The energy mix: the good, the bad & the ugly

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“The Good Fight Against GHG Emissions”

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Since the Kyoto conference in 1997, the global energy mix has worsened from an emissions perspective

Since the Kyoto Protocol in late 1997, global coal use has grown by 50%

Growth in global PED by fuel (mmboe/d) and increase in global CO2 emissions (%), 1998-2018

- Coal: +30 mmboe/d
- Gas: +28 mmboe/d
- Oil: +21 mmboe/d
- Renewable: +10 mmboe/d
- Hydro: +7 mmboe/d
- Nuclear: +1 mmboe/d

% increase in CO2 emissions: +49%

Source: BP Statistical Review of World Energy
Diesel to gas switch at heart of KRI’s growth

Pearl Petroleum led diesel to gas switch a huge boost for KRI

Switch accelerated by Pearl Petroleum expansion plan

THE FIRST TEN YEARS

<table>
<thead>
<tr>
<th>Total Investment</th>
<th>USD 1.3bn</th>
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</thead>
<tbody>
<tr>
<td>Enabled GDP Impact</td>
<td>USD 10.7bn – USD 18.3bn</td>
</tr>
<tr>
<td>Employment Impact</td>
<td>20,000 jobs</td>
</tr>
<tr>
<td>Temporary during construction phase</td>
<td>2,200 jobs (2017)</td>
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<tr>
<td>Savings generated due to fuel substitution</td>
<td>USD 21.3bn</td>
</tr>
<tr>
<td>Fuel cost savings to KRG</td>
<td>29m tCO₂e</td>
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<tr>
<td>Local staff employment</td>
<td>Over 80%</td>
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<tr>
<td>Local procurement</td>
<td>USD 0.3bn</td>
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THE NEXT TEN YEARS

<table>
<thead>
<tr>
<th>Total Investment</th>
<th>USD 4.3bn</th>
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<tbody>
<tr>
<td>Enabled GDP Impact</td>
<td>USD 28.6bn – USD 41.6bn</td>
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<tr>
<td>Employment Impact</td>
<td>84,000 jobs</td>
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<tr>
<td>Temporary during construction phase</td>
<td>7,500 jobs (2027)</td>
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<tr>
<td>Savings generated due to fuel substitution</td>
<td>USD 33.2bn</td>
</tr>
<tr>
<td>Fuel cost savings to KRG</td>
<td>77m tCO₂e</td>
</tr>
<tr>
<td>Local staff employment</td>
<td>90% within next 5 years</td>
</tr>
<tr>
<td>Local procurement</td>
<td>100% eventually</td>
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<tr>
<td>Localisation</td>
<td>USD 1.2bn</td>
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The power sector has failed to reduce CO2 emissions, until it succeeds mass electrification is irrelevant to climate goals

Power demand is expected to grow across the world

Power generation by fuel in selected regions (2017, TWh)

Coal generates 38% of total power but 72% of power sector CO2 emissions. It is also a large emitter of other pollutants

Power sector CO2 emissions since 2000

Source: IEA
Fortunately, global gas resources are abundant, pervasive and can be extracted at low cost

Significant gas volumes can be produced at low cost

Global gas resources breakeven cost curve

- Weighted average breakeven price: $3.9/mmBtu
- Current global gas demand: ~3.8 tcm

Levelised costs for different UK firm power options

<table>
<thead>
<tr>
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<th>GBP per MWh</th>
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<tr>
<td>2017 Actual</td>
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<tr>
<td>Nuclear + battery</td>
<td></td>
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<tr>
<td>Offshore wind + battery</td>
<td></td>
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<tr>
<td>Nuclear + CCGT + gas storage</td>
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</table>

Battery costs an order of magnitude higher than gas storage

Sources: Rystad Energy, LEA estimates
Transport sector emits c.25% of global CO2 emissions. Gas can play a role in heavy road haulage and marine bunkering.

NGVs compete with EVs on cost as alternative to ICEs.
Fuel cost per mile of passenger car fuels (US, $ cents / mile)

But NGVs currently lack the necessary infrastructure.

Global fleet size (mln)

Global charging / refuelling points (mln)

Heavier transport is difficult to electrify, but gas is demonstrating potential in shipping and trucking.

Increasing use of LNG as a bunker fuel in maritime transport.

New regulation coming into effect in 2020 that limits the sulphur content in marine fuels may present opportunities for other fuels but electricity unlikely to make inroads.

Attempts at electrification of passenger planes are underway but, given current technology, only very small electric passenger planes are viable. The weight and size of a battery required to power a large plane are likely to prevent any meaningful electrification of the sector.

Weight and range concerns may limit the extent of electrification of the freight industry.

Gasification of the freight sector (LNG and CNG) is developing in Europe and the US, and could pose a larger threat to oil demand than power.
Ultimately we have to put CO2 in the ground where it came from. Carbon Capture, Utilization and Storage is essential.

1. Aggressive substitution of coal with gas & renewables
   - Gas and renewables partnership in firm power generation
   - Displace existing coal capacity and prevent new-builds
   - O&G companies build sensible renewables expertise

2. Stringent methane emission and flaring reduction efforts
   - Protect gas’ environmental credentials by minimising fugitive emissions
   - Reducing methane emissions is needed to secure public approval of gas

3. Investment drive into CCUS supported by carbon price
   - Investment drive into the technology and research needed to drive down costs of CCUS just as the renewable sector benefitted in the past.
   - Global carbon price to generate a level playing field to incentivize innovation for most cost effective solutions

4. Investment into biological CCS i.e. forestry
   - Protect and enhance a powerful natural carbon sink and habitat
   - Tackling deforestation and land degradation caused by logging, agriculture, primary bioenergy etc

Continued investment into R&D and advocacy of the key contributions of the oil & gas industry

www.danagas.com
Getting policy right is really important, the UK’s efforts in 2013 are worth emulating elsewhere.

UK introduced an Emissions Performance Standard in to discourage new-build coal

Replacing coal with gas and suitable renewables in power has had an unequivocal impact on CO2 emissions

Relative change in power generation and CO2 emissions in the UK

“Coal’s rapid decline drives carbon emissions down to 1890 levels”

Financial Times. 07.03.18

Source: UK BEIS. Notes: *EU ETS forecast prices are average traded futures prices for the respective year
Some final reflections – the challenge is also political

Pope Francis has urged oil executives and energy leaders to rapidly transition to clean fuels in order to avert climate disaster.

The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive.

The Brazilian president has said NGOs could be burning down the Amazon rainforest to embarrass his government after he cut their funding. Bolsonaro had no evidence but said 'everything indicates' that NGOs are going to the Amazon to set fire to the forest.
THANK YOU

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