Monetising flared gas ... innovative applications of proven technology

EPRG & CEEPR International Energy Policy Conference
Session: “A reality check on energy technology – are today’s tools fit for purpose?”

2 September 2019

Mark Davis, CEO Capterio
mark.davis@capterio.com / +44 7552 050 089
www.capterio.com
Executive summary

Gas has a key role in the transition, but we must address emissions

- Gas is widely seen as a transition fuel to help to drive decarbonisation
- Most players expect gas consumption to increase significantly
- But there is lot of waste, and a large economic and environmental impact

The GHG problem is fixable … with today’s technologies

- Flaring and methane emissions are becoming increasingly transparent
- Existing proven technologies can deliver at no net cost
- Certification technologies are already driving change

... but new approaches and business models are needed

- The business as usual approach isn’t working; real change will need:
  - New incentives
  - New operating models
  - New technologies
- It Must, Can and Pays to be done!

Source: Capterio
**Gas has a key role in the transition, but we must address the GHG emissions challenge**

<table>
<thead>
<tr>
<th>The GHG problem is fixable with today’s proven technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>But technology is not the barrier: systemic change needs innovative approaches and business models</td>
</tr>
</tbody>
</table>
Gas is widely seen as a transition fuel, and its increasing market share is helping to drive decarbonisation ...

Gas has lower GHG intensity ...

Total GHG intensity (kgCO2e/boe)

- Coal 595
- Resid Fuel 455 (-45%)
- Diesel 436
- Kerosene 421 (-25%)
- Gasoline 410
- Gas 329

... and robust growth ...

Gas growth rate (% on prior year)

Market share (% primary)

CO2 intensity (tonnes / toe)

Source: BP Statistical Review of World Energy, 2019; IPCC; World Bank (GDP is PPP, 2011)
... and gas is expected to grow in the medium term, but the outlook in 2050 is, for gas, more challenging

**Gas consumption outlook**

EJ per year

- **2018**
  - Shell Sky: 0.5
  - BP: 1.5
  - IEA Ref: 136

- **2040**
  - Shell Sky: 151
  - BP: 189
  - IEA Ref: 184

- **2050**
  - Shell Sky: 184
  - ETC: 77-118

**Commentary**

Wide range of outlooks, but with Asia and rest of China underpinning demand increase, partly by shift from coal:

- **BP**: “Rapid Transition” & “Less Globalisation” scenario sees expanded role of gas, with much higher market share

- **Shell “Sky”**: sees strong gas growth in the shorter term, but losing share to stronger renewables

- **ETC “Mission Possible”**: believes that gas will be replaced in core areas, remaining only for critical sectors (e.g. “Hard to Abate”)

Source: BP Outlook; Shell Scenarios; Energy Transitions Commission
... but the industry’s social license to operate is challenged by 273 BCM of gas is waste, increasing emissions and missing revenue

END USE
occurs when the gas is combusted in the end use

OPERATING
gas used in operations to power facilities

FLARING
burning of waste gas (often incompletely)

VENTING
the deliberate release of methane

LEAKING
the accidental release of methane

Primarily CO2 with some CH4
Primarily CO2
Primarily CO2 with some CH4
Primarily CH4
Primarily CH4

Emissions: 273 BCM

Source: Capterio; World Bank; IEA
Methane emissions are challenging, given 84x potency vs CO2

**VENTING**
the deliberate release of methane

**LEAKING**
the accidental release of methane

**FLARING**
CO2-equivalent emissions by source
Million tonnes per year

- 100%: 0.24
- 98.5%: 0.33
- 90%: 0.80
- 80%: 1.37
- 70%: 1.94
- 60%: 2.51

Illustrated for a 10 million scf/day flare

Source: Capterio; FLIR
Wasted gas is a large economic opportunity and doubles the CO2-equivalent emissions of natural gas

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaring</td>
<td>145</td>
<td>20.7</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>161</td>
<td>23.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Venting</td>
<td>67</td>
<td>9.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Leaking</td>
<td>45</td>
<td>6.4</td>
<td>2.6</td>
</tr>
<tr>
<td>Total</td>
<td>3,849</td>
<td>549.4</td>
<td>7.2</td>
</tr>
</tbody>
</table>

- Flaring alone is equivalent to consumption of whole of Africa, or 30% of Europe
- Missed revenue $39 billion per year (at $4/mmbtu) – some 7% of total
- CO2-equivalent emissions from natural gas are >100% greater when methane emissions are included

Note: gas priced at approx. global average of 4 $/MMBTU. CO2e emissions from methane estimated using a multiple of 84 of that of CO2, based on a 20-year timescale. We assume methane slip is 10% at flares, due to incomplete combustion and that natural gas is predominantly methane.

Source: BP Statistical Review of World Energy (2019); World Bank / GGRF / NOAA (2019); IEA World Energy Outlook (2019); Capterio estimates
Gas has a key role in the transition, but we must address the GHG emissions challenge

The GHG problem is fixable with today’s proven technologies

But technology is not the barrier: systemic change needs innovative approaches and business models
Emissions from the natural gas system are daily news ... with many companies making commitments

- Flaring up
- Regulation down
- Guarantees of origin?

Source: Literature searches
“Business as usual” has not made material progress on flaring due to 3 main factors

Global flared gas has not materially reduced in a decade ...

- **2007**
- **2010**
- **2015**

... due to ...

1. **Lack of awareness** from the consumers, market and/or operators
   - Awareness lacking
   - Lack of measurement / standards
   - Some operators are in denial

2. **Capture not sufficiently commercially attractive**
   - Low value of gas capture
   - High unit cost
   - Lack of infrastructure

3. **Capture is commercially attractive, but not operationally deliverable**
   - Lack of funding from partners
   - Challenging bureaucracy
   - Lack of execution capacity

Source: World Bank GGFR, 2018
Capterio has developed a new global tool to inspect each of the 10,000 flares globally and yield unique insights.

Global and country view of flares

Flare frequency by flare size

Source: Capterio Global Flare Tool; NOAA / GGFR / Colorado School of Mines
There are several proven technology options to monetise waste gas.

**Uses of Flared Gas**

- **Onsite**
  - Re injection: EOR | Disposal | Storage
  - Powergen: Operations | Services
  - Heat: Operations | Services
  - Raw gas: Pipeline | Virtual pipeline
  - Liquids: Condensate | LPG | CNG | GTL
  - Petchems: Methanol | Ammonia
  - Products: Cement | Fertilizer
- **Saleable product**
  - Other: Alternative protein, ...
Projects demonstrate that capturing flared gas with innovative, modular and scalable solutions can work with strong IRRs

- Standardised
- Modular
- Plug and Play
- Limited FEED
- Reusable
- Rapid deployment
- Low cost
- Attractive IRRs

Source: Capterio; IEA
New technologies help to monitor and measure emissions, but so far, no all-seeing method, so integrating datasets is key ...

- **Satellites**: powerful and scalable tool that will provide daily GHG emissions data at the facility level.

- **Airborne surveys**: can pinpoint GHG emissions sources.

- **Stationary monitoring stations**: can provide regional GHG atmospheric concentration data and wind speeds to help ground truth satellite and aerial surveys.

- **IoT sensors**: can take advantage of existing infrastructure and provide a continuous GHG emissions monitoring.

- **Vehicle-mounted sensors**.

- **Pedestrian surveys**: provide highly sensitive and accurate GHG emissions data.

Source: SYSTEMIQ; RMI
Gas has a key role in the transition, but we must address the GHG emissions challenge

The GHG problem is fixable with today’s proven technologies

But technology is not the barrier: systemic change needs innovative approaches and business models
To drive real change in the upstream, many countries will need to consider change, supported by new types of players

**Improving the economic incentives**
- Review and revise fiscal policy
- Open-up third party access
- Bring third party capital

**Drive more enforcement**
- Create bodies in-country to oversee flare monetisation and total gas conservation
- Technology and measurement
- Establish “teeth”

**Build new national capabilities**
- Build national capability in flare abatement and total gas conservation
- Bring best technology and capabilities

**New data and insights**
- Data transparency
- Bring the best technology solution with deep expertise

**Bring new operating models**
- New ways of funding/operating

Source: Capterio
A very clear message is becoming evident ...

IT MUST BE DONE

It’s critical to the industry – and the planet – that the GHG emissions of natural gas are reduced

IT CAN BE DONE

Technologies can be applied in upstream production and downstream consumer areas to drive change

IT PAYS TO DO IT

Solving the issues are a triple win: for asset owners, national government, consumers (and the planet)

Source: Capterio; SYSTEMIQ; RMI
Monetising flared gas ... innovative applications of proven technology

EPRG & CEEPR International Energy Policy Conference
Session: “A reality check on energy technology – are today’s tools fit for purpose?”

2 September 2019

Mark Davis, CEO Capterio
mark.davis@capterio.com / +44 7552 050 089
www.capterio.com