature

- LNG takes up only 1/600th volume as compare to CNG and thus can be stored in large quantity on board
- This makes it suitable for long haul journeys giving a comparable driving range with diesel trucks

Heat Management & Boil-off in LNG Vehicles



- Ambient heat input vaporises LNG which is termed as – boil off
- Boil-off increases the tank pressure
- The tank pressure is maintained by venting out boil-off gas
- LNG storage tanks are designed to contain LNG for min of 5 days without venting to avoid loss of fuel

Due to higher fuel carrying capacity, LNG trucks are suitable for long haul applications

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Source: Secondary Research

Mono-fuel LNG trucks from leading OEMs are available in the European & US markets; OEMs are also developing dual fuel LNG trucks

Types of LNG Trucks Available in Europe & US

Europe

IVECO	Iveco Stralis		Mono Fuel
VOLVO	Volvo FM 460 PK		Dual Fuel
SCANIA	Scania G410		Mono Fuel

US

McNeilus GET IN. · Peterbilt · VOLVO · AUTOCAR Always Up · KENWORTH. The World's Best. · FREIGHTLINER · Cummins Westport

Mono Fuel

Almost all the LNG trucks in the US are powered by Cummins Westport mono-fuel engine

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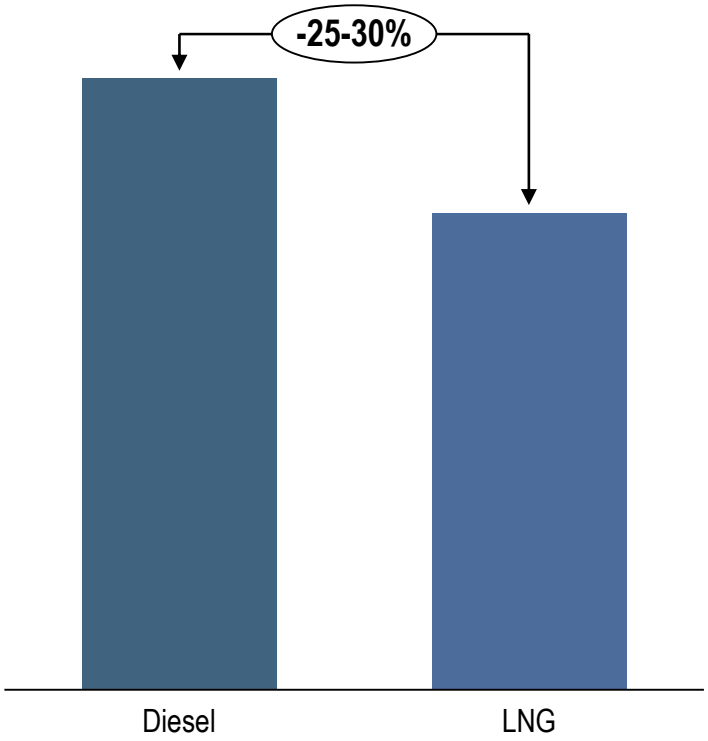
Source : OEM websites, Secondary Research

Increasing use of LNG worldwide as an economically viable & environmental friendly fuel for trucks is encouraging LNG vehicle development in India

Running Cost Advantage



Running cost per year with LNG retail price modelled based on imported LNG

Environmental Benefits

Lower CO2 Footprint

LNG trucks have 20% less emissions than diesel truck measured on tank to wheel basis

Reduced Noise

LNG trucks are significantly less noisy than comparable diesel trucks.

Non Toxic in Nature

LNG is non toxic and non corrosive thus it will not pollute land or water in case of any leakage

Tata Motors has been at the forefront of development of LNG CVs and showcased the first LNG-run bus in India

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Source: Secondary Research, NRI Analysis

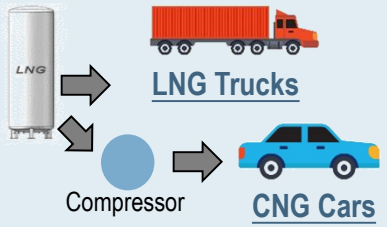
Different configurations of the LNG stations are available which can be deployed according to requirements

LNG Fixed Station

Filling is done directly from storage to truck on pressure differential principle

- ✚ Low Capital Requirement
- ✚ Low Operational Cost
- ✚ Low Space Requirement
- ▬ Requires minimum number of trucks to be served daily to avoid loss of fuel by venting

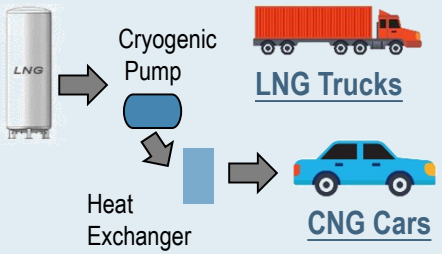
L-CNG Fixed Station



- LNG filling is done on pressure differential principle
- Boil-off is recovered and converted to CNG by using compressor

- ✚ Require Medium Capital
- ✚ Both LNG & CNG can be filled
- ▬ Can't fuel High pressure trucks

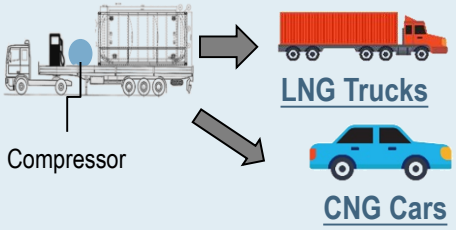
LNG & CNG Fixed Station



- LNG is fueled using pump
- LNG transferred by cryogenic pump is compressed before regasification in heat exchanger by second pump for CNG cars

- ✚ Fuels all kinds of NG vehicles
- ✚ High Refueling capacity
- ▬ High capital costs
- ▬ High operational costs

LNG Mobile Station



LNG dispenser is attached to the LNG tanker along with the CNG compressor and dispenser

- ✚ External power supply not needed
- ✚ No operator needed
- ▬ Difficult to recover boil-off
- ▬ Can't be used for high pressure trucks

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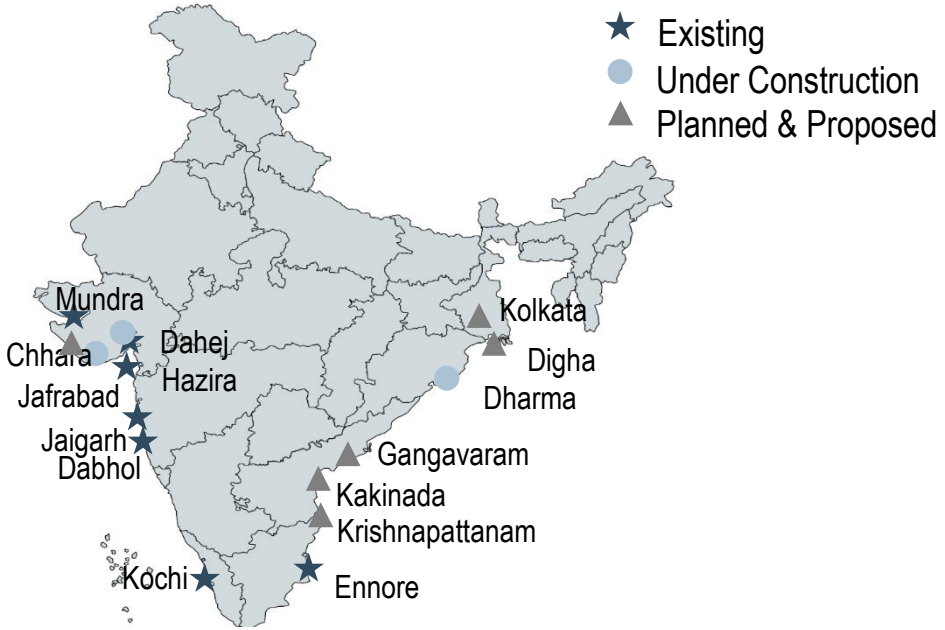
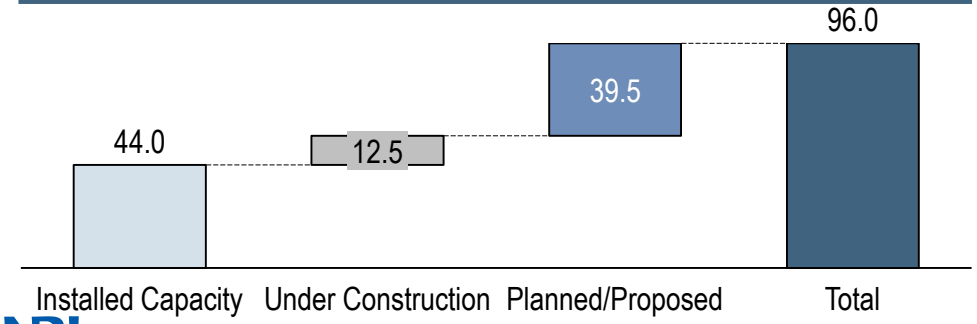
Source: Secondary Research

Upcoming LNG terminals will bring natural gas supply to underserved states, while LNG infra on the major highways is needed for LNG adoption

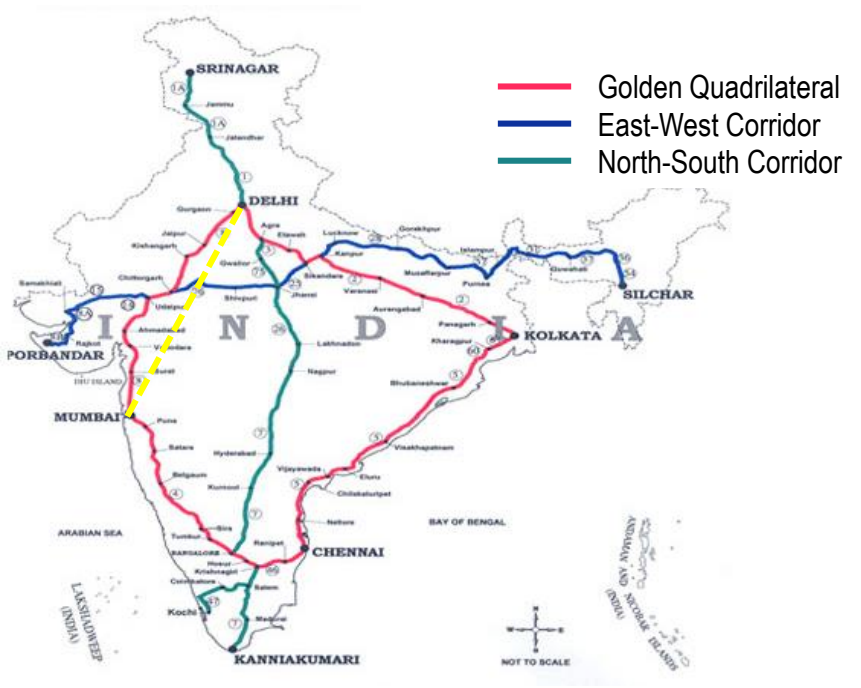
Status of under construction terminals



LNG terminals in India - capacity [MMTPA]



Major highway corridors in the country



- Development of LNG stations along the major national highways should be done to push the adoption of LNG
- In phase I Petronet is planning 20 LNG stations on the identified highways

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Source : PPAC, PLNG, Secondary Research

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Rapidly developing infrastructure and reduction in costs due to domestic manufacturing will lead to a likely penetration of 50% NGV by 2030

Infrastructure

- CNG infrastructure development is expected to complete in timely manner thereby giving boost to CNG vehicle sales
- Similar boost to LNG infra will lead to added benefits

Technology

- The demand push resulting from countrywide infrastructure will incentivize OEMs to launch dedicated NGV platforms leading to better economies of scale and efficient products

Localization

- Localization of NGV components such as LNG cryogenic cylinders and certain CNG powertrain components will reduce the acquisition cost for the customer boosting their TCO savings

Regulations

BS VI

- Implementation of BSVI emission norms will increase price differential between CNG and diesel vehicles, making CNG vehicles more attractive

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Source: NRI Analysis

A strong network of 15,000 CNG & 1,500 LNG stations has the potential to transform the Indian mobility scenario

2019

1,596
CNG stations

Emission Regulations: BSIV

3.3 mn
NG vehicles

2030

~15,000
CNG stations

~1,500
LNG stations

Emission Regulations: BSVI

33 mn
NG vehicles

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Source: PNGRB, NRI Analysis

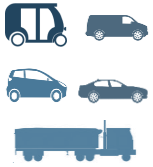
NGVs can be at the forefront of transforming mobility in India with savings in import bill along with safeguarding employment in the industry

CNG Stations by FY30

~15000

LNG Stations by FY30

~1500



CNG/LNG Vehicles on the road*

3.3 Cr

Forex Savings by FY30

~INR 16,00,000 Crore

Employment Generation

350,000-375,000

*Includes PV, 3W, buses and LNG trucks

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Source : NRI Analysis, CSE, Business Press

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