

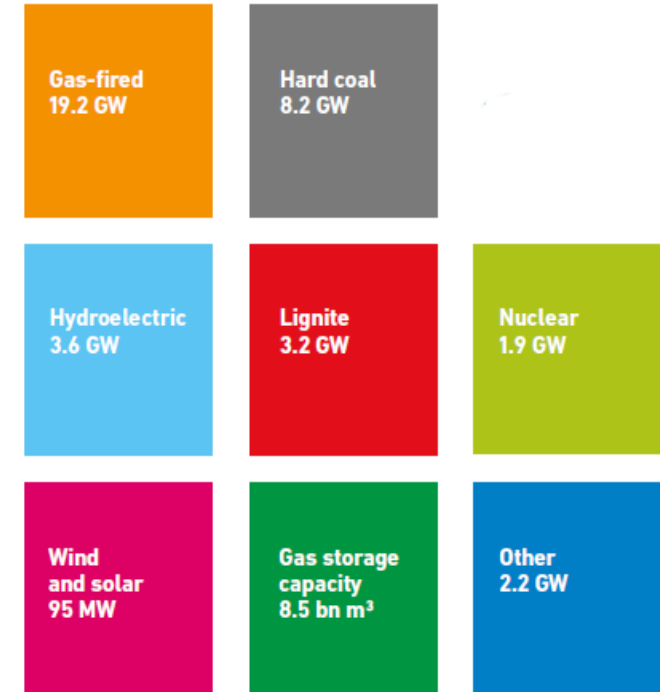
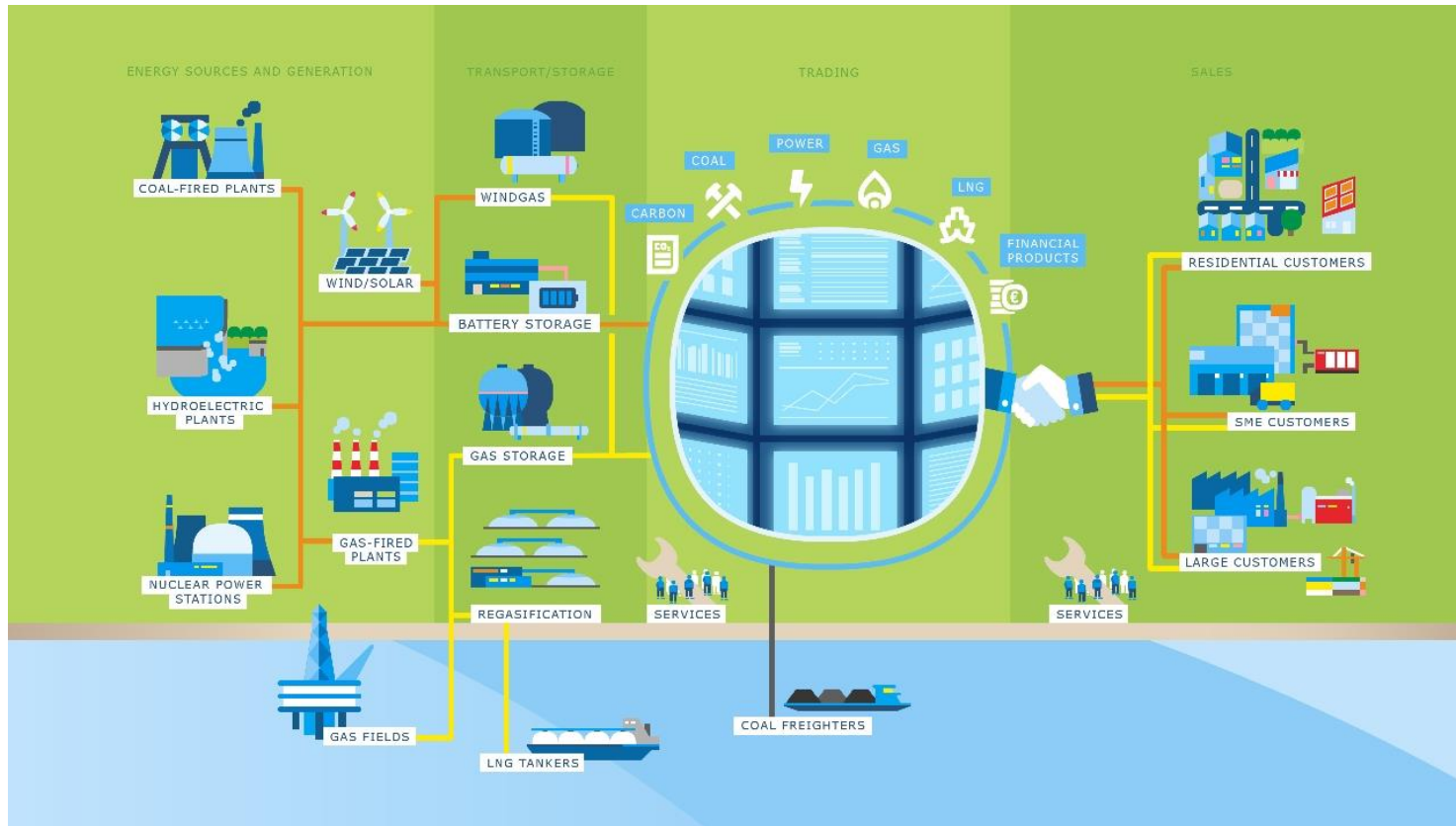


6th Electricity Price Forecasting & Market Coupling 2018

A Combined Modelling Framework for Energy, Reserve and System Balancing

Colin Silvester and Christopher Bates, Uniper

Uniper – A Company with a Century of Experience in Generation and Energy Markets



Scope of our power assets in Europe and Russia

Electricity Supply Undergoing Huge Changes in Europe

UK generates a day's electricity without coal

Share of power from the fossil fuel fell to zero on Friday for first time since 1882



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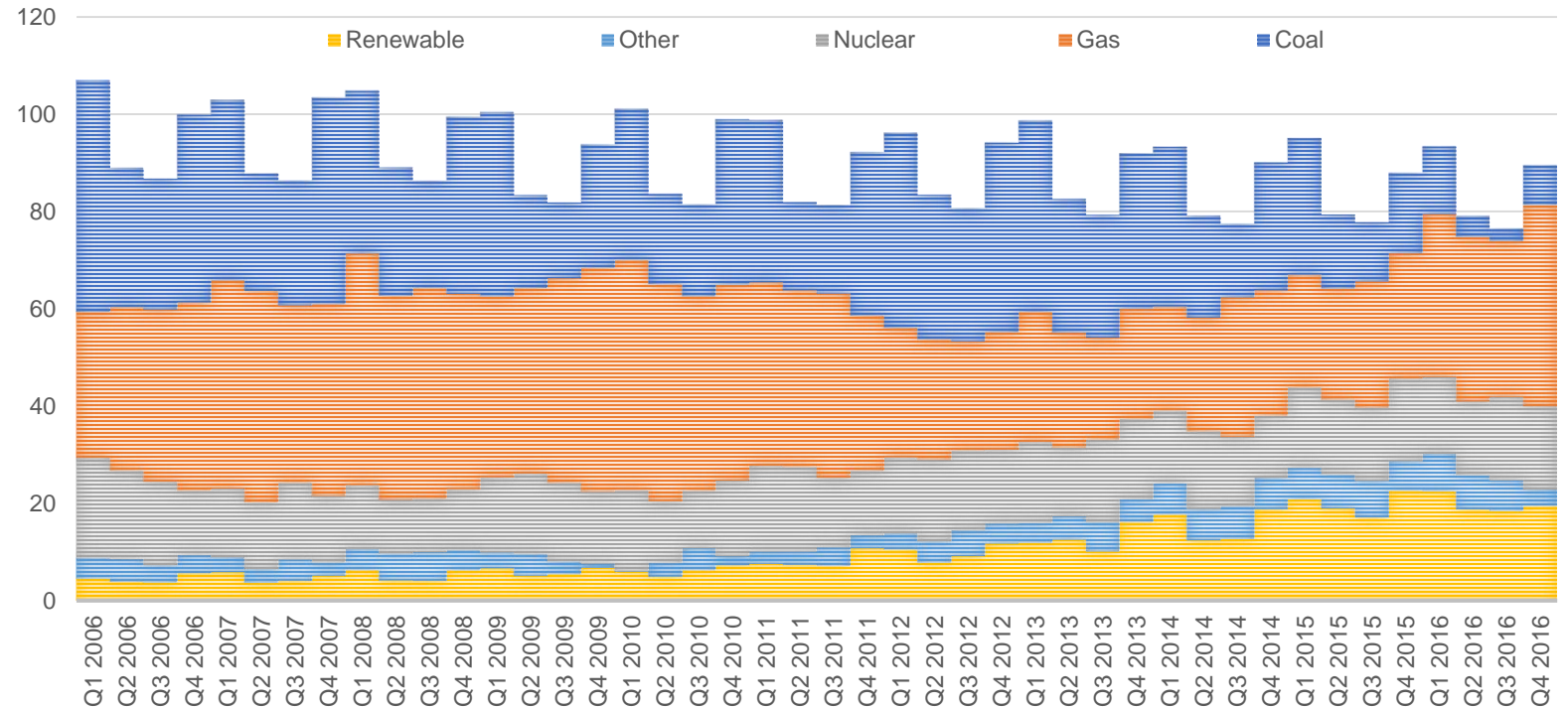
APRIL 22, 2017 by: **Pilita Clark**, Environment Correspondent

Britain has gone a full day without turning on its coal-fired power stations for the first time in more than 130 years.

Power price surges to record high on supply shortage fears

Prices for the hour to 8pm on Thursday evening traded at £999/MWh.

QUARTERLY UK GENERATION 2006-2016



Transition From Fossil to Renewables in UK



Renewables incentivised by:

- Renewables obligations and Feed-in-Tariff subsidies;
- Declining CAPEX costs for wind and solar.



Fossil generation discouraged by:

- Tightening legislation on NO_x and SO₂ leading to 'invest or close';
- Carbon Fuel Tax;
- Reduced residual demand



Demand decline from:

- Energy Efficiency
- Weaker economic growth
- Self-generation, especially domestic PV

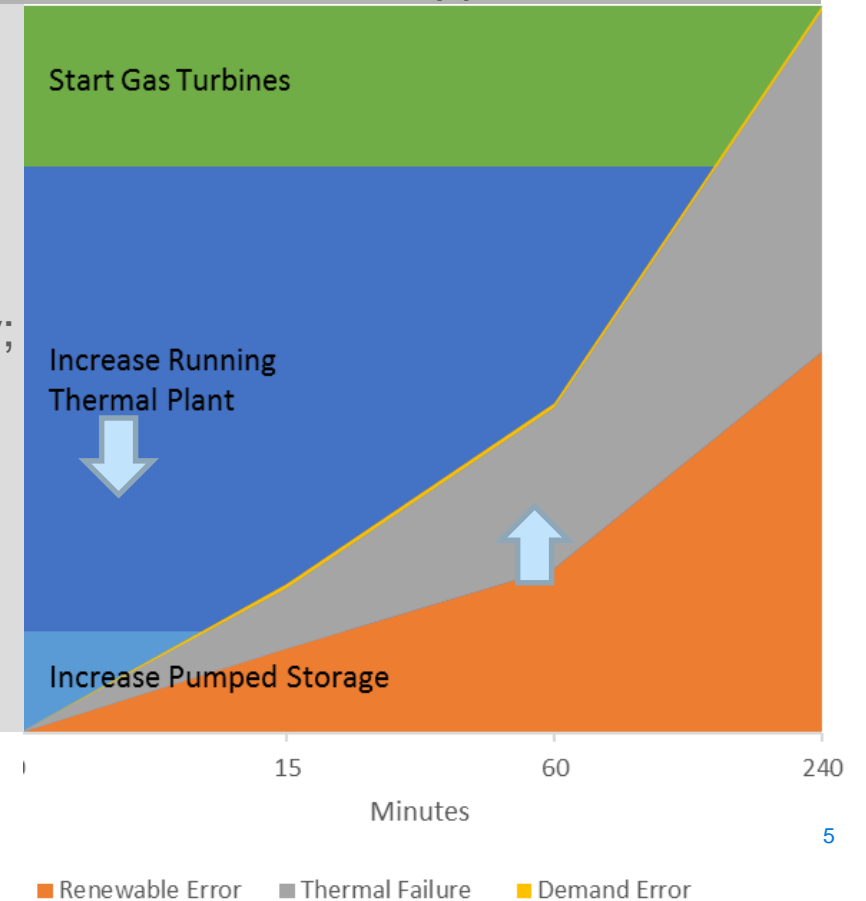
The Ancillary Services Challenge

Frequency Containment Reserve (FCR)

- Timescale seconds to minutes;
- FCR requirement increases as the inertia of the system decreases;
- FCR provision cost is mainly capacity element. Battery Storage is well suited to this application.

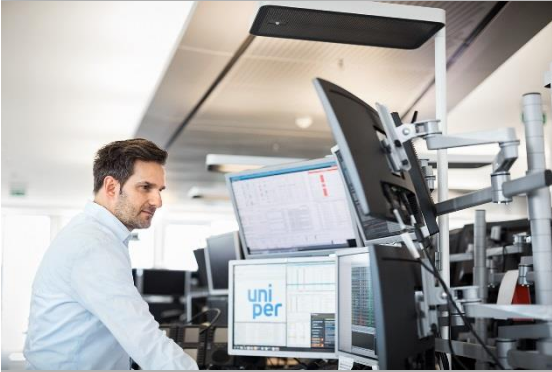
Frequency Restoration Reserve (FRR)

- Timescale minutes to hours;
- Wind and PV limitations for full FRR provision;
- Typically provided by storage hydro and spinning thermal units;
- Renewables increase demand for reserve and reduce the supply;
- FRR provision includes significant capacity and energy costs.



Provision of Grid Stability

Managing Imbalances

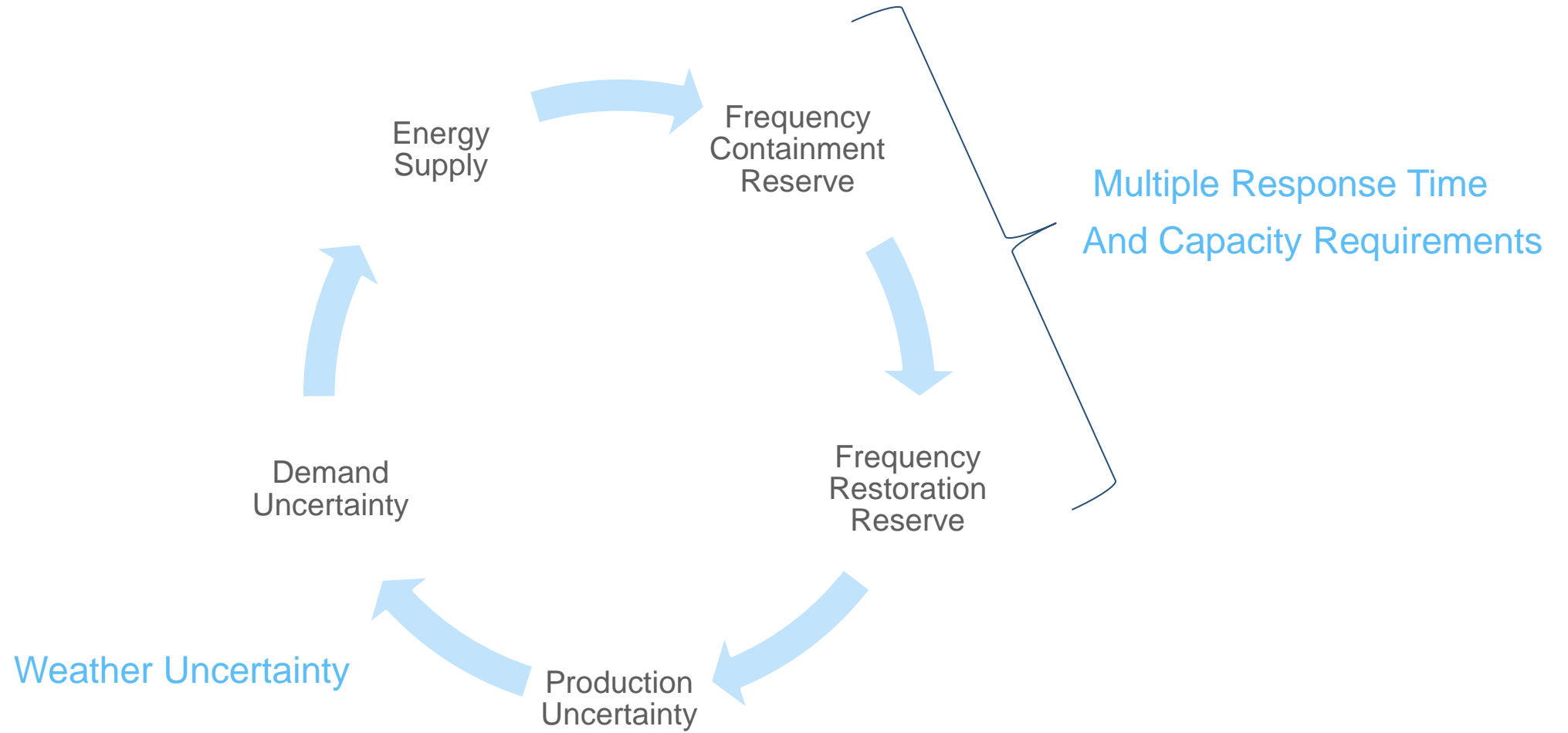


- In most European countries approach is to procure ancillary services through markets and bilateral contracts.
- Generators offer balancing capacity and energy with different response characteristics.
- TSO balances system at least cost.
- Variations from forecast cashed-out at imbalance prices.

Transmission Constraints

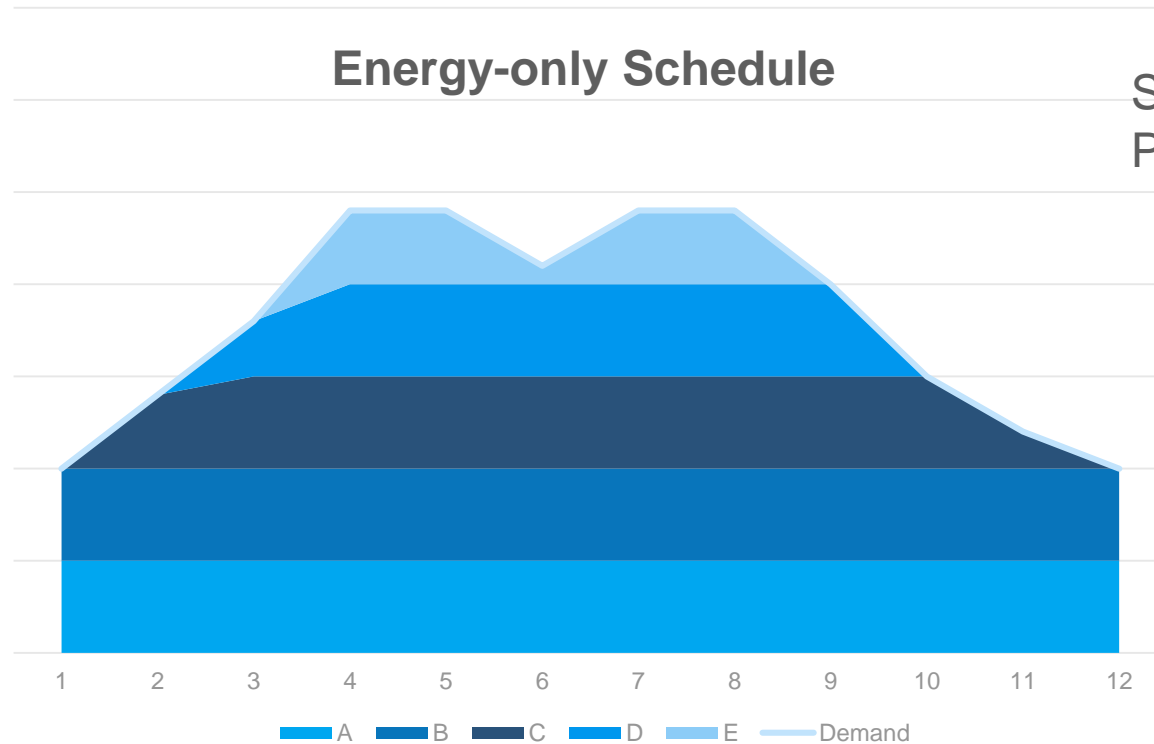
- Approaches to dealing with constraints are:
 - Scheduling with regional flow constraints;
 - Unconstrained Schedule followed by redispatch.

The Modelling Challenge



Conventional Modelling Approaches

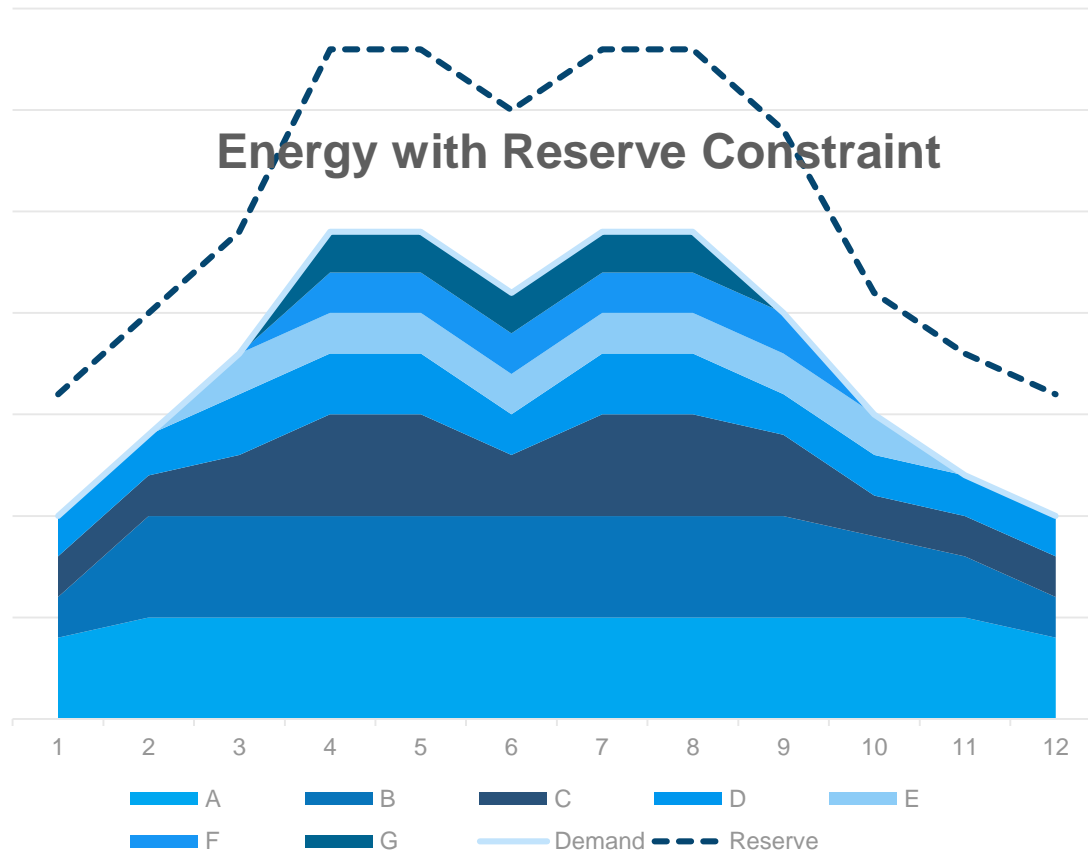
Chronological Modelling Required to understand value of volatile markets for constrained generating units.



Ancillary Service Model
Energy prices used as opportunity costs in calculating cost of AS

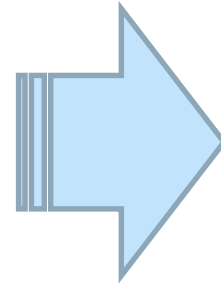
✗ Reserve not allocated in energy schedule.
Reserve has to be secured by starting standing units
➡ Expensive reserve

Conventional Modelling Approaches



✓ Larger number of generators are committed, providing spinning reserve

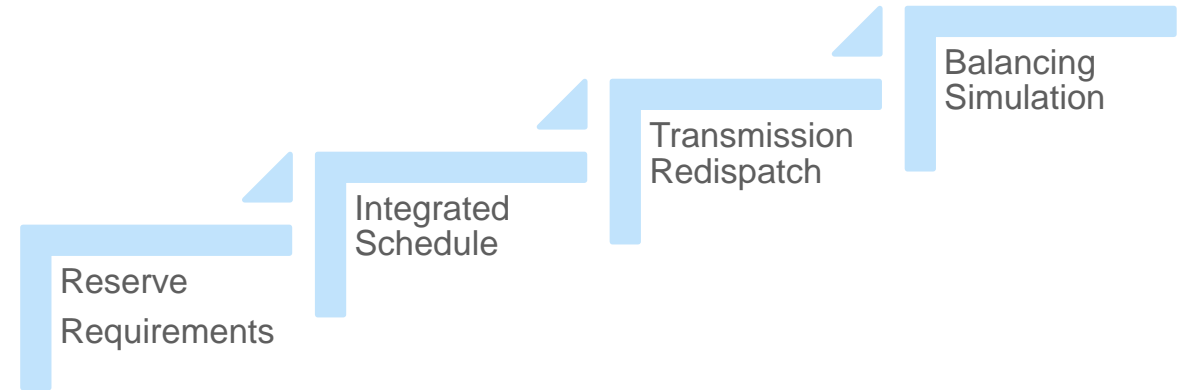
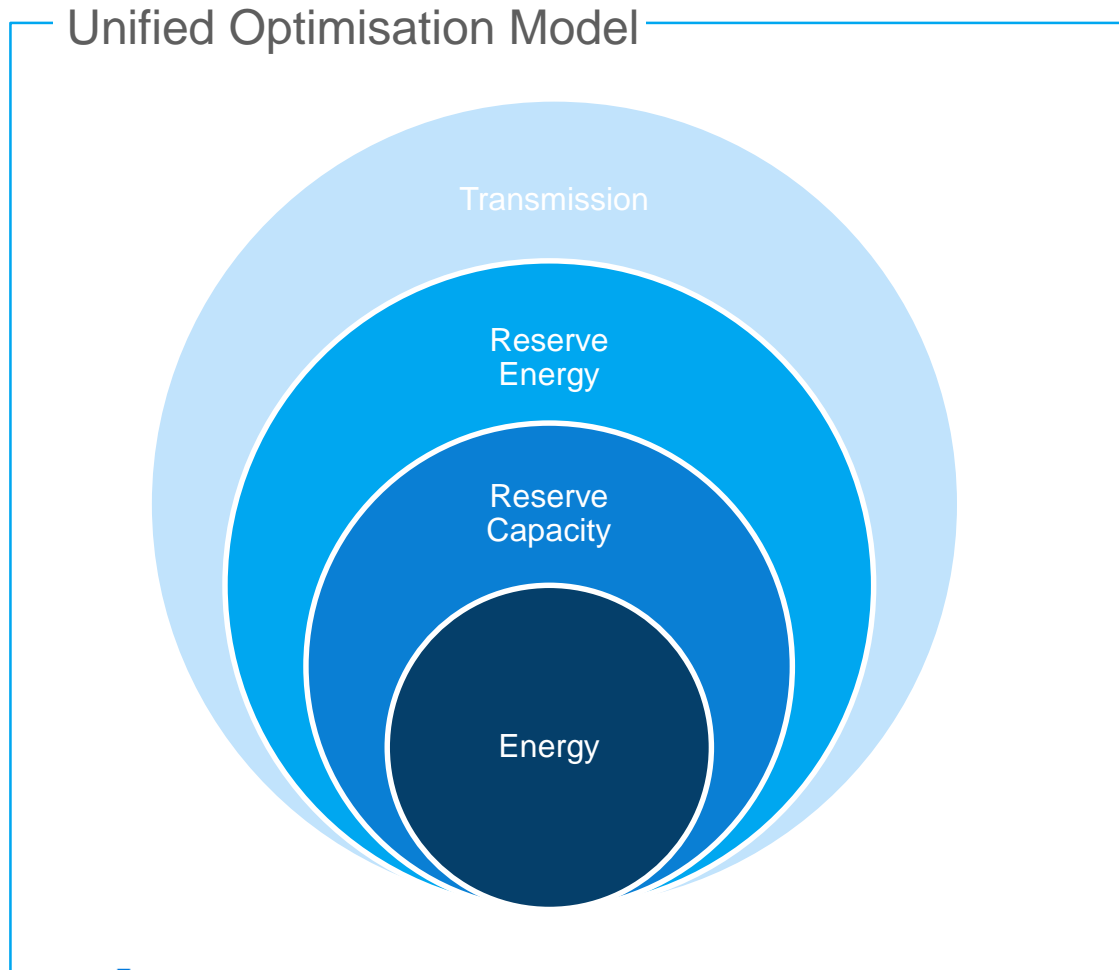
System Marginal Prices



Ancillary Service Model
Energy prices used as opportunity costs in calculating cost of AS

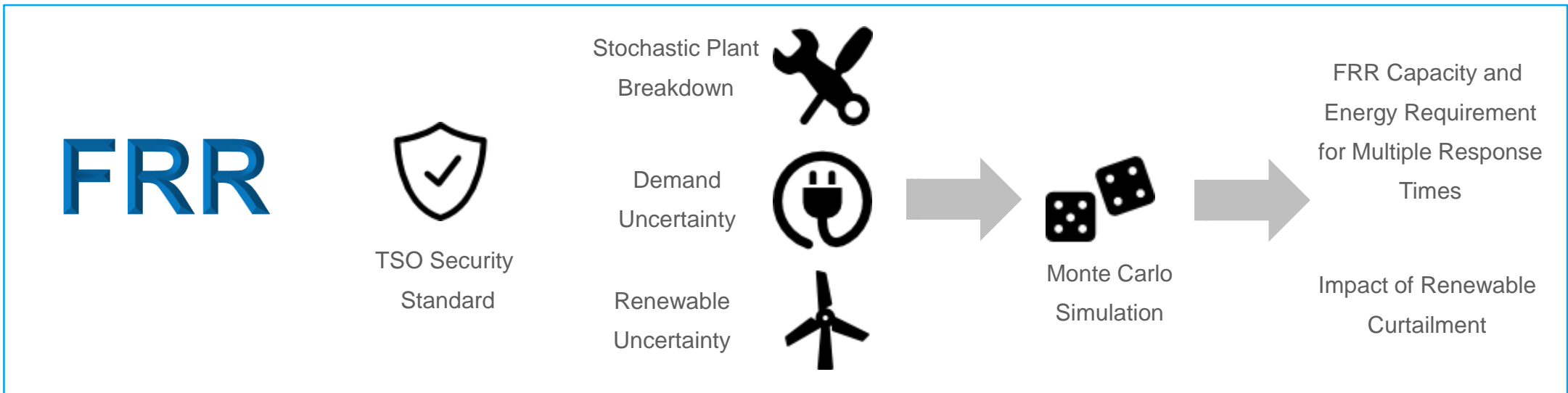
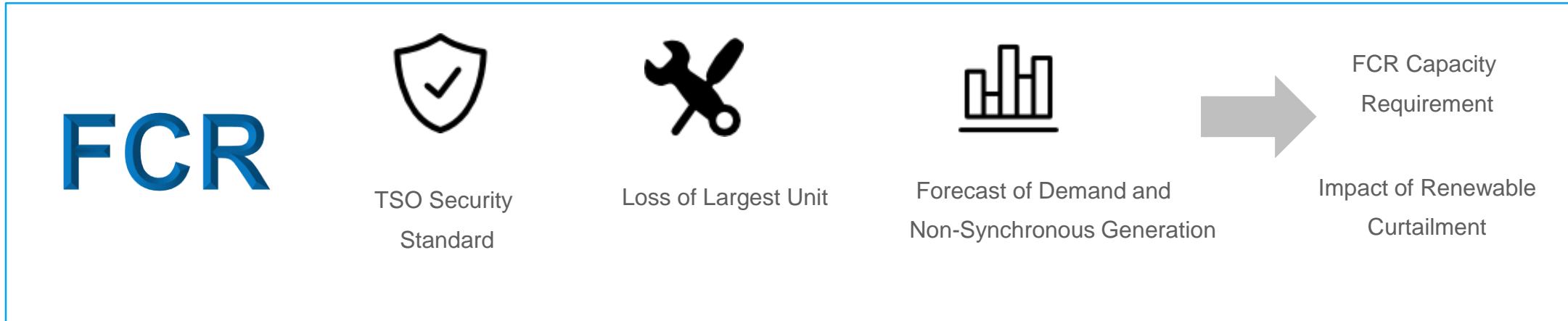
✗ Models MW not MWh
No distinction between:
• Response rates
• Energy cost of reserve
➔ Inefficient allocation of generators to reserve

Integrated Market Model

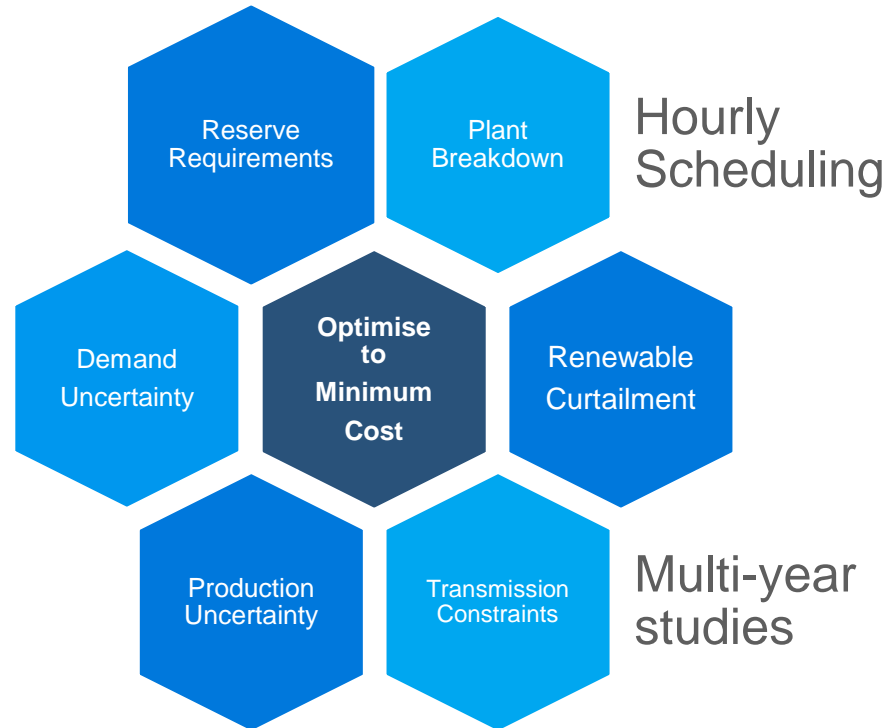


- Reserve Requirement Derived from TSO's security standard and expected conditions.
- Integrated model of energy, reserve capacity and balancing energy.
- Optional models of :
 - Redispatch for transmission constraints;
 - Outturn balancing actions, for separation of capacity and energy costs.

Calculating Reserve Requirements



Optimiser Features



- **Generator Operational Plans**
- **Prices for Energy, Reserve and Redispatch**
- **Merit order for Balancing Actions**

Optional Simulations

Balancing Market Simulation:

- Integrated Model provides:
 - Positioning of each generator for reserve
 - Merit order of balancing service providers
- Simulation over multiple uncertainties.
- Delivers:
 - Distributions of balancing costs and imbalance prices
 - Provides a view on potential split between capacity and energy costs for reserve.

Transmission Constraints:

- Integrated model can incorporate transmission constraints and allow interregional provision of reserve.
- Alternatively, the model can simulate Redispatch actions
 - Unconstrained schedule
 - Transmission constrained schedule
- Comparison of schedules allow pricing and volumes of Redispatch

Key Output Characteristics

For a changing UK market our model has shown:

PRICES

More expensive units running than in energy-focused models. Costs allocated to energy price and ancillary service income.

RESERVE

Realistic mix of spinning thermal reserve and hydro to cover frequent small volumes. High cost plant only at tails.

BALANCING

Increased curtailment of renewables to reduce costs for system balancing

IMBALANCES

Wind cost-rates for imbalance seen higher than for other plant types

Key Messages



Ancillary Services are growing in importance to support the renewables transition.
Conventional plant must maximise flexibility to capture market value



Traditional modelling approaches lead to a sub-optimal allocation of generators commitment and costs to energy and reserve markets.



Uniper has developed a modelling framework that gives an integrated view on the converging markets for energy and capacity. Model has a UK-focus but principles should apply to other European markets.

Thank you!

If you need any further information, please contact us:

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