

UNCONVENTIONAL TECHNOLOGIES

**IN
LNG BUSINESS**

OPPORTUNITIES IN INDIA

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PRESENTATION STRUCTURE

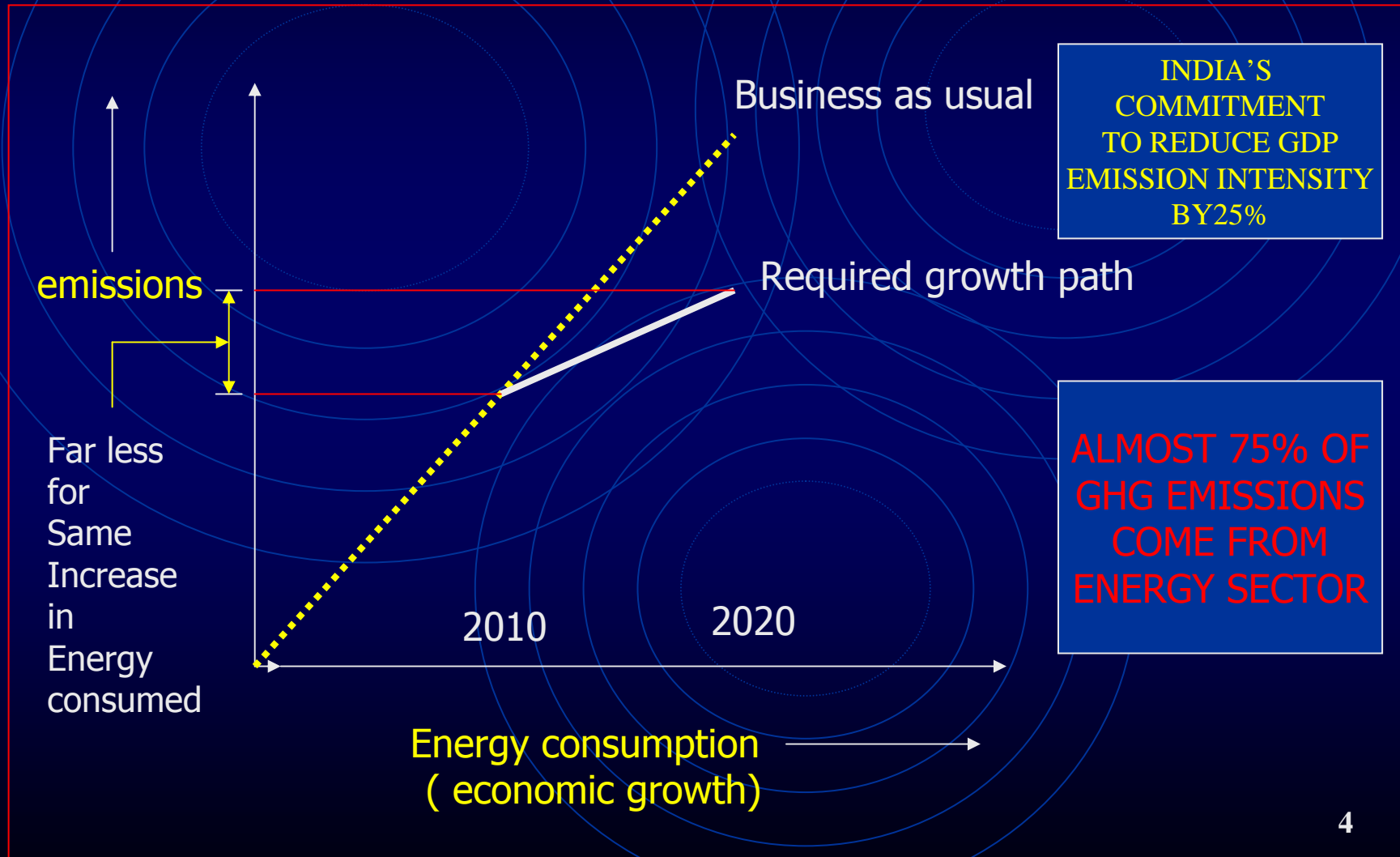
- Indian Gas Market – Characteristics and Growth Imperatives
- Why increase share of Gas ? Rationale
- Gas Market – Relevance of Infrastructure
- How to increase share of Gas ? Proposed Strategy
- Unconventional Technologies and Proposed Strategy
 1. Floating LNG Terminals
 2. Small LNG Solution
 3. Coal-to-Gas Conversion
 4. Gas in Automobiles
 5. LNG Distribution

INDIA - GAS MARKET CHARACTERISTICS

- **Gas demand in India is known to be supply driven**
- Demand in all foreseeable scenarios is far more than indigenous supply- LNG import imminent
- Growth in demand constrained by lack of infrastructure in the form of gas pipelines and LNG imports
- Gas pricing, though confused, is hopefully converging to market determined pricing
- India's commitment to reduce GHG emission intensity of its GDP by 25% by year 2020 needs drastic *increase in share of gas in energy mix in short period- not feasible without major fuel switch application development*

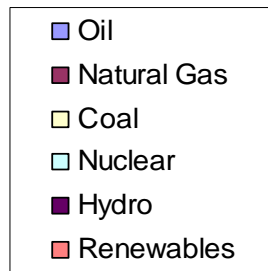
INDIA - GROWTH PATH IMPERATIVE

INDIA'S ECONOMIC GROWTH AMBITION OF 7-10% p.a.



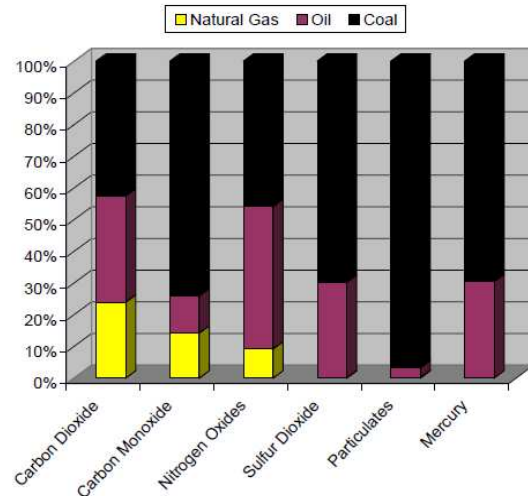
WHY INCREASE SHARE OF GAS ? RATIONALE

India's energy mix-2010



Source: BP Statistical Review, June, 2011

Emission Levels of Fossil Fuels
(pounds per billion BTU of energy input)

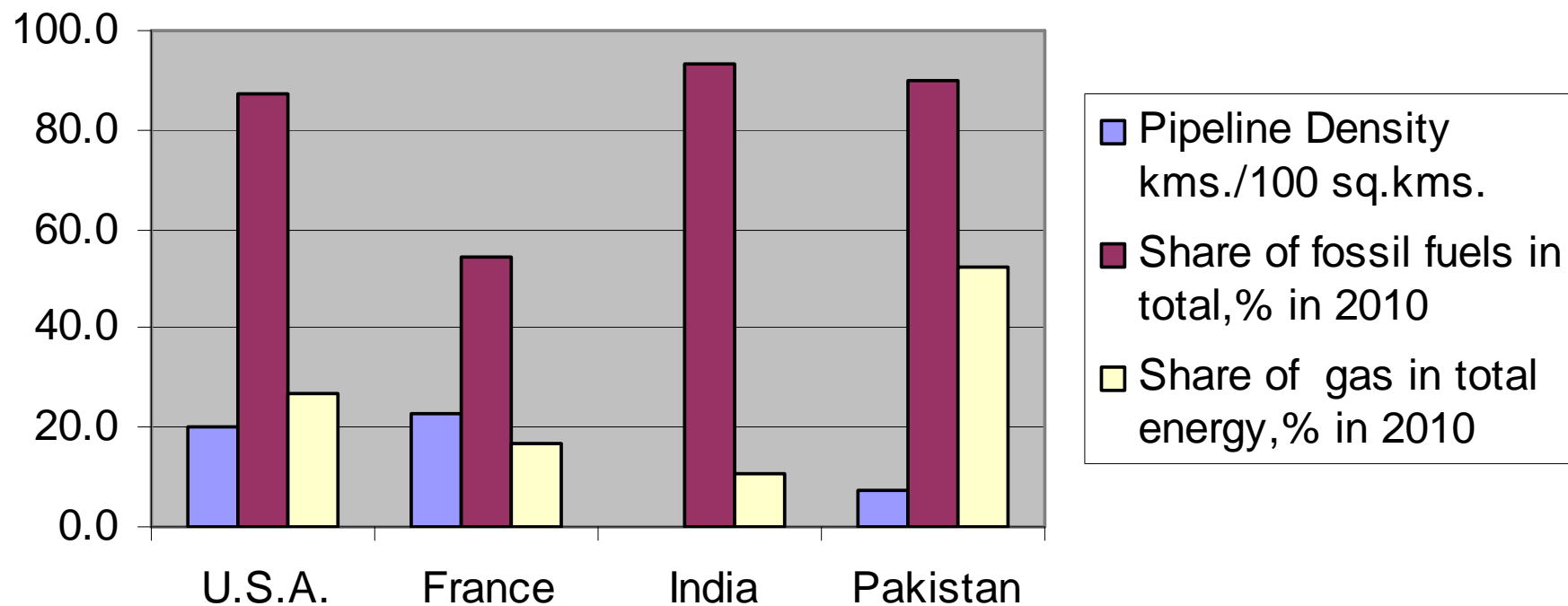


Source: EIA

- 'Global warming' & 'Climate change' real concerns of world
- India's energy mix (more than 50% share of coal) not environmentally sustainable
- Share of gas as meager 11% is too low compared to world average of 24%
- Gas is clean energy source and can be used with high efficiency
- Hence need to drastically change energy mix and focus on gas as energy source

GAS MARKET - RELEVANCE OF INFRASTRUCTURE

Share of gas in energy mix and pipeline density



Source: Compilation, computation and interpretation from various published information

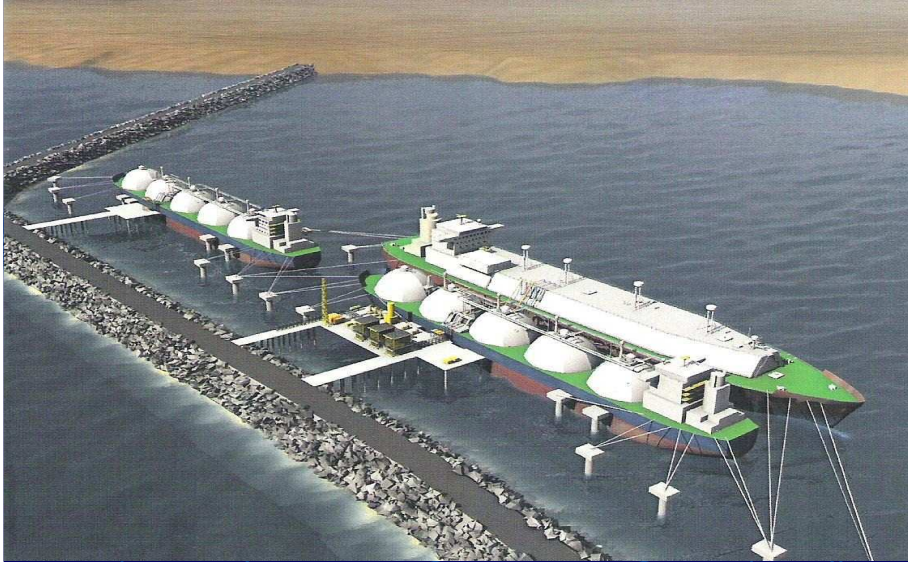
HOW TO INCREASE SHARE OF GAS IN ENERGY MIX? POSSIBLE STRATEGY

- Flood the markets with gas supplies---More LNG import terminals and monetization of stranded gas
- Create a credit-worthy and sustainable user base - Effective fuel switch plans and policy initiatives
- Create infrastructure for promotion of gas usage – More pipelines, LNG transport by road, rail, sea
- Create a true free and matured gas market so as to ensure global competitiveness and sustainability – Transparent price discovery mechanism

UNCONVENTIONAL TECHNOLOGIES AND PROPOSED STRATEGY

- **Increase supplies**---- Floating storage and re-gasification units for LNG imports, small LNG plants for stranded and unconventional gas sources
- **Transport**---- LNG by road, rail, sea (small carriers/barges, hub and spoke concept)
- **Fuel switch**---- coal to gas conversion for power generation, LNG/LCNG for gas in automobiles

FLOATING LNG TERMINAL

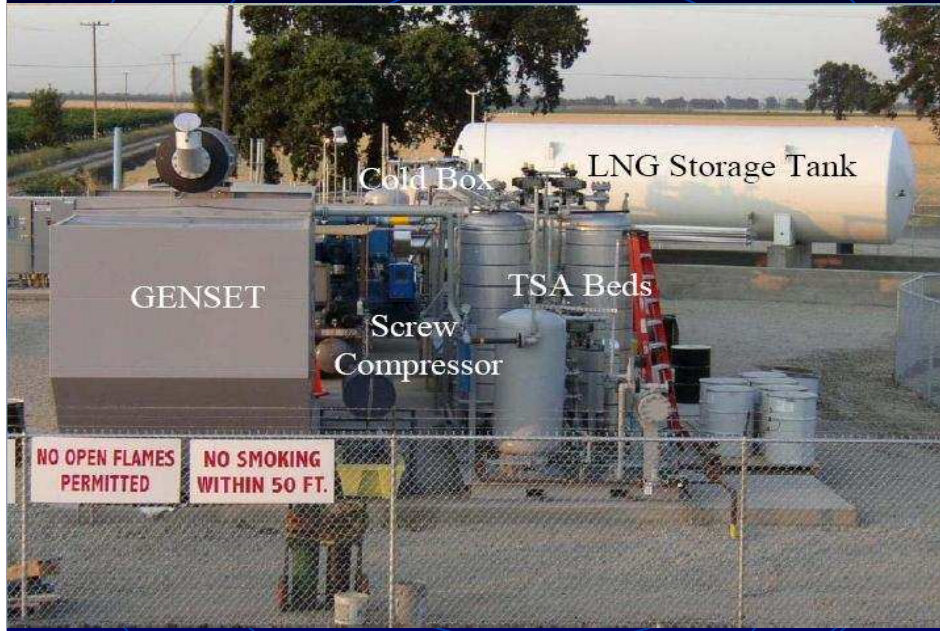


- Alternate to land based terminals
- Three basic variants:
 1. Gravity Based Structures
 2. Floating Storage and Re-gas Units
 3. Energy Bridge Concept

FSRU ADVANTAGES

- **Quick to implement:** Needs 2-3 years max. to implement
- **Lower capital cost:** Possibility of using old LNG carrier reduces capital investment per unit capacity compared to land based terminal (Re-gas cost of the order of US\$ 0.4 per mmbtu can be achieved without considering port related investment servicing. Hence competitive)
- **Flexibility:** FSRU can be redeployed at another location, if required, without major investment and in worst case it can be redeployed as LNG carrier.
- **Proven technology:** Becoming very popular as number of terminals established and many more being planned. Suited to India's needs.

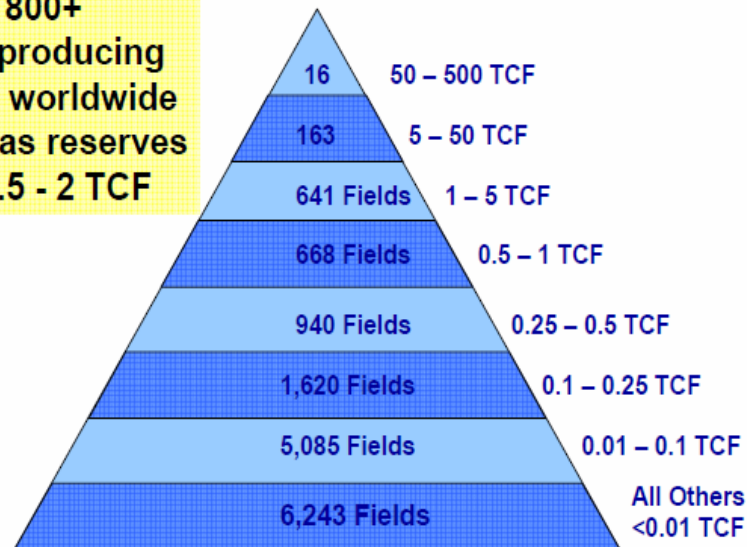
SMALL LNG SOLUTION



ADVANTAGES:

- Flexibility (skid mounted)
- Logistically easy (as compared to CNG) (Transportation, storage, Re-gas cost range – US\$1.5-2.5/mmbtu)
- Economical (as compared to CNG) (Liquefaction costs range – US\$ 1.5-3/mmbtu)
- Low gestation period (mostly shop fabricated)

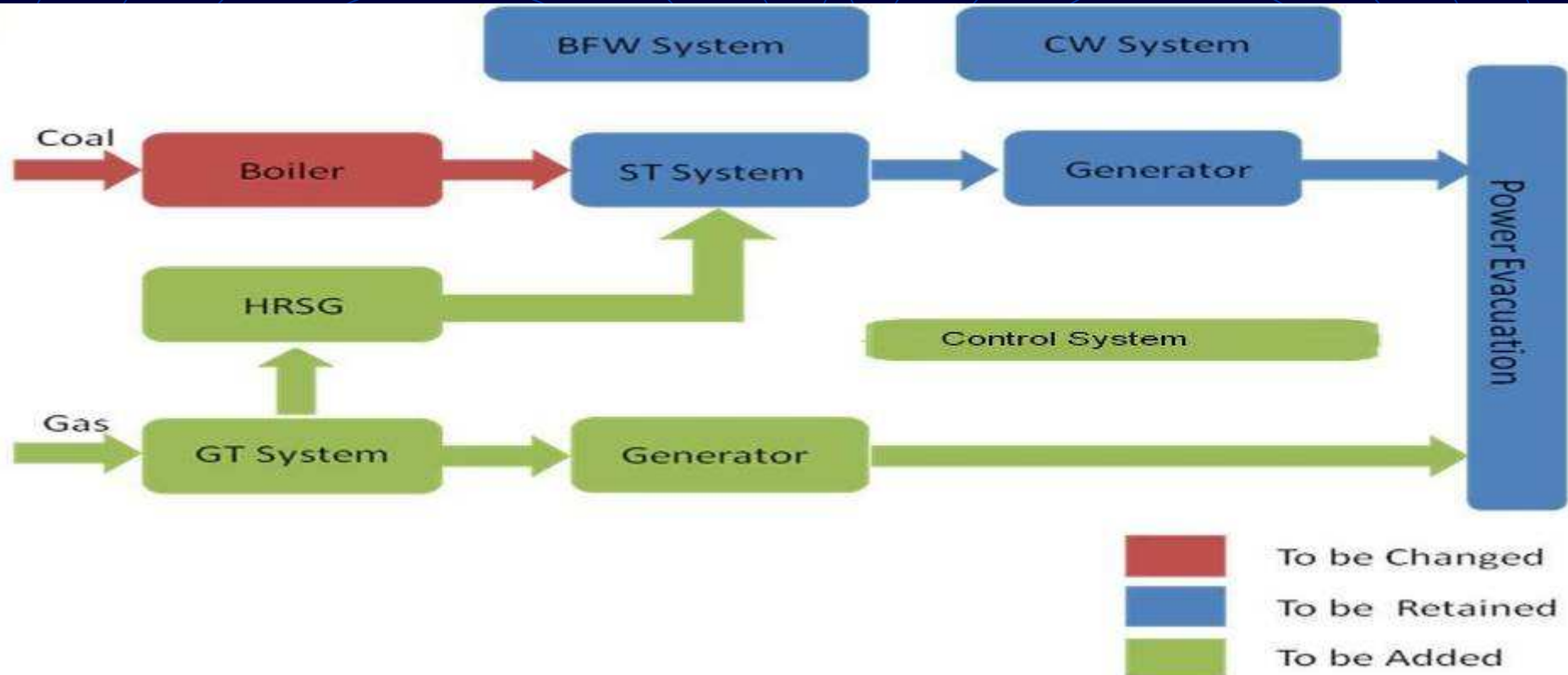
800+
non-producing
fields worldwide
with gas reserves
of 0.5 - 2 TCF



TARGET CANDIDATES:

- Small reserves not suited to large LNG plant
- Stranded gas
- Associated gas being flared
- Coal Bed Methane
- Coal Seam Methane
- Pipeline gas to serve isolated demand centers

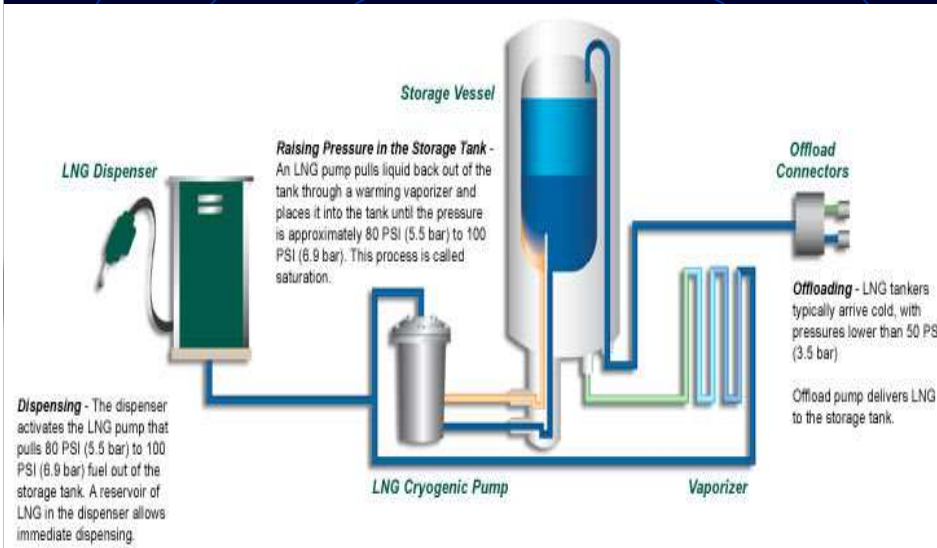
COAL TO GAS CONVERSION CONCEPT



Optimize use of existing assets. Add up-to 200% extra capacity.
Increased power generation without increasing carbon emissions.
Leverage CDM benefits to make gas based generation competitive to coal based generation

GAS IN AUTOMOBILES

LNG IN HEAVY VEHICLES



LCNG DISPENSATION



- Lower distribution cost
- Lower storage cost
- Lower energy consumption at filling station (Pump Vs. compressor)
- Lower cost for preventive maintenance
- LNG and LCNG both can be distributed in the same premises by using same storage infrastructure

LNG DISTRIBUTION

INDIA'S LONG COASTLINE. HUB AND SPOKE CONCEPT TO SUPPLEMENT PIPELINE INFRASTRUCTURE



The background is a dark blue gradient with three sets of overlapping concentric circles in a lighter blue color. The circles are arranged in a triangular pattern, with one set in the top left, one in the top right, and one centered at the bottom. The text "THANK YOU" is centered in the middle of the page in a yellow, serif font.

THANK YOU