Towards recovery and shared prosperity;

Natural gas opportunities for a sustainable world.

IEF-BCG Background Materials Session 2
Panel Session 2:
Market Signals & Policy Pathways:
Investment and Innovation on the Road to Recovery
Disclaimer

The observations presented herein are meant as background for the dialogue at the 7th IEF-IGU Ministerial Gas Forum hosted by the government of Malaysia. They have been prepared in collaboration with Boston Consulting Group and should not be interpreted as the opinion of the International Energy Forum or Boston Consulting Group on any given subject.
Market Context

- The Global LNG market is heavily affected by the COVID-19 pandemic, with mixed mid-term outlooks, but strong long-term market fundamentals for gas growth.
- Gas is expected to play a key role in energy transition but requires collaboration and support.

Session Objectives

Review market conditions and new policy pathways that affect investment in gas demand and supply, research and development and new technologies.

Key Questions

COVID-19 Impact on Investments and LNG market conditions

- How much investment in natural gas E&P and infrastructure is deferred due to COVID-19?
- Is there risk that a supply gap or bottle neck will increase market volatility on the short-, to medium-term?

Lesson learnt and path forward

- How can gas trading hubs facilitate further regional cooperation and gas market integration in Asia?
- Natural gas market share will grow in Asian markets but may well recede in Europe under Paris Agreement pledges and net zero policies announced after the pandemic.
- What lessons if any can be drawn from Europe and other world regions or are Asian gas markets unique?

Carbon management

- Which carbon management approaches (ETS, taxation, technology, standards) best support the industry?
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COVID-19 Impact on Investments and LNG Market Conditions
Impact of current events on additional capacity planned to come on-line by 2020-2025 split into four categories (I)

- **Assets ramping up or under construction**: c. 62 Mtpa
  - Limited risk of delays in assets operating in 2020; additional delays can be expected for assets to be commissioned by 2021-2022
    - Assets expected to come on-line in 2020 have their future revenues locked in through LT contracts (hence limited exposure to today’s commodity volatility), and final construction phase requires smaller workforces limiting impact of COVID-19

- **Projects with FID taken to date**: c. 48 Mtpa
  - Assets planned to finish construction in 2021-22 could be delayed due to (i) COVID pandemic limiting working at full-capacity (i.e. workforce reduction due to infection spread, lack of raw material due to limitations in global trade, etc.) and (ii) if large LNG volumes are still uncommitted: e.g. integrated projects, with high upstream investments and equity offtake
  - Under-construction assets starting production in 2023-25 more likely to ease COVID short-term impact

- **Qatar’s expansion**: c. 44 Mtpa
  - Material risk of delay, particularly on projects with offtake not fully committed to date
    - Assets that already have all offtake fully committed should experience limited risk of delay
    - Upcoming very low LNG price environment and demand contraction likely to delay projects with uncertain offtake or financing
      - Increasing liquidity in 2020-2021 will make it even harder for these projects to secure extra offtake through LT contracts

- **Projects with no FID taken to date**: ~100 Mtpa on pipeline
Impact of current events on additional capacity planned to come on-line by 2020-2025 split into four categories (II)

- **Assets ramping up or under construction**
  - c. 62 Mtpa
  - Limited risk of delays in assets operating in 2020; additional delays can be expected for assets to be commissioned by 2021-2022

- **Projects with FID taken to date**
  - c. 48 Mtpa
  - Material risk of delay, particularly on projects with offtake not fully committed to date

- **Qatar's expansion**
  - c. 44 Mtpa
  - Current market environment may push first phase of Qatar’s expansion beyond 2025
    - Phase 1, initially planned for 2024, has been delayed by up to six months by the coronavirus pandemic hindering the bidding process for potential partners, which might drag start up date after 2025

- **Projects with no FID taken to date**
  - ~100 Mtpa on pipeline
  - Most projects with initially planned FID in 2020 have already announced delays on FID decision
    - Projects owned by infrastructure developers are having difficulties to secure financing in current market environment
    - Projects owned by E&P players have been forced to reduce CAPEX due to low oil prices
    - Additional competition driven by large expiration of LT contracts linked to existing assets (~140 Mtpa), if LNG demand does not catch up
Current events could now lead to ~10-15 Mtpa reduction in capacity scenarios by 2023 and 50-60 Mtpa by 2025.

Comparison of Pre-COVID liquefaction capacity base scenario and revised base case

<table>
<thead>
<tr>
<th>Year</th>
<th>Pre-COVID liq. Scenario - Base case</th>
<th>Revised liq. Scenario - Base case</th>
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<tr>
<td>2019</td>
<td>428</td>
<td>428</td>
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<tr>
<td>2021</td>
<td>459</td>
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<td>2023</td>
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<td>2025</td>
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Revised perspectives on Global LNG liquefaction capacity by 2025 indicates ~30-50 Mtpa lost growth

<table>
<thead>
<tr>
<th>Low LNG Liq. capacity scenario</th>
<th>Base LNG Liq. capacity scenario</th>
<th>High LNG Liq. capacity scenario</th>
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<td>2025  486</td>
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<td>2025  564</td>
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- Potential delay of projects that were planned to be commissioned by 2020, but start not after 2021
- 2-years delay of all projects under construction and for those with FID taken
- Qatar expansion happening after 2025
- No non-FID projects coming on-line between 2020-2025

- Potential delay of projects that were planned to be commissioned by 2020, but start not after 2021
- 1-year delay of all projects under construction and for those with FID taken
- ~8 Mpta of Qatar’s expansion before 2025
- No non-FID projects coming on-line between 2020-2025

- Potential delay of projects that were planned to be commissioned by 2020, but start not after 2021
- No delay for projects under construction,
- Some projects with FID taken delayed to start production after 2025
- 25 Mtpa of Qatar’s expansion before 2025
- ~15 Mtpa non-FID projects coming on-line between 2020-2025

Legend: No FID taken | Qatar expansion | FID taken | Ramping up or under construction | Operating in 2019 | Pre-COVID liq. Scenarios
US playing a key role balancing the market in the short run

US LNG netbacks are now negative to both Europe and Asia

US LNG exports utilization likely to remain low as the global market remains over-supplied

2019-present estimated US GOM netbacks ($/MMBTU)

Projected LNG exports (BCF/D)

1. Calculated as NEA spot minus (1.15*Henry Hub + shipping costs) 2. Calculated as TTF minus (1.15*Henry Hub + shipping costs)

Source: US EIA, Argus, Bloomberg, press reports, BCG analysis
Market likely to still be oversupplied in 2025

(Mtpa)

Supply scenario

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Undersupply

Oversupply
LNG suppliers adjusting to lower-for-longer demand by reducing liquefaction output & delaying projects

Drop in utilization of liquefaction terminals, particularly exacerbated in the US

Evolution of utilization of liquefaction facilities

No FID on new developments taken to date, not happening since 1998
Evolution of capacity of FIDs projects per year (2014-2020 YTD)

Source: BCG LNG market model
Lessons Learnt and Path Forward
Market liberalization could benefit contract origination, although specific local skills are required to succeed

Example: Opening of Korean gas & LNG market could create interesting opportunities for sellers

- Current regulated tariffs mainly reflects KOGAS basket of long-term supply contracts resulting into uncompetitive prices versus cheap spot LNG cargoes
- Several large buyers are waiting for expiration of their wholesale contracts with KOGAS to import directly, although regulation does not facilitate direct imports

- Restrictive regulation and lack of open third party access to LNG and gas infrastructure is incentivizing new regas developments
- Korean government has set 2025 as date to start allowing reselling LNG for volumes beyond KOGAS contracts
  - Up to 9MTPA of volumes to compete in the liberalized market post 2025 due to large KOGAS contracts expiring

Source: Press research; BCG Analysis
~190 bcma linked to legacy contracts expected to expire by 2025, half of those relate to contract supplying Asia.
Increasing difficulty to find counterparts for new long-term contracts.

Source: Cedigaz; Press research; BCG Analysis
Greater market liquidity and volatility driving value from trading and optimization

- LNG market liquidity continues to increase, along with greater spot market volatility
  - Spot and short-term now ~30% of the global market
  - Spot prices ranged from $12 to <$2/MMBtu in the past 2 years

- Trading and portfolio optimization is delivering greater value in this environment
  - Development of financial instruments enabling greater trading
  - Time and location-based arbitrage are both more viable and higher value

- Given the market context, competitors are continuing to shift to a portfolio model
  - Midstream market is increasingly consolidated
  - Other Majors are moving toward a portfolio model combining origination with commercial optimization

### Rapid growth in spot and short-term trade

Global volume of spot/short term LNG trade

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<th>Year (Jan)</th>
<th>ICE+CME cleared volume (Mtpa)</th>
<th>End month open interest</th>
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### Strong growth in JKM derivatives market over the past years, expected to continue

Growth in Platts JKM derivatives supported by spot liquidity and LNG indexation (K LOTS)
LNG market shifting toward more gas-on-gas pricing ...

Price formation for LNG Imports transitioning towards liquid price signals

% WW LNG imports

- 2005: 86%
  - Oil Price Escalation (Brent Indexed): 14%
  - Gas-On-Gas competition (HH, NBP, TTF etc.): 72%
- 2010: 71%
  - Oil Price Escalation (Brent Indexed): 29%
  - Gas-On-Gas competition (HH, NBP, TTF etc.): 42%
- 2015: 67%
  - Oil Price Escalation (Brent Indexed): 33%
  - Gas-On-Gas competition (HH, NBP, TTF etc.): 34%
- 2019: 59%
  - Oil Price Escalation (Brent Indexed): 41%
  - Gas-On-Gas competition (HH, NBP, TTF etc.): 18%

Three key drivers

Evolution of regulatory environment
- Development of TPA regulation
- Unbundling infrastructure companies from suppliers / retailers
- Power sector liberalization

Infrastructure development
- Continuous development of new infrastructure that, together with rules to allow third parties access, fosters competition

Increased access to new sources of supply
- Domestic production
- New pipeline routes
- US LNG

Source: IGU Wholesale Price Survey 2020
... along with continued growth of spot and short term contract sales

Global volume of spot / short-term\(^1\) LNG trade, and countries in LNG market (mtpa, # countries)

% share of global LNG

1. Spot contracts
Source: GIIGNL; BCG analysis
Sentiment for energy transition is strong in many parts of the world

Europe is committing to climate-neutrality by 2050

President of European Union Ursula von der Leyen

"We are acting to make the EU the world’s first climate neutral continent by 2050. The climate law is the legal translation of our political commitment, and sets us irreversibly on the path to a more sustainable future ..."
— EU commission press release, 04 March 2020

EVP for the European Green Deal
Frans Timmermans

"We are turning words into action today, to show our European citizen that we are serious about reaching net-zero greenhouse gas emissions by 2050. The European climate law is also a message to our international partners that this is the year to raise global ambition together ..."
— EU commission press release, 10 March 2020

Source: Pew Research Center, Global Attitudes and Trends survey
Several large Asian economies stand the most to gain from energy transitions

Energy intensity of GDP vs. Energy import dependence

Higher energy intensity

Lower energy intensity

Fuel imports as a share of GDP (%)

Note: Fuel imports consists of coal, petroleum, natural gas, lubricants, and related materials
Source: Enerdata, World Bank, BCG analysis
Renewables are becoming more cost competitive in Asia

2015-2020 Solar and onshore wind vs. coal competitiveness index

Note: Calculated as the % difference in coal LCOE vs. the lower of the onshore wind and solar LCOEs for each country * 100
Source: Bloomberg New Energy Finance, BCG analysis
Resilient Asian countries have relied on cheap coal, but the falling cost of renewables is supporting greater levels of deployment.

Solar and wind are starting to compete with coal & gas in Asia ($/MWh)

And renewables are taking a greater share of the mix

Share of non-hydroelectric renewables in total energy mix over 2016-2019 (%)

Green stimulus and policy measures in Asia represent significant portion of global total and support deployment of EVs

Chinese & Korean announced green stimulus is as large as the EU’s

Approved & announced global green stimulus ($ billions)

- China: 260
- EU: 200
- South Korea: 60
- ROW: 80
- Total: 600

Policies: China & South Korea supporting EVs through subsidy extensions

- China EV & infrastructure spending:
  - EV charging infrastructure
  - HV transmission & other infrastructure
  - EV subsidy extension & “cash for clunkers”

- South Korea Green New Deal stimulus:
  - R&D funding for EVs & batteries
  - EV subsidy extension
  - Acceleration of EV & hydrogen targets

- EU Green Deal:
  - Hydrogen investment
  - Energy efficiency support
  - Low carbon vehicle support

Source: BNEF, Vivid Economics, Energy Policy Tracker, press reports BCG analysis
Implications: Faster energy transitions in Asia will challenge key drivers of oil and gas demand growth

APAC expected to drive 80% of oil demand growth through 2040 ...

\[
\begin{align*}
\text{2018-2040 change in oil demand under IEA SPS (MB/D)} \\
\begin{array}{c|c|c|c}
\text{2018} & \text{APAC} & \text{ROW} & \text{2040} \\
96.9 & 7.6 & 1.9 & 106.4 \\
\end{array}
\end{align*}
\]

... And ~50% of global natural gas demand growth

\[
\begin{align*}
\text{2018-2040 change in natural gas demand under IEA SPS (BCM/A)} \\
\begin{array}{c|c|c|c}
\text{2018} & \text{APAC} & \text{ROW} & \text{2040} \\
3,952 & 373 & 334 & 5,404 \\
\end{array}
\end{align*}
\]

But a hastened transition would have consequences for oil & gas

- Increased adoption of EVs would erode expected oil demand, especially in China where the government has prioritized deployment
- An accelerated rollout of renewable energy sources could slow the expected gas demand growth

Source: IEA, BCG analysis
Three main type of natural gas markets – Asian markets moving toward market liberalization

- **Illiquid markets/monopolies**
  - One/few single domestic buyers deliver 100% of the supply
  - Infrastructures operated under closed access where the equity holder retains the right to allocate the capacity
  - The Government tends to regulate the price; only a few companies with capacity to sell to end user

- **Liberalized markets without liquid price signal**
  - Multiple buyers to deliver the supply; need to have commercial department to balance supply and demand
  - Infrastructures operated under open access rules
  - Prices negotiated between buyers and sellers without transparent price signal
  - The Government regulates that price is set by supply-demand forces

- **Liberalized markets with a liquid price signal**
  - Multiple buyers can access and trade supply; hub liquidity allows for non-integrated operations
  - Infrastructures operated under open access rules
  - There is a transparent price signal that is used by players to negotiate prices
Carbon Management
Cost competitiveness is the critical challenge for global gas demand

Gas remains uncompetitive vs. coal in Asia...

... And is increasingly challenged vs. wind/solar

Source: Bloomberg, Lazard, BCG analysis
Regulation of localized pollution the most effective lever for improving gas competitiveness – Example of China

LCOE with no externality costs

2019 LCOE ($/MWh)

-38%

LCOE with $40/t CO₂ price

2019 LCOE ($/MWh)

-13%

LCOE with local pollution externality costs

2019 LCOE ($/MWh)

+6%

Note: Based on average base case LCOE for China in 2019 per Bloomberg; Local pollution externality costs per University of Texas LCOE study

Source: Bloomberg, University of Texas, BCG analysis
Improving urban air quality is a key policy priority in China

Peak emissions before 2030 and net zero by 2060 - major step for the economic (and fossil fuel) powerhouse

PM2.5 targets in early 2013, after emissions far exceed targets set in 2012
• 2017 was the target compliance year for the new standards

Northern cities critical to meeting targets
• "2+26 policy" launched in 2017 targeting Beijing, Tianjin, and 26 other Northern cities with severe air pollution
• Aim to reduce PM2.5 emissions by 15% to meet 2017 targets

Focus on switching coal boiler use and rationalizing inefficient industries
• Direct mandates to switch fuel use enforced on a local level
• Industry capacity cut among less efficient plants (e.g., steel, aluminum)

Regulations on coal to gas switching used to achieve air quality improvements

Government uses targeted enforcement to pursue fuel switching goals

More than 1,100 Chinese officials were held accountable for violations of air pollution laws in November 2016

2,480 inspection personnel dispatched to 2+26 cities to enforce policy in September 2017 – January 2018

2+26 face stronger emissions limits – leading to gas demand growth

~43% of urban gas consumption growth from 2015-2017 took place in 2+26 cities

CO₂ price of >40$/t needed for Asia to prompt coal to gas switching

Cost equivalence of coal and gas power generation

Note: Short run marginal cost for CCGT (54% efficiency) and coal plant (39% efficiency); transport cost 1 $/mmbtu, 9$/tonne
Source: BCG Analysis
Adoption of carbon pricing is growing, though prices often remain too low to prompt significant fuel switching

Carbon pricing initiatives as a share of global emissions covered

Share of global annual GHG emissions (%)

- Europe
- Asia Pacific
- South America
- North America
- CIS
- Africa

Effect of China ETS in 2020

Average carbon prices on major indices

$ per metric of CO$_2$

$20-40/t typically estimated as required carbon price to incentivize widespread fuel switching

Source: World Bank, Eurostat, Climate Policy Initiative, RGGI, BCG analysis
Gas commerciality is playing a crucial role on technology adoption, but carbon pricing may be a driver going forward

**Impact:** DRI production is up 30% globally since 2015, reducing GHG intensity of iron and steel

Global DRI production has grown by nearly 30% over last three years

Global direct reduced iron production 2011-2018 (million tons)

- 2015: 53
- 2016: 51
- 2017: 59
- 2018: 70

DRI lowers CO₂ emissions and energy intensity of ironmaking

- Natural gas DRI lowers CO₂ emissions by 66% relative to standard blast furnace ironmaking
- DRI lowers the energy intensity of ironmaking by using a chemical process, while the conventional method involves melting iron ore

DRI production growth is centered in regions with access to cheap gas

Regional growth in DRI production 2015-2018 (million tons)

- Middle East: 11
- Africa: 3
- North America: 3
- CIS: 3
- Asia Pacific: 0
- Eurasia: 0
- Latin America: -3

Climate policy can drive greater DRI adoption

Iron & steel make up ~7% of global energy related GHG emissions

The DRI-EAF route is widely seen as the most viable way to significantly reduce the carbon intensity of the iron and steel industry

Note: DRI can be coal based or natural gas based – around 90% of global DRI is natural gas based; analysis excludes Indian DRI as most coal based DRI is produced in India

Sources: World Steel Association, Midrex, BCG analysis
~50% of global economy considering carbon tax; potentially extended to imports in the future

Domestic carbon tax potentially extended in future to imports

Early discussions on border carbon tax have begun in Europe

Should differences in levels of [climate] ambition worldwide persist […] the Commission will propose a carbon border adjustment mechanism, for selected sectors, to reduce the risk of carbon leakage

—The European Green Deal (2019)

1. Singapore, China, USA, Japan, Hong Kong, Thailand, Republic of Korea, Thailand and Vietnam
2. The circles represent subnational jurisdictions. The circles are not representative of the size of the carbon pricing instrument, but show the subnational regions (large circles) and cities (small circles)
3. ETS = Emission Trading System
Source: DOSM, MATRADE, World Bank
Key decisions still to be taken on EU CBT policy

Simple

- Direct emissions
- Emissions from the last stage of production before import
- Primary inputs
- Exclude transport emissions
- Easier to implement but high risk of being circumvented

Complex

- Indirect emissions
- Emissions from the whole value chain
- Finished and intermediate products
- Include transport emissions
- Harder/costlier to implement but less likely to be circumvented

All these variables will be decided through the forthcoming legislative process
Indicative planning for Q2 2021
### Sectors most impacted by the border tax

#### EU priority sectors for carbon border tax

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Cements</th>
<th>Steel</th>
<th>Non-fer. metals</th>
<th>Chem</th>
<th>Pulp &amp; paper</th>
<th>Glass</th>
<th>Electrcity</th>
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</tbody>
</table>

#### EU 27 production value-added ($B)

<table>
<thead>
<tr>
<th>Segments impacted</th>
<th>EU 27 production value-added ($B)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residential, com’l, T&amp;L</strong></td>
<td>686</td>
</tr>
<tr>
<td><strong>Packaged foods, soft drinks, spirits</strong></td>
<td>263</td>
</tr>
<tr>
<td><strong>Various consumer, construction, and industrial applications</strong></td>
<td>106</td>
</tr>
<tr>
<td><strong>Metals, coal, non-metal</strong></td>
<td>76</td>
</tr>
<tr>
<td><strong>Metallurgy, machinery, mechanical equipment</strong></td>
<td>27</td>
</tr>
<tr>
<td><strong>Component makers and automotive OEMs</strong></td>
<td>328</td>
</tr>
<tr>
<td><strong>Telco eqpt, PCs and mobile devices, electrical eqpt</strong></td>
<td>200</td>
</tr>
<tr>
<td><strong>Patented bio-pharma, vaccines, generics</strong></td>
<td>143</td>
</tr>
<tr>
<td><strong>Component makers, LCA, business jets, military aircraft Washers, dryers, refrigerators, vacuums, etc.</strong></td>
<td>124</td>
</tr>
<tr>
<td><strong>Washers, dryers, refrigerators, vacuums, etc.</strong></td>
<td>39</td>
</tr>
</tbody>
</table>

**Source:** Oxford Economics; BCG analysis
Regional, national, and subnational carbon pricing initiatives and share of global emissions covered, *The World Bank*

Share of global annual GHG emissions

Data as of May 2018

Note: Only the introduction or removal of an ETS or carbon tax is shown. Emissions are presented as a share of global GHG emissions in 2012 from (EDGAR) version 4.3.2 including biofuels emissions. Annual changes in GHG emissions are not shown in the graph. Due to the dynamic approach to continuously improve data quality using official government sources, the carbon tax only covering F-gases in Spain was added. The information on the China national ETS represents early unofficial estimates based on the announcement of China’s National Development and Reform Commission on the launch of the national ETS of December 2017.

Source: State and Trends of Global Carbon Pricing 2018 – World Bank
Prices in implemented carbon pricing initiatives, The World Bank

Note: Nominal prices on April 1, 2018, shown for illustrative purpose only. The Australia ERF Safeguard Mechanism, British Columbia GGIRCA, Kazakhstan ETS and Washington CAR are not shown in this graph as price information is not available for those initiatives. Due to the dynamic approach to continuously improve data quality using official government sources, the carbon tax covering only F-gases in Spain and F-gas tax in Denmark were added. Prices are not necessarily comparable between carbon pricing initiatives because of differences in the sectors covered and allocation methods applied, specific exemptions, and different compensation methods.

Source: State and Trends of Global Carbon Pricing 2018 – World Bank
Five major developments expected to impact the carbon ecosystem and its participants

- **Overall carbon markets expected to grow strongly**
- **Markets will likely become increasingly short**
- **Profit pools will grow**
- **Liquidity for both voluntary and mandatory markets will increase**
- **Market fragmentation will persist, but some scenarios show consolidation**

- **Value will shift towards upstream/Intrinsic project value, i.e. access to projects will be key**
- **Own origination (backed by balance sheet) will become an even bigger differentiator**
- **There is value in scale and having an integrated offering; in-house demand a sizeable added benefit**
- **Ability to deploy capital & carry risk will allow to capture additional upside**
- **Trading and risk management capabilities will increasingly become a differentiator**

**Value capture potential also linked to speed to market & ability to scale up quickly**
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Thank You

Towards Recovery and Shared Prosperity