‘Burnout’ – the endgame for fossil fuels: Implications of rapid digitalisation, electrification and efficiency enhancement for global and UK gas markets

October 2018,
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1. Burnout envisages a world where technology drives the energy transition

2. Coal prices collapse as coal is phased out of power

3. OPEC seeks market share as fuel efficiency and EVs decrease oil demand

4. Fuel switching to gas ramps up in power and petrochemicals

5. Burnout does better than Paris NDCs in reducing global CO$_2$ emissions

6. Cumulative fossil fuel revenues decrease by over $20$ Trillion in Burnout
Digitalisation is the key driver of cheaper oil and gas supply; coal is phased out of power

- **Coal:**
  - Lower coal energy intensity in the power sector
  - Increase extraction costs due to policy changes

- **Gas/Oil:**
  - Cheaper sensors make oil/gas easier to find
  - Increase overall resource base
  - Decrease slope of extraction cost curve

- **Oil:**
  - OPEC floods the market to gain market share
  - Increase OPEC country production
  - Non-OPEC countries adjust to residual demand

**Sources:** Aurora Energy Research; IEA
On the demand side, electrification and digitalisation decrease demand for oil and increase demand for power

- **Oil:**
  - Consumers choose EVs & more efficient vehicles
  - Decrease final energy intensity in transport sector
  - 560 million EVs globally by 2040

- **Power:**
  - Digital technologies pervade all aspects of life
  - Automation leads to reshoring of manufacturing
  - Increase electricity use per unit of GDP

- **GDP:**
  - China, India, SE Asia economies slow down
  - Services increases as a share of the economy
  - Decrease GDP growth rates from 2030s

Sources: Aurora Energy Research; IEA
Agenda

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A decrease in coal demand reduces new coal investment and causes existing coal production to shut down.

Notes: 1) Includes Africa, Japan, Russia, Eastern Europe, Australia, Former Soviet Union, Great Britain, Latin America, Canada, Brazil, France and Venezuela.
As coal is phased out of power systems around the world, the coal price plummets

Notes: 1) As of 6/09/2018
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Source: Aurora Energy Research, me-freight.com International Seaborne Market, IEA

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Improved fuel efficiency and a switch to EVs cause oil demand to decline from the 2030s, ending 10% lower than IEA’s forecast.

Deviation in oil consumption from Aurora Central, 2040, Mbbld

- Aurora Central 2040: 105.5
- GDP: -4.3
- EVs: -2.4
- Increased fuel efficiency: -9.3
- Price rebound effect: 5.8
- Burnout 2040: 95.3

Notes: 1) Includes changes in stock inventories

Source: Aurora Energy Research, IEA
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Global oil demand\(^1\), Mbbl/d

- History
- Aurora Central
- IEA NPS 2017
- Burnout

Notes: 1) Includes changes in stock inventories

Source: Aurora Energy Research, IEA
This demand destruction causes the oil price to drop to $32/bbl by 2040, near the long run historic price.

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Fuel switching towards gas occurs in both the power and manufacturing sectors

The power sector sees a switch from coal towards gas and non-fossil sources.

Share in global power sector¹, %

<table>
<thead>
<tr>
<th>Year</th>
<th>Coal</th>
<th>Gas</th>
<th>Non-fossil</th>
<th>Oil</th>
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<td>26</td>
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<td>2040</td>
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<td>32</td>
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</tbody>
</table>

Total final energy demand, Mtoe

- 2016: 2,150 Mtoe
- 2040: 3,450 Mtoe

...whilst manufacturing sees a shift towards gas and power

Share in global manufacturing sector, %

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<td>19</td>
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<td></td>
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</tbody>
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Total final energy demand, Mtoe

- 2016: 2,903 Mtoe
- 2040: 4,270 Mtoe

Notes: 1) On final consumption basis: Mtoes of fuel multiplied by average fleet efficiency (37% LHV for coal, 49% LHV for gas, 32% LHV for oil); 2) Includes hydro, renewables, biomass and nuclear

Source: Aurora Energy Research
This fuel switching causes global gas supply and demand to maintain an upwards trajectory across the forecast.

Source: Aurora Energy Research, IEA
Gas prices are similar to the Central scenario, despite higher demand and lower production costs

Source: Aurora Energy Research, IEA

Notes: 1) As of 6/09/18

Long run cost approaches cost of LNG to Japan
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Burnout scenario achieves lower global CO$_2$ emissions than NDCs alone, but does not hit the 2°C target.

Global CO$_2$ emissions from fuel use, Gigatonnes CO$_2$

- History
- IEA SDS 2017
- Aurora Central
- IEA NPS 2017
- IEA CPS 2017

- Includes policies needed to hit the 2°C target but also clean air Sustainable Development goals
- IEA NPS includes Nationally Determined Contributions from Paris Agreement, but does not hit the 2°C target

Source: Aurora Energy Research, IEA
Burnout scenario achieves lower global CO$_2$ emissions than NDCs alone, but does not hit the 2°C target.

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Includes policies needed to hit the 2°C target but also clean air Sustainable Development goals.

Business As Usual
Agenda

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Compared to BAU scenario, Burnout sees $21 Trillion loss in oil and coal revenues to 2040; whilst gas market expands significantly

- Cumulative change in revenues (2018-2040) between Aurora Central and Burnout is substantial:
  - A decrease of $19 Trillion for oil
  - A decrease of $2.4 Trillion for coal
  - An increase of $0.33 Trillion for gas

- Gas consumption growth prevents total revenues under Burnout being as low as during the energy commodity price slump in 2016

Source: Aurora Energy Research, BP

Notes: 1) Volume x price; 2) At the ARA price; 3) Sum of (hub price x volume consumed by regions buying from that hub); 4) Using 2016 data from BP Statistical Review 2017
Key takeaways

- Technology and consumer preferences drive the energy transition in Burnout and achieve greater emissions savings than Paris NDCs alone
- Governments should create an environment where innovative business models and technologies are stimulated and able to be financed competitively

- Oil demand peaks in the mid 2020s as a result of the growth in EVs and improvements in fuel efficiency, causing oil prices to drop substantially thereafter
- This results in almost $20 Trillion in lost revenue for oil companies between 2018 and 2040

- Gas and power become increasingly important energy vectors, together comprising 52% of final energy consumption in 2040 (up from 39% today)
- Between 2018 and 2040, gas market revenues more than double to $1.8 Trillion/year
European Gas Market Service
Market analysis and forecasts for all participants in the European gas market

1 European Gas Market Forecasts
• European gas market development until 2040 including hub prices, seasonal and regional spreads, demand evolution, supply development within Europe and in key supplying regions, LNG and pipeline import flows
• Key modelling assumptions result from in-depth market research drawing on our unparalleled expertise across the energy, policy, environmental and financial sectors, and are further refined through a detailed consultation process across private and public sector players
• Forecasts are produced with our in-house European gas flow dispatch model that includes 430+ pipelines, all storages and LNG import facilities as well as detailed modelling of demand zones
• Comprehensive annual report (~120 pages) with full review and outlook of the market; quarterly updates (~20 pages) focusing on changes in forward prices, geopolitical and technology developments
• Additionally, a presentation with all exhibits plus underlying data in xls is provided

2 Global Energy Market Forecasts
• Aurora’s long-term forecasts for oil, gas and coal markets presents a fully consistent view on fuel prices, production, and consumption by major countries and regions
• Identifies key areas of long-term uncertainty in global energy markets
• Provides central, high, low, and P10/P90 price sensitivity analyses, based on historical variation in key sources of uncertainty
• Produced with our in-house global energy market model, which provides full substitution among the commodities and regions (e.g., impact on European gas price if China’s growth slumps or India builds more coal power stations)
• Our global energy market model is used to underpin BP’s Energy Outlook and the scenarios they present
• The annual main report (~160 pages) provides a full outlook on the expected supply and demand balance going forward, published once a year with quarterly updates

3 Monthly market summaries
• Monthly summary on key performance parameters of the European gas market that set the market results into perspective for management to stay on top of the developments
• North West European Gas System Performance Summary: monthly snapshot of key operating characteristics of the gas market. Key statistics include hub prices, volumes, trade, suppliers market share, indigenous production flexibility and storage provision for security of supply

4 Analytics and data platform EOS
• Access to detailed historical and real-time European gas market data
• Data with daily granularity includes
  – Demand, supply and production
  – Pipeline flows and imports/exports
  – Storage utilisation and LNG sent-outs
  – Regional gas prices and commodity price data
• Data can be viewed, charted and downloaded

5 Bilateral meetings & analyst support
• Bilateral workshops with senior members and subject experts of Aurora’ team to discuss Aurora’s analyses and views on the market
• Short-notice support by our analysts on questions arising from our research

6 Invitation to Aurora’s annual Spring Forum
• In our by-invitation-only annual Spring Forum industry leaders discuss the challenges of the energy industry of tomorrow
• Being held at distinguished venues at the University of Oxford
• Key note speakers of our 2018 Forum included Clair Perry MP (Minister State, BEIS), Magnus Hall (CEO, Vattenfall), Spencer Dale (Chief Economist, BP) and Steven Fries (Chief Economist, Shell)

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