IGU Diplomatic Gas Forum

The Vital Role of Natural Gas towards a Sustainable Energy Future

Seoul, Korea
Opening Remarks

Prof. Joe Kang
President, IGU
2018 World in Review

Main Energy Related Trends

**Poor Air Quality**
91% of World Population lives in Areas with Unhealthy Air

**Urbanisation**
Over half of the world’s population lived in cities in 2018, up from just a third in 1960.

**Energy Access**
Globally energy access continues to increase, but much more needs to be done to meet UN Sustainable Development Goals.

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**PM10 Annual mean concentration (ug/m3)**
2014-17

Source: WHO

**World Urban and Rural Population billions**

Source: UN

**Annual electricity access growth rate 2010-2016**

Source: World Bank

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A Sustainable Future – Powered by Gas
Greatest urbanization will occur in regions with lowest gas penetration today

Gas share of energy consumption

<table>
<thead>
<tr>
<th>Region</th>
<th>Gas Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle East</td>
<td>59</td>
</tr>
<tr>
<td>Non-OECD Europe</td>
<td>40</td>
</tr>
<tr>
<td>OECD Americas</td>
<td>33</td>
</tr>
<tr>
<td>OECD Asia Oceania</td>
<td>24</td>
</tr>
<tr>
<td>OECD Europe</td>
<td>24</td>
</tr>
<tr>
<td>Non-OECD Americas</td>
<td>22</td>
</tr>
<tr>
<td>Africa</td>
<td>13</td>
</tr>
<tr>
<td>Non-OECD Asia (ex. China)</td>
<td>12</td>
</tr>
<tr>
<td>China</td>
<td>4</td>
</tr>
</tbody>
</table>

Projected urban population growth (2015-50)

<table>
<thead>
<tr>
<th>Region</th>
<th>Growth (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle East</td>
<td>118</td>
</tr>
<tr>
<td>Non-OECD Europe</td>
<td>-11</td>
</tr>
<tr>
<td>OECD Americas</td>
<td>134</td>
</tr>
<tr>
<td>OECD Asia Oceania</td>
<td>2</td>
</tr>
<tr>
<td>OECD Europe</td>
<td>70</td>
</tr>
<tr>
<td>Non-OECD Americas</td>
<td>132</td>
</tr>
<tr>
<td>Africa</td>
<td>867</td>
</tr>
<tr>
<td>Non-OECD Asia (ex. China)</td>
<td>797</td>
</tr>
<tr>
<td>China</td>
<td>271</td>
</tr>
</tbody>
</table>

Includes weighted average of power generation, buildings, and industry sectors; based on 2015 data
Source: IEA, UN Population Division, BCG analysis
Policy plays a critical role for shaping gas market development

Policy is critical to developing gas value chains

Examples of successful policies

- Production targets
- Priority upstream licensing
- Market-based pricing
- Competitive tariff structures
- Foreign gas trade agreements
- Anchor agreements by public utilities
- Capacity development targets
- Expedited permitting
- Capex support/lending programs
- Pricing of environmental externalities
- Fuel switching requirements/incentives
- Priority sector-based incentives

Example: Divergence between China and India

Gas consumption (bcm)

China

India

>4x

Looking Toward the Future

Industry Priorities

1. Cost competitiveness
   1A. Reducing LNG costs through the supply chain
   1B. Pricing environmental externalities
   1C. Development of local gas production

2. Security of supply
   2A. Expanding gas pipeline and storage infrastructure
   2B. More flexible LNG contracting
   2C. Development of new access-enabling technologies

3. Sustainability
   3A. Adoption of local air pollution policies
   3B. Development of low carbon technologies for gas
   3C. Addressing the methane emissions challenge

Industry action required ➤ Gov. action required
Thank you
Welcome Remarks

Vice Minister Taeho Lee
Ministry of Foreign Affairs
Congratulatory Remarks

Deputy Minister Young Jun Joo
Ministry of Trade, Industry and Energy
Congratulatory Remarks

Acting Chair and CEO Young Doo Kim
NOC of WGC2021 / KOGAS
Coffee Break

(10:30 ~ 10:50)
IGU Diplomatic Gas Forum

The Vital Role of Natural Gas towards a Sustainable Energy Future

Seoul, Korea
Improving the Air We Breath

March 28, 2019
Korea Diplomatic Forum

Mel Ydreos
Director Public Affairs
International Gas Union
2015 Case Studies:
New York, Istanbul, Toronto, Beijing

Outdoor air pollution is among the most significant environmental threats to human health:

Premature deaths each year (WHO)

Deaths from outdoor air pollution will double from current levels by 2050 absent policy changes (OECD)

More natural gas = fewer pollutants and CO₂ emissions
Istanbul – Natural Gas improved air quality

Istanbul Improving Air Quality

SOx (μg/m³) vs. Natural Gas Consumption (thousand m³)
Financial Times coverage during COP 21

Energy. Climate summit

Natural gas industry’s mission to clear the air

Large groups cite fuel’s green benefits as they argue for more favourable treatment.

The natural gas industry is seeking to separate itself from other fossil fuels, promoting the dramatic improvements in air quality achieved by cities including New York, Toronto and Lisbon through replacing coal and oil.

At the international climate talks in Paris, gas producers are arguing that they should receive more favourable treatment from governments because of the environmental benefits of gas.

Large oil and gas groups including Royal Dutch Shell, BP, Total and Brazil’s state oil giant have signed a statement backing efforts to cut carbon dioxide emissions, and are now promoting shifting power generation from coal to gas.

Coal-fired power stations release considerately more ash and carbon dioxide emissions than gas-fired ones.

The International Gas Union, which represents industry associations and leading gas companies including Gazprom of Russia, South America and Qatar, is also highlighting the benefits in terms of reduced local pollution from switching from coal to oil and gas.

An estimated 5.7 million people worldwide die each year as a result of outdoor air pollution, and many of those deaths are believed to be caused by burning coal, fuel oil and petrol.

Cities that have used more gas and less coal and oil have achieved large cuts in pollution that cause respiratory illnesses, including the particularities—small airborne particles of soots and liquids—that are responsible for lung cancer, heart attacks, strokes and asthma attacks.

Guidelines of the World Health Organization, which issued a report in Paris yesterday criticising the industry’s stance, said that, along with other changes including tighter curbs on pollution from coal-fired power stations, the emphasis on boosting gas in New York had contributed to a significant improvement in air quality.

The weight of particular matter in New York’s air has dropped from an annual average of 12 micrograms per cubic meter in 2005 to 8.8 micrograms per cubic meter in 2012-14.

Other cities including Toronto and Lisbon have seen similar improvements. Beijing, which suffers from severe air pollution problems, has been working to cut pollution through a series of measures including relocation of heavy industry, increased use of public transport and the conversion of all power plants榭heating targets.

By 2015, Beijing expects to decrease 35 per cent of its energy from gas, and 5 per cent from coal, and a plan to eliminate all coal by 2030.

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2016 Case Studies: Berlin, Dublin, Krakow, Rotterdam

Outdoor air pollution is among the most significant environmental threats to human health:

- Premature Deaths in the EU (EEA)
- Total Health-related Costs associated with air pollution (EEA)

More natural gas = fewer pollutants and CO₂ emissions

NATURAL GAS: IMPROVING THE AIR WE BREATHE

Four European Cities Take Action

- Berlin
- Dublin
- Krakow
- Rotterdam

- 2016 Case Studies: Berlin, Dublin, Krakow, Rotterdam

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2018 Case Studies: Beijing, Shanghai, Urmqi, Santiago

Natural Gas: Improving the Air We Breathe

Deaths in China in 2015 were caused by P.M. pollution - 4000 every day.

Of the global population lives in areas exceeding the WHO air quality guidelines.

Air pollution continues to be "the world's single greatest environmental risk to health" - World Health Organisation.

Beijing, China
- 2013/2014: Unprecedented pollution - P.M. concentration of 85.9 mg/m³
- 2015: Half the days ranked 'unhealthy'
- 2015: Aggressive coal to gas substitution policy implemented
- 2017: 54% decrease in P.M. vs. 2016
- 4453 coal-fired boilers shut down
- 900,000 households moved from coal to gas

Shanghai, China
- 2000-2012: Embarks on a coal to gas boiler retrofits program
- 2012-2013: Incentives to encourage gas projects
- 2016: Reduction in all major air pollutants
- P.M. concentration improved by 15.1% vs. 2015 and 27.4% vs. 2013
- P.M. concentrations dropped by 14.5% vs. 2015

Urumqi, China
- 2012: Initiative to switch household heating from coal to natural gas
- 12,900 coal boilers replaced with gas in 6 months
- 2013: P.M. decreased by 62.8% year on year
- 2014: Gas largely replaces coal as dominant heating fuel
- P.M. decreased by 79.5% year on year
- 73% reduction in pollution-related lung cancer

Santiago, Chile
- 1989: P.M. concentration registered at 68.9 µg/m³, 7x the recommended level
- 1994: Law for the Environment enacted
- Protocol for Natural Gas Integration between Chile and Argentina implemented
- 2016: Reduction of 33% of P.M. and 58% of P.M. since 1990
- Reduction 2.63 µg/m³ of P.M. from industrial sources

More natural gas = fewer pollutants and CO₂ emissions.
Beijing – Natural Gas improves the air quality

Beijing
Improving
Air Quality

![Graph showing the comparison of gas to coal ratio and PM 2.5 levels from 2008 to 2016. The gas to coal ratio increases, while PM 2.5 levels decrease over time.](image)
Urumqi, China

Drastic Improvement in just 2 years, after coal to gas heating replacement effort

**2012**
- Air quality improvement initiative launched to replace coal-fired heating with gas
- Gas grew to 76% of total heating fuel in 2012-13 heating season from nearly 0%
- 12,900 coal boilers replaced with gas in first six months

**2013**
- Monthly PM$_{2.5}$ concentration dropped by 62.8% vs. 2012
- 5 MT reduction in coal consumption
- 35,000-ton reduction in SO$_2$ & 17,000 in soot

**2014**
- Gas largely displaced coal as dominant heating fuel
- Monthly PM$_{2.5}$ concentration dropped by 75.5%
- 50% reduction in SO$_2$ since 2012 heating season
- 73% reduction in pollution-related lung cancer
Thank you
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The Vital Role of Natural Gas towards a Sustainable Energy Future

Tahir Faruqui, General Manager Downstream LNG

Shell
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The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this presentation "Shell", "Shell group" and "Royal Dutch Shell" are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to Royal Dutch Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. "Subsidiaries", "Shell subsidiaries" and "Shell companies" as used in this presentation refer to entities over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations", respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management’s expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as “aim”, “ambition”, “anticipate”, “believe”, “could”, “estimate”, “expect”, “goals”, “intend”, “may”, “objectives”, “outlook”, “plan”, “probably”, “project”, “risks”, “schedule”, “seek”, “should”, “target”, “will” and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this presentation, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell’s products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; and (m) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Royal Dutch Shell’s Form 20-F for the year ended December 31, 2017 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in this presentation and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, March 28, 2019.

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THE MARITIME INDUSTRY IS A MAJOR SOURCE OF GHG EMISSIONS

SHIPPING GLOBALLY EMITS (2012 ESTIMATE)

972 million tonnes CO$_2$e

3% of global emissions

OR

WORLD COASTLINES AS DEFINED BY SHIPPING ROUTES

According to the International Maritime Organization (IMO), maritime CO$_2$ emissions are projected to increase between 50% and 250% by 2050
LNG IS A CLEANER MARINE FUEL

LNG has lower local emissions (SOx, PM, NOx) vs heavy fuel oil in marine engines*

Natural gas emits virtually zero SOx

PARTICULATE MATTER

90%*

80% lower NOx

WELL TO WAKE CO2 EMISSIONS

21%* Equivalent to 500 heavy duty trucks removed from the road for a single ship

*Significantly reduced NOx depending on Tier I/II/III engine and diesel emissions from an LNG-Powered Ship; M. Anderson, K. Sala, E. Fridell; Environ. Sci. Technol. 2015, 49, 12568-12575

*Thinkstep, Greenhouse Gas Intensity of Natural Gas prepared for Natural & Bio Gas Vehicle Association (NGVA) Europe, V1.0, 05/05/2017 for ship and truck WtW savings. One example of emissions reduction using one large high pressure 2 stroke engine. Unburned methane in the exhaust (methane slip) has higher GHG impact than fuel completely combusted to CO2.
LNG MARINE FUEL IS AVAILABLE IN 150 LOCATIONS, OVERLAPPING WITH KEY MARITIME HUBS
GLOBAL ORDERS FOR LNG-FUELLED VESSELS ARE GROWING

126 LNG VESSELS IN OPERATION AND 137 LNG VESSELS ON THE ORDERBOOK

Source: DNV GL, 2018
COLLABORATIVE INDUSTRY & REGULATOR RELATIONSHIPS ARE KEY FOR GLOBAL UPTAKE OF LNG

- Collaborative relationships between ship owners, charterers, ports, policy-makers, and fuel suppliers
- Developing global infrastructure hubs on the back of supporting demand
- Ensuring harmonized industry standards
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The Vital Role of Natural Gas towards a Sustainable Energy Future

James Rockall

WLPGA
A Sustainable Future – Powered by Gas

LPG – the sister to natural gas
Future of primary energy

Primary Energy demand /Billion toe

Source: BP Energy Outlook 2018 ET scenario
Lack of energy access is global threat
What constitutes a sustainable energy future?

Focus on a sustainable future through energy

We need our future energy to be:

• Available
• Affordable
• Acceptable
• Accessible
What does unacceptable look like?

Outdoor air pollution - 9 million deaths per year

Indoor air pollution - 4 million deaths per year
Autogas – improving urban air quality
Cooking For Life

One billion new users = 1 million fewer premature deaths
Clean Energy Access

A Sustainable Future – Powered by Gas
Universal Energy Access can be possible

If Coca-Cola can get to remote Africa then so can LPG
고맙습니다
Thankyou
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The Vital Role of Natural Gas towards a Sustainable Energy Future

Vincent DEMOURY

General Delegate, GIIGNL
83 Members in 26 countries – LNG importers and LNG terminal owners and operators
THE WORLD NEEDS MORE AND CLEANER ENERGY

Energy is “central to nearly every major challenge and opportunity the world faces” - UN

Global population (Bn)

Growing population

Rising demand

Ongoing supply

Mitigating climate change

Improving air quality

Source: World Bank

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Switching from coal to cleaner-burning natural gas can play a significant role in improving air quality today.

**Air pollution in Asia** (Annual mean, ug/m³)

- **Islamabad, Pakistan**: 107 (PM₁₀), 448 (PM₂₅)
- **Dhaka, Bangladesh**: 82 (PM₁₀), 146 (PM₂₅)
- **Seoul, S. Korea**: 26 (PM₁₀), 48 (PM₂₅)
- **Bangkok, Thailand**: 28 (PM₁₀), 41 (PM₂₅)
- **Manila, Philippines**: 29 (PM₁₀), 118 (PM₂₅)
- **Kuala Lampur, Malaysia**: 25 (PM₁₀), 47 (PM₂₅)
- **Ha Noi, Vietnam**: 23 (PM₁₀), 49 (PM₂₅)
- **Yangon, Myanmar**: 26 (PM₁₀), 47 (PM₂₅)
- **Beijing, China**: 73 (PM₁₀), 92 (PM₂₅)
- **Delhi, India**: 143 (PM₁₀), 292 (PM₂₅)

**WHO regards a limit of 10 for PM 2.5 and a limit of 20 for PM 10**

Source: World Health Organisation
A Sustainable Future – Powered by Gas

NATURAL GAS AND LNG ARE UP TO 90% CLEANER THAN COAL

LNG fuelled power generation has the lowest SOx, NOx and PM 2.5 emissions of reliable power sources

45-55% lower CO₂ emissions compared to coal and up to 90% lower air pollutant emissions

1 Bn people without access to electricity, outdoor air pollution is greatest in populated areas

Air pollution from gas-fired and coal fired power plants

<table>
<thead>
<tr>
<th></th>
<th>Lb/MWh</th>
</tr>
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<tbody>
<tr>
<td>Sulphur dioxide</td>
<td>0.67</td>
</tr>
<tr>
<td>Nitrogen oxide</td>
<td>0.70</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>0.09</td>
</tr>
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</table>

Coal emissions

Natural gas emissions

Source: National Energy Technology Laboratory
Liquefied Natural Gas (LNG) is natural gas that has been cooled to -162°C to enable it to be transported over long distances and increase energy density.

In 2018, more than 600 LNG cargoes were delivered to South Korea from 23 exporting countries.
20 producing countries supplied LNG to 42 importing countries in 2018

LNG PROVIDES AFFORDABLE ENERGY ACCESS TO 42 COUNTRIES WITH A COMBINED POPULATION OF 4.9BN

Source: GIIGNL Annual Report

A Sustainable Future – Powered by Gas
314 MT OF LNG IMPORTED WORLDWIDE IN 2018

Asia represents 76% of global LNG imports

Source: GIIGNL Annual Report
ABUNDANT LNG SUPPLY WORLDWIDE

LNG provides low-carbon energy from multiple regions

Liquefaction capacity by region (mtpa) 1978-2018

Pre-FID projects (mtpa)

Source: GIIGNL Annual Report, IGU 2018 World LNG Report

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WHY LNG?

A Sustainable Future – Powered by Gas
LNG DELIVERS **AIR QUALITY IMPROVEMENTS**

*Beijing gas demand boosted by measures to reduce air pollution*

**Beijing air quality and gas demand**

![Graph showing air quality and gas demand trends](image)

- **Gas demand**
- **Air quality**

*Source: US Embassy, Beijing Gas Group*
LNG PROVIDES FLEXIBLE BACKUP TO RENEWABLES

*LNG supports generation when the wind doesn't blow or solar is low*

<table>
<thead>
<tr>
<th>LNG send out (GWh/h)</th>
<th>Power generation (GWh/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spanish power generation</strong> (Dec. 2017)</td>
<td></td>
</tr>
</tbody>
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- Wind generation (hourly)
- Solar generation (hourly)
- LNG send out (daily)

Source: REE, Enagas
LNG PROVIDES SECURE LOW CARBON ENERGY

Japanese gas utilities have well-diversified LNG sources and are well prepared for a possible supply disruption.
A CLEANER, MORE AFFORDABLE AND AVAILABLE FUEL FOR TRANSPORT

1. LNG supply is available in key markets globally

2. The LNG road network is developing in EU & China

3. The marine segments are adopting LNG
   - Container
   - Tanker
   - Bulker
   - PCT
   - OSV
   - Ferry

4. Key downstream infrastructure is being developed

Source: Shell

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The Vital Role of Natural Gas towards a Sustainable Energy Future

Mark Lipton

GE Marine
LNG Fueled Vessels: Growing Opportunities for Korean Shipbuilding and Shipping Industries

247 LNG fueled ships confirmed, and 110 additional LNG ready ships

Market Trends

ROK government plans for 100 LNG fueled ships and 5 LNG bunkering ports by 2025

Shipping companies placing orders for LNG-fueled ships...containerships, bulk carriers

Korean shipyards continue to lead in LNGC, winning 55 LNGCs out of 69 ordered in 2018

LPG as clean marine fuel, the first LPG fueled ferry with Korean partners

Ship conversion for environmental compliance...steam turbine powered LNGC to more efficient gas turbine
Emissions Case for LNG

Outperforms conventional marine fuel
• Zero SOx
• 90% NOx reduction
• 99% decrease in PM

No waste disposal or discharge issues

Significant GHG reductions
• 20% compared to existing
• 40% with ship Energy Efficiency Design Index measures
• Further benefits with bio or synthetic gas

Unmatched local emissions performance and major improvement for GHG
Buquebus ferry Francisco – built by Incat

- Commissioned in 2013; ~16,000 hours on LNG to date
- Powered by 2 x LM2500 dual fuel gas turbines driving water jets
- 450 tonnes deadweight
  - Length = 91 meters
  - Breadth = 26.9 meters
  - Draft = 2.94 meters
  - Service speed = 52.5 knots
  - LNG stored in two, 40 m3 tanks
- Operating profile (106 nautical miles):
  - Begin in Buenos Aires
  - Start on liquid fuel
  - Accelerate to service speed and transfer to LNG
  - Arrive in Montevideo in ~2 hours
SEA LNG – The Marine Industry Advocate for LNG

1. Stranded fuels
2. Business as usual “BAU”
3. Tight supply for distillates
4. LNG economies of scale
5. LNG liquefaction technology improvements
6. Tight MGO, unavailable HSFO, improve LNG

LNG as a marine fuel delivers best ROI for a 10 year NPV basis*

* Source: “LNG as a marine fuel – the investment opportunity,” SEA LNG newbuild 14,000 teu liner vessel on Asia-USWC trade
Thank you
Hansch van der Velden,
Director Corporate Communications, Gasunie, the Netherlands
Chair Marketing & Communications Committee, IGU
IGU Marketing & Communications Committee.
Members from: Columbia, Qatar, Canada, Austria, the Netherlands, Russia, UK, Korea, Norway, Oman, Belgium, Egypt, Poland, Ukraine, Czech Republic, Slovak Republic, Poland, Switzerland etc.

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1952: 4,000 dead in 5 days (London)

In 2060, 6-9 million premature deaths
Costs: 1% of global GDP (2.6 trillion USD) (OECD, 2016)
Riding a bike not always a good idea
Cities are taking comprehensive actions:

- Displacing polluting fuels
- Closing coal plants
- Gas for heating/cooking
- Gas in (public) transport: CNG, LNG, LPG
# Korean government: mix of measures

**3 June 2016 and 26 September 2017**

<table>
<thead>
<tr>
<th>Targets</th>
<th>June 3 measures</th>
<th>September 26 measures</th>
</tr>
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<tbody>
<tr>
<td><strong>Power generation</strong></td>
<td>14 percent reduction in domestic emissions by 2021</td>
<td>30 percent reduction in domestic emissions by 2022</td>
</tr>
<tr>
<td>Coal-based power generation</td>
<td>- Prohibition of new coal-fired power plants - Toughened regulations on coal-fired plant emissions</td>
<td>- Plans underway for 9 new plants (strengthened) - Shutting down old plants during the spring season; permanent shutting of old plants before the current government’s term ends (new)</td>
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<tr>
<td>Renewable energy</td>
<td>Increase to 11 percent by 2025</td>
<td>Increase to 30 percent by 2030 (strengthened)</td>
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<tr>
<td><strong>Dust control</strong></td>
<td>Total emission control (new)</td>
<td></td>
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<tr>
<td>Emission charge</td>
<td>A charge on nitrogen oxide under consideration</td>
<td>Introduced a charge on nitrogen oxide emissions (strengthened)</td>
</tr>
<tr>
<td>Total emission control</td>
<td>Total emission control for the Seoul capital region</td>
<td>Extended total emission control to Chung-cheong, Dong-nam, and Gwang-yang (strengthened)</td>
</tr>
<tr>
<td><strong>Eco-friendly vehicles</strong></td>
<td>Spread of electric vehicles</td>
<td>- Increased the spread of eco-friendly vehicles including electric and LPG-based cars (strengthened) - Subsidy program for eco-friendly cars (new)</td>
</tr>
<tr>
<td><strong>Transportation</strong></td>
<td>Reduced harmful emissions from construction machineries</td>
<td>- Tightened regulations on ships and port facilities (new) - Extended target for low-pollution construction machineries (strengthened) - Tightened regulations on 2-wheeled motor vehicles; Distribute 2-wheeled electric motor vehicles (new)</td>
</tr>
<tr>
<td>Old diesel vehicles</td>
<td>Banned old diesel vehicles from driving in the Seoul capital area</td>
<td>Extended the low emission zone (strengthened)</td>
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<tr>
<td><strong>Susceptible groups</strong></td>
<td></td>
<td>- Improved environmental quality standards on fine dust (new) - Indoor fine dust standards for susceptible groups (new)</td>
</tr>
<tr>
<td>Environmental quality standards</td>
<td></td>
<td>- Strengthening of monitoring networks in and around education institutions (strengthened) - Air quality monitoring of indoor sports facilities (new)</td>
</tr>
<tr>
<td>Infrastructure build-up</td>
<td>Expansion of fine particulate monitoring network</td>
<td>- Convert school buses to environment-friendly vehicles - Home visiting care services for susceptible groups - Introduction of “Clean Air Zones” program</td>
</tr>
<tr>
<td>Education and environmental services</td>
<td>Air quality education and awareness manual</td>
<td></td>
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<tr>
<td><strong>International cooperation</strong></td>
<td>Fine dust issue upgraded to ministerial level (Korea-China-Japan Environmental Ministerial Talks)</td>
<td>Fine dust issue upgraded to summit level (Korea-China Summit)</td>
</tr>
<tr>
<td>Agreement</td>
<td></td>
<td>International fine-dust convention under consideration</td>
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Public acceptance of bad air is quickly evaporating
Citizens are taking the lead
**Hoe werken de meetbuisjes?**

**In het labo**
De meetstof

- Triethanolamine (TEA) wordt aangebracht op een reostrijf stalen gaasje.

Het meetbuisje

- kop
- 2 metalen gaasjes met TEA
- acrylaat buisje
- sluitdopje

We bewaren de buisjes zoveel mogelijk op een donker, koel plek waar ze niet aan het meten zijn, voor en na de meting.

**Het meten**

Het meetbuisje wordt gespoeld.

- Sulfatofluoride of NO$_3^-$ in de buisje komt in het buretje.

- Een NO$_3^-$-molecuul NO$_3^-$ is een goede indicator voor verhogen geraadpleegde luchtvorming.

- Een NO$_3^-$-molecuul NO$_3^-$ komt in het buretje.

De meetopstelling

- Twee differentiaties per meetstof.

Stikstofoxide in de buisje wordt in contact gekomen met de meetstof op de gaasjes en wordt opgeslagen in nitriet (NO$_2^-$).

De snelheid waarop dat gebeurt hangt af van de temperatuur, de oplossing van het buisje en de concentratie van stikstofoxide in de lucht.

Het meeten start na een maand, wanneer de buisjes gesloten worden.

**Terug in het labo**
De analyse

- De twee gaasjes worden gespoeld met water.
- Water met nitriet.
- Saltzman-Griess reagens wordt toegevoegd aan het water.
- Door het reagenskleurt het water met nitriet paars.
- Een spectrofotometer meet de kleur in het water en veel NO$_3^-$ veel NO$_2$.

**Het resultaat**

De hoeveelheid nitriet op het gaasje laat toe de gemiddelde concentratie van stikstofoxide in de lucht gedurende de meetperiode op het meetpunt te berekenen, uitgedrukt in µg/m$^3$.

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Clean air in mega cities is a **Mission Possible.**
Korea: Chef de Mission
Korea: Chef de EMISSION...
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