LNG BUSINESS STRATEGIES : TRAINING FOR PARTICIPANTS FROM SAARC COUNTRIES

SAARC ENERGY CENTRE, ISLAMABAD, 15-19TH NOVEMBER , 2021

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FLOW OF PRESENTATION

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Section 2 : SAARC – Energy scenario
Section 3 : Natural Gas & its advantages
Section 4 : Liquified Natural Gas (LNG)
Section 5 : LNG Value Chain
Section 6 : Liquefaction Process
Section 7 : LNG Shipping
Section 8 : Regasification – LNG receiving terminals
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Section 9 : Elements of Natural Gas/LNG Pricing
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Section 10 : Gas Sale Purchase Agreement (SPA)
Section 11 : Regulatory Framework & Government support
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SECTION 1

Global Energy Environment
What have been the trend of consumption of different sources of energy?
Global Energy Demand Forecast

Industrialization of Western economies; energy use still largely biomass
Expansion of global and local transport, fuelled by coal and oil
Unprecedented rise in Western living standards
Rapid industrialization in China

CAGR %

Sources: McKinsey Energy Insights' Global Energy Perspective, December 2017, IEA Energy Balances (Historical); Smil, V. (Historical)
Share of energy sources: 1994 to 2019
(Source: BP Statistical Review 2021)
Emerging issues

- Excessive consumption of fossil fuels is resulting in
  - Global warming & Climate Change
  - Health hazards due to emissions
- Huge disparity in energy consumption by the developed and the ‘developing’ nations
- The emerging technologies for energy sourcing are expensive
IEA’s WEO 2021: Comparison of impact of Air Pollution (PM 2.5 Concentration) in Emerging & Developing (EMDE) & Advanced Economies

- Emerging economies face the brunt of health hazards and mortalities due to hazardous emissions
In the backdrop of curtailing emissions and global warming & increase in energy needs, how the future of energy unfolds?
Future of Global Energy

UN Framework Convention on Climate Change (UN FCCC)

In 1992, an environmental treaty was signed at the ‘Earth Summit’ at Rio de Janeiro to combat human interference with climate system.

In 2015, in the 21st Conference of Parties (COP) at Paris, an Agreement signed by 196 countries, set a goal to limit global warming to below 2, preferable to 1.5 degrees Celsius, compared to pre-industrialized world.

To fulfil the goal, the countries submitted their plans for climate action, known as Nationally Determined Contributions (NDCs). The countries are to also submit a Long-term Low Greenhouse gas Emissions Strategy (LT-LEDS).

UN Sustainable Development Goals (SDG)

In 2015 seventeen SDG were adopted by United Nations as a universal call to action to end poverty, protect the planet and ensure that by 2030 all people enjoy peace and prosperity. In one way or the other, all the SDG complement each other. The following are relevant in our context:

- ‘Good health and well being’ is the 3rd SDG
- ‘Clean and affordable energy’ is listed as the 7th SDG.
- ‘Climate action’ to limit the increase in global mean temperature to two degrees Celsius above the pre-industrial levels is the 13th SDG.

Fulfilling SDGs and the NDCs and Long-term emission strategy are pivotal to any future planning of energy.
Future of Energy: Energy Scenarios

- **Availability of affordable energy** is a key index that differentiates ‘developed’ and ‘developing / emerging’ nations.
- **Climate change, and need for low carbon emissions across the globe**, triggered a need for ‘inclusive’ growth and planning for sourcing of future energy requirements.
- **Energy Scenarios utilize modern tools** to visualize the future energy systems and its impact on environment with
  - Definite time-bound goals for energy and climate change targets.
  - Beginning with the existing set of choices or plans to achieve the objectivity of fulfilling the energy needs.

- **Some key inputs to scenario mappings are:**
  - **Economics and demographic factors** like, GDP Growth rates, Population, Urbanization, Per capita income & energy consumption
  - **Energy prices of different sources**, including Electricity, the fastest growing source of end-use of energy (fossil fuels/ nuclear/ renewables)
  - **State of technology, innovation & deployment**, and costs
  - **Commitments to reduction in carbon footprints.**

*Energy scenarios mapping not only impact the choice for the energy-mix, technology and investments, but also the intensity with which the societies and nations pursue its behaviour and policies.*
Future of Energy: Limitations of Energy Scenarios

Limitations of energy scenarios:

- Scenarios are not ‘definitive forecast’
- The stakeholders of prevailing energy sources tend to influence the outcomes.
- The projections of futuristic energy sources lack of experiential data and cannot be correctly estimated.
- Political ideology impacts the intensity and timing with which the energy policies are pursued and stringently implemented across nations.

Some of the popular energy scenarios are as follows:

- World Energy Outlook by IEA (International Energy Agency)
- International Energy Outlook by EIA (U.S. Energy Information Administration)
- World Energy Council’s Scenario
- The Greenpeace Energy (R)evolution -2015
- Market research organizations like Goldman Sachs, McKinsey, DNV, Rystad Energy, Shell, Wood Mackenzie, IGU, Poten Partners etc come out with their reports on projections of demand for energy and energy commodities.

*Just as the future cannot be forecasted, the emergence of cost-effective energy options cannot be predicted.*
What are the plays for

Energy & Natural Gas / LNG

in the different future energy scenario
Projected Energy Transition Timelines in the World

**ENERGY TRANSITION TIMELINE**

Highlights of our forecast energy transition to 2050. The green slope represents the share of non-fossil energy sources in the energy mix.

- **2020**
  - Energy peaks
  - Coal peaks
  - COVID-19 drop-off removing 5% of energy demand through to 2035

- **2021**
  - CH4 peaks

- **2022**
  - PV installations 1TW

- **2023**
  - Half of all passenger vehicles sales electric
  - 19% of energy mix non-fossil

- **2025**
  - 2030: Wind overtakes hydro
  - 2031: Solar overtakes all energy demand for space heating peaks
  - 2032: Peak primary energy demand

- **2026**
  - 2033: Manufacturing energy demand peaks
  - 2034: Peak final energy demand

- **2027**
  - 2035: Half of world’s road vehicles electric
  - 2036: Gas overtakes all energy demand for space heating peaks

- **2028**
  - 2037: Natural gas peaks
  - 2038: More electricity is used than space cooling
  - 2039: 1.5°C carbon budget exceeded

- **2029**
  - 2040: Commercial PWs outnumber commercial fossil-fuel vehicles
  - 2041: 2°C carbon budget exceeded
  - 2042: Oil bubbles

- **2030**
  - 2043: Lithium-ion batteries reach 1 TWh
  - 2044: Non-fossil space overtakes fossil space
  - 2045: Energy intensity is halved since 2018

- **2031**
  - 2046: Energy demand is halved since 2018
  - 2047: Sustainable gas trade exceeds coal trade

- **2032**
  - 2048: Maritime energy demand peaks
  - 2049: Gasoline gas trade exceeds coal trade

- **2033**
  - 2050: Energy transition is complete
World Primary Energy Projections

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<tr>
<th>Source</th>
<th>2019</th>
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<th>2040</th>
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<tr>
<td>Oil</td>
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<td>164</td>
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<tr>
<td>Coal</td>
<td>158</td>
<td>131</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td>596</td>
<td>617</td>
<td>605</td>
<td>590</td>
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</table>

2019
- Coal: 27%
- Oil: 29%
- Natural gas: 26%
- Hydro: 1%
- Solar: 1%
- Wind: 1%
- Hydropower: 3%
- Bioenergy: 9%
- Geothermal: 1%
- Nuclear: 5%

2050
- Coal: 9%
- Oil: 16%
- Wind: 14%
- Solar: 14%
- Hydropower: 4%
- Bioenergy: 12%
- Geothermal: 1%
- Nuclear: 6%
- Natural gas: 24%
World Energy Supply Transition (2020-2050)
IEA – WEO 2021: Share of Fossil and Non-fossil

- Expected projections in the STEPS, APS & NZE Scenarios
- APS scenario is somewhat nearer to many other projections
Global source-wise energy demand: Shell’s LNG Outlook 2021
(Based on Wood Mackenzie data for H1 2020)

- Share of gas is higher than renewables between 2020 and 2040
Global Gas demand: Shell’s LNG Outlook 2021
(Based on Wood Mackenzie Data for H1 2020)

- The gas demand reaches about 5000 BCM by 2040.
- Highest growth is in the electricity sector
- Region-wise, the highest growth is in Asia
Global Gas demand: Shell’s LNG Outlook 2021
(Based on Wood Mackenzie Data for H1 2020)

- Demand for LNG is more than that for piped imports
- LNG demand is expected to grow @ 3.5%
### IEA – WEO 2019: Natural Gas demand and consumption (in BCM)

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<th>Current Policies</th>
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<td></td>
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<td>1 708</td>
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<td><strong>Industrial use</strong></td>
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<td>909</td>
<td>1 229</td>
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<td><strong>World natural gas demand</strong></td>
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<td>3 952</td>
<td>4 720</td>
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<td><strong>Asia Pacific share</strong></td>
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<td>21%</td>
<td>26%</td>
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<td><strong>Low-carbon gases</strong></td>
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<td></td>
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<td>53</td>
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<td><strong>World total gases</strong></td>
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<td><strong>Conventional gas</strong></td>
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<tr>
<td></td>
<td>2 318</td>
<td>3 004</td>
<td>3 293</td>
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<tr>
<td><strong>Existing fields</strong></td>
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<td>3 004</td>
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<td><strong>New fields</strong></td>
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<td>1 094</td>
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<td><strong>Tight gas</strong></td>
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<td><strong>Shale gas</strong></td>
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<td>568</td>
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<td><strong>Coalbed methane</strong></td>
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<td>88</td>
<td>103</td>
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<td><strong>Other production</strong></td>
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<tr>
<td><strong>World natural gas production</strong></td>
<td>2 507</td>
<td>3 937</td>
<td>4 720</td>
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<tr>
<td><strong>Shale gas share</strong></td>
<td>0%</td>
<td>14%</td>
<td>22%</td>
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<td><strong>LNG</strong></td>
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<td><strong>Pipeline</strong></td>
<td>378</td>
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<td>528</td>
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<td><strong>World natural gas trade</strong></td>
<td>514</td>
<td>788</td>
<td>1 126</td>
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<tr>
<td><strong>Share of production that is traded</strong></td>
<td>20%</td>
<td>20%</td>
<td>24%</td>
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<td><strong>Henry Hub price ($2018/MBtu)</strong></td>
<td>6.1</td>
<td>3.2</td>
<td>3.3</td>
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</table>
Energy Transition - Features

- PRESSURE IS MOUNTING as emissions are set to remain stubbornly high until mid-30s.
- DECARBONIZATION IS ON THE AGENDA of industry and government, but not at the pace or depth to meet the Paris agreement.
- HYDROGEN & CCS have the potential to transform the industry.
- THE WORLD IS MOVING from more oil to cheapest oil as demand declines.
- MULTIPLE ENERGY TRANSITIONS from coal & oil to natural gas, and from fossil fuels to renewables and decarbonized gas.
- In all the scenarios, LNG IS SET TO THRIVE in a strong gas market.
Role of Natural Gas in Energy Transition

• Considered as Transitional Energy: ‘The Bridge of Union’ between fossil fuels based economy and desired decarbonized sustainable world of 2050.

• Pressure to transition from gas to other new energy sources – Hydrogen. However, large investments in infrastructure and production costs of new energy sources make use of gas as destination rather than a bridge energy source.

• Natural gas not seen as the most viable long-term solution compared to the momentum experienced by renewable energy.

• Necessary to decarbonize the gas value chain. Convert methane (CH4) into hydrogen along with capturing and storing CO2 (CCS).

• On a long term basis gas may not remain competitive as most of infrastructure would require replacement by 2050.
Global CO2 Emissions Projections

Global energy-related CO₂ emissions, GtCO₂ p.a.

- **2023**: Emissions peak
- **2030**: 1.5°C carbon budget exceeded
- Delayed Transition Reference Case
- Accelerated Transition
- 1.5°C Pathway

World Energy Segments

**Source**: DNV Study
World Energy Segments

Source: DNV Study

**NORTH AMERICA**

- Business cases and sub-regional policies will drive towards substantial regional decarbonization.
- Oil use declines by more than two thirds and coal will have a marginal role from the mid-2030s on.
- Strong natural gas growth supplies increasing domestic demand and underpins LNG export boom in the coming decade.

**LATIN AMERICA**

- Will switch from energy exporter to energy importer for reasons such as global energy system transformation, international competition behind supply, and shrinking demand for fossil fuels.
- Electricity production from hydropower, natural gas and fuel-oil will diversify into hydropower, solar, and wind.
- Fossil fuels will represent less than 50% of the primary energy mix in 2050.

**SUB-SAHARAN AFRICA**

- Least-developed and least electrified world region; only 42% of its people currently have access to electricity.
- Soaring energy demand from a growing population and economy will be confronted by efficiencies, e.g., traditional biomass cooking replaced by gas and electricity.
- Off-grid solar PV plays a significant role in energy access, and with grid-connected solar accounts for almost 40% of power generation in 2050.

**MIDDLE EAST AND NORTH AFRICA**

- Natural gas and oil dominate the primary energy mix and will continue to do so until 2050.
- Natural gas consumption remains high (50% of the region’s primary energy mix in 2050) benefitting from low oil and gas extraction costs.
- The region will start to realize its vast potential for renewable energy, reaching a 20% share in primary energy mix in 2050.

**INDIAN SUBCONTINENT**

- 500 million people and GDP growing fourfold will see rising energy demand in this region.
- Despite the rapid growth of renewable, fossil energy sources will also grow and represent 62% of the energy mix in 2050.
- The region’s enormous two- and three-wheeler vehicle fleet will transition almost entirely to electricity before 2040.

**GREATER CHINA**

- Powerhouse for renewables growth and the energy transition, both for domestic use and abroad.
- This share of electricity in final energy demand will grow from a high of 31% in 2018 to 52% in 2050.
- The highest of all regions, over 90% from renewable sources.
- Coal will reduce its dominant share in the power mix (currently 60%) to 12% over the forecast period.

**SOUTH EAST ASIA**

- Energy demand, especially from space-cooling and appliances, grows significantly but levels off towards the end of the forecast period.
- Manufactured goods production more than doubles until 2050, driving demand for natural gas and transforming the region into a net importer of LNG.

**OECD PACIFIC**

- Falling population and improved efficiencies will almost halve energy use in the forecast period.
- Electricity mix is dominated by wind, and at 50% of energy demand, is the second-most electrified region in 2050 after China.
- Hydrogen will gain a foothold (9% of energy use), see initially from Australia’s SMR processes, but later mainly via renewable-powered electrolysis.

**KEY**

- Share of non-fossil primary energy sources 2050
- Share of fossil primary energy sources 2050

The region’s dependency oil and gas export revenue will remain strong, and few incentives for change.

On most decarbonization indicators, this region lags, although there is considerable potential for energy efficiencies.

Only one fifth of the region’s primary energy needs is met by renewable sources in 2050.
Does the world have enough gas reserves?

- As a result of intensive exploration, the reserves have grown over the years
- Between 1999 and 2019, the reserves have grown from 132 tcm to 199 tcm
Region-wise Reserves to Production ratios : 1989 - 2019
( Source : BP Statistical Review : 2020)

- We have adequate gas for meeting our future needs for this century.
Country-wise Proven Natural Gas reserves and production - 2018

Source: BP Statistical Review, IGU, others

- Countries exporting LNG or Reserves more than 1 tcm
- Yemen's LNG capacity of 6.7 MTPA is shutdown since 2015 due to internal turmoil.
- Actual Gas-in-place reserves may be more.

<table>
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<tr>
<th>SI No</th>
<th>Country</th>
<th>Proven Reserves</th>
<th>Production in 2018</th>
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<td>Billion Cubic Meters (BCM)</td>
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World 196.5 3867 316
SECTION 2

SAARC – Energy Scenario
SAARC Region Features

- 500 Million more people by 2050 and GDP growing fourfold will see rising energy demand in this region.
- Despite the rapid growth of the renewables, fossil-energy sources will also grow and represent 62% of the energy mix in 2050.
- The region’s enormous two and three-wheeler vehicle fleet will transition almost entirely to electricity before 2040.

Source: DNV Study
SAARC Region Features

- About 1.5 billion people live in this region. Another ~ 500 million expected to join by 2050.
- Amounts to about 24% worlds population.
- Poverty and lack of access to affordable energy restricting growth.
- Bhutan, Nepal, and Sri Lanka do not produce any hydrocarbons.
- Maldives imports all its energy requirement.
- No regional energy co-operation – Need to have.
### Per Capita Consumption (*Kg of OE*)

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<th>Country</th>
<th>Year</th>
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<td>Maldives</td>
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### Per Capita Consumption (Kg of OE)

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Kg of OE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2014</td>
<td>229</td>
</tr>
<tr>
<td>Bhutan</td>
<td>2007</td>
<td>367</td>
</tr>
<tr>
<td>India</td>
<td>2014</td>
<td>637</td>
</tr>
<tr>
<td>Maldives</td>
<td>2007</td>
<td>892</td>
</tr>
<tr>
<td>Nepal</td>
<td>2014</td>
<td>434</td>
</tr>
<tr>
<td>Pakistan</td>
<td>2014</td>
<td>460</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>2014</td>
<td>516</td>
</tr>
<tr>
<td>USA</td>
<td></td>
<td>6960</td>
</tr>
<tr>
<td>Canada</td>
<td></td>
<td>7897</td>
</tr>
<tr>
<td>Australia</td>
<td></td>
<td>5334</td>
</tr>
<tr>
<td>China</td>
<td></td>
<td>2236</td>
</tr>
</tbody>
</table>
# Primary Energy Consumption & Outlook

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>5.7</td>
<td>4.3</td>
<td>6.7</td>
<td>9.3</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>25.7</td>
<td>37.5</td>
<td>60.6</td>
<td>85.3</td>
</tr>
<tr>
<td>Bhutan</td>
<td>0.6</td>
<td>0.7</td>
<td>0.9</td>
<td>1.5</td>
</tr>
<tr>
<td>India</td>
<td>651.2</td>
<td>816.8</td>
<td>1,102.7</td>
<td>1,391.3</td>
</tr>
<tr>
<td>Maldives</td>
<td>0.4</td>
<td>0.5</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Nepal</td>
<td>10.0</td>
<td>13.5</td>
<td>16.3</td>
<td>21.2</td>
</tr>
<tr>
<td>Pakistan</td>
<td>57.7</td>
<td>74.6</td>
<td>108.6</td>
<td>147.3</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>9.6</td>
<td>11.4</td>
<td>12.9</td>
<td>16.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>760.9</strong></td>
<td><strong>959.3</strong></td>
<td><strong>1,309.5</strong></td>
<td><strong>1,590.5</strong></td>
</tr>
</tbody>
</table>
SECTION 3

Natural Gas & Its Advantages
Natural Gas & its Advantages

- It is the lowest carbon hydrocarbon- Methane (CH4).
- Odorless, colorless, and non-toxic.
- Available in abundance- As per EIA estimates recoverable reserves are enough to last over 230 years at the present rate of consumption.
- A versatile fuel/energy source. It is used for heating, cooking, electricity generation and as feedstock for a variety of industrial products.
- It is the cleanest burning hydrocarbon. It produces half the CO2 and one tenth of the air pollutants compared to coal when burnt for electricity generation and therefore a preferred fuel to reduce the emissions.
# LNG / Natural Gas Cleanest Fuel

(gm/100Kms)

<table>
<thead>
<tr>
<th>FUEL</th>
<th>EMISSONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO2</td>
</tr>
<tr>
<td>Petrol</td>
<td>22000</td>
</tr>
<tr>
<td>Diesel</td>
<td>21000</td>
</tr>
<tr>
<td>LPG</td>
<td>18200</td>
</tr>
<tr>
<td>LNG / NG</td>
<td>16275</td>
</tr>
</tbody>
</table>

*Source: US Energy Department*
Emissions from Different Energy Sources

Source: EIA
SECTION 4

Liquified Natural Gas (LNG)
LNG is natural gas which has been converted to liquid form for ease of storage or transport.

LNG occupies about 1/600th of the volume of natural gas.

Depending on the composition, natural gas becomes liquid at approximately -162 Centigrade (-259F) at atmospheric pressure.

LNG is stored in containers which are like thermos bottles.

LNG is odorless, colorless, non-corrosive, non-flammable and non-toxic.

Density – 420 to 470 Kg/m3.
# Typical LNG Composition

<table>
<thead>
<tr>
<th>Origin</th>
<th>Nitrogen (N₂X)</th>
<th>Methane (CH₄) C1 %</th>
<th>Ethane (C₂H₆) C2 %</th>
<th>Propane (C₃H₈) C3 %</th>
<th>Butane (C₄H₁₀) C4+ %</th>
<th>Gas GCV MJ/m³ (n)</th>
<th>Wobbe Index MJ/m³ (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia NWS</td>
<td>0.04</td>
<td>87.33</td>
<td>8.33</td>
<td>3.33</td>
<td>0.97</td>
<td>45.32</td>
<td>56.53</td>
</tr>
<tr>
<td>Malaysia Bintulu</td>
<td>0.14</td>
<td>91.69</td>
<td>4.64</td>
<td>2.60</td>
<td>0.93</td>
<td>43.67</td>
<td>55.59</td>
</tr>
<tr>
<td>Nigeria</td>
<td>0.03</td>
<td>91.70</td>
<td>5.52</td>
<td>2.17</td>
<td>0.58</td>
<td>43.41</td>
<td>55.50</td>
</tr>
<tr>
<td>Qatar</td>
<td>0.27</td>
<td>90.91</td>
<td>6.43</td>
<td>1.66</td>
<td>0.74</td>
<td>43.43</td>
<td>55.40</td>
</tr>
<tr>
<td>Trinidad</td>
<td>0.01</td>
<td>96.78</td>
<td>2.78</td>
<td>0.37</td>
<td>0.06</td>
<td>41.05</td>
<td>54.23</td>
</tr>
</tbody>
</table>

Source: GIIGNL
Flammability of LNG: Safer Fuel

- **Over Rich**: 100%, Will not burn
- **Flammable**: 15%, Upper flammability limit
- **Too Lean**: 5%, Lower flammability limit
- **0%**: Will not burn
LNG : The Cheapest Fuel

<table>
<thead>
<tr>
<th>Fuel</th>
<th>RLNG Delivered</th>
<th>Naphtha</th>
<th>Fuel Oil</th>
<th>Diesel</th>
<th>LPG</th>
</tr>
</thead>
</table>

Assumptions:
- Crude Oil : USD 80/barrel
- LNG Linkage to Oil : 13%
- 1 USD : INR 74

The above illustration is for India.

However, local taxes in respective countries can alter the above.

**The relative economic advantages of Natural Gas in respective SAARC Member countries will be discussed later**
Pipeline gas imports from US to Mexico reduces LNG import requirements, while the newer importers such as Uruguay and Colombia push up LNG demand.

Reform of subsidized domestic gas prices allows for further LNG imports.

Growing LNG demand as domestic gas production cannot keep up with requirement. Potential new demand creation during period of low prices.

LNG being pushed into Europe in 2020. Declining domestic production requires increasing LNG imports in the later years.

All figures in MMT
LNG value chain  Contd..

Carbon intensity of the LNG supply chain

- Upstream gas production, processing & transportation emissions: 50%
- Liquefaction emissions: 33%
- Shipping emissions: 16%
- Regasification emissions: 1%
- Downstream emissions: 75%
- Other emissions (excluding downstream combustion): 25%

Source: Sphera, GHG Intensity of Natural Gas Transport (2017); GTII-USL, LNG carbon offsetting (2020)
World LNG Liquefaction & Regas capacity
**Risk Factors: Upstream**

- Exploratory work, surveys, exploratory drilling, Appraisal / delineation drilling, Development plan & drilling, Production profile, Gas gathering stations, gas processing plant, compressing station, Pipeline connectivity

- Significant financial resources required – commitment of hundreds of million dollars to billion dollars. Production operating costs, royalty, tax payment are also part of operating production costs

- Security of gas supply – sufficient reserves: as a thumb rule for each million ton per year of LNG (47 BCF) production for twenty years - a reserve base of about 1.5 TCF is required.
Risk Factors: Downstream & Management

- **Technical**: Surface & sub-surface facilities, project scope, infrastructure, operations & maintenance
- **Economic**: reserves, production, project schedule, financing cost, market issues (demand-supply, prices), taxes, levies & royalties
- **Commercial**: shareholders & partners, customers, contracts, competition, legal issues, insurance
- **Project management**: Ownership – JV partners & agreements, supply chain management, project development & execution plan, human resources, management systems, procedures & policies
- **Political**: Concerned government bodies, approving authorities, laws of the land, regulators, tax authorities, industrial & community relations, geopolitical factors
SECTION 6

Liquefaction Process
Liquefaction

- Sufficient proven gas reserves and security of gas supply: Capacity, Minimum design life 25 years.
- Gas composition and appropriate liquefaction technology: Capex, Opex, Thermal efficiency and License fee.
- Business model & Financing of project: Ownership, Joint-venture, Tolling, Capacity booking: “Use or Pay”
- Long term offtake agreements: Firm offtake and/or merchant sales capacity.
- Shipping arrangement: Different business models depending on buyers or seller responsibility. Term arrangement, spot arrangement.
World LNG Liquefaction & Regas capacity

Units: Gt/yr

Historical data source: IGU (2019)
Global liquefaction capacity reached **452.9 MTPA** in 2020.

### Capacity Additions for 2020

- **20 MTPA** of liquefaction capacity brought online
- **5%** year-on-year growth vs 2019
- **Australia 87.6 MTPA** - Market with the highest liquefaction capacity
- **Qatar 77.1 MTPA** - Market with the second highest liquefaction capacity
- **USA** Capacity added in the USA +20 MT

### Pre-FID

- **892.4 MTPA** of liquefaction capacity currently in pre-FID stage as of Feb 2021
  - **351.6 MTPA** from USA
  - **227.8 MTPA** from Canada
  - **50.0 MTPA** from Australia
  - **44.0 MTPA** from Russia
  - **37.2 MTPA** from Mozambique

### FIDs and Under Construction

- **Energía Costa Azul T1** Only 1 project took FID in 2020: **3.3 MTPA**
- **Qatar Petroleum took FID on North Field East** in Feb 2021: **32 MTPA**

**139.1 MTPA** of liquefaction capacity under construction or sanctioned for development as of Feb 2021.

*Source: GIIGNL*
## World’s Top LNG Producing Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Million Ton</th>
<th>Market Share %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>77.8</td>
<td>22</td>
</tr>
<tr>
<td>Qatar</td>
<td>77.1</td>
<td>22</td>
</tr>
<tr>
<td>USA</td>
<td>44.8</td>
<td>13</td>
</tr>
<tr>
<td>Russia</td>
<td>29.6</td>
<td>8</td>
</tr>
<tr>
<td>Malaysia</td>
<td>23.9</td>
<td>7</td>
</tr>
<tr>
<td>Nigeria</td>
<td>20.6</td>
<td>6</td>
</tr>
<tr>
<td>Indonesia</td>
<td>15.0</td>
<td>4</td>
</tr>
<tr>
<td>Algeria</td>
<td>10.6</td>
<td>3</td>
</tr>
<tr>
<td>Trinidad &amp; Tobago</td>
<td>10.1</td>
<td>3</td>
</tr>
<tr>
<td>Oman</td>
<td>9.8</td>
<td>3</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>8.3</td>
<td>2</td>
</tr>
<tr>
<td>Angola</td>
<td>4.6</td>
<td>1</td>
</tr>
<tr>
<td>Peru</td>
<td>3.8</td>
<td>1</td>
</tr>
<tr>
<td>Norway</td>
<td>3.2</td>
<td>1</td>
</tr>
<tr>
<td>Equatorial Guinea</td>
<td>2.6</td>
<td>1</td>
</tr>
</tbody>
</table>
World Liquification Capacity

Source: Rystad Energy
Capex Analysis of Liquefaction Plants

$/Ton of LNG Capacity

Source: Apache from Public Data
SECTION 7

LNG Shipping
LNG Shipping

The global LNG fleet grew by 7% year-on-year in 2020.

5,757 trade voyages, an increase of 1% year-on-year.

572 active vessels
35 new vessels
37 FSRUs
4 FSUs

Approximately 15 vessels laid-up
Global LNG vessel orderbook: 130 carriers

Source: IGU
LNG Ships & Capacity

Source: Rystad Energy
World LNG Liquefaction & Regas capacity

Units: Gt/yr

Historical data source: IGU (2019)
Typical Layout of a Receiving Terminal

- Flare
- Merchant LNG
- Truck, railcar and container loading
- Sales gas LP pipeline
- Metering station
- LNG storage tank
- Sub cooler
- BOG line
- BOG compressor
- Vaporiser
- Recondensation
- Buffer tank
- LNG booster pump
- Vaporiser
1) Total terminals - 133
2) Floating terminals – 24
3) World LNG Receiving capacity- 851 MTPA
4) Capacity Utilization -35%
5) No of countries - about 40
### World’s Top LNG Importing Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Million Ton 2019</th>
<th>Million Ton 2020</th>
<th>Market Share %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>76.87</td>
<td>74.43</td>
<td>21</td>
</tr>
<tr>
<td>China</td>
<td>71.68</td>
<td>68.91</td>
<td>19</td>
</tr>
<tr>
<td>South Korea</td>
<td>40.14</td>
<td>40.81</td>
<td>11</td>
</tr>
<tr>
<td>India</td>
<td>23.98</td>
<td>26.63</td>
<td>7</td>
</tr>
<tr>
<td>Chinese Taipei</td>
<td>16.66</td>
<td>17.76</td>
<td>5</td>
</tr>
<tr>
<td>Spain</td>
<td>15.72</td>
<td>15.37</td>
<td>4</td>
</tr>
<tr>
<td>UK</td>
<td>13.55</td>
<td>13.43</td>
<td>4</td>
</tr>
<tr>
<td>France</td>
<td>15.57</td>
<td>13.06</td>
<td>4</td>
</tr>
<tr>
<td>Turkey</td>
<td>9.37</td>
<td>10.72</td>
<td>3</td>
</tr>
<tr>
<td>Italy</td>
<td>9.77</td>
<td>9.07</td>
<td>3</td>
</tr>
<tr>
<td>Pakistan</td>
<td>8.10</td>
<td>7.42</td>
<td>2</td>
</tr>
<tr>
<td>Thailand</td>
<td>5.00</td>
<td>5.61</td>
<td>2</td>
</tr>
<tr>
<td>Netherland</td>
<td>5.79</td>
<td>5.33</td>
<td>1</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>4.07</td>
<td>4.18</td>
<td>1</td>
</tr>
<tr>
<td>Portugal</td>
<td>4.12</td>
<td>4.07</td>
<td>1</td>
</tr>
</tbody>
</table>
A Floating Storage & Regasification Unit (FSRU) serves the same purpose as a land based Regasification terminal.
Floating Storage and Regasification Unit (FSRU)

- An FSRU is a LNG carrier with the onboard capability to regasify LNG into natural gas.
- An FSRU is permanently moored to a docking facility at a location close to a market access point.
LNG-FSRU Containment Technology

**Spherical Moss Containment**
- 26% of LNG fleet is Moss type
- No ‘Sloshing’ Issues
- Less Fuel efficient
- Less maneuverable

**Membrane Containment**
- 74% of LNG fleet is membrane type
- ‘Sloshing’ issues
- Lower Fuel Consumption
- Better maneuverability
Inside LNG Containment Tank
## FSRU vs Land Based Terminal

<table>
<thead>
<tr>
<th>Item</th>
<th>FSRU</th>
<th>Land Based Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industry Status</strong></td>
<td>Emerging but increasingly accepted</td>
<td>Industry Standard</td>
</tr>
<tr>
<td><strong>Capital Cost</strong></td>
<td>Much lower Capital Costs</td>
<td>Higher Capital Costs</td>
</tr>
<tr>
<td><strong>Time to in-Service</strong></td>
<td>Rapid access to International LNG</td>
<td>Longer time of Implementation</td>
</tr>
<tr>
<td><strong>Construction Timeline</strong></td>
<td>18-24 months for Marine Infrastructure</td>
<td>36 months</td>
</tr>
<tr>
<td></td>
<td>18 – 32 months for FSRU</td>
<td></td>
</tr>
<tr>
<td><strong>Operating Cost</strong></td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td><strong>Unit Regasification Cost</strong></td>
<td>Cost effective way to meet low demand or to “grow into” LNG</td>
<td>Competitive as compared to FSRU</td>
</tr>
<tr>
<td><strong>Land Acquisition</strong></td>
<td>Minimal or no land necessary</td>
<td>Land Acquisition is time consuming and expensive</td>
</tr>
<tr>
<td><strong>Environmental Impact</strong></td>
<td>Minimal Impact</td>
<td>Bigger Environmental footprint</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Can be relocated and used a regular LNG carrier for trading purposes</td>
<td>Cannot be relocated to another location</td>
</tr>
<tr>
<td><strong>Scalability</strong></td>
<td>Limited Scalability</td>
<td>Easy to expand</td>
</tr>
</tbody>
</table>
World FSRU Status

Source: Rystad Energy
Tolling

- Traditionally the liquefaction plants have been owned and operated by same companies that owned gas resources. Tolling is a new model of LNG plants operations. Customer pays “toll” to run gas through the liquefaction plant. The model is essentially based on associated risks, fiscal & tax consideration and financing issues.
  - Plant owner provides liquefaction services and collects toll.
  - The Plant owner collects the same toll regardless of how much customer pays for gas or gets LNG sales or how much the customer makes or loses on each cargo.
  - Customers take the risk of volatility in gas prices or LNG prices. They need to pay the plant usage fee (toll) on “use or pay” basis. This model provides reduced risk to the customers in case of high volatility of prices of gas/LNG. Risk is limited to the usage fee.
  - Tolling model is popular and well practiced in US: LNG Liquefaction plants at Cheniere, Sabine Pass, Cove Point, Corpus Christi, Lake Charles etc. are operating on tolling model. Recent contracts shows a tolling fee of US 3$ per mmbtu to reserve capacity of liquefaction plus cost of gas consumed in the plant operations.
SECTION 9

Elements of Natural Gas/LNG Pricing
Natural Gas Pricing

• Unlike Oil, natural gas is sold by units of energy (Btu, Therms, Joules). Customer pays for the energy derived from gas, not for a specific volume of gas.

• As natural gas is difficult to transport, its prices are tend to be set locally or regionally unlike oil where prices are set globally. This has led to distinct different gas markets.

• About 55% of traded natural gas is transported by pipelines. Price of such natural gas is set through: Negotiations, regulation or open market mechanisms like oil market.

• In LNG market majority of the cargoes are sold on long term basis with prices:
  • Indexed to cost of feed gas
  • Floating prices in the destination market
  • Indexed to Oil or other commodities

• In mature gas markets traded prices are influenced by
  • Supply – demand scenario
  • Weather variations, disruptions
Reliable Natural Gas Price Benchmarks

• Pricing Transparency
  • Timely reporting of physical trades
  • Helps establish a price index for pricing long term deals
  • Facilitates development of futures market

• Market Diversity and Size
  • Multiple participants
  • Large volumes

• Access to Infrastructure
  • Non-discriminatory third-party access: higher volumes

• Standardization of Contracts
  • Standard contracts to access infrastructure
  • Standard contracts for sale and purchase
  • Short & simple contracts

• Physical Delivery Point
  • Allow physical delivery of gas
  • NBP, TTF are called virtual trading points, but are physical locations
Reliable Natural Gas Price Benchmarks Vs LNG Market

- LNG Market does not meet these criteria fully
- Pricing transparency of spot cargoes is limited. Industry remains secretive about pricing
- Japan has a diversified & big market but access to infrastructure and standard contracts are missing
- China has a large and diversified market but lags in market liberalization
- Fully standardized LNG SPA is presently not feasible in spite of lot of efforts
- Both sellers & Buyers in LNG industry have not shown much interest to be transparent in pricing barring Cheniere, Sabine Pass and Corpus Christi projects who have shared their data. METI of Japan has published spot and short term cargoes data
# Global Gas Markets

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas-on-gas markets</td>
<td>Prices indexed to substitute energy prices</td>
<td>Oil-linked price markets</td>
<td>Regulated markets</td>
</tr>
</tbody>
</table>
| Liberal markets with volatile prices generally not in 'sync' with other energy sources.  
  - Large number of suppliers and buyers;  
  - Ample storage and transportation systems;  
  - Sophisticated markets with financial instruments. | Gas prices movements in proportion with other fuels (especially oil-based products and coal)  
  - Limited number of suppliers, many buyers;  
  - Storage and transport controlled by few players;  
  - Some financial markets trading gas. | Gas prices linked directly to oil prices. Large proportion of imported gas.  
  - Limited number of suppliers, many buyers;  
  - Storage and transportation controlled by buyers;  
  - No significant financial markets trading gas. | Controlled markets with government mandated prices.  
  - Usually limited number of buyers and sellers;  
  - Most infrastructure controlled by state;  
  - No or limited influence of market forces. Pooled prices often used. Government takes price risk. |
| US, UK, Canada and NW Europe | Europe (Central, Southern), SE Asia | Japan, Korea, Taiwan, LNG China, LNG India | Middle East, Russia, Non LNG Asia (inc. China, India) |

*Source: NATGAS*
Gas prices are set in relation to regional gas supply & demand where gas competes with other gas. Popular in US, UK and NW Europe

- Large number of buyers & sellers competing without government intervention
- Established benchmarks or Hub prices with transparent, regularly updated and easily available pricing information
- Infrastructure is openly accessible and usage fee are reasonable
- Characterized by common regulations, standardized contracts, extensive infrastructure, government support and truly liberalized market
- US export pricing:
  - PUS Hub + Feed Gas Pipeline tariff + Energy retainage + Liquefaction costs + Shipping cost
Gas Pricing Indexed to other Energy Sources

- Such pricing mechanism is practiced in areas having limited gas grid and emerging gas trading market viz Central & South Europe and South Africa. Larger part of the gas remains priced linked to Oil products (Diesel, Kerosene), Coal, Electricity under long term contracts.
- As a result of weakening / delinking of Oil & Gas bond, such markets are shrinking.
  - Increasing access of short term cargoes at negotiated prices with no linkage to oil
  - Entry of US LNG
Gas Pricing linked to Oil

- Largely practiced in traditional LNG markets of North Asia – Japan, Korea, Taiwan and emerging LNG markets such as China, India.
- Asia has been a major consumer of LNG for long. It consumes 2/3rd of global LNG production.
- The major Asian consumers shifted from coal & oil to LNG over a period of time after experiencing oil shock and negotiations with LNG suppliers for:
  - LNG prices at a discount to current oil prices
  - A price cap (ceiling) on LNG prices to ensure stable gas prices
- In return of long term contract with guaranteed minimum LNG prices Japan particularly gave credit facility to developers to fund export projects
Weakening of Oil Linkage in LNG Contracts & Pricing

Oil Indexation in LNG Sale Purchase Agreement (SPA) over the years

Source: Rystad Energy
Gas Pricing in Regulated Markets

- Regulated markets constitute major part in the world
- The gas markets are immature and largely controlled by State. All infrastructure is owned by State or a state company
- Gas prices are set by State nationally or regionally (multiple prices). State manages the differences in supply prices and all supply is added to a pool of gas volume. Private sector participation in sale or pricing is little
- There is no transparency in pricing. No active gas markets. There is little incentive for private sector for participation in supply or infrastructure
- Regulated markets are inefficient because gas is usually priced below its cost due states social & political policies. It leads to payment of subsidies which distorts the market and is detrimental to the development of free market.
- There is a trend to reduce state control on gas pricing and move towards market driven environment
# Gas Pricing Mechanism & World Total Gas Consumption

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<thead>
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<th>Region</th>
<th>Total Consumption</th>
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<tr>
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<td>Africa</td>
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<td>Middle East</td>
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<tr>
<td>Total</td>
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</tbody>
</table>

1. OPE  Abcd
2. GOG  Efgh
3. BIM  Ijkl
4. NET
5. RCS
6. RSP
7. RBC
8. NP
Gas / LNG Contracts

Flexible LNG contracts

Source: Nexant World Gas Model
Comparative Analysis of Gas Prices in selected Global Markets

Gas prices in selected global markets, $ per MMBtu

1 Million British thermal units.
Sources: Bloomberg, EIA, ICE Index, Platts; McKinsey analysis
Long-term LNG Pricing

Long-Term Oil-Linked LNG Prices vs. Brent at Various Slopes

US$/bbl vs. US$/mmBtu for various slope percentages (10%, 11%, 12%, 13%, 14%, 15%, 16%)
Risk mitigation in Gas Price Volatility

• There are several clauses that can be incorporated in the SPA to restrict the price volatility.
  
  • **A floor price**: a minimum price is set in the contract which would be applicable even if the oil price drops lower than floor price. This gives comfort to the seller in low oil price regime.

  • **A ceiling Price (Ceiling cap)**: A maximum price is set for oil in the contract which would be price cap. The ceiling price is taken for pricing even if the market oil price is higher. This gives comfort to the buyer.

  • **Period for Averaging Oil price**: Contracts define the duration of months for taking the average oil price. 3 month, 6 months, 12 months
The straight line oil parity curve is based on 1 bo = 6 mmbtu and 1 ft³ = 1000 btu. Thus, the energy equivalent gas price at $60 / bo is $10/mmbtu.

Slope of line = 16.7% - LNG is priced equally to oil on energy equivalent basis (Based on 1 Bo generating 5.8-6.0 mmbtu of energy).

Slope lower than 16.7 implies LNG is being sold at a discount to Oil.

Typical ‘S’ Curve based pricing formula: 

\[ P_{\text{LNG}} = A \times P_{\text{Crude Oil}} + B \]

- A = Slope of the curve (Majority of LNG Contracts have slope between 12% to 15%)
- \( P \) = Crude Oil Price
- B = A constant added to reflect fixed cost, often related to shipping cost to buyers import terminal
Key Shifts in LNG Contracts & Pricing

Number of contracts for short, medium and long term from 2014-17

Source: Poten Partners
SECTION- 10

Gas Sale Purchase Agreement (SPA)
LNG Sales & Purchase Agreements

• Negotiation and finalization of a typical LNG sale & purchase agreement (SPA) is a lengthy process and takes several months to years.

• Several milestones between the parties are documented before a SPA is finalized
  - Term sheet
  - Letter of intent (LOI)
  - Memorandum of understanding
  - Heads of agreement

  Typically, HOA represents one step before definitive agreement (SPA)

• These preliminary documents are normally not legal binding and give sufficient time and opportunity to parties to resolve any dispute and move ahead

• Once all the issues, milestones and condition precedent (CP’s) are met then the main agreement – LNG sale & purchase agreement is signed between the seller and buyer. This SPA is the bridge between the liquefaction plant and the receiving regasification plant.
The SPA is a detailed agreement. While there are various common clauses, there is no single standard world SPA format. Parties negotiate and develop their own SPA. A short term model contract has been developed by GIGNL, AIPN.

SPA lays down all possible clauses to help smooth implementation. While it contains numerous clauses, following clauses are very important:

- Commitment
- Term
- Transportation & Delivery
- Volume
- Take or Pay
- Diversion rights
- Price
- Technical Specifications -
  - Measurement & quality of LNG
  - LNG specification
  - Specifications of LNG ship
  - Specifications of jetty etc of the receiving terminal
The SPA’s typically also include following clauses:

- Process of Invoicing & Payment
- Currency of payment
- Security of payment – corporate guarantee, revolving letter of credits, prepayment
- International law for arbitration for dispute resolution
- LNG quality
- Force Majeure
- Process for testing & measurement
- Transfer of title and risk
- Taxes, levies and liabilities
- Confidentiality
SECTION 11

Regulatory Framework
Regulatory Framework : Government Support

- **Create maximum value from hydrocarbon resources**: Governments are expected to create legal and fiscal frameworks for promoting and governing gas & LNG development.

- **Equitable**: Ensure that the rules, regulations and laws are followed by all – government as well as private sector companies.

- **Align to Equitable PPP model**: Formulate long-term policies and enabling legislation which creates legal environment for investors to explore, develop & produce domestic hydrocarbon resources as well as develop projects viz LNG.

- **Stable & Sustainable Business Environment**: The objective is to create a stable and viable investment climate for substantive and continued investment in hydrocarbon sector.

- **Simple Administrative Working**: Simplify rules, regulations & procedures. Create an independent regulator which works at an arm’s length principle and is not seen as a government. Regulator for Upstream, Midstream and Downstream sectors.
Regulatory Framework: Role of a Regulator

- Independent regulator to oversee, supervise, monitor and advise the government on project approval and implementation
- Key role to monitor the industry players
- Setting tariffs across the value chain. Periodical review involving experts and industry consultation
- Setting & collection of taxes and fees. Clear & consistent approach and not arbitrary or random
- Clarity of role between separate regulators and close coordination: Upstream, Midstream, Downstream, and power. Separate safety regulator viz OISD, DGMS
- Petroleum & Explosives Safety Organization (PESO): To provide operational & technical advice, approvals under the explosive act 1884 & petroleum act 1934 pertaining to manufacture, import, export, transport, possession, sale and use of explosives, petroleum products, and compressed gasses
- Scope of work – control – jurisdiction
  - City & local natural gas distribution network
  - Natural gas pipelines
  - Petroleum products pipelines
  - Gas/LNG & Petroleum products storage and transportation
  - Gas exchanges
  - Technical standards & specifications including safety standards of oil, gas, petrochemicals plants, equipment, testing & measurement
LNG business in India is growing around 4% annually. Slowly moving towards a mature market.

LNG business in India is largely unregulated. Anybody can construct a LNG receiving terminal. The only regulation issued by Petroleum & Natural Gas Regulatory Board (PNGRB) gives freedom to establish LNG/RLNG dispensing unit by anybody irrespective of CGD license being held by anyone. PNGRB is presently in the process of industry consultation and registering the LNG terminal operators in the country.

Some of the best practices of mature markets of Europe viz third party access, tolling, capacity booking with use or pay provisions, competitive regas charges, Storage & reloading of cargoes, bunkering etc. are being practiced on mutually negotiated terms.

For construction of terminal, facilities developers can follow European, Japanese or US standards. SIGTTO and other international standards are followed for marine operations. Practically worlds all LNG producers have supplied LNG to India.
SECTION 12

Gas Hubs & Exchange
A gas hub is a platform where the title (Ownership) of gas molecules is exchanged between a number of buyers and sellers in both spot and future trades.

The participants in a hub include – Market players. Transmission system operators (TSO’s), Hub operators, Brokers and exchanges.

A hub or a trading point is the place where buyers and sellers exchange the ownership of gas on paper and in physical delivery.

The basic role of a hub is the transport of gas from supplier to consumers as per the contract at their time of maturity.

Gas in a hub has a single price. In other words the gas can be transferred at zero cost within the hub.

Types of hubs : Physical hub, Virtual hub, Balancing hub, Financial hub, Benchmark hub.
Physical hubs and Virtual hubs

- A common classification of hubs is physical delivery hub and virtual market hub.
- A physical hub is centrally located, sufficiently interconnected geographical location in the network where a price is set for natural gas delivered at that specific location. Hubs in North America – Henry hub.
- A virtual hub has numerous virtual trading points associated with the entry-exit system (market area) from which point the same or other network users can transport the gas to exit points. Hubs in Europe – virtual hub often overlaps national boundaries.
**Gas Hubs & Exchanges**

**Balancing hub and Financial hub**

- Balancing hubs are used by shippers to balance their portfolios that are near maturity and delivery.
- Transmission system operators (TSO’s) physically balance the gas grid regularly. In an open market a balancing hub is needed so that TSO’s can balance the grid.
- A balancing hub could also be a transit hub which transports substantial volume of gas but very little trading actually happens.
- A financial hub offers future contracts used by the shippers to optimize portfolios and manage long term risk (hedging or speculative contracts) up to 3 years or more.
- All trading hubs must be balancing hubs but only a few can be financial hubs. National Balancing Point (NBP) and Title Transfer Facility (TTF) have the liquidity and trading volumes of futures with longer maturities, thus, they are benchmark hubs.
Gas Hubs & Exchanges

Benchmark Hub (Price marker hub)

• A benchmark hub offers prices for other hubs. Number of such hubs is limited
• The benchmark hub or price marker hub must have good liquidity from a spot to several years forward and should be:
  • Fully transparent
  • Open
  • Accessible to different participants
• It is a risk management hub and is therefore, a financial hub, but not all financial hubs are benchmark hub
LNG Hubs

- LNG hub development is a complex process and not free from controversial issues.
- LNG hub would facilitate price benchmarking by circumventing the need for a physical trading point in gas hubs.
- LNG is transported in storage format (cargoes) and it does not depend on pipeline network transportation infrastructure.
- Current hub indexes – Argus ANEA, Platts JKM, SGXLNG Group(SLInG) do not have delivery infrastructure.
- LNG hub is fraught with limitations:
  - Larger product size
  - Significant time gap between contracting and delivery
  - Variations in LNG cargo specifications
  - Lack of interconnectivity and compatibility between LNG terminals
  - Different operating rules
  - No governmental regulations
LNG Hubs

- The current LNG hub price indexes are all based on assessment and not on actual trading prices
- Liquidity in LNG trading is limited
- There is no functional LNG hub in Asia. Singapore is the leading candidate for a regional LNG benchmark hub but presently has following issues
  - Slow development of futures market
  - Low volumes in spot trading
End of Presentation
Thank you for your attention