Shell LNG
Outlook 2020
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Gas continues to provide more and cleaner energy solutions

The last decade has seen rapid growth in energy demand and corresponding greenhouse gas emissions which have created the need for more and cleaner energy options. A combination of new policy, favourable economics and partnership with renewables is driving the momentum for coal-to-gas switching.

2019 was a year of record LNG supply growth

2019 saw record LNG supply growth as the recent wave of new LNG liquefaction projects nears completion. Most of this growth was absorbed by Europe. Year-on-year growth in Asian imports slowed from highs of 2017 and 2018, but Asia still remains a growth region. Increased liquidity, new spot trading mechanisms and a wider variety of indices being used for long-term contracts point towards LNG becoming an increasingly flexible commodity.

Record supply investment due to confidence in long-term LNG demand growth

2019 was also a year of record final investment decisions (FIDs), with 71 million tonnes of new capacity being sanctioned, indicating belief in long-term LNG demand. Increasing uncontracted and flexible supply is set to offer more options for customers in the future.
Gas continues to provide more and cleaner energy solutions
Growing population and rising living standards drive demand for energy with lower emissions

Growing population

Rising energy demand & emissions

Increased urbanisation

Unsafe air quality

Source: Shell’s interpretation of Wood Mackenzie H1, World Bank, The World Air Quality Index 2019 data

Royal Dutch Shell

February 2020
Renewables and gas expected to replace coal in the global energy mix

Global energy demand growth by fuel type

- Gas: 43%
- Renewables: 37%
- Oil: 16%
- Nuclear: 5%
- Coal: -10%
- Other: 9%
- Global: 1% CAGR

Energy demand 1% CAGR

Source: Shell interpretation of Wood Mackenzie H1 2019 data

CAGR - Compound annual growth rate

Gas and coal share in the energy mix 2019-2040

- India 2030 gas target
- China 2030 gas target
- Europe
- North America
- Global

2019 [ ] 2040 [ ]

Source: Shell interpretation of Wood Mackenzie H1 2019 data

CAGR - Compound annual growth rate
Coal-to-gas switching helping level global CO₂ emissions

![Graph showing CO₂ change and CO₂ savings](image-url)


*Advanced economies include United States, European Union, Australia, Canada, Chile, Iceland, Israel, Japan, South Korea, Mexico, Norway, New Zealand, Switzerland & Turkey

**Power sector coal-to-gas switching in Advanced economies only

Equivalent to over 50% of CO₂ emissions from South America for a full year

-57%
Record coal phase-out and generation reduction in 2019
Opportunity for more displacement of coal in the power sector

Net change in global coal generation

Global coal phase-out capacity announcements by date

Power capacity by fuel

Source: Shell interpretation of national government policy announcements, Carbon Brief, Global Energy Monitor, GlobalData plc and Wood Mackenzie 2019 data
Use of coal and other solid fuels outside the power sector also impacts air quality

Coal and solid fuel use in the industrial sector

Source: Maplecroft 2018 and Shell interpretation of Wood Mackenzie data H1 2019
*Res & comm: residential and commercial sector and also includes use in cooking and heating
BCMe – Billion Cubic Metres equivalent

Coal and solid fuel use in res & comm* sector

Air quality index 2018

Risk

Extreme High Medium Low

China
India
United States
Brazil
Indonesia
Japan
South Korea
Thailand
Kazakhstan
Vietnam
Coal-to-gas switching in the industrial sector can improve air quality

Air quality levels in Morbi, Gujarat

<table>
<thead>
<tr>
<th></th>
<th>PM2.5</th>
<th>PM10</th>
<th>SO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>0</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>2019</td>
<td>0</td>
<td>50</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Shell’s interpretation of International Gas Union, Financial Times, Central Pollution Control Board (India) data 2018 and 2019
PM: particulate matter SO2: sulfur dioxide

Gas demand post-ban on coal units in Morbi industrial sector in 2019

Air quality in India

Top 20 most polluted industrial clusters in 2018

Number of times above the WHO’s safe limit
Growth of renewables favours gas in the power mix

Average thermal load factors

Thermal load factors

South Australia electricity supply December 2019

Source: Shell interpretation of Wood Mackenzie H1, national data and OpenNEM 2019 data
Challenges to the role of gas in the energy transition

Industry to address

Methane emissions
Need for improved measurement and reporting and continual reduction in methane emissions

Future pathways
Credible routes to deploy clean gas at scale such as carbon capture and storage (CCS) and biogas are needed

Cost control
Need to drive cost reductions to make natural gas more affordable for customers, ensuring it remains highly competitive compared to other energy sources

Driven by influencers

Public perception
Gas faces a challenge from those arguing to remove all fossil fuels from the global energy mix. However, the supply of reliable energy cannot all be met by renewables—at least not yet.

Gas is a fuel for today and tomorrow. It can act as a partner for renewable sources to offer reliable, flexible and cost-effective access to more and cleaner energy at scale, and all stakeholders must work harder to ensure public support for gas to play its full role.

Policies
To accelerate change, governments need to introduce long-term policies that enable development of lower-carbon and renewable sources of energy, supported by technologies like CCS. Also, carbon-pricing mechanisms can help reduce emissions and encourage the use of cleaner sources of energy.

Emissions from coal and gas
Tonnes of CO₂e/toe

Biogas production
BCM

Source: Shell interpretation of IPCC Emissions factors and IEA World Energy Outlook data 2019
Gas to play a key role in reducing emissions from hard-to-electrify sectors

Global gas demand growth by sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>2019</th>
<th>2040</th>
<th>Gas demand 2% CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>2,000</td>
<td>4,000</td>
<td>28%</td>
</tr>
<tr>
<td>Industry</td>
<td>4,000</td>
<td>5,000</td>
<td>23%</td>
</tr>
<tr>
<td>Res &amp; comm</td>
<td>2,000</td>
<td>2,000</td>
<td>9%</td>
</tr>
<tr>
<td>Transport</td>
<td>1,000</td>
<td>1,000</td>
<td>40%</td>
</tr>
</tbody>
</table>

Share of gas demand growth by sector 2019-2040

Source: Shell interpretation of Wood Mackenzie H1 2019 data
Asia set to be the key growth region for LNG

Global gas supply by source

- 2019: Domestic production 45%, Pipeline imports 15%, LNG imports 40%
- 2040: Gas demand 2% CAGR

LNG imports by region

- 2019: Asia 74%, Europe 9%, Americas/Mid-East & Africa 8%
- 2040: LNG demand 4% CAGR

LNG imports into Asia

- 2019: China 23%, JKT 1%, South Asia 28%, Rest of Asia 48%
- 2040: Asia LNG demand 4% CAGR

Source: Shell interpretation of Wood Mackenzie H1 2019 data
2019 was a year of record LNG supply growth
Current wave of LNG capacity additions coming to an end
85% now online

Source: Shell interpretation of IHS Markit 2019 data
DES: delivered ex-ship
Record LNG supply growth absorbed mainly in Europe

### LNG supply growth range by country

<table>
<thead>
<tr>
<th>Country</th>
<th>Previous forecast range 2019</th>
<th>Actuals 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>-10</td>
<td>10</td>
</tr>
<tr>
<td>USA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Russia</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rest of world</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### LNG demand growth range by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Previous forecast range 2019</th>
<th>Actuals 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>20</td>
<td>-10</td>
</tr>
<tr>
<td>Europe</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Americas</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Middle East &amp; Africa</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Shell interpretation of IHS Markit, Wood Mackenzie, Poten & Partners Q4 2018 and 2019 data
LNG imports rise by 40 million tonnes in 2019
China continues to be among top three global LNG growth markets

Net imports: 2019 YoY
MTPA (DES)

Source: Shell interpretation of IHS Markit, Wood Mackenzie and Poten & Partners 2018 and 2019 data
Note: Sweden, Canada, Colombia, Norway, Finland, Malta, Israel, Jamaica, Puerto Rico, Kuwait, Brazil, Panama, Poland and Dominican Republic are not included in the above chart as change is minimal
LNG imports continue to meet China’s growing need for cleaner energy

China gas demand vs domestic production

China LNG and pipeline gas imports

Source: Shell interpretation of NDRC 2019 data
European LNG imports increased by 74% in 2019 with declining domestic production and pipeline imports ...

Source: Shell interpretation of Wood Mackenzie, S&P Global Platts and Gazprom Export LLC. 2019 data
Russian sales volumes adjusted to reflect standard calorific value (40MJ/m$^3$ at 15°C)
... and increased coal-to-gas switching in the power sector and storage due to mild winter

Coal-to-gas switching range

$/MMBtu

€/tonne CO₂

Coal generation vs gas generation

TWh

Year-end gas inventory

BCM

Source: Shell interpretation of IHS Markit, Wood Mackenzie and Gas Infrastructure Europe (Aggregated Gas Storage Inventory) 2019 data
Growing industrial gas demand and declining domestic gas spurs LNG demand in South and South-east Asia

Source: Shell interpretation of Wood Mackenzie and IHS Markit 2019 data
Higher nuclear availability and mild winters reduced imports into Japan and South Korea

### Power generation mix

<table>
<thead>
<tr>
<th>Year</th>
<th>Nuclear</th>
<th>Coal</th>
<th>Gas</th>
<th>Oil</th>
<th>Renewables</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>26%</td>
<td>41%</td>
<td>25%</td>
<td>7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>23%</td>
<td>42%</td>
<td>27%</td>
<td>6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>7%</td>
<td>29%</td>
<td>38%</td>
<td>18%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>5%</td>
<td>30%</td>
<td>39%</td>
<td>17%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Shell interpretation of IHS Markit, Japan Ministry of Economy, Trade and Industry, Korea Energy Economics Institute 2019 data

Power generation mix includes January through October data. Winter months are from October through March. 2020 includes YTD data.

### Winter* average temperature

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Korea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LNG imports

<table>
<thead>
<tr>
<th>Year</th>
<th>Japan</th>
<th>South Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Shell interpretation of IHS Markit, Japan Ministry of Economy, Trade and Industry, Korea Energy Economics Institute 2019 data

*Winter months are from October through March. 2020 includes YTD data.
**US supply adds volume and flexibility to the global LNG market**

**US LNG exports by destination**

<table>
<thead>
<tr>
<th>Year</th>
<th>Americas</th>
<th>Asia</th>
<th>Europe</th>
<th>Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Shell interpretation of IHS Markit, US Department of Energy 2019 data

**US LNG deliveries to Asia**

<table>
<thead>
<tr>
<th>Year</th>
<th>MT</th>
<th>China % of total US deliveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td>15%</td>
</tr>
</tbody>
</table>

**Source:** Shell interpretation of IHS Markit, US Department of Energy 2019 data
Global gas prices softened in 2019

Global gas prices
$/MMBtu

Asia spot price
JKM as % of Brent

US LNG export margins*
$/MMBtu

Source: Shell interpretation of ICE, CME, S&P Global Platts 2019 data

*Excludes liquefaction fee; netback calculated as: JKM and TTF minus regasification and transportation cost minus 115% Henry Hub
Increasingly liquid and transparent spot market

Spot LNG deliveries
Cargoes

JKM eWindow/Market on Close
Cargoes

ICE JKM LNG futures
Cargoes

Source: Shell interpretation of IHS Markit, S&P Global Platts and ICE 2019 data

*About 300 lots is equal to 1 cargo
### Average volume and length of new contracts

<table>
<thead>
<tr>
<th>Years</th>
<th>MTPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>12</td>
</tr>
<tr>
<td>2012</td>
<td>8</td>
</tr>
<tr>
<td>2014</td>
<td>1</td>
</tr>
<tr>
<td>2016</td>
<td>0.5</td>
</tr>
<tr>
<td>2018</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Shell interpretation of Wood Mackenzie and IHS Markit 2019 data

### New LNG contract volumes (by seller type)

<table>
<thead>
<tr>
<th>Years</th>
<th>MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1000</td>
</tr>
<tr>
<td>2012</td>
<td>800</td>
</tr>
<tr>
<td>2014</td>
<td>600</td>
</tr>
<tr>
<td>2016</td>
<td>400</td>
</tr>
<tr>
<td>2018</td>
<td>200</td>
</tr>
</tbody>
</table>

### Share of new LNG contract volumes (by price indexation)

<table>
<thead>
<tr>
<th>Years</th>
<th>Share of total volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Oil-linked: 20%</td>
</tr>
<tr>
<td>2012</td>
<td>EU Gas Hub: 40%</td>
</tr>
<tr>
<td>2014</td>
<td>HH: 60%</td>
</tr>
<tr>
<td>2016</td>
<td>Hybrid: 80%</td>
</tr>
<tr>
<td>2018</td>
<td>JKM: 100%</td>
</tr>
</tbody>
</table>

Source: Shell interpretation of Wood Mackenzie and IHS Markit 2019 data
End of the current supply wave in 2020

LNG supply growth range by country

MTPA

Source: Shell interpretation of IHS Markit, Wood Mackenzie, Poten & Partners 2019 data

LNG demand growth range by region

MTPA

Source: Shell interpretation of IHS Markit, Wood Mackenzie, Poten & Partners 2019 data
Global LNG market equilibrium expected to be restored

LNG import growth by region

Source: Shell interpretation of IHS Markit 2019 data
Record supply investment due to confidence in long-term LNG demand growth
Expected supply shortage in mid-2020s resulted in record FIDs

Investment in liquefaction capacity by contract type

LNG equity offtake by buyer type

Source: Shell interpretation of IHS Markit 2019 data
Record FIDs delay expected supply-demand gap
LNG demand estimated to double by 2040

Emerging LNG supply-demand gap
MTPA

Demand drivers for LNG
MTPA

Source: Shell interpretation of IHS Markit, Wood Mackenzie, FGE and Poten & Partners Q4 2019 data
LNG bunkering demand accelerating

385 LNG fuelled ships currently in operation/on order*

- Car carriers
- Ro-Ro cargo ships
- Bulk carriers
- General cargo ships
- Tugs
- RoPax
- Other vessels
- Crude oil tankers
- Cruise ships
- Offshore supply ships
- Oil/Chemical tankers
- Container ships
- Car/Passenger ferries

Confirmed LNG demand # of ships

<table>
<thead>
<tr>
<th>Year</th>
<th>In operation</th>
<th>On order</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>2025</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>2030</td>
<td>0</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>2035</td>
<td>0</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>2040</td>
<td>0</td>
<td>0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

LNG bunker demand projection MTPA

Source: Shell interpretation of DNV GL, Woodmac, IHS Markit & IEA 2018 and 2019 data

* Based on announcements with deliveries going out to 2027. Does not include 150 LNG-ready ships
China gas demand expected to double

China gas demand by sector

- 2019: 26%, 19%, 48%, 7%
- 2025: 52%, 31%, 17%
- 2040: Domestic production, Pipeline imports, LNG imports

China supply by source

- 2019: 52%, 31%, 17%
- 2025: Domestic production, Pipeline imports
- 2040: LNG imports, Power of Siberia

Source: Shell interpretation of Wood Mackenzie 2019 H1 data
Growing gas demand expected in South and South-east Asia
More LNG infrastructure investment needed

South Asia gas supply growth by source

Source: Shell interpretation of Wood Mackenzie and IHS Markit 2019 data

South-east Asia gas supply growth by source

LNG demand and regasification capacity

Source: Shell interpretation of Wood Mackenzie and IHS Markit 2019 data
01 Gas continues to provide more and cleaner energy solutions

- 80% of energy demand growth expected to be met by renewables and gas
- Coal-to-gas switching helping level global CO₂ emissions
- Record coal phase-out and generation reduction in 2019

02 2019 was a year of record LNG supply growth

- European LNG imports increased by 74%
- Higher nuclear availability and mild winters reduced imports into Japan and South Korea
- End of the current supply wave in 2020
- Global LNG market equilibrium expected to be restored

03 Record supply investment due to confidence in long-term LNG demand growth

- Expected supply shortage in mid-2020s resulted in record FIDs
- Record FIDs delay expected supply demand gap
- LNG demand estimated to double by 2040

Summary