LNG BUSINESS STRATEGIES : TRAINING FOR PARTICIPANTS FROM SAARC COUNTRIES

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FLOW OF PRESENTATION

Section 1 : Global energy environment

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

- *Floating storage & regasification unit (FSRU)*

Section 9 : Elements of Natural Gas/LNG Pricing

- *Price volatility*

Section 10 : Gas Sale Purchase Agreement (SPA)

Section 11 : Regulatory Framework & Government support

Section 12 : Gas Hubs & Exchange

SECTION 1

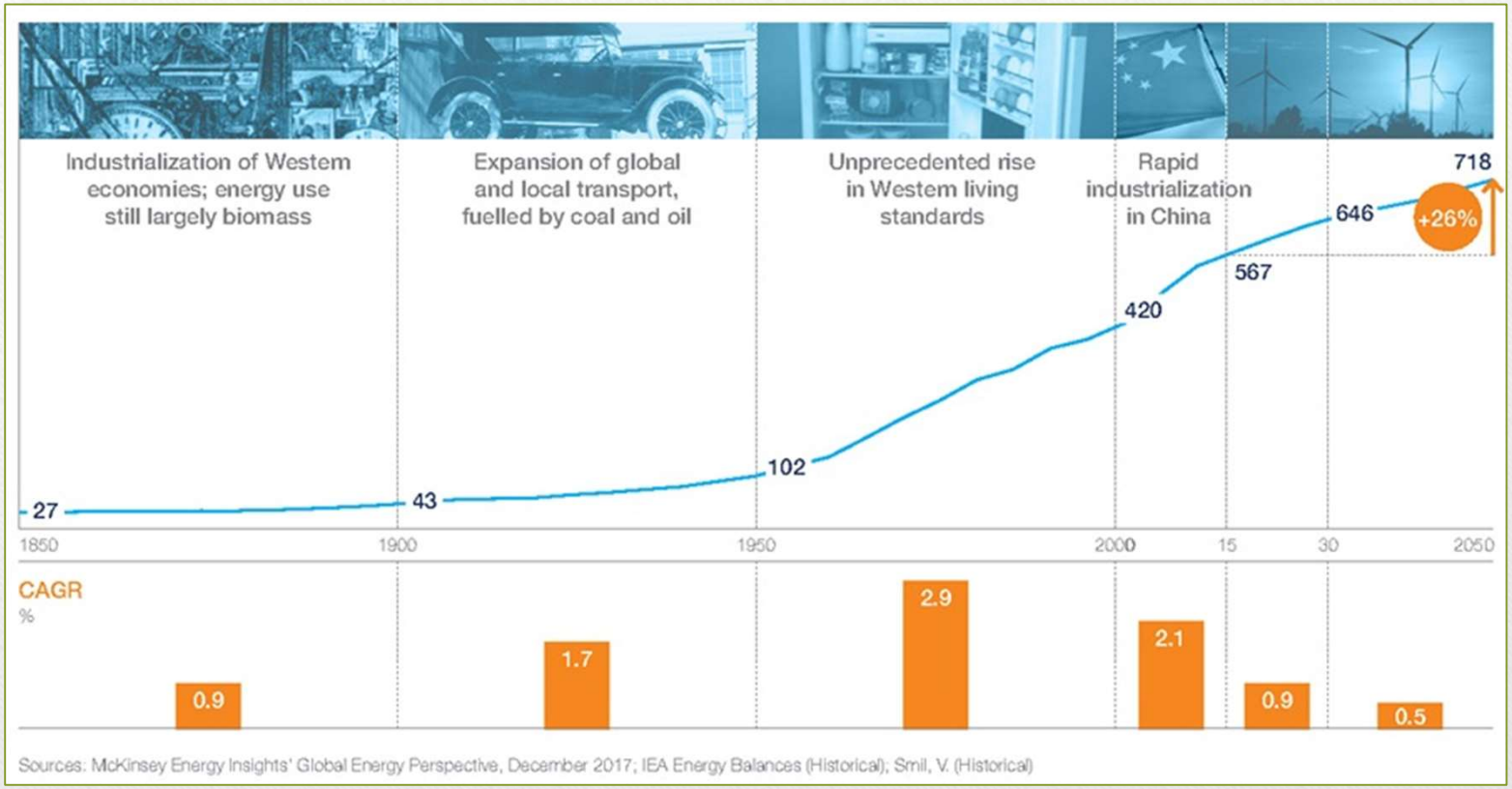
Global Energy Environment

What have been the trend

of consumption of

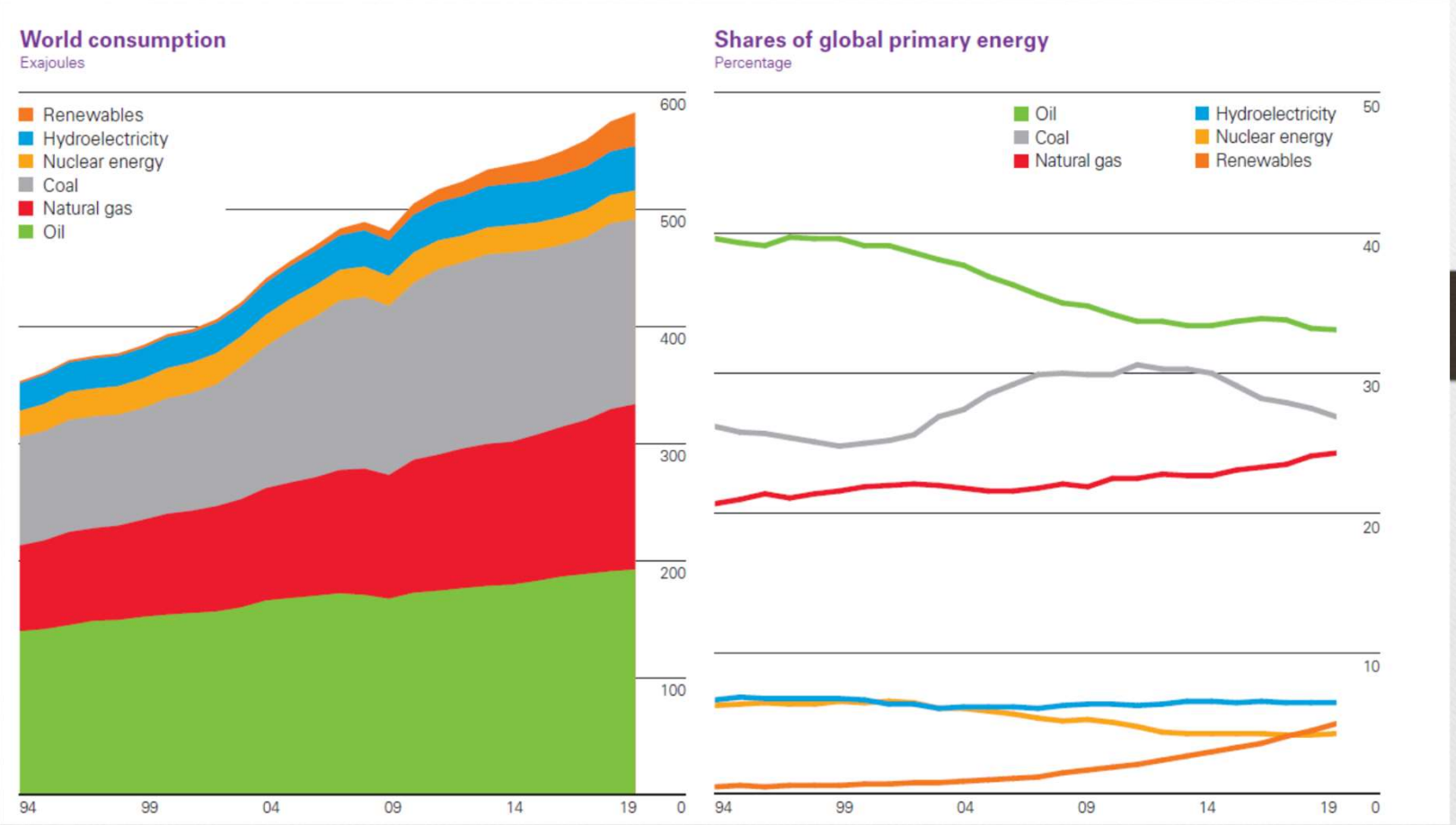
different sources of energy ?

Global Energy Demand Forecast



Share of energy sources : 1994 to 2019

(Source : BP Statistical Review 2021)

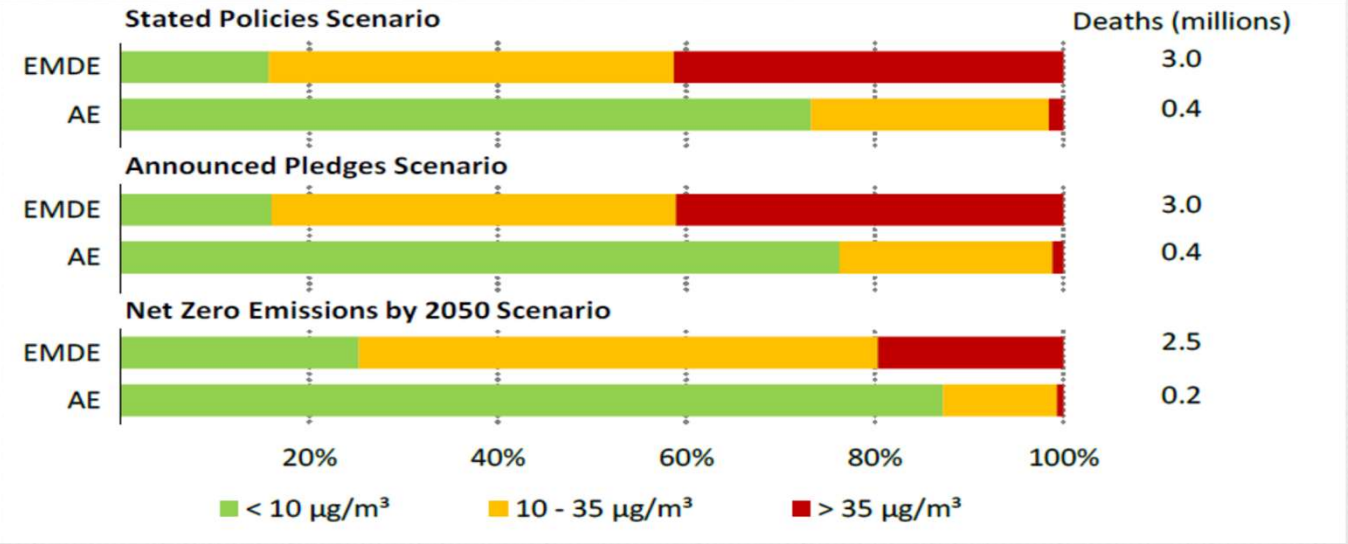


Emerging issues

- 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.

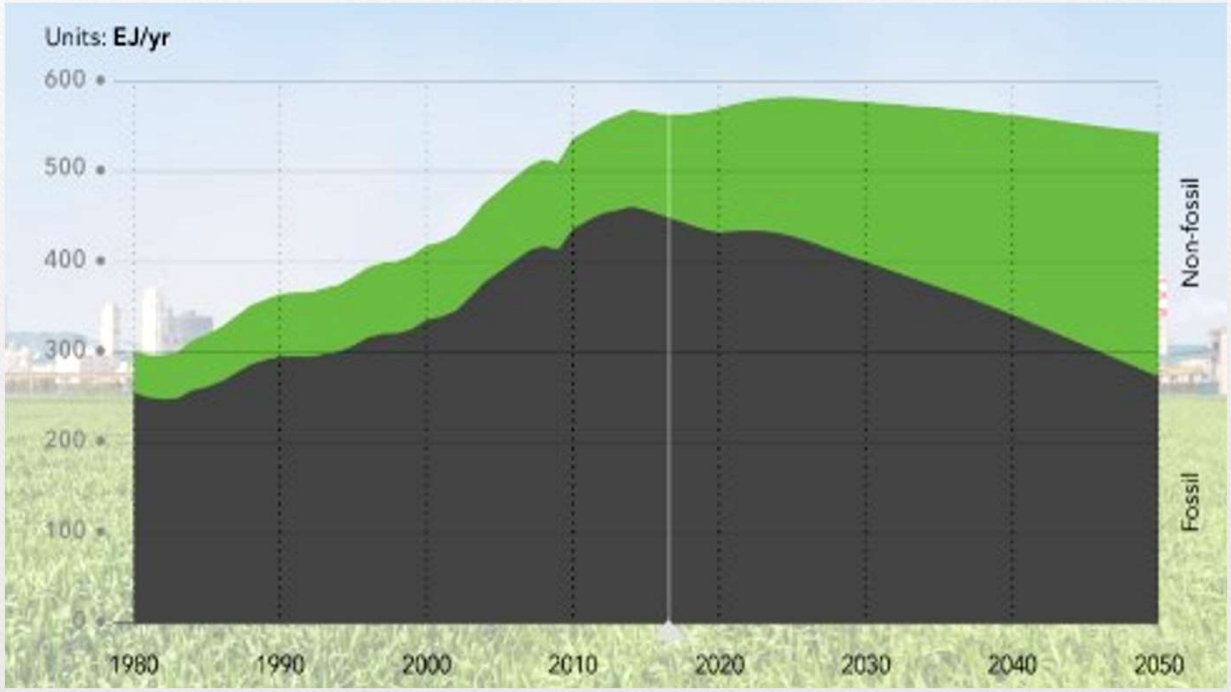
Just as the future cannot be forecasted, the emergence of cost-effective energy options cannot be predicted.

What are the plays for

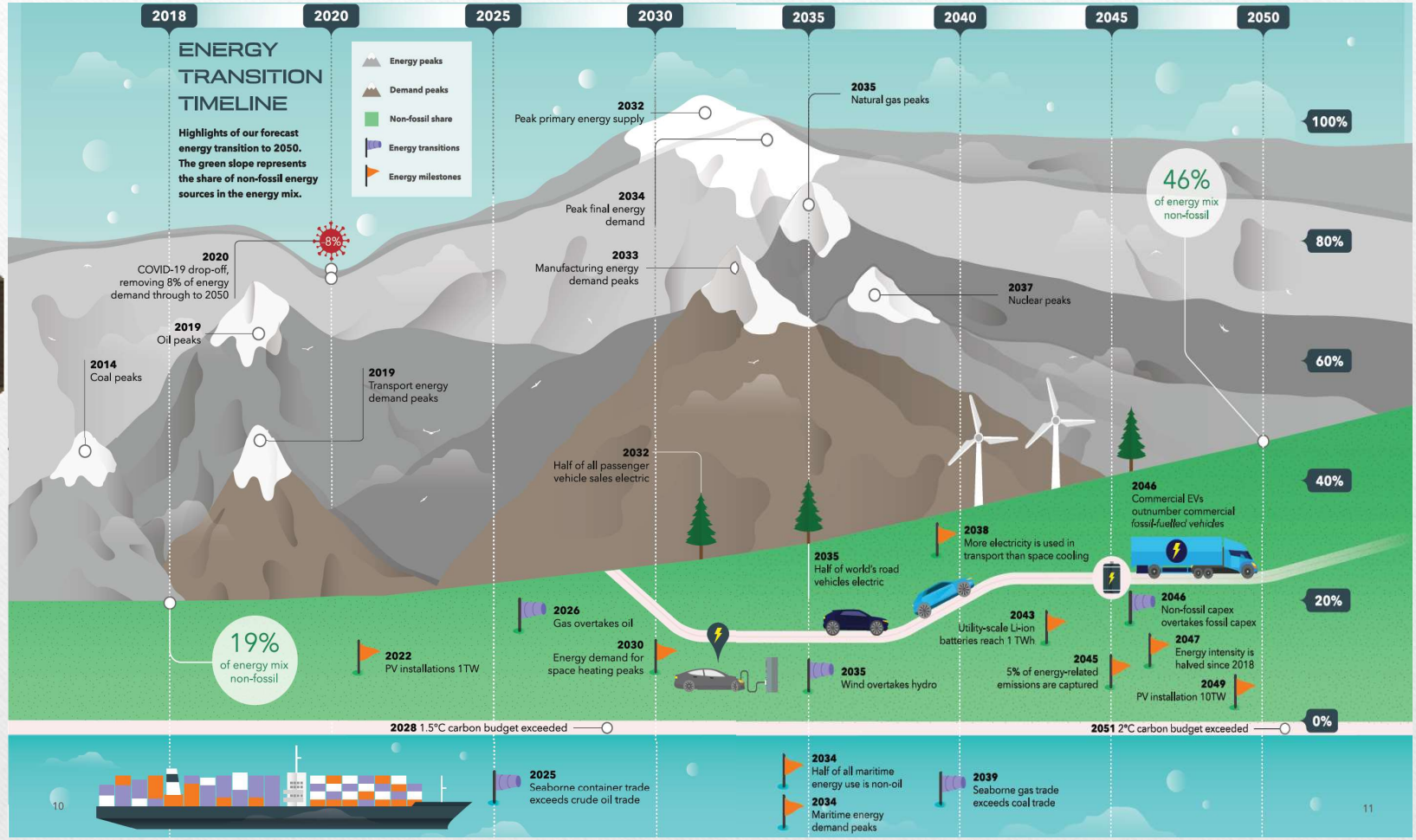
Energy & Natural Gas / LNG

in the different future energy scenario

Primary Energy Forecast



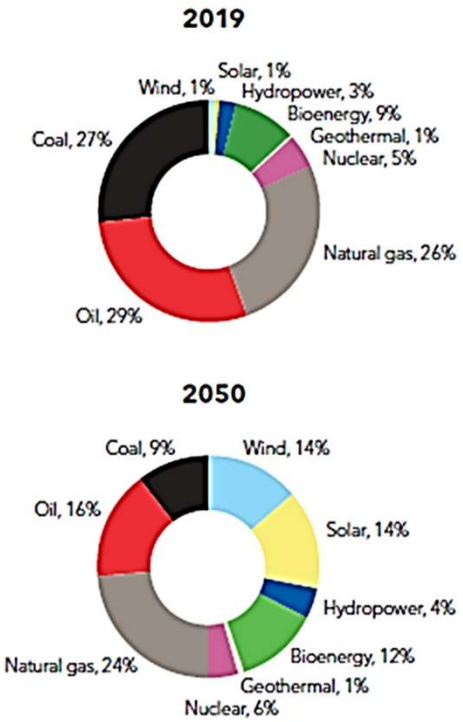
Projected Energy Transition Timelines in the World



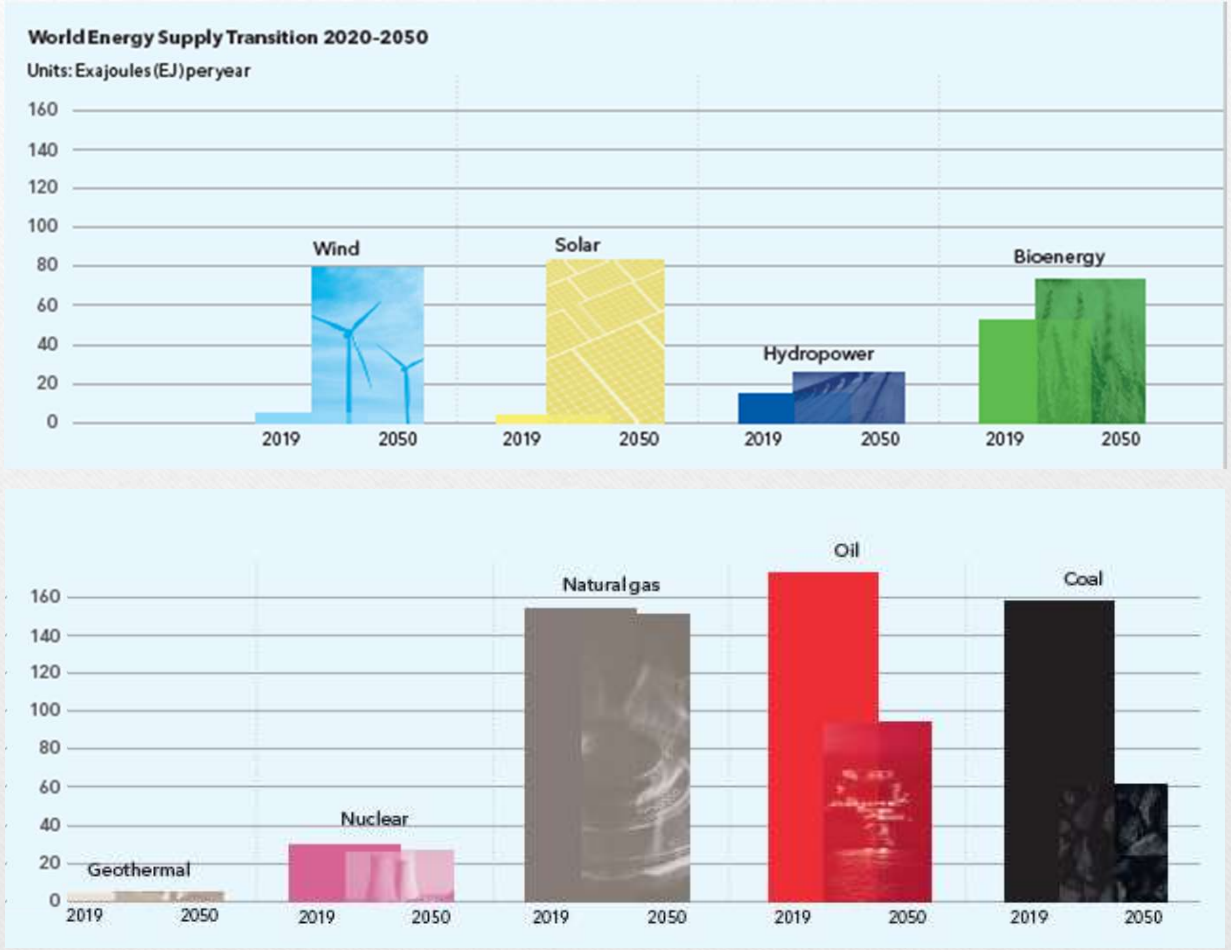
World Primary Energy Projections

Units: EJ/yr

Source	2019	2030	2040	2050
Wind	5	20	42	81
Solar	4	25	54	85
Hydropower	15	22	25	26
Bioenergy	54	61	67	73
Geothermal	3	5	4	4
Nuclear	29	30	28	27
Natural gas	155	160	157	139
Oil	173	164	133	94
Coal	158	131	95	61
Total	**596**	**617**	**605**	**590**

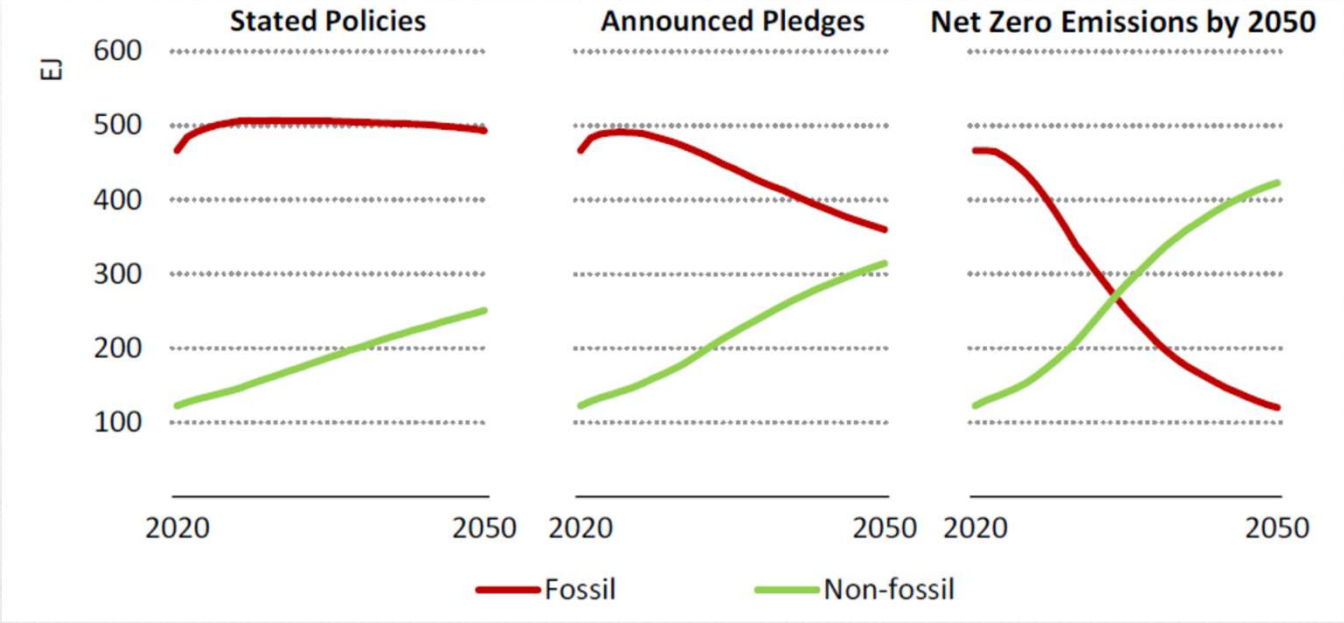


World Energy Supply Transition (2020-2050)



IEA – WEO 2021 : Share of Fossil and Non-fossil

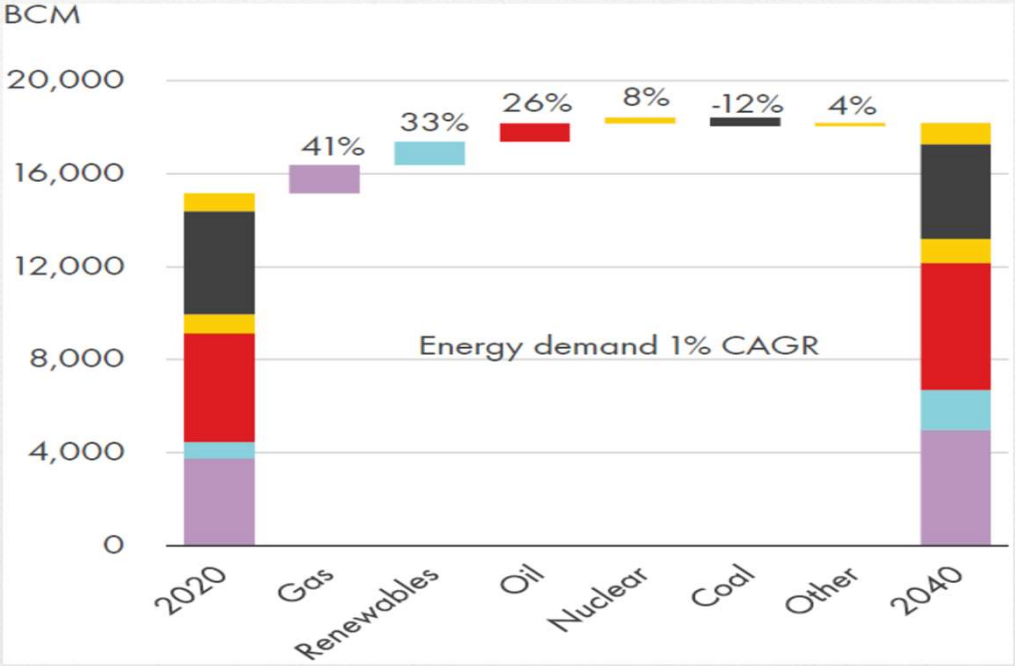
- Expected projections in the STEPS, APS & NZE Scenarios
- APS scenario is somewhat nearer to many other projections



Global source-wise energy demand : Shell's LNG Outlook 2021

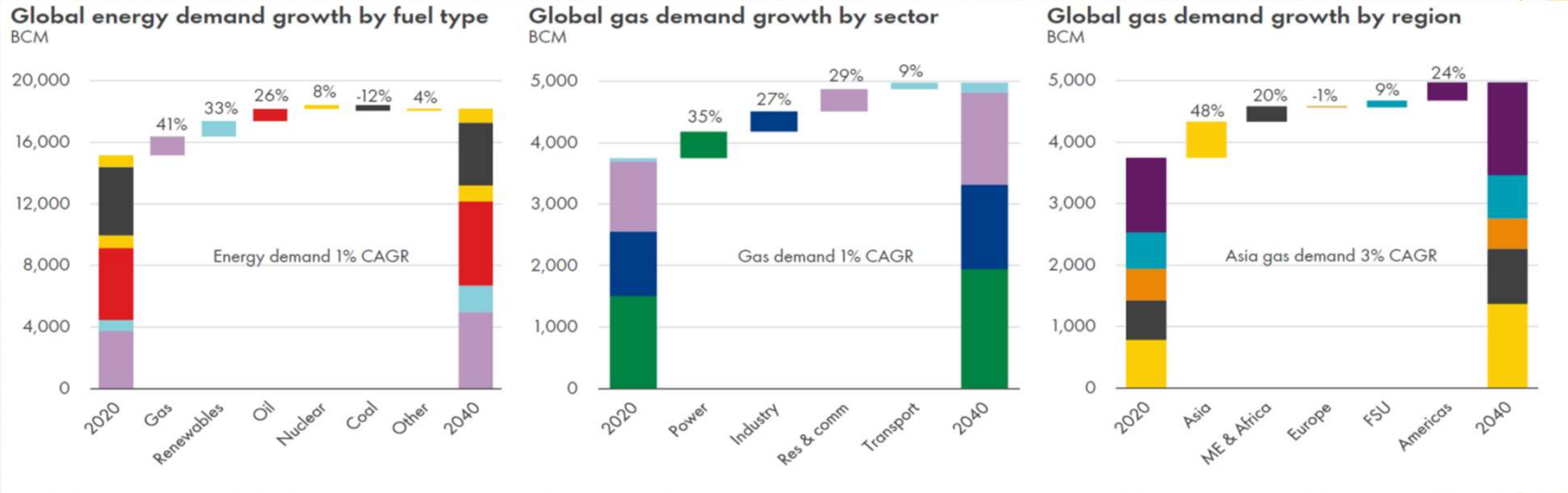
(Based on Wood Mackenzie data for H1 2020)

- Share of gas is higher than renewables between 2020 and 2040



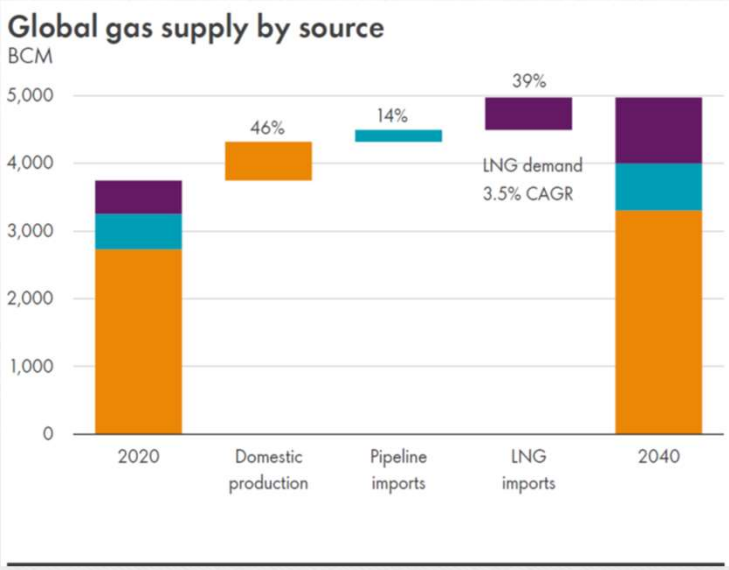
Global Gas demand : Shell's LNG Outlook 2021
(Based on Wood Mackenzie Data for H1 2020)

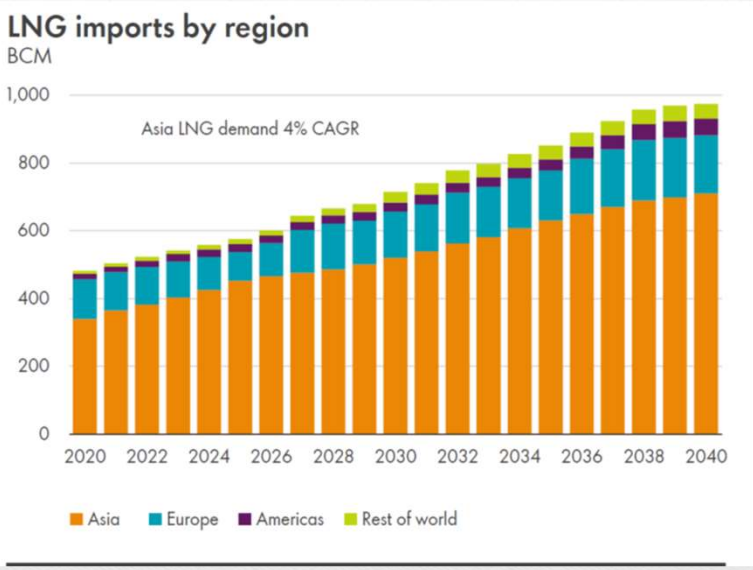
- The gas demand reaches about 5000 BCM by 2040.
- Highest growth is in the electricity sector
- Region-wise, the highest growth is in Asia



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)

			Stated Policies		Sustainable Development		Current Policies	
	2000	2018	2030	2040	2030	2040	2030	2040
Power	908	1 571	1 708	1 936	1 580	1 248	1 823	2 197
Industrial use	644	909	1 229	1 474	1 108	1 114	1 243	1 527
Buildings	651	846	945	998	740	557	1 011	1 131
Transport	70	137	200	295	268	330	181	249
Other sectors	257	490	639	701	568	605	681	788
World natural gas demand	**2 530**	**3 952**	**4 720**	**5 404**	**4 264**	**3 854**	**4 940**	**5 891**
Asia Pacific share	*12%*	*21%*	*26%*	*28%*	*29%*	*34%*	*26%*	*28%*
Low-carbon gases	-	4	53	90	138	269	29	52
World total gases	**2 530**	**3 956**	**4 773**	**5 494**	**4 402**	**4 123**	**4 968**	**5 943**
Conventional gas	2 318	3 004	3 293	3 694	3 004	2 689	3 433	3 926
Existing fields	2 318	3 004	2 200	1 659	2 200	1 659	2 200	1 659
New fields	-	-	1 094	2 035	804	1 030	1 234	2 266
Tight gas	148	274	267	238	262	141	253	232
Shale gas	3	568	1 020	1 290	863	871	1 113	1 532
Coalbed methane	38	88	103	129	101	103	102	143
Other production	-	3	36	54	34	50	38	58
World natural gas production	**2 507**	**3 937**	**4 720**	**5 404**	**4 264**	**3 854**	**4 940**	**5 891**
Shale gas share	*0%*	*14%*	*22%*	*24%*	*20%*	*23%*	*23%*	*26%*
LNG	136	352	598	729	608	636	633	768
Pipeline	378	436	528	549	463	358	589	704
World natural gas trade	**514**	**788**	**1 126**	**1 278**	**1 071**	**993**	**1 222**	**1 472**
Share of production that is traded	*20%*	*20%*	*24%*	*24%*	*25%*	*26%*	*25%*	*25%*
Henry Hub price ($2018/MBtu)	**6.1**	**3.2**	**3.3**	**4.4**	**3.2**	**3.4**	**3.8**	**5.1**

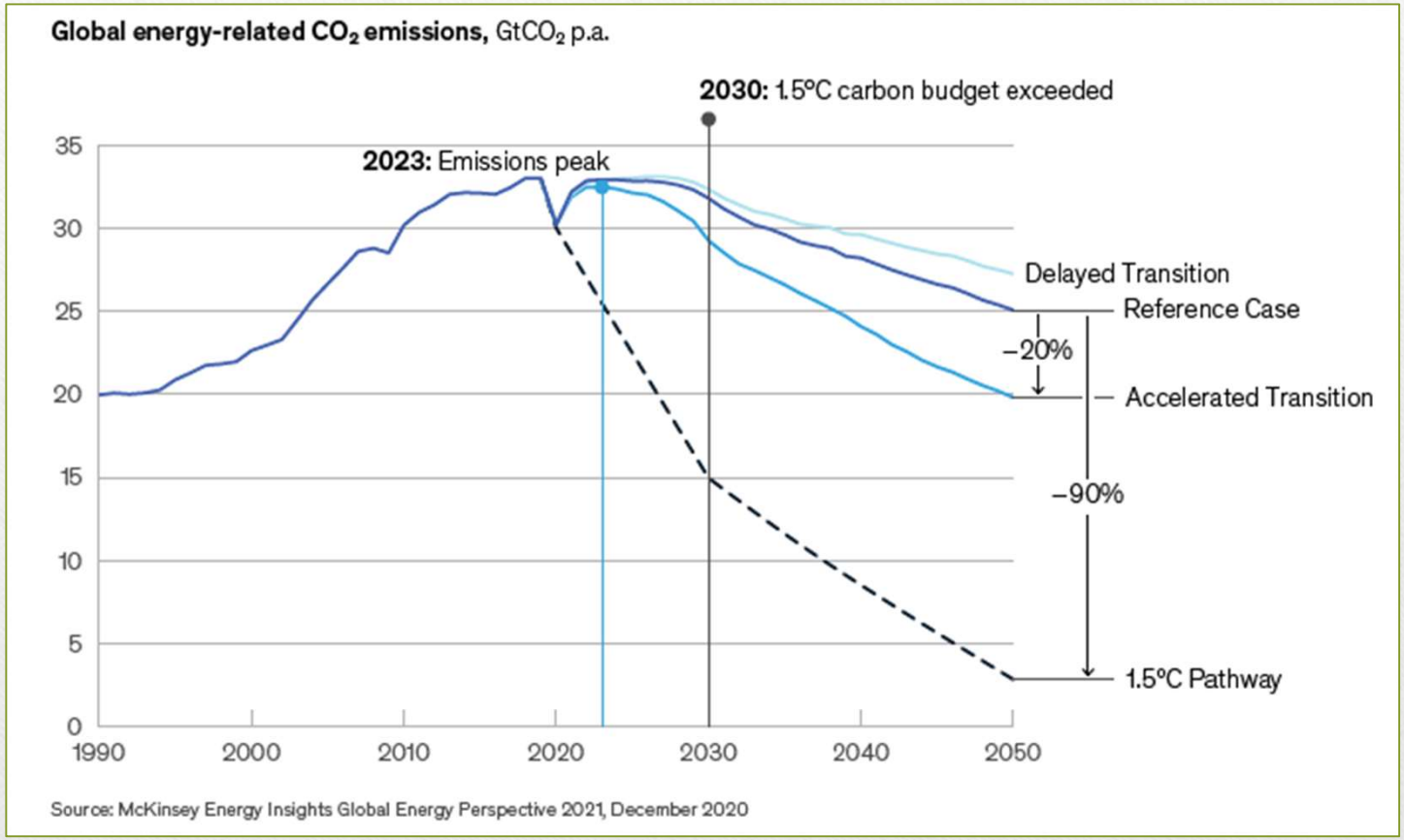
Energy Transition - Features

- 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.**

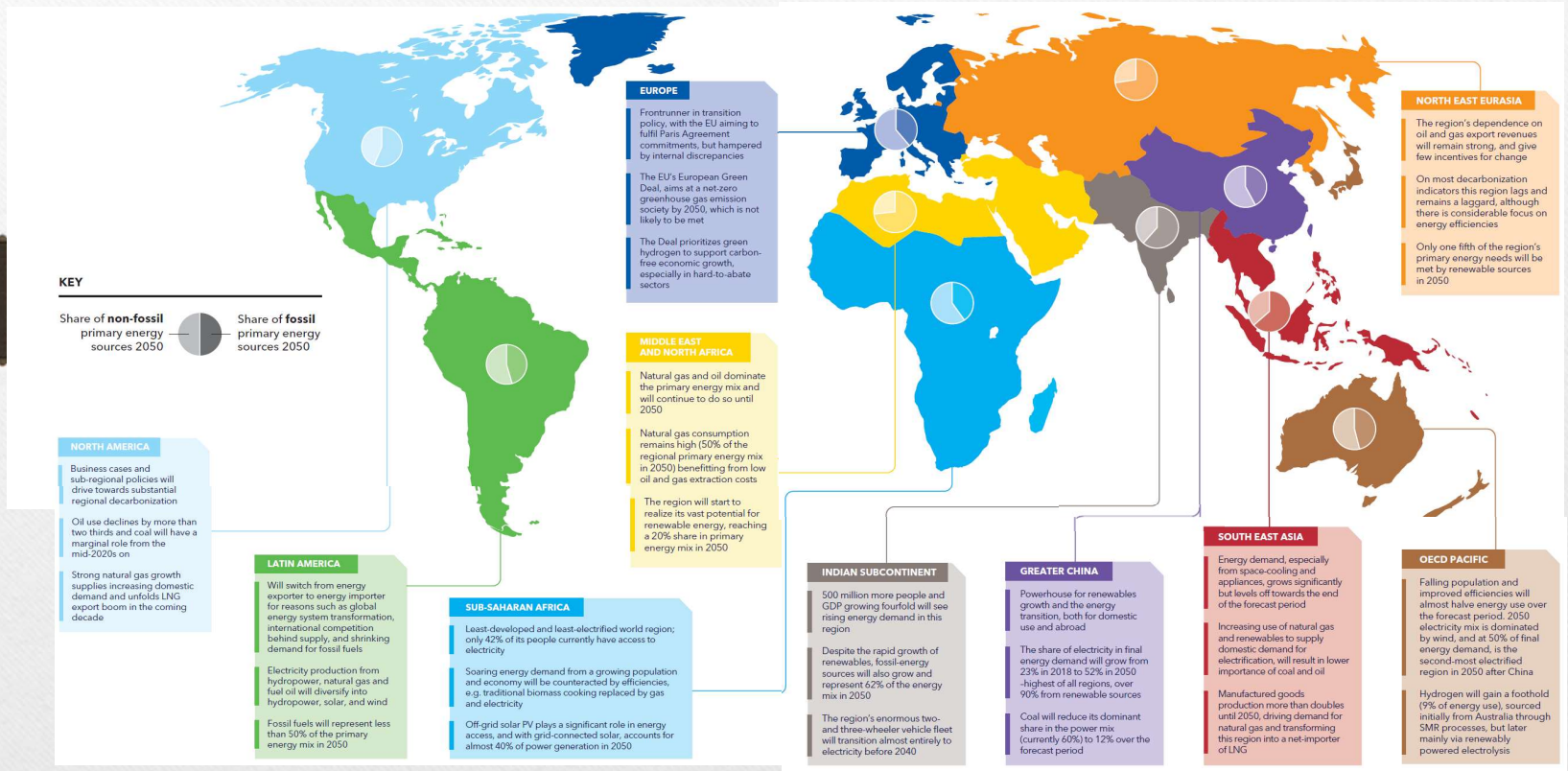
Role of Natural Gas in Energy Transition

- 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 (CH_4) into hydrogen along with capturing and storing CO_2 (CCS).
- On a long term basis gas may not remain competitive as most of infrastructure would require replacement by 2050.

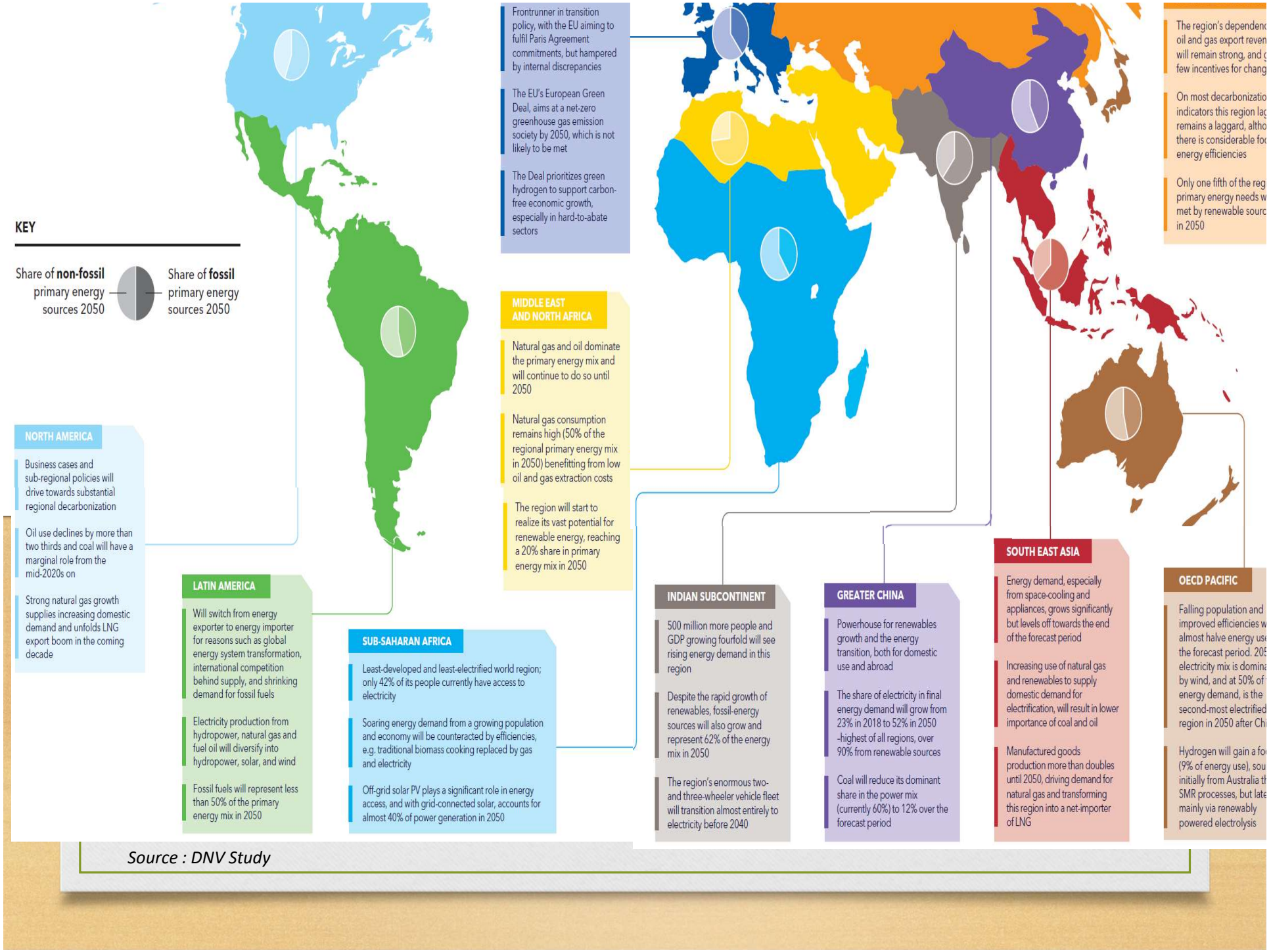
Global CO2 Emissions Projections



World Energy Segments



Source : DNV Study

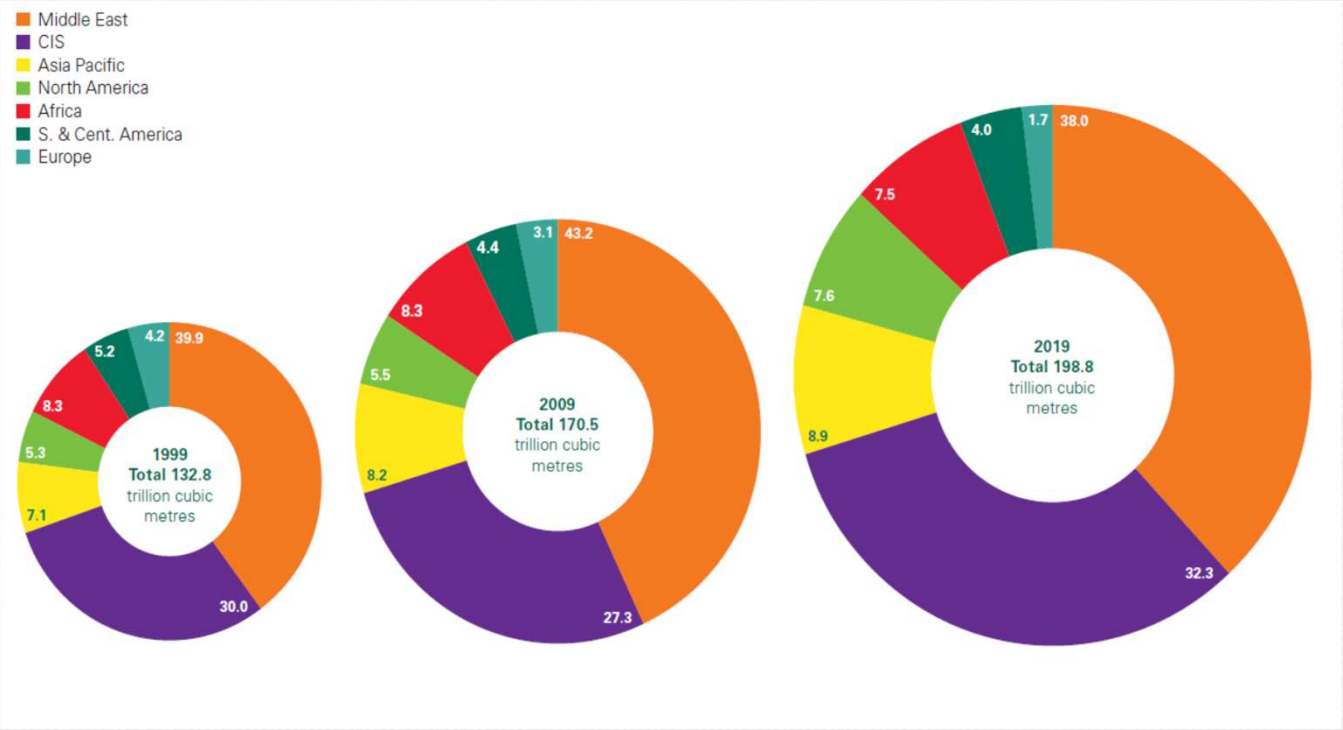


Source : DNV Study

Does the world have enough gas reserves ?

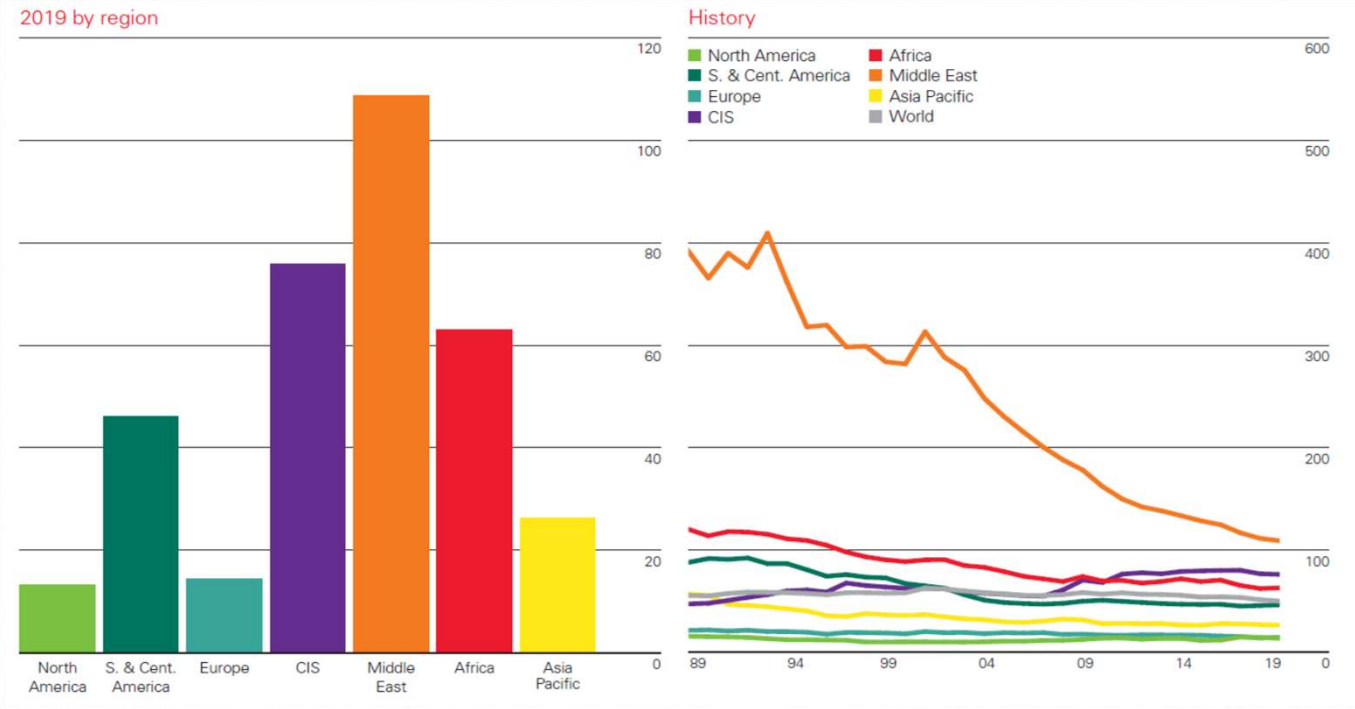
Global Gas Reserves : 1999, 2009, 2019
(BP Statistical Review : 2020)

- 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

Sl No	Country	Proven Reserves	Production in 2018	
		Trillion Cubic Metres (TCM)	Billion Cubic Metres (BCM)	LNG Export (in MTPA)
1	Russia	38.9	670	19
2	Iran	31.9	240	
3	Qatar	24.7	175	79
4	Turkmenistan	19.5	61	
5	USA	11.9	831	23
6	Venezuela	6.3	33	
7	China	6.1	161	
8	S Arabia	5.9	112	
10	UAE	5.9	64	6
11	Nigeria	5.3	49	21
12	Algeria	4.3	92	10
13	Iraq	3.6	13	
14	Indonesia	2.8	73	15
15	Australia	2.4	130	69
16	Malaysia	2.3	72	24
17	Europe (Excl Norway & CIS	2.3	130	
18	Egypt	2.1	58	2
19	Azerbaijan	2.1	18	
20	Kazakhstan	2.1	24	
21	Canada	1.9	184	
22	Kuwait	1.7	17	
23	Norway	1.6	120	5
24	India	1.3	27	
25	Oman	0.7	36	10.5
26	Peru	0.4	13	4
27	Trinidad & Tobago	0.3	34	12.5
28	Papua New Guinea	0.2	5	7
29	Cameroon	0.1	5	1
30	Eq Guinea	0.1	6	4
31	Yemen	0.1	3	Refer Footnotes
32	Angola	0.1	6	4
World		**196.5**	**3867**	**316**

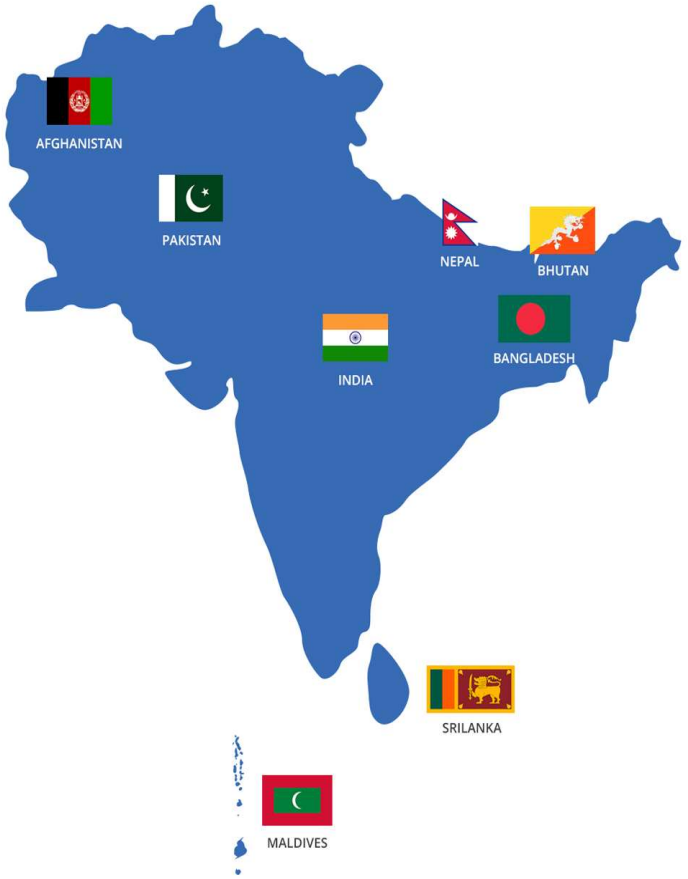
- Countries exporting LNG or Reserves more than 1 tcm
- Yemen's LNG capacity of 6.7 MTPA is shutdown since 2015 due to internal turmoil.
- Actual Gas-in-place reserves may be more.

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.
- Predominantly fossil fuels dependent region. Coal for India and Pakistan. Bangladesh relies on natural gas.
- 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)*

Country	Year	Kg of OE
Afghanistan		
Bangladesh	2014	229
Bhutan	2007	367
India	2014	637
Maldives	2007	892
Nepal	2014	434
Pakistan	2014	460
Sri Lanka	2014	516

Per Capita Consumption *(Kg of OE)*

Contd..

Country	Year	Kg of OE
Afghanistan		
Bangladesh	2014	229
Bhutan	2007	367
India	2014	637
Maldives	2007	892
Nepal	2014	434
Pakistan	2014	460
Sri Lanka	2014	516
USA		6960
Canada		7897
Australia		5334
China		2236

Primary Energy Consumption & Outlook

MTOE

Country	2012/ FY13	2017/ FY18	2023/ FY24	2030/ FY30
Afghanistan	5.7	4.3	6.7	9.3
Bangladesh	25.7	37.5	60.6	85.3
Bhutan	0.6	0.7	0.9	1.5
India	651.2	816.8	1,102.7	1,391.3
Maldives	0.4	0.5	0.8	1.2
Nepal	10.0	13.5	16.3	21.2
Pakistan	57.7	74.6	108.6	147.3
Sri Lanka	9.6	11.4	12.9	16.2
Total	**760.9**	**959.3**	**1,309.5**	**1,590.5**

SECTION 3

Natural Gas & Its Advantages

Natural Gas & its Advantages

- It is the lowest carbon hydrocarbon- Methane (CH_4).
- 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 CO_2 and one tenth of the air pollutants compared to coal when burnt for electricity generation and therefore a preferred fuel to reduce the emissions.

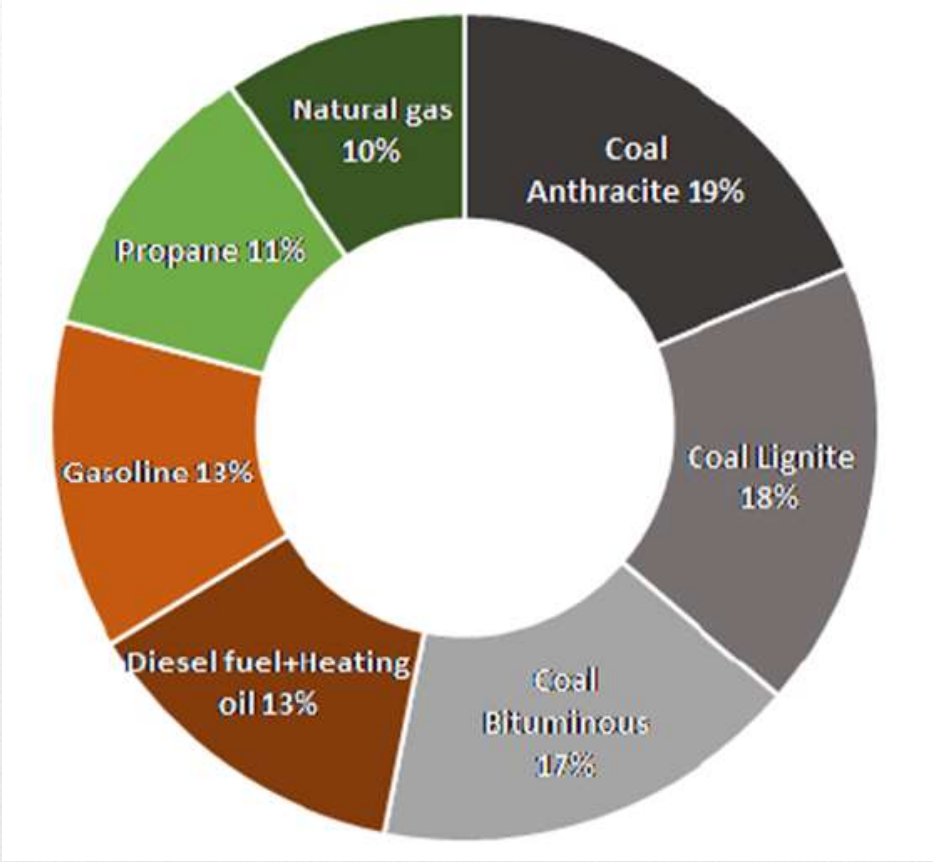
LNG / Natural Gas Cleanest Fuel

(gm/100Kms)

FUEL	EMISSIONS					
	CO2	CO	NOx	SOx	Particulate Matter	Unburnt Hydrocarbons
Petrol	22000	634	78	8.3	1.1	85
Diesel	21000	106	108	21	12.5	21
LPG	18200	168	37	0.38	0.29	18
LNG / NG	16275	22.2	25.8	0.15	0.29	5.6

Source: US Energy Department

Emissions from Different Energy Sources



Source : EIA

SECTION 4

Liquified Natural Gas (LNG)

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

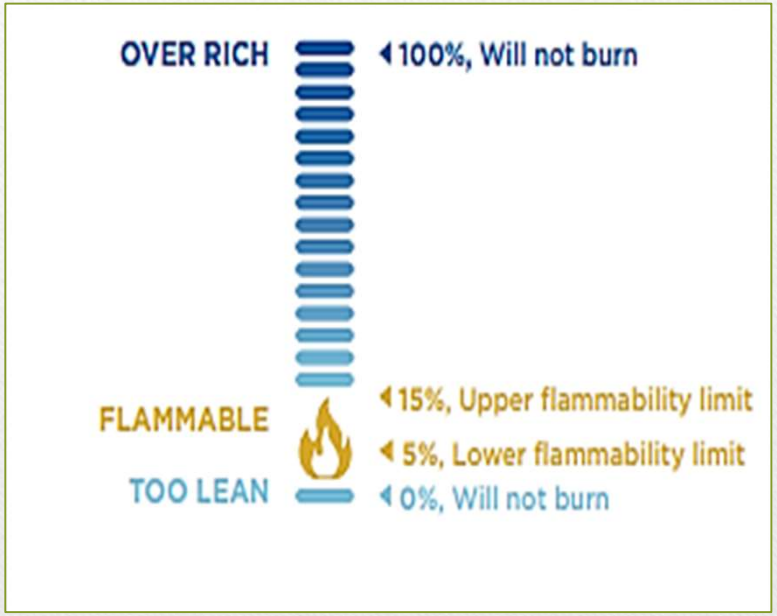
LNG IN A THERMOS FLASK

Typical LNG Composition

Origin	Nitrogen (N_2X)	Methane (CH_4) C1 %	Ethane (C_2H_6) C2 %	Propane (C_3H_8) C3 %	Butane (C_4H_{10}) C4+ %	Gas GCV MJ/m³ (n)	Wobbe Index MJ/m³ (n)
Australia NWS	0.04	87.33	8.33	3.33	0.97	45.32	56.53
Malaysia Bintulu	0.14	91.69	4.64	2.60	0.93	43.67	55.59
Nigeria	0.03	91.70	5.52	2.17	0.58	43.41	55.50
Qatar	0.27	90.91	6.43	1.66	0.74	43.43	55.40
Trinidad	0.01	96.78	2.78	0.37	0.06	41.05	54.23

Source : GIIGNL

Flammability of LNG : Safer Fuel



LNG : The Cheapest Fuel

Fuel	RLNG Delivered	Naphtha	Fuel Oil	Diesel	LPG
Price	16.07	21.42	16.32	26.40	24.86

Assumptions :

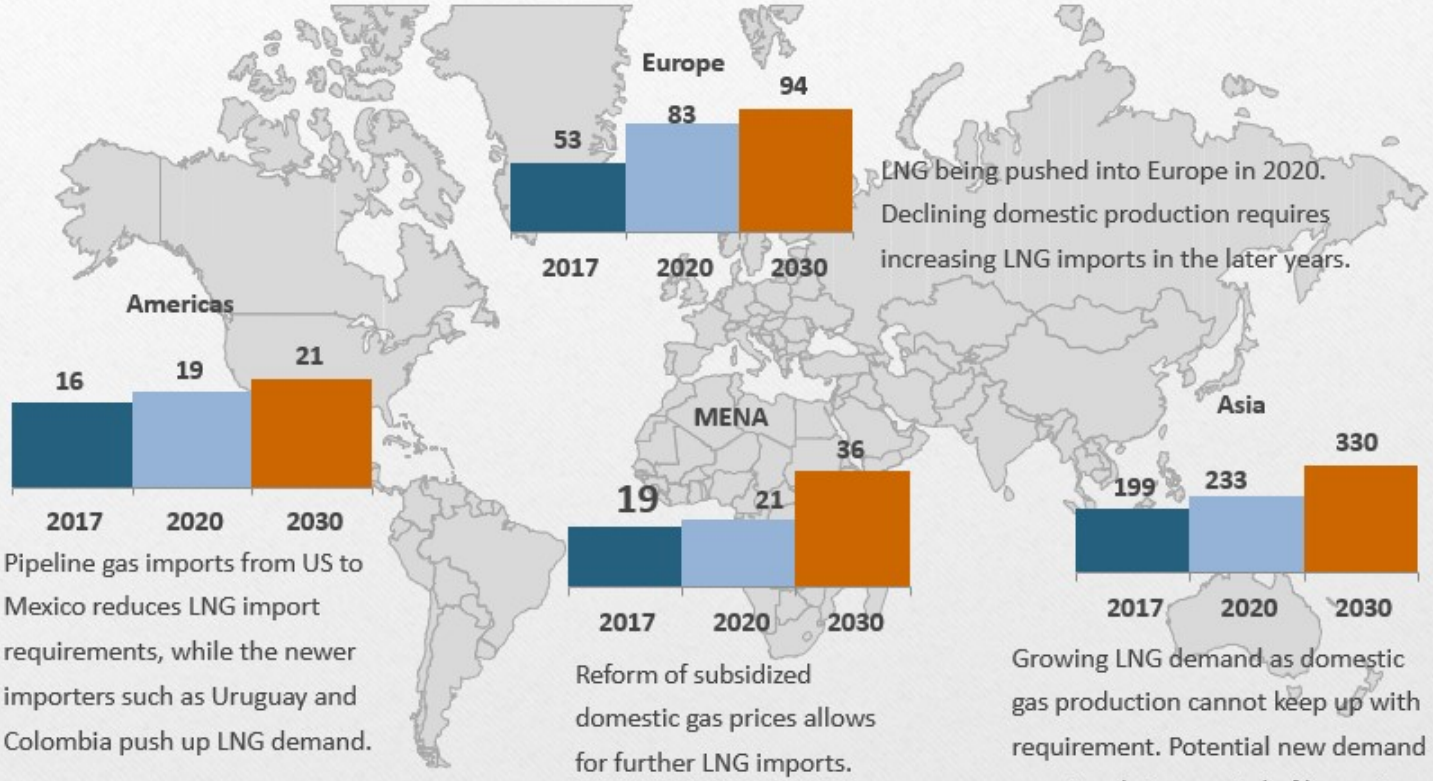
- Crude Oil : USD 80/barrel
- LNG Linkage to Oil : 13%
- 1 USD : INR 74

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

LNG Demand Forecast

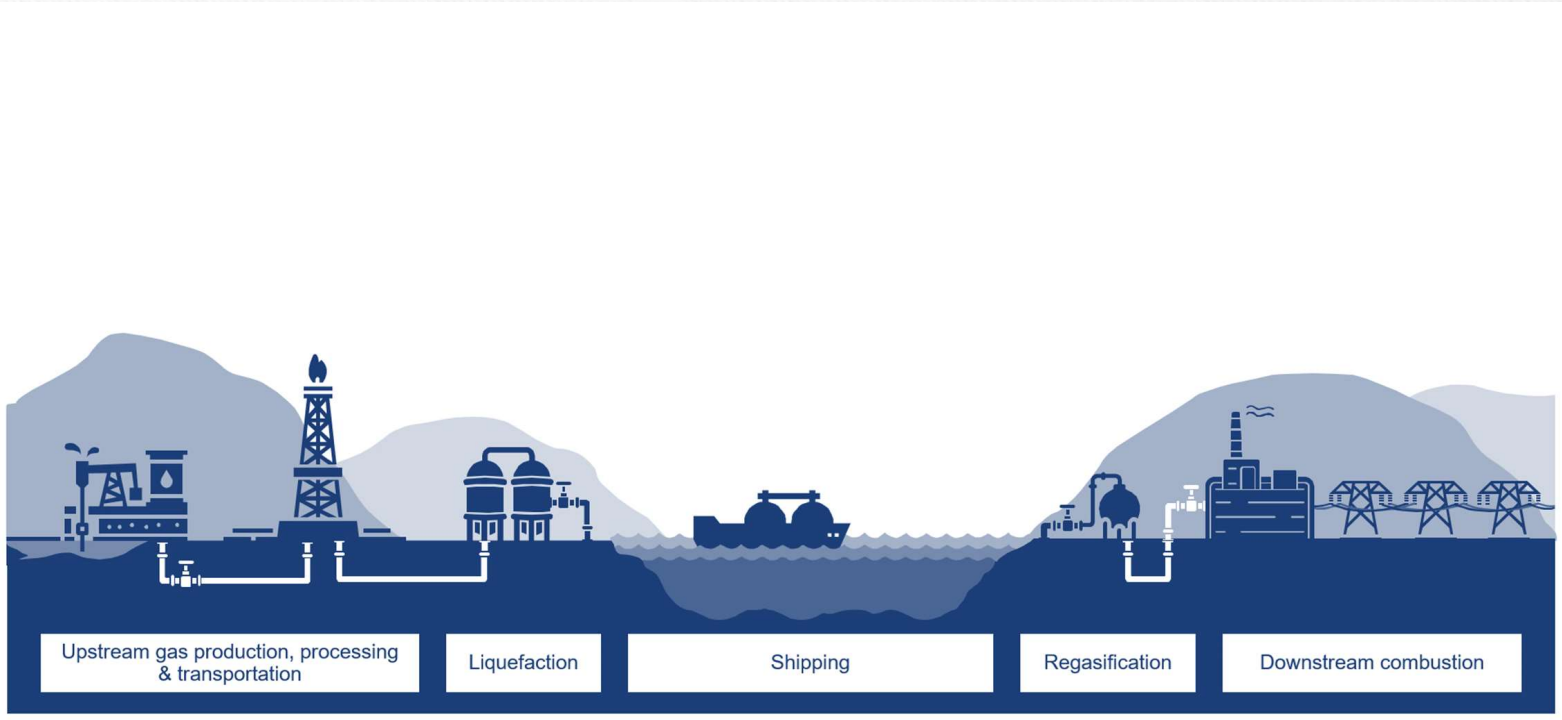


All figures in MMT

SECTION 5

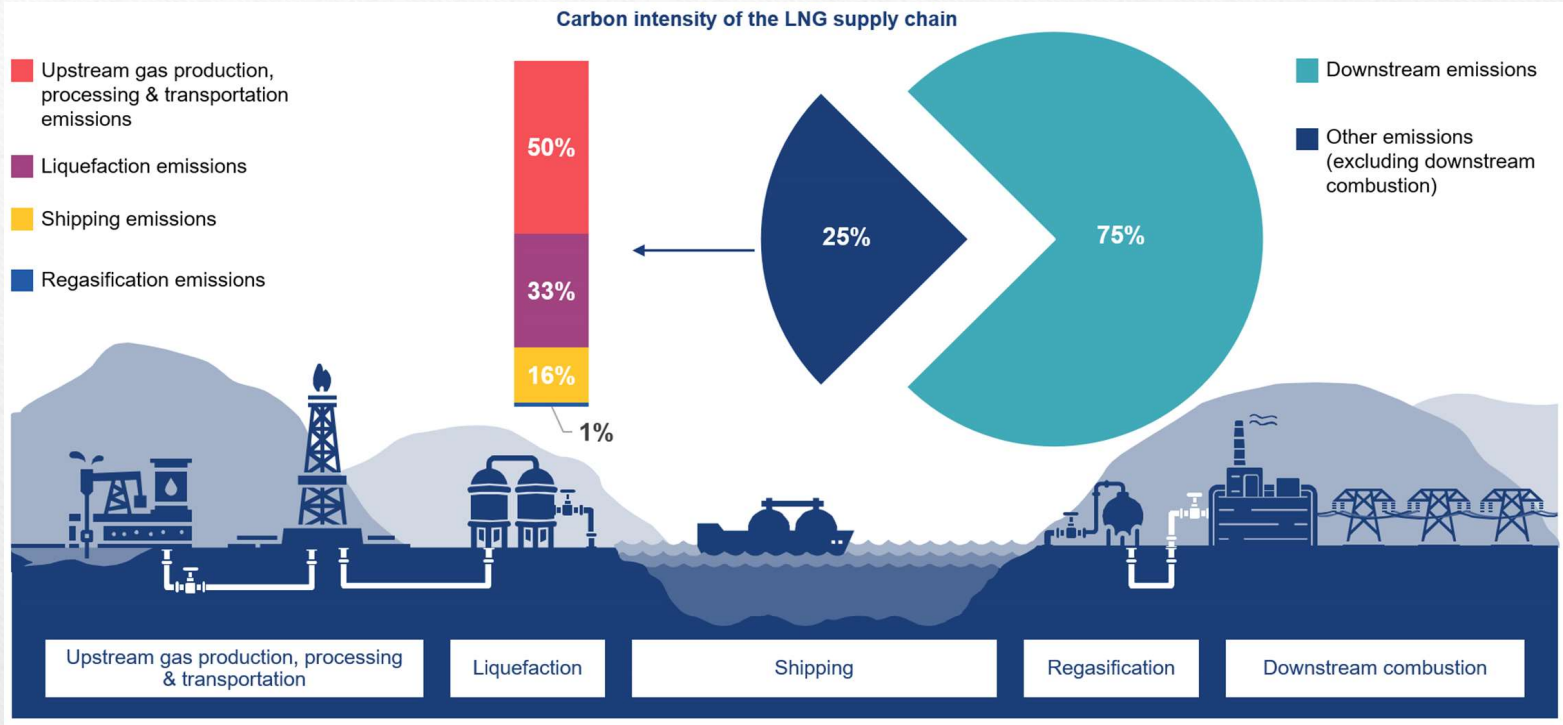
LNG Value Chain

LNG value chain



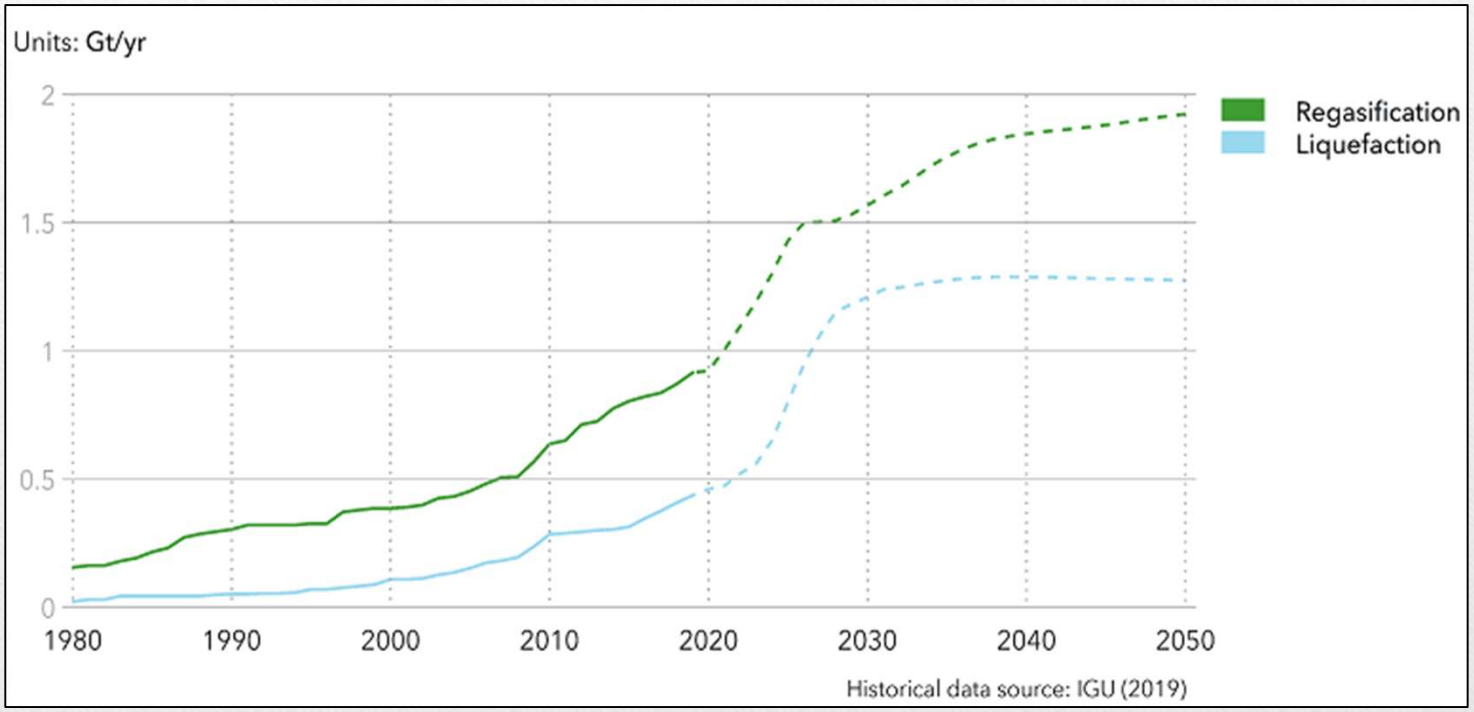
Source: Sphera, GHG Intensity of Natural Gas Transport (2017); GIIGNL, LNG carbon offsetting (2020)

LNG value chain *Contd..*



Source: Sphera, GHG Intensity of Natural Gas Transport (2017); GIIGNL, 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

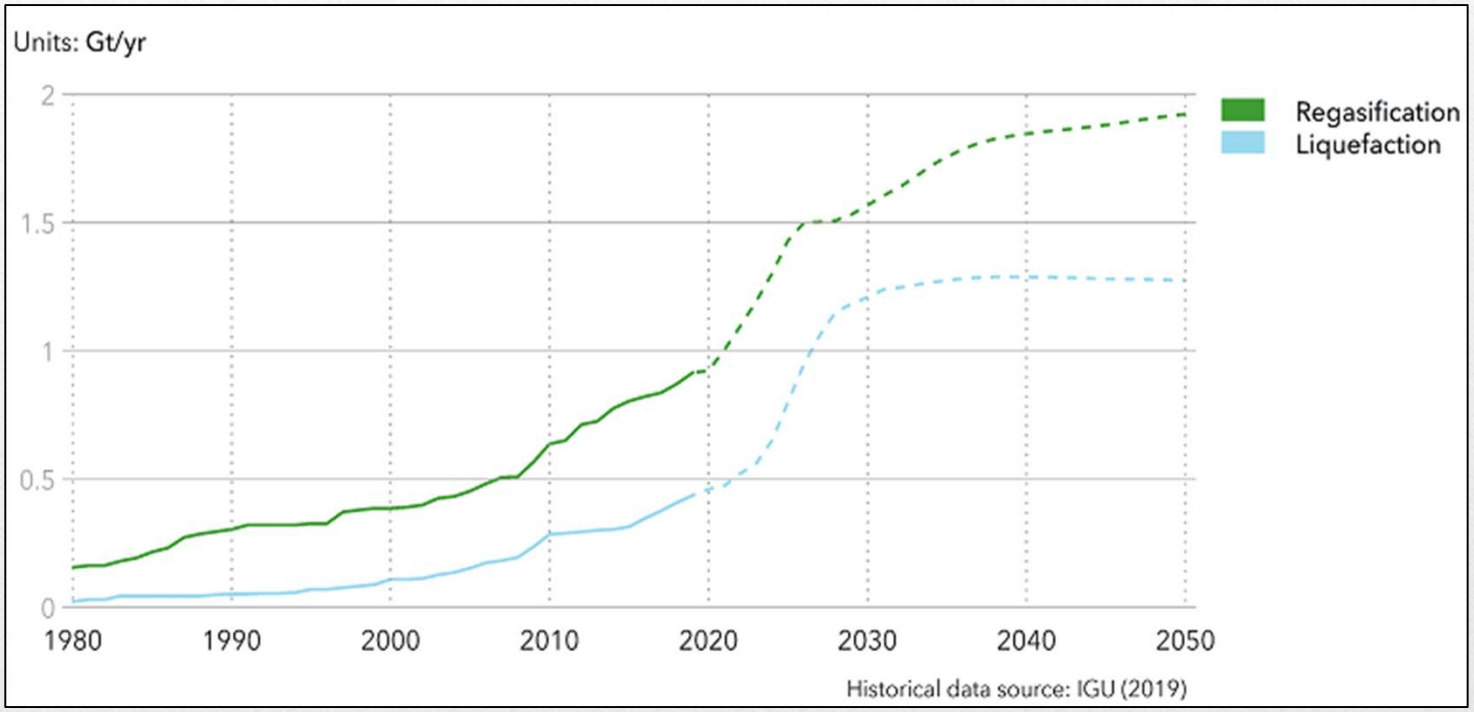
SECTION 6

Liquefaction Process

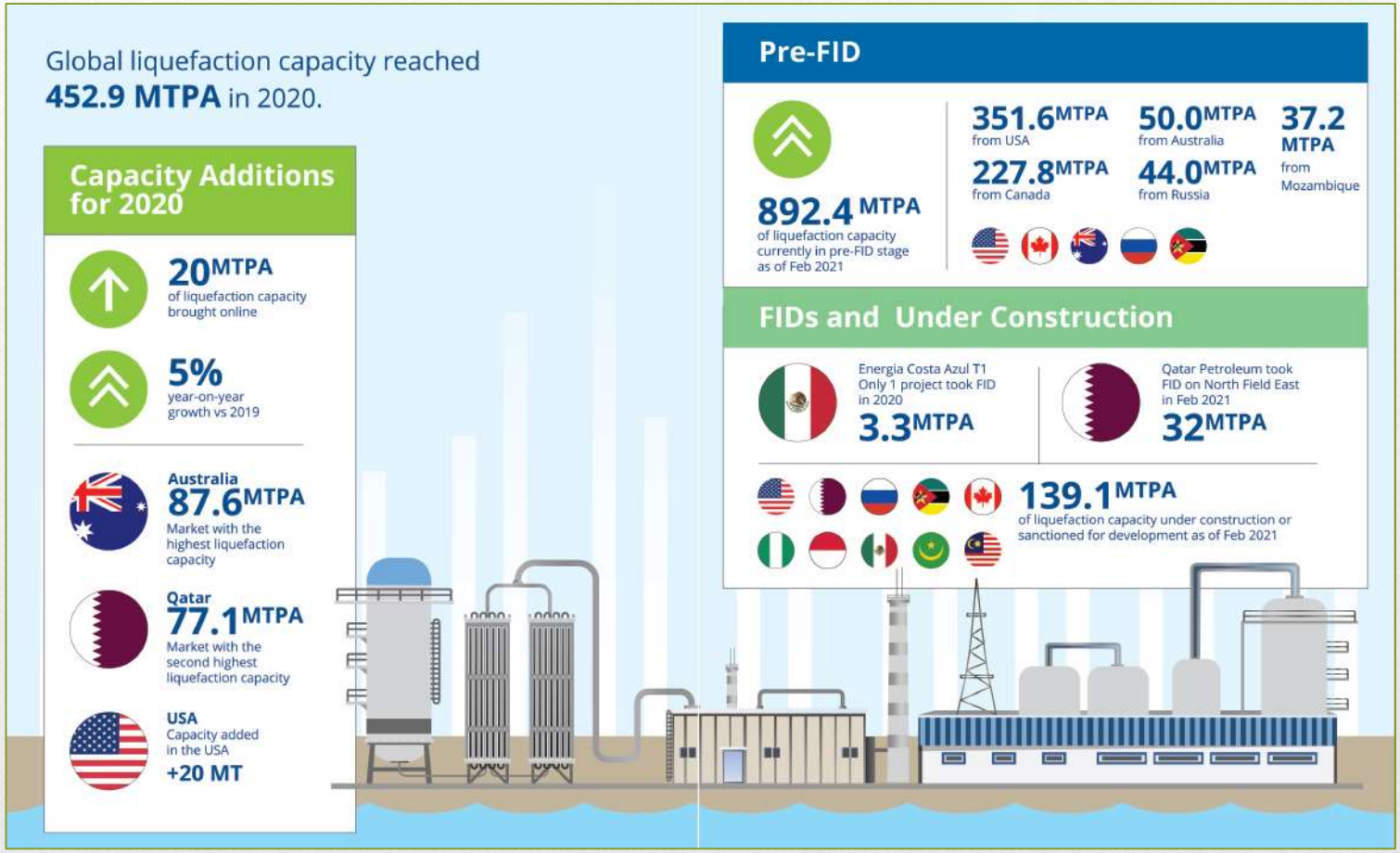
Liquefaction

- 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



World Liquification Capacity *contd..*

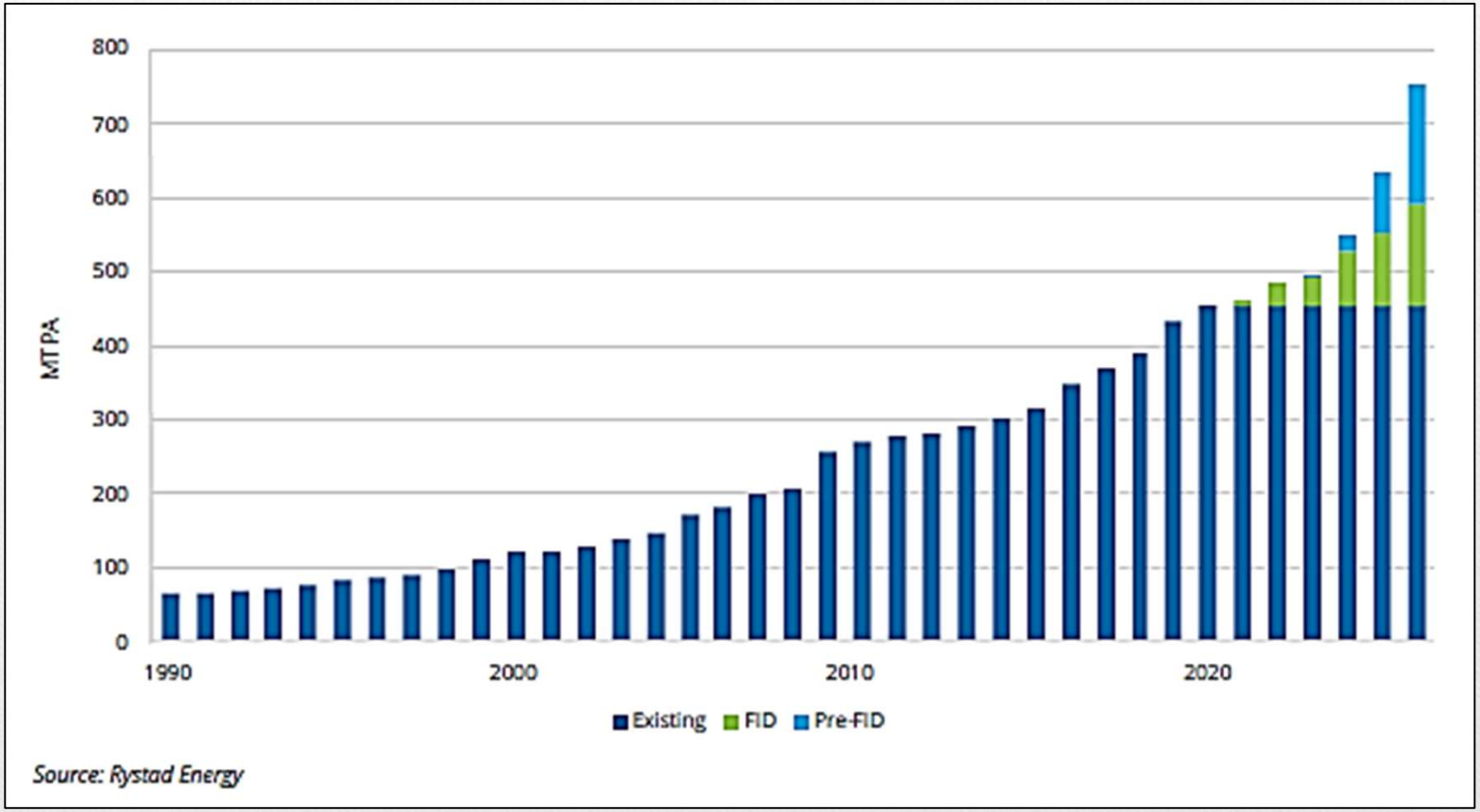


Source: GIIGNL

World's Top LNG Producing Countries

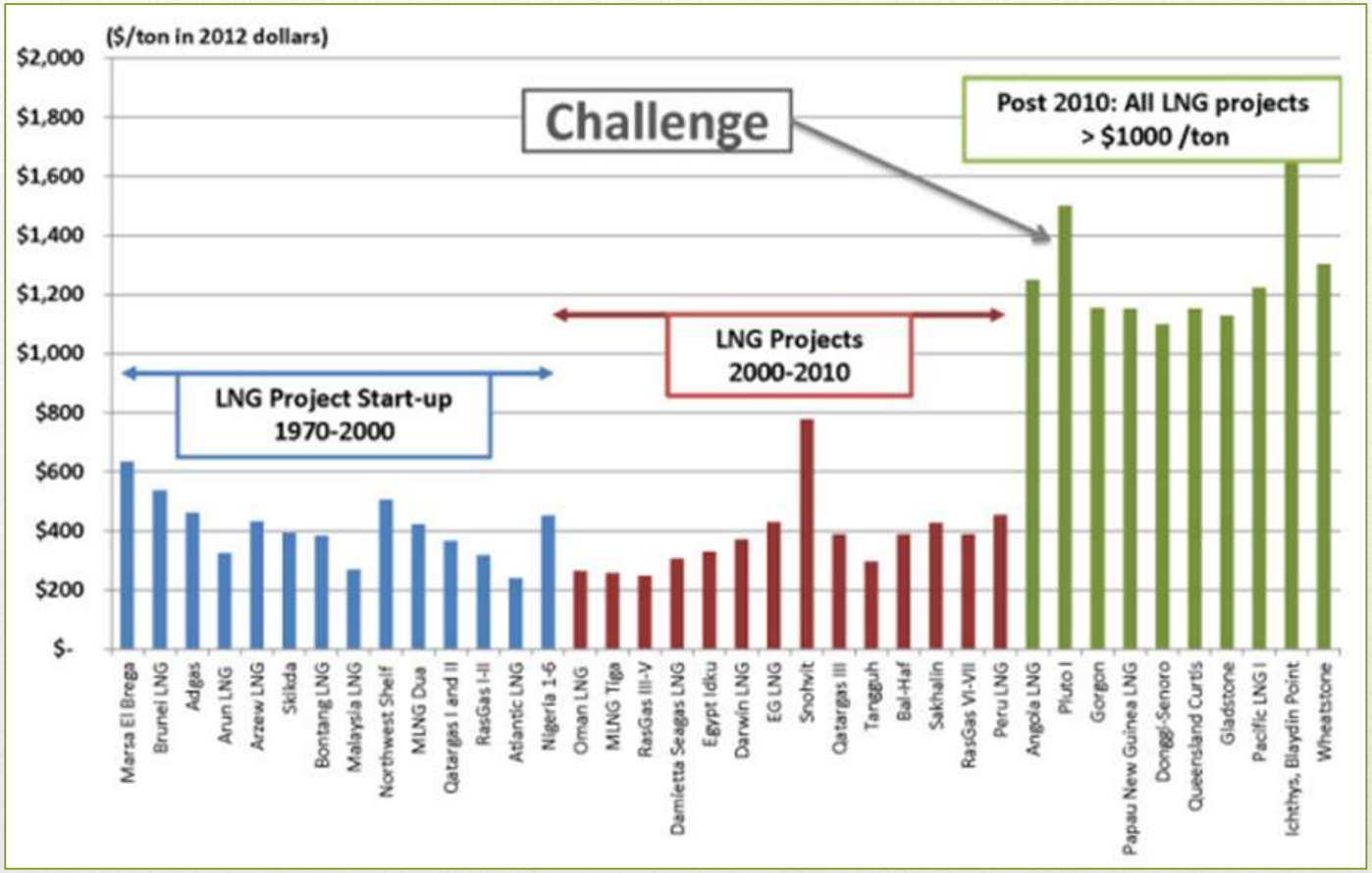
Country	Million Ton	Market Share %
Australia	77.8	22
Qatar	77.1	22
USA	44.8	13
Russia	29.6	8
Malaysia	23.9	7
Nigeria	20.6	6
Indonesia	15.0	4
Algeria	10.6	3
Trinidad & Tobago	10.1	3
Oman	9.8	3
Papua New Guinea	8.3	2
Angola	4.6	1
Peru	3.8	1
Norway	3.2	1
Equatorial Guinea	2.6	1

World Liquification Capacity



Capex Analysis of Liquefaction Plants

$/Ton of LNG Capacity

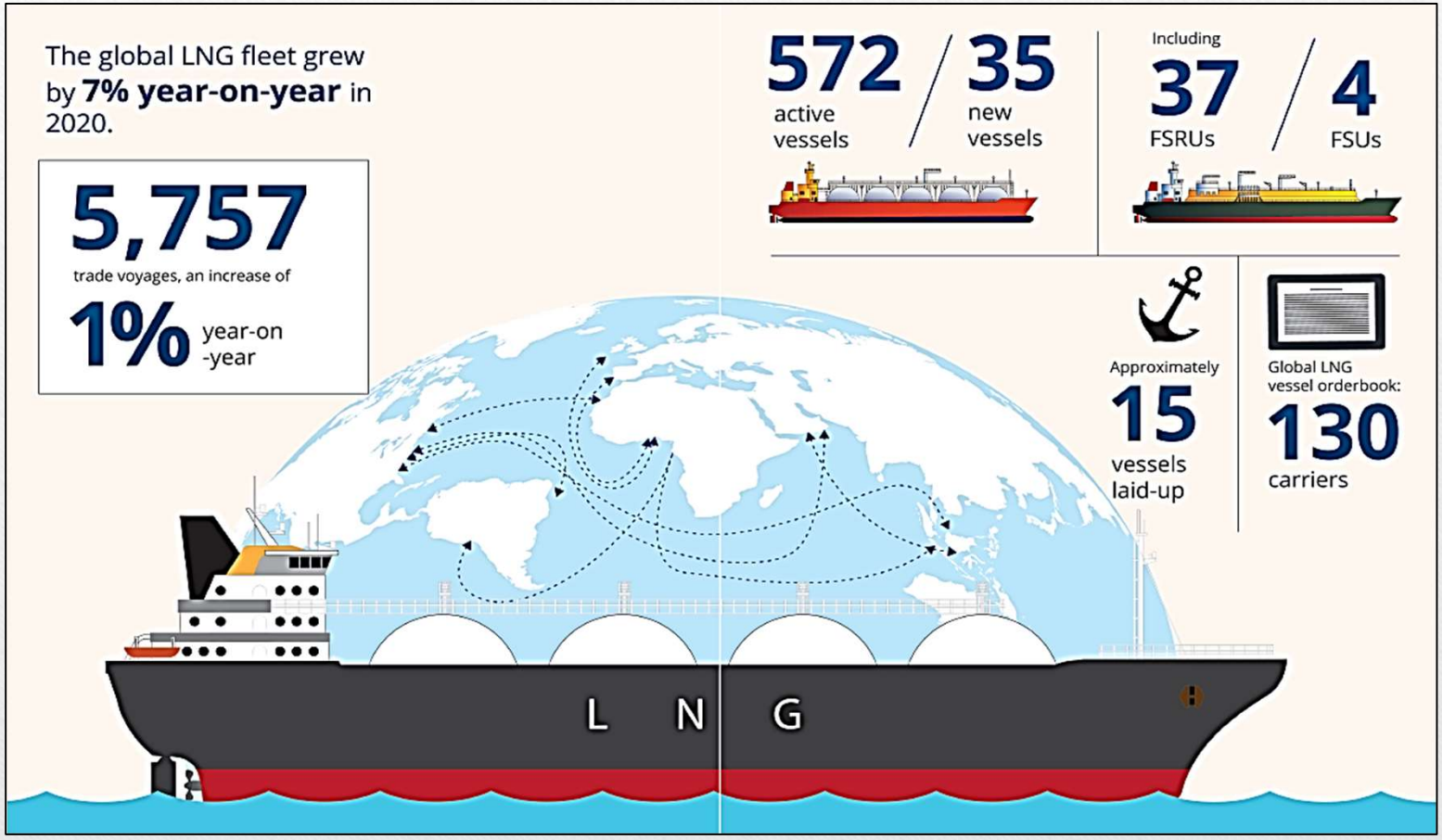


Source: Apache from Public Data

SECTION 7

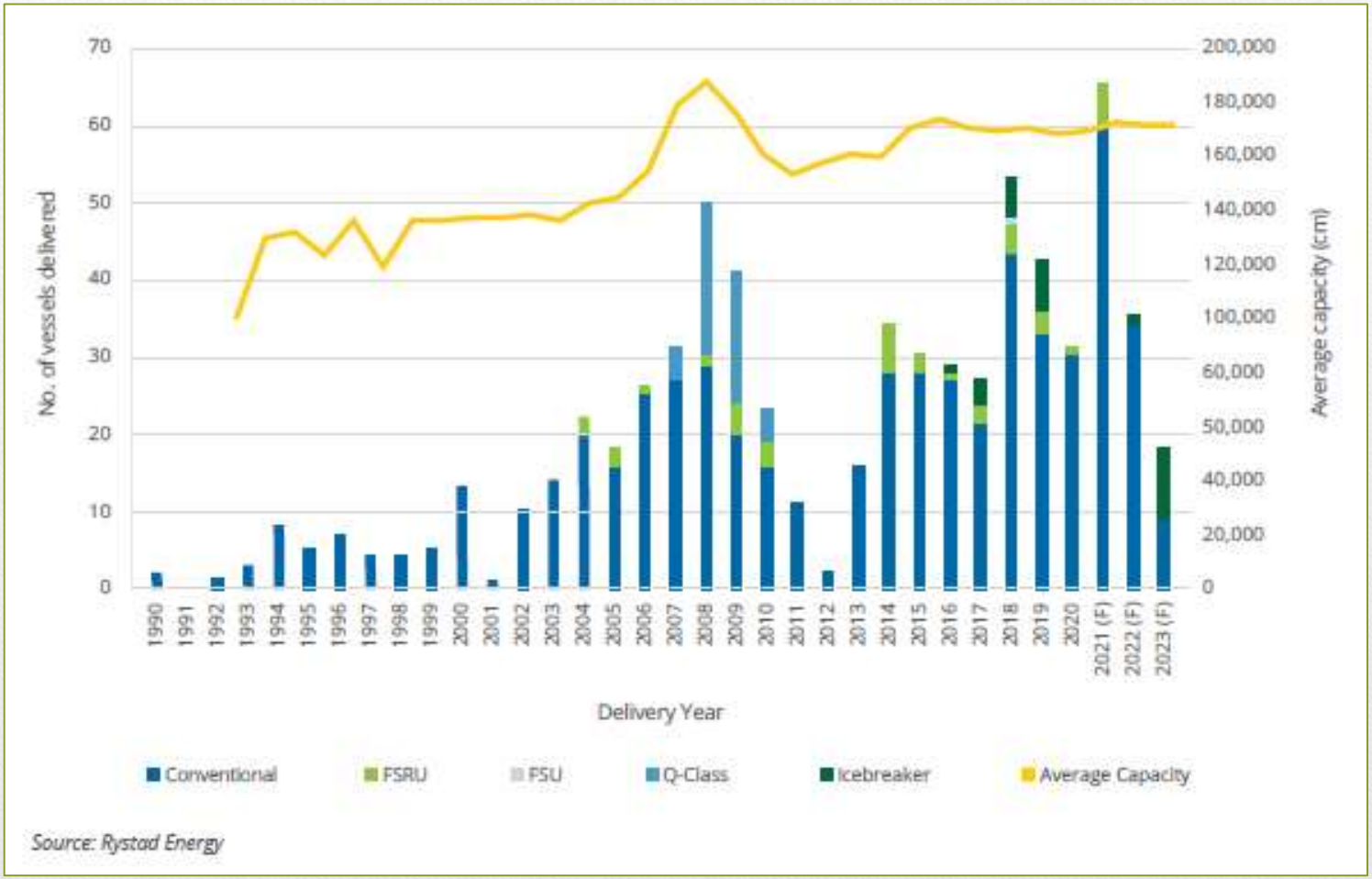
LNG Shipping

LNG Shipping



Source: IGU

LNG Ships & Capacity

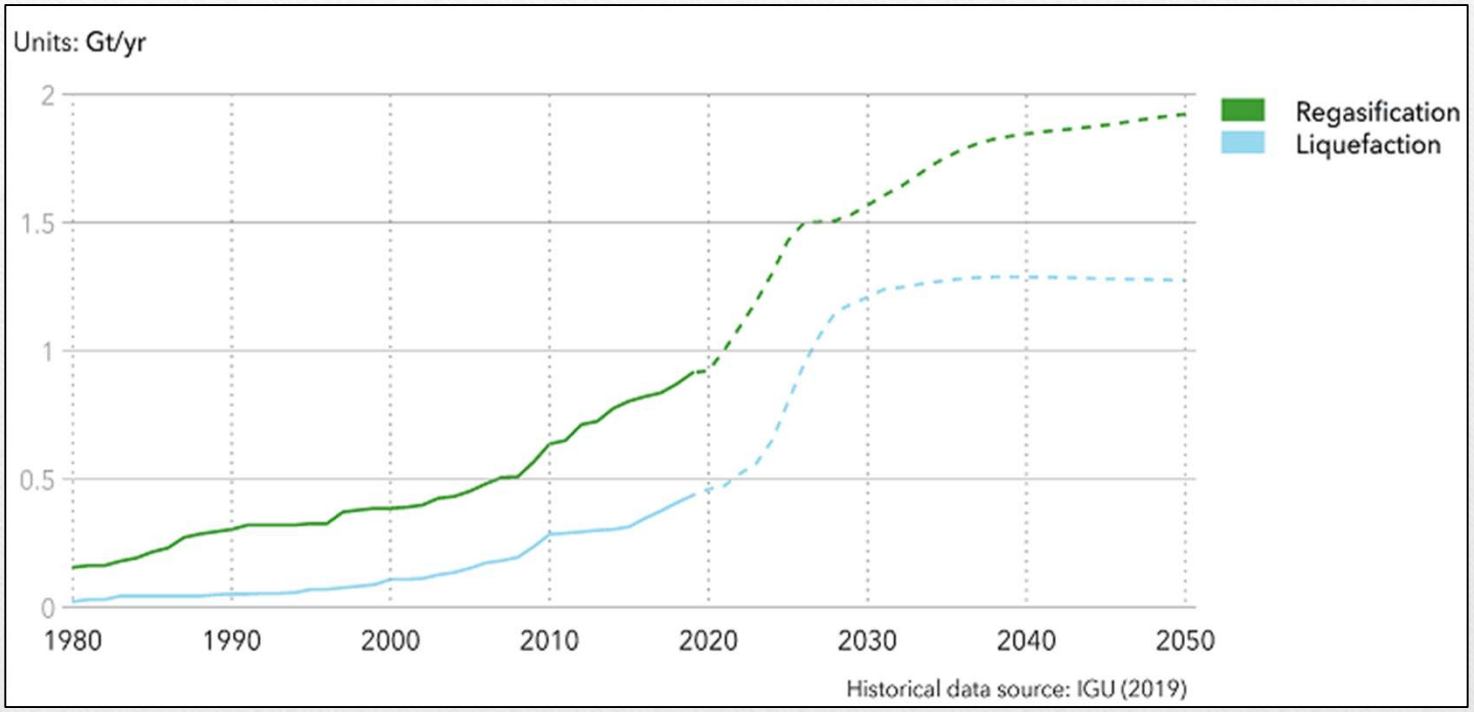


Source: Rystad Energy

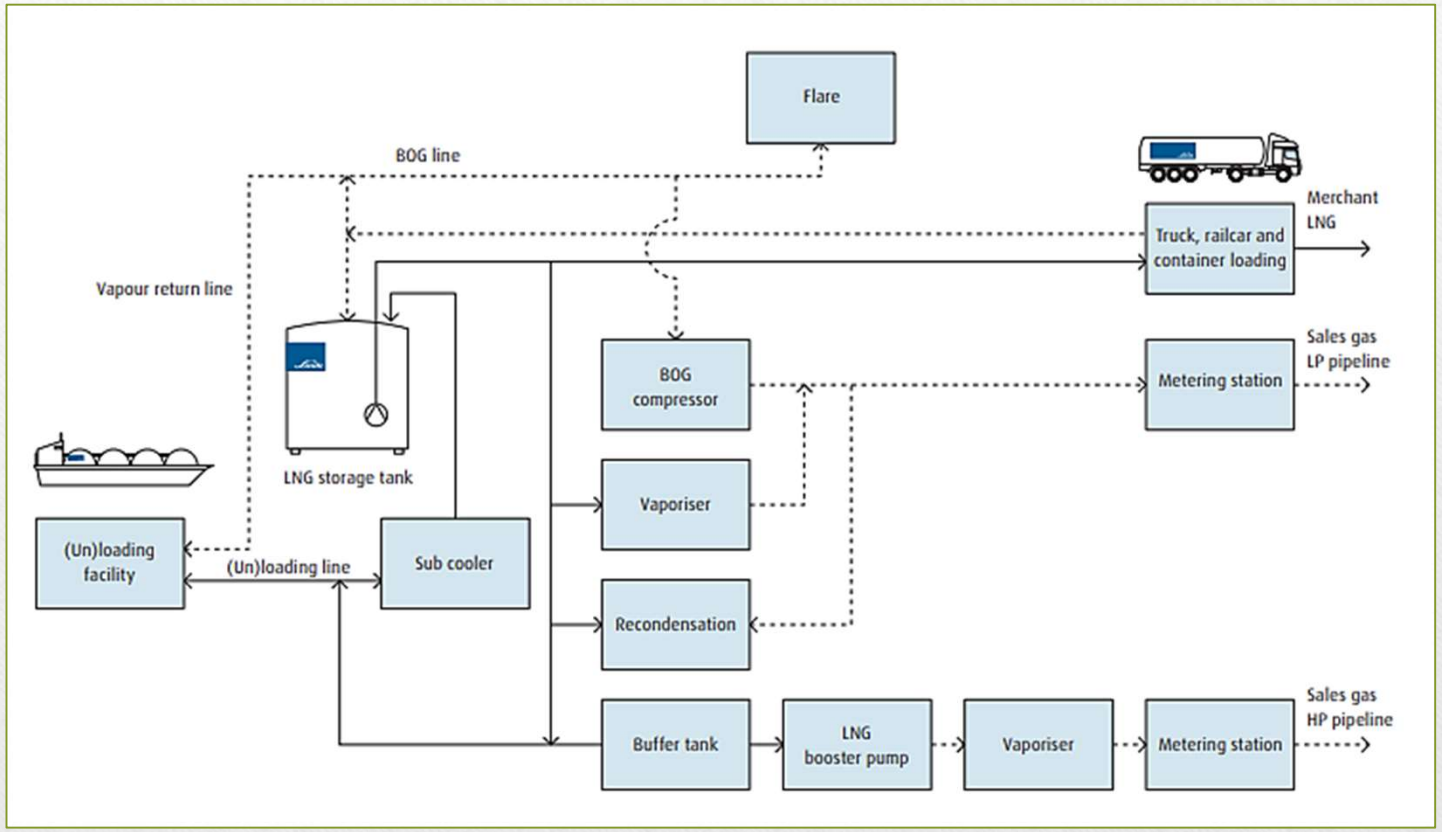
SECTION 8

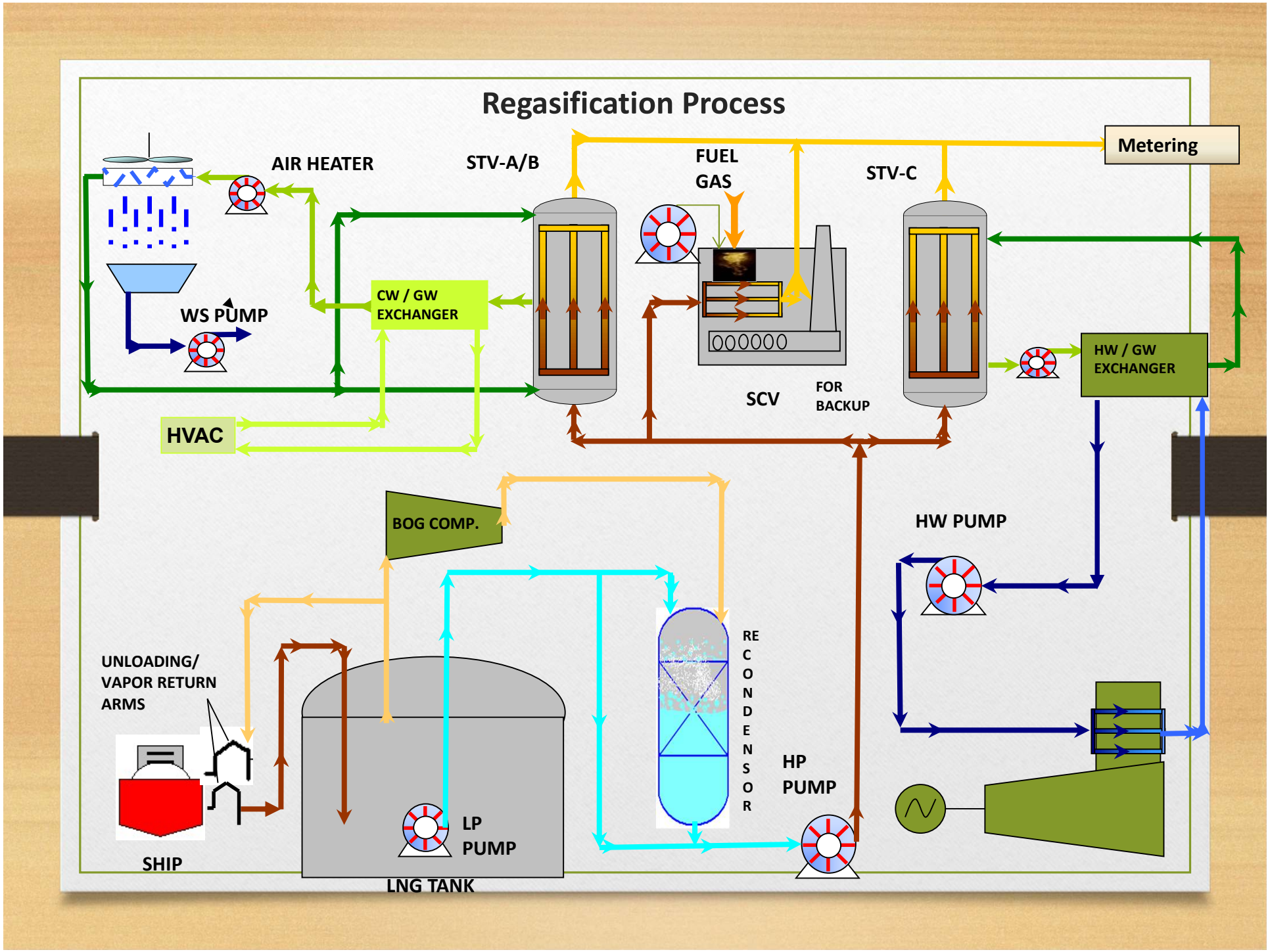
Regasification

World LNG Liquefaction & Regas capacity

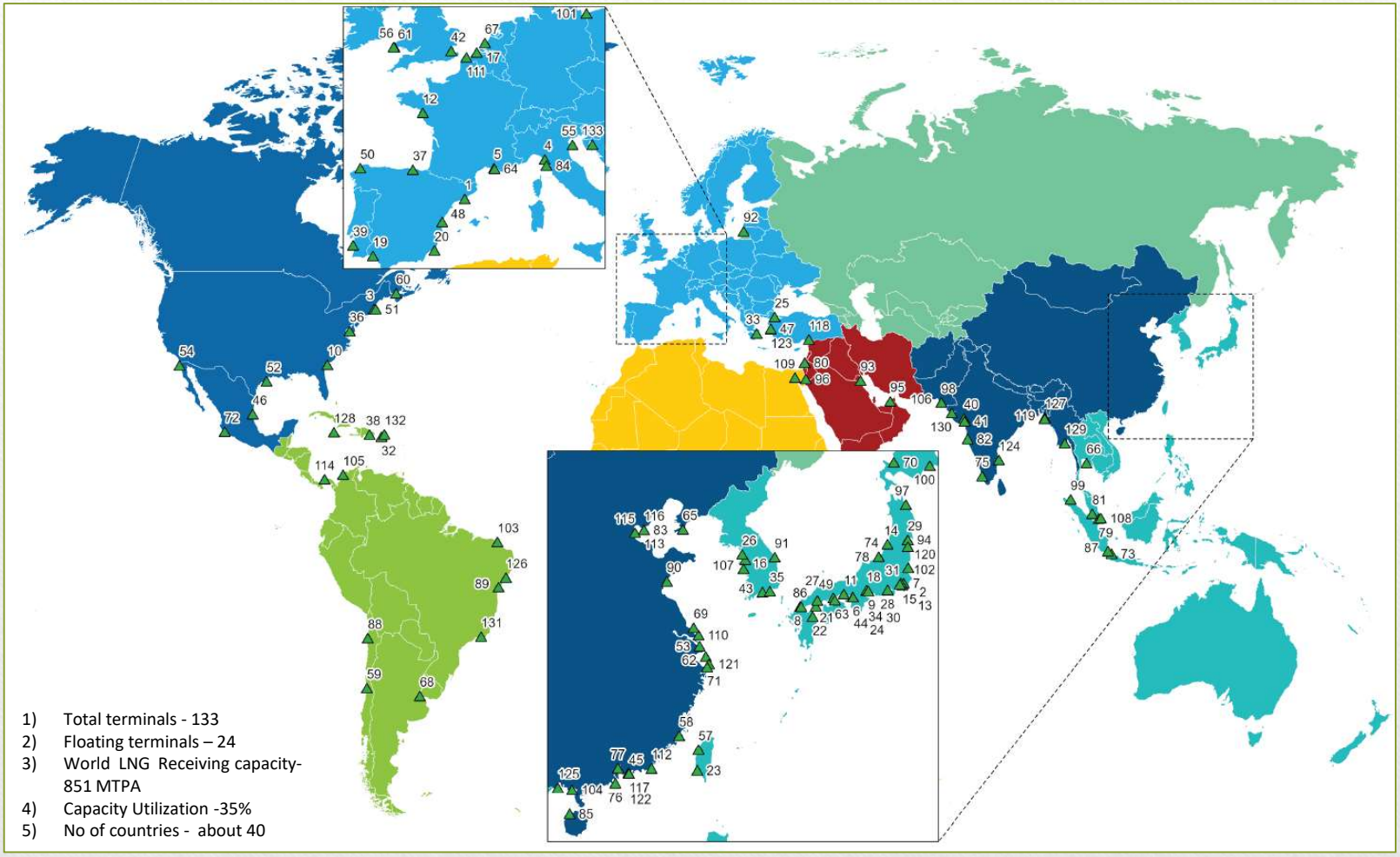


Typical Layout of a Receiving Terminal




Regasification Process
AIR HEATER
STV-A/B
FUEL GAS
STV-C
Metering
WS PUMP
CW / GW EXCHANGER
HVAC
SCV
FOR BACKUP
HW / GW EXCHANGER
BOG COMP.
HW PUMP
UNLOADING/ VAPOR RETURN ARMS
RECONDENSOR
HP PUMP
LP PUMP
SHIP
LNG TANK

World's LNG Receiving Terminals

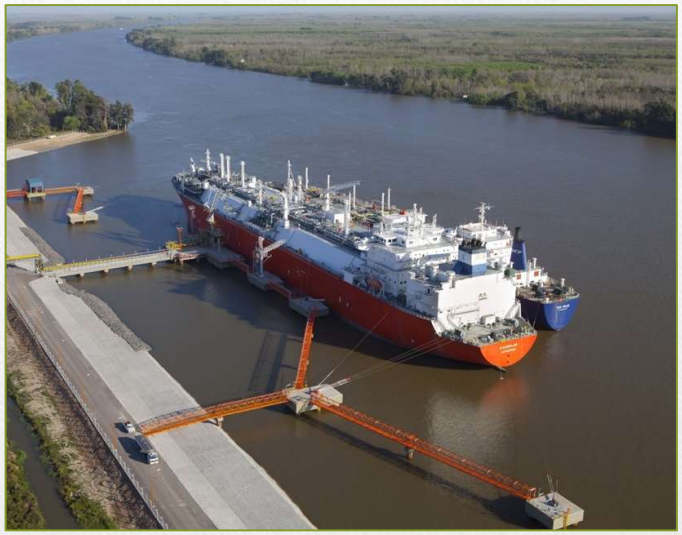


1) Total terminals - 133
2) Floating terminals – 24
3) World LNG Receiving capacity- 851 MTPA
4) Capacity Utilization -35%
5) No of countries - about 40

World's Top LNG Importing Countries

Country	Million Ton 2019	Million Ton 2020	Market Share %
Japan	76.87	74.43	21
China	71.68	68.91	19
South Korea	40.14	40.81	11
India	23.98	26.63	7
Chinese Taipei	16.66	17.76	5
Spain	15.72	15.37	4
UK	13.55	13.43	4
France	15.57	13.06	4
Turkey	9.37	10.72	3
Italy	9.77	9.07	3
Pakistan	8.10	7.42	2
Thailand	5.00	5.61	2
Netherland	5.79	5.33	1
Bangladesh	4.07	4.18	1
Portugal	4.12	4.07	1

Floating Storage and Regasification Unit (FSRU)



A Floating Storage & Regasification Unit (FSRU) serves

the same purpose as a land based Regasification terminal

Picture courtesy Excellerate Energy

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

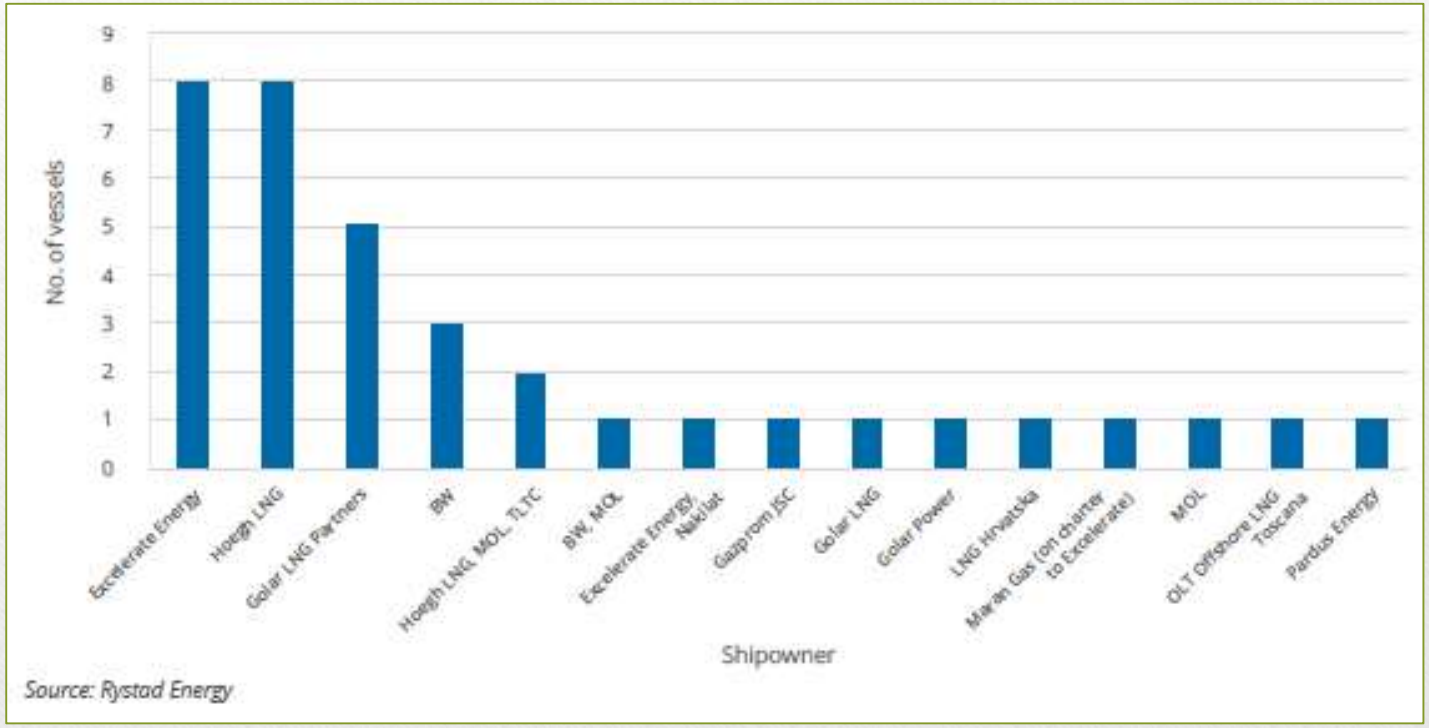
- 74% of LNG fleet is membrane type
- ‘Sloshing’ issues
- Lower Fuel Consumption
- Better maneuverability

Inside LNG Containment Tank

FSRU vs Land Based Terminal

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

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

Group 1	Group 2	Group 3	Group 4
Gas-on-gas markets	**Prices indexed to substitute energy prices**	**Oil-linked price markets**	**Regulated markets**
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 - on - Gas Pricing

- 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

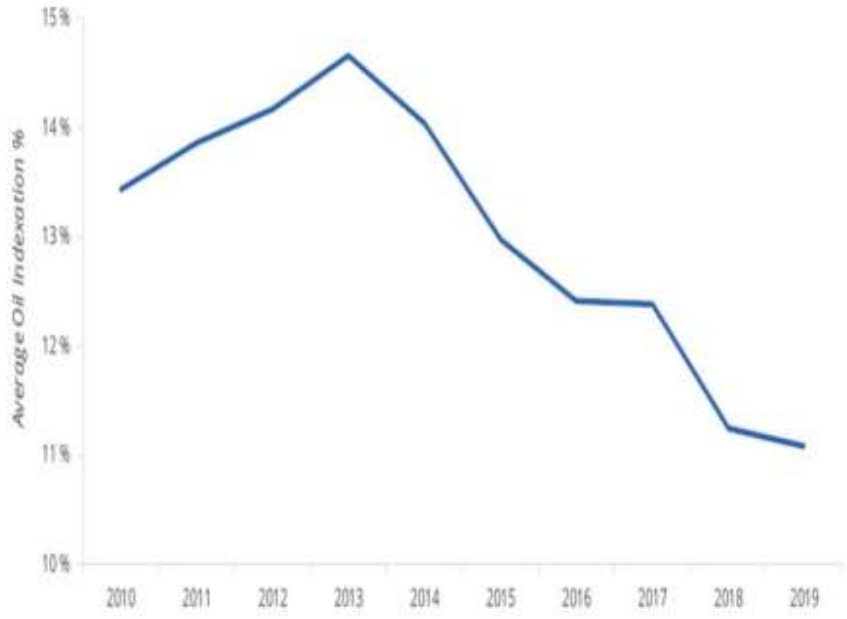
- Such pricing mechanism is practiced in areas having limited gas grid and emerging gas trading market viz Central & South Europe and South Africa. Larger part of the gas remains priced linked to Oil products (Diesel, Kerosene), Coal, Electricity under long term contracts
- As a result of weakening / 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 Chine, 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

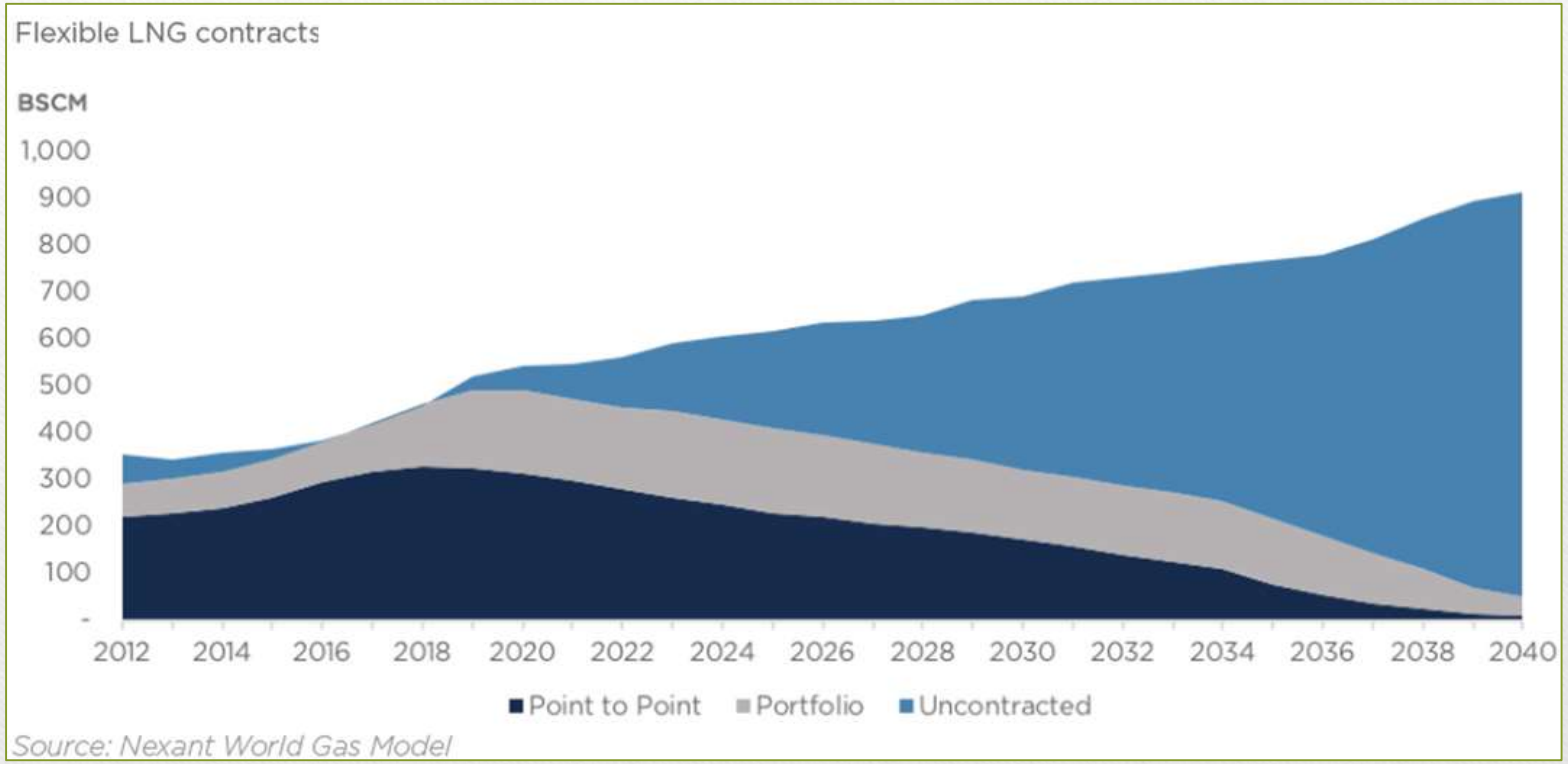
Gas Pricing Mechanism & World Total Gas Consumption

BCM

Region	Total Consumption								
	OPE	GOG	BIM	NET	RCS	RSP	RBC	NP	TOT
North America	0.0	1,057.7	0.0	0.0	0.0	0.0	0.0	2.6	1,060.3
Europe	106.2	428.9	0.0	0.0	0.0	1.6	0.0	0.0	536.7
Asia	299.0	102.7	4.4	0.0	65.9	0.2	1.1	0.0	473.2
Asia Pacific	245.4	96.6	2.3	0.0	4.5	34.2	0.0	4.0	387.1
Latin America	41.0	34.1	4.2	11.5	14.1	25.5	17.6	1.1	149.2
FSU	6.8	191.9	32.4	0.0	224.9	73.6	102.8	0.0	632.3
Africa	8.2	11.9	8.1	0.0	31.4	5.2	98.3	0.8	163.9
Middle East	24.9	21.7	78.1	0.0	7.5	395.4	12.6	0.1	540.4
Total	731.6	1,945.5	129.5	11.5	348.3	535.7	232.4	8.7	3,943.1

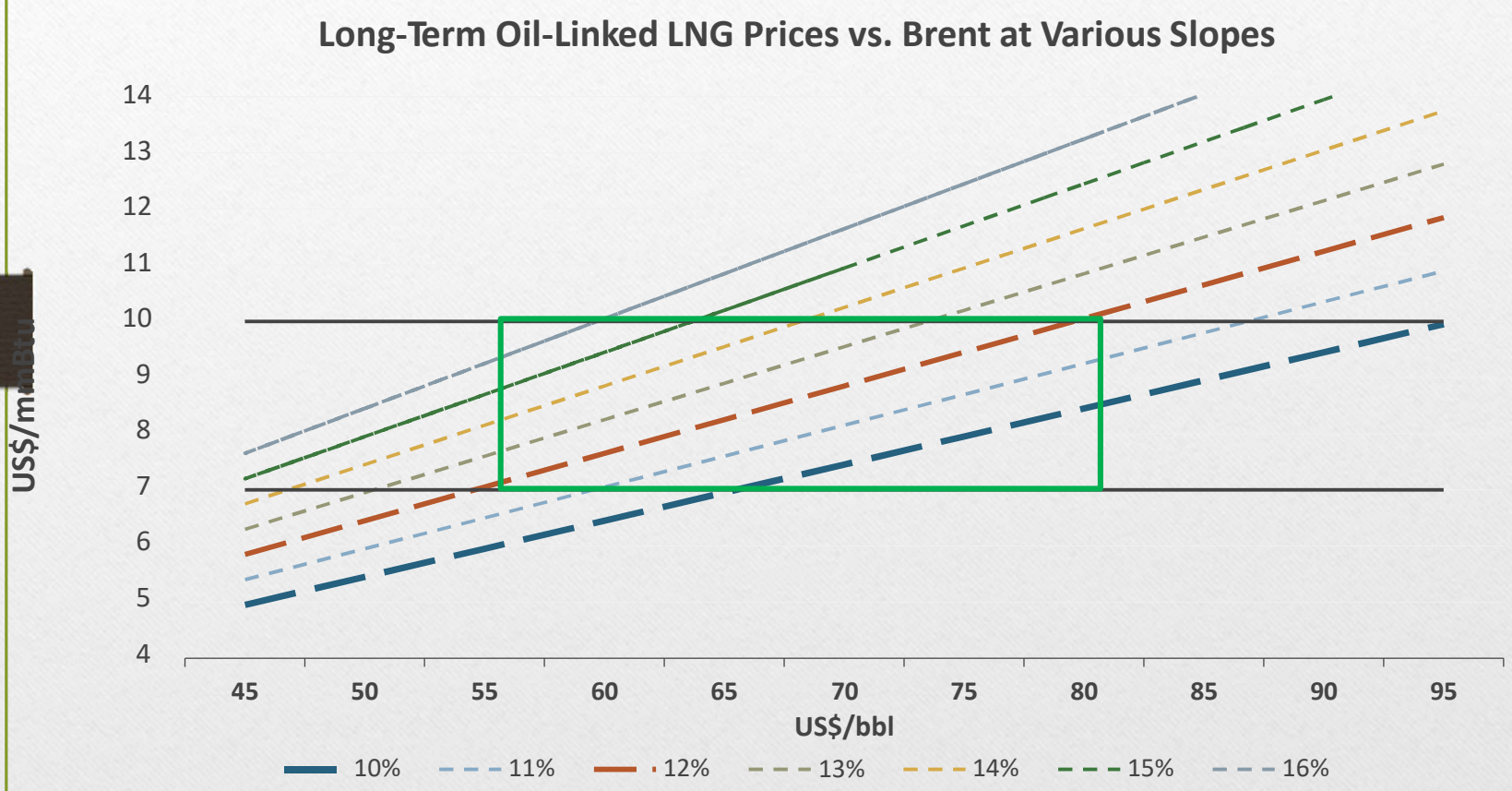
1. OPE Abcd
2. GOG Efgh
3. BIM Ijkl
4. NET
5. RCS
6. RSP
7. RBC
8. NP

Gas / LNG Contracts



Comparative Analysis of Gas Prices in selected Global Markets

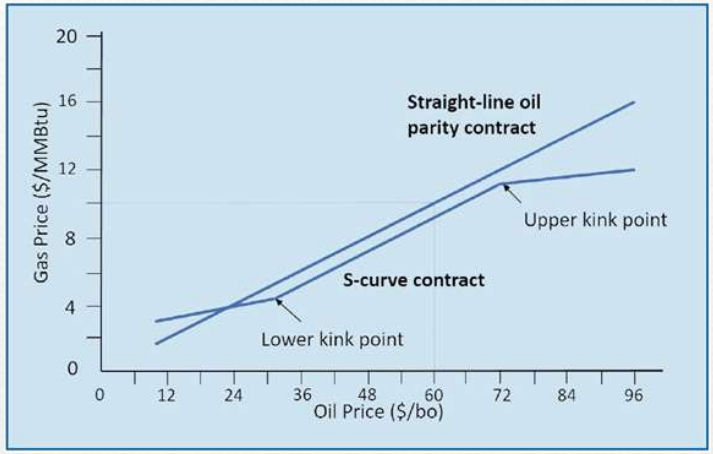
Long term LNG Pricing



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, 6months, 12 months

Risk mitigation in Gas Price Volatility : S-Curve



- 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 1Bo 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: Plng: A*PCrude 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

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.

LNG Sales & Purchase Agreements

- 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

LNG Sales & Purchase Agreements

- 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
  - Governing laws of LNG SPA – Laws of England, New York or Singapore
  - 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

Regulatory Framework : LNG Business

- 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

Gas Hubs & Exchanges

- 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

Gas Hubs & Exchanges

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 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