Gas security of supply Significant Code Review

Economic modelling by Redpoint Energy

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Assumptions

Principles

- Stochastic shocks calibrated to historic data to the extent possible
  - Demand
  - UKCS output
- Assumptions made for shocks that could not be calibrated to historic data
  - Interconnector/storage outages
  - Rare events (less than one in ten years)
- Probability distributions of shocks account for:
  - Persistence of shocks
  - Extreme events (i.e. long tail in the distribution of shocks)

Key assumptions

- Annual non-power gas demand and gas supply assumptions based on National Grid's Gone Green scenario
- Commodity prices based on forward curves up to 2015 and IEA's 2010 World Energy Outlook thereafter
- Uncertainty about LNG pricing – prices driven by a random combination of Henry Hub and Japanese Crude Cocktail (oil-indexed pricing)
- LNG shipments respond to changes in GB gas price with a minimum delay of seven days
- Value of Lost Load estimated by LE for different tranches of demand
- No new interconnectors built within model horizon
- New storage infrastructure is built only if there are current plans in place
- Reverse flow possible on BBL from 2016

Options and sensitivities modelled

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Options modelled

- Option 1: Cash-out at the full value of lost load
- Option 2: Cash-out at a capped value of lost load
- Option 3: Further interventions
- Option 4: Capped cash-out and further interventions

Sensitivities

- Energy scenario - *based on Project Discovery's Dash for Energy scenario*
- Infrastructure outages - *double the mean duration and probability of outages on all supply infrastructure*
- LNG price - *LNG price is permanently driven by the JCC price*
- Demand side response - *no new interruptible contracts are signed under Options 1 and 2*
- Frozen cash-out - *cash-out price is frozen at 80% of the previous day's price and 20% of domestic customer VoLL*

Modelling different market arrangements

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All options

- NDM interruptions last for a minimum of 14 days and have minimum size of 20 mcm
- DM and NDM interruptions were used as proxies for "load shedding" and "physical network isolations" respectively

Current arrangements

- Under current arrangements gas price is assumed to be frozen at the previous day's level when firm demand is interrupted

Cash-out at (capped) value of lost load

- Allowing cash-out to rise to VoLL of domestic customers assumed to encourage suppliers and DM customers to sign interruptible contracts
- This is assumed to affect approximately two thirds of DM demand

Further interventions

- Further market interventions assumed to take the form of a storage obligation
- Obligation level increases with time as UKCS output decreases
- Gas under the obligation can only be used to prevent NDM customer interruptions

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Methodology

Model concept

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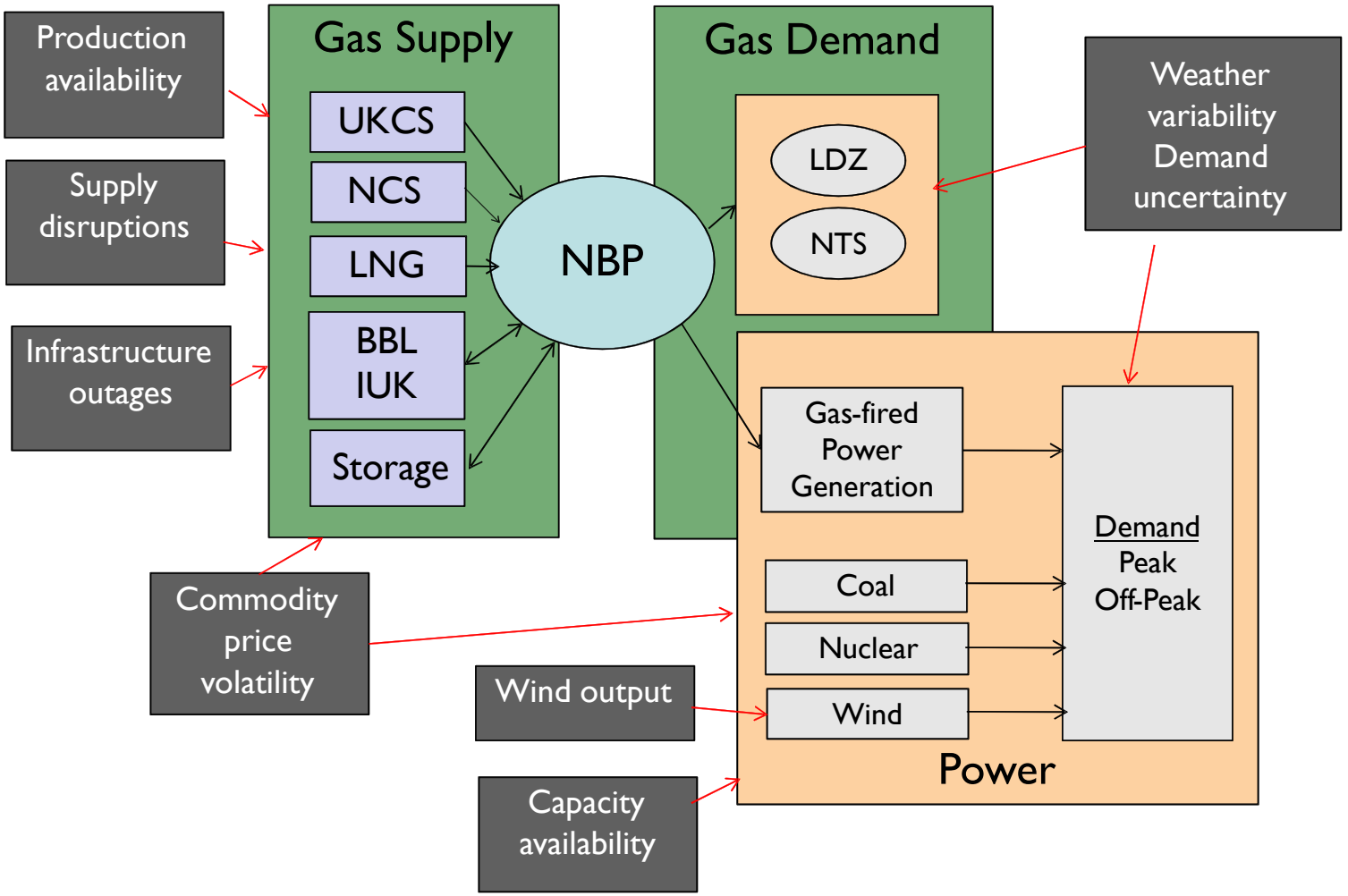
Requirement

- Evaluate impact of supply and demand shocks on security of supply under different market arrangements

Modelling approach

- Full representation of the GB gas market
- EU and global gas markets represented through connections to GB market (e.g. IUK and LNG imports)
- Stochastic model in which market reacts to unexpected shocks
- Optimisation within-day to meet demand at lowest possible cost given outturn values of stochastic factors
- Gas market co-optimised with simple representation of the electricity market

Model mechanics



Modelling supply and demand shocks

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Demand

Continuous variation in NPG demand calibrated to historic data

Changing gas demand for power generation due to stochastic wind, plant outages and seasonal factors

Storage

Storage outages reflected in reduced deliverability of gas in store

LNG supply

Import capacity shocks

UKCS / NCS output

Continuous variation calibrated to historic data plus negative supply shocks less than 1 in 10 years

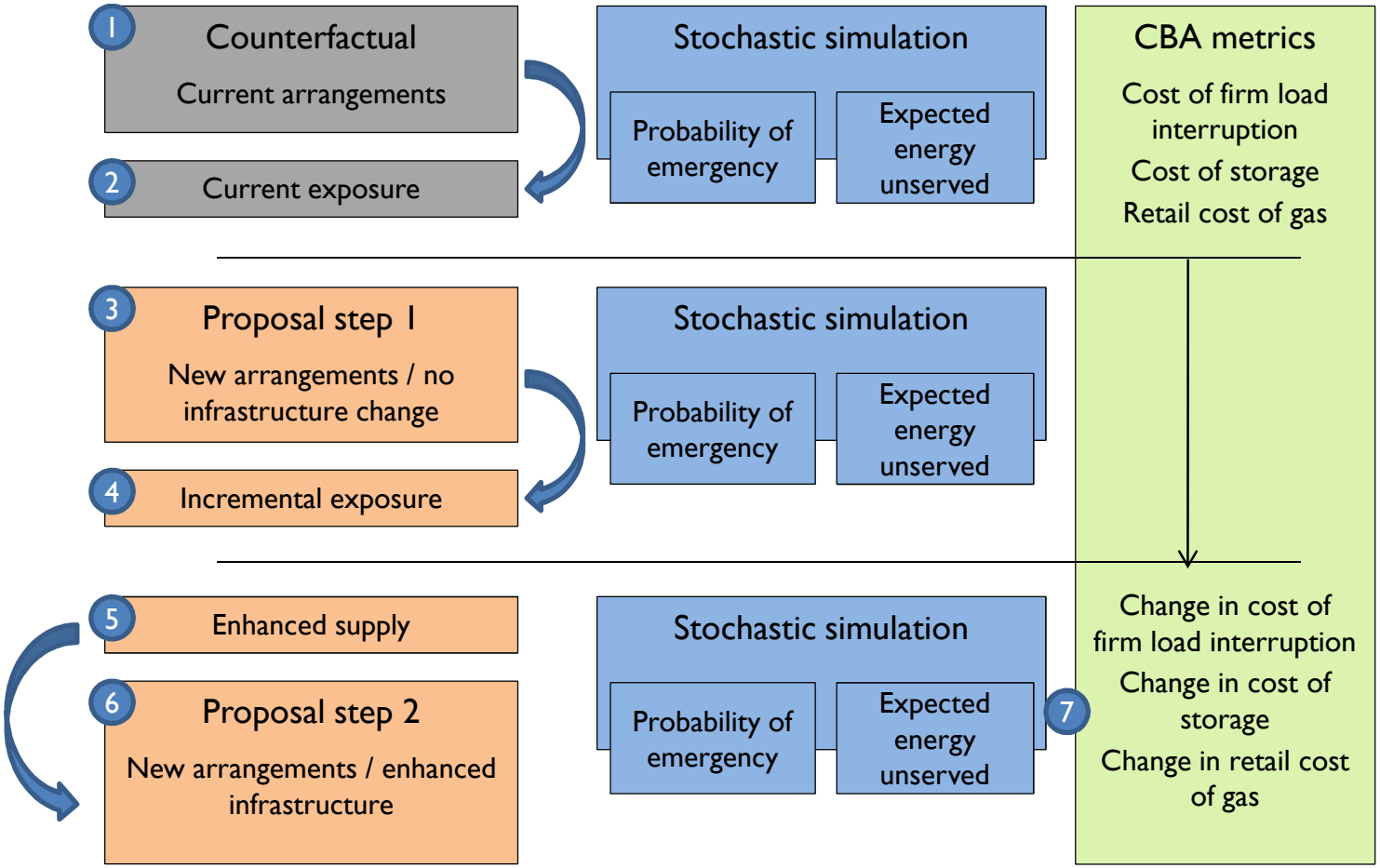
Continental price shocks

Asymmetry between IUK imports and exports to reflect effect of PSO in times of tight supply-demand balance. NCS supply partly diverted to continent when continental price is high

Interconnector availability and gas quality issues (IUK only)

Modelled as sudden shocks with stochastic impact and duration.

Overview of approach



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Model strengths and limitations

Model strengths

- Full stochastic representation of the GB gas market
- Modelling of interaction with EU and global gas markets
- Full calibration of variation in UKCS and NCS output as well as variation in demand
- Does not assume perfect foresight
- Persistence and extreme events taken into account in distribution of shocks
- Co-optimisation with the electricity market
- Full calibrated stochastic treatment of wind generation
- Estimation of shipper response to changes in market arrangements

Model limitations

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- Many potential shocks cannot be calibrated to historic data
- Daily granularity of the model limits the extent to which the onset and development of an emergency can be modelled within day
- Effect of smart metering is difficult to predict and only accounted for implicitly through demand assumptions
- Shipper response to changes in market arrangements limited to physical storage
- Only one form of market intervention modelled
- Does not take into account any effects of interruptions on social net welfare beyond those reflected in the Value of Lost Load
- Gas consumers and shippers are assumed to be risk-neutral but some may be risk-averse in reality