

Storage Value in GB: Single vs Multiple Revenue Streams

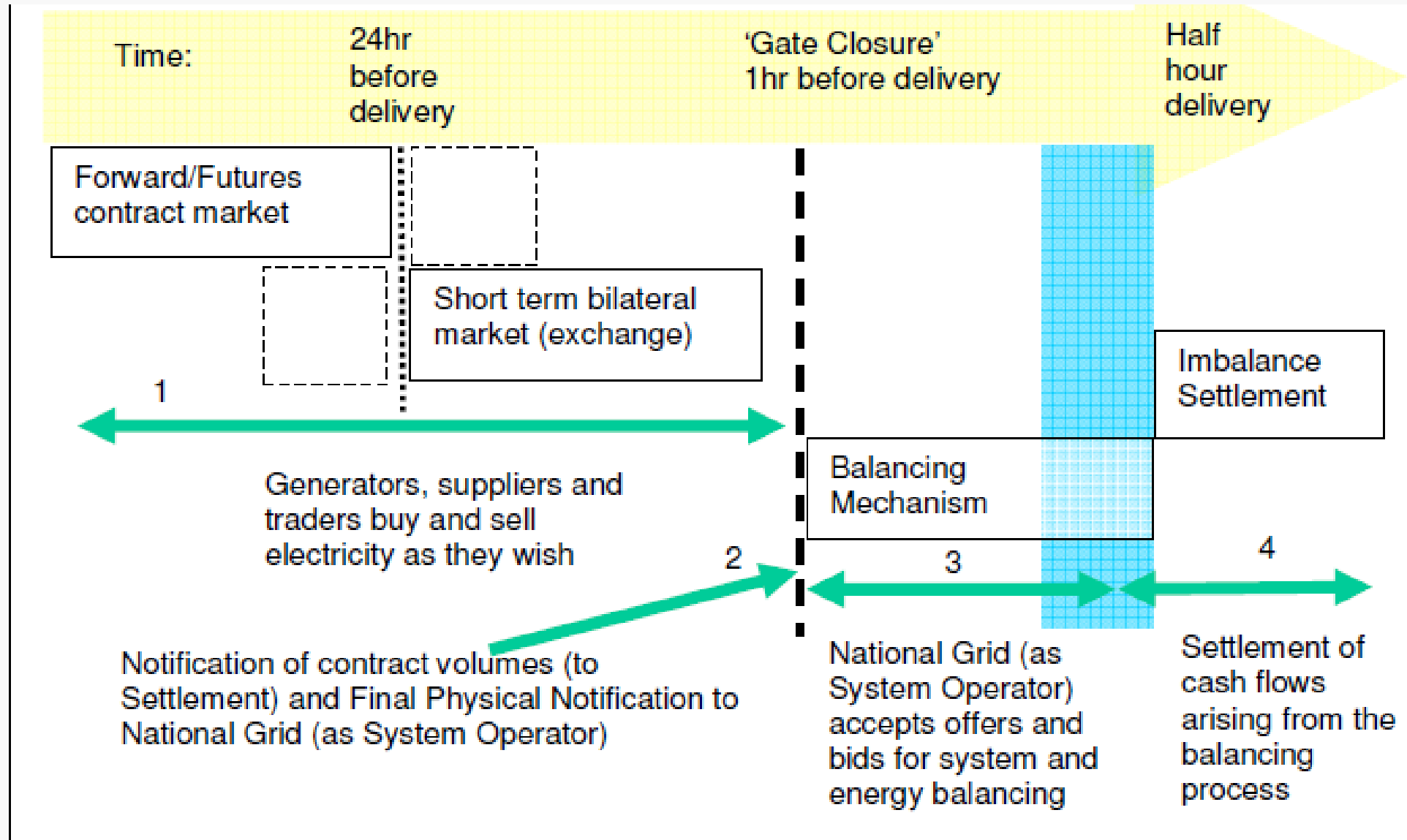
UKES

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Uncertainty over storage as a business case

- General theme that arbitrage values insufficient to support storage technologies.
- Additional revenues from ancillary services can greatly improve the economics.
- Very few studies on GB: none of them explore Balancing Mechanism as a viable revenue mechanism.
- What additional revenue can multiple market participation bring ?

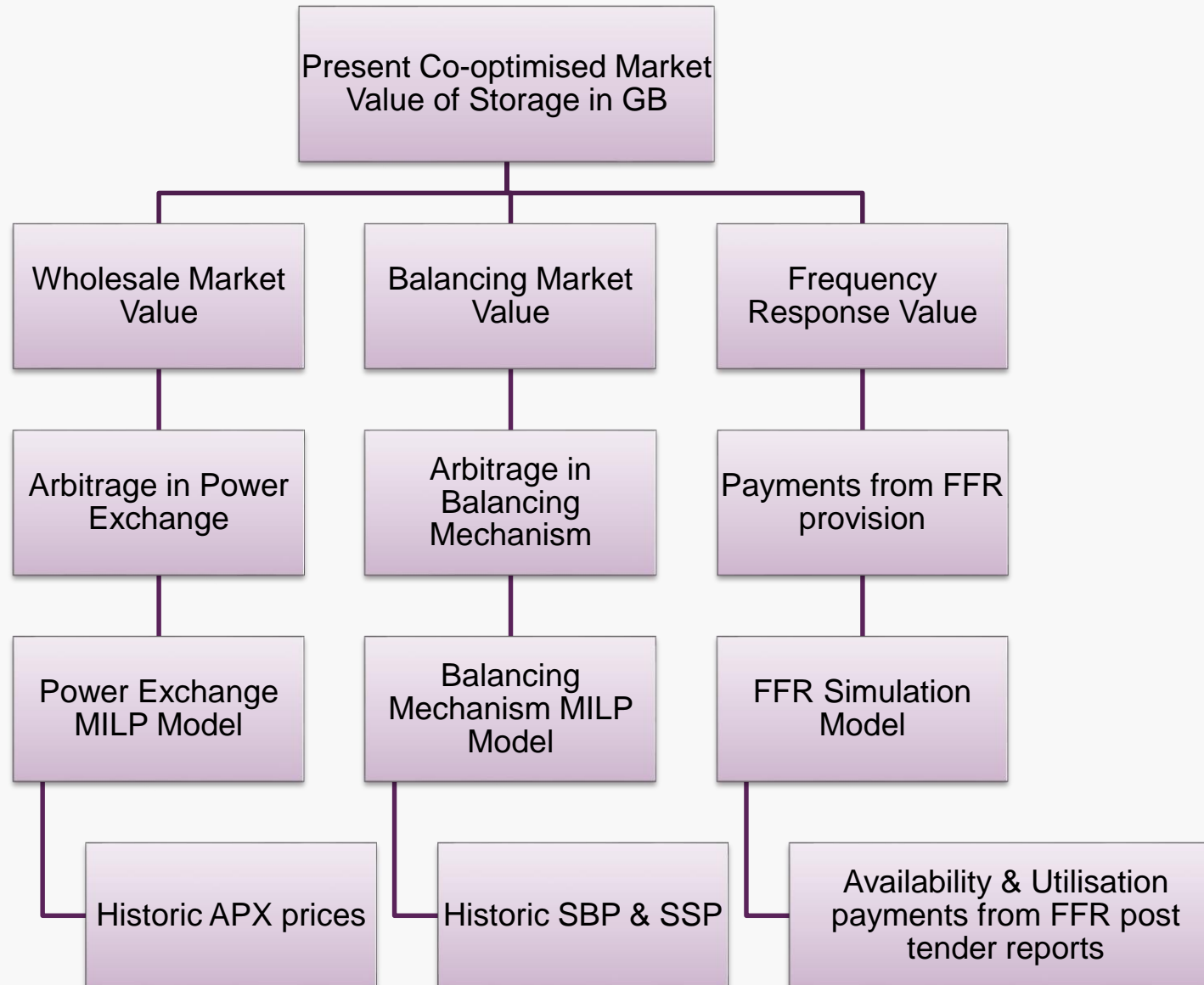
GB electricity markets overview



Revenue Mechanisms

- APX power exchange allows for short term wholesale electricity trading
 - Spot Market is open for trading during the 24 hours preceding delivery and closes 1 hour ahead of delivery.
- Balancing Mechanism: National Grid accepts bids and offers to balance demand and supply
 - At any time there is a system buy price (SBP) and system sell price (SSP)
 - Reflects buying price and selling price of electricity from the system perspective to maintain balance.
 - Penalising algorithm: $SSP \leq APX \text{ prices} \leq SBP$
- Firm Frequency Response as an ancillary service
 - Procured months in advance, for specific time windows.
 - Availability payment and Utilisation payment

Overview of Model

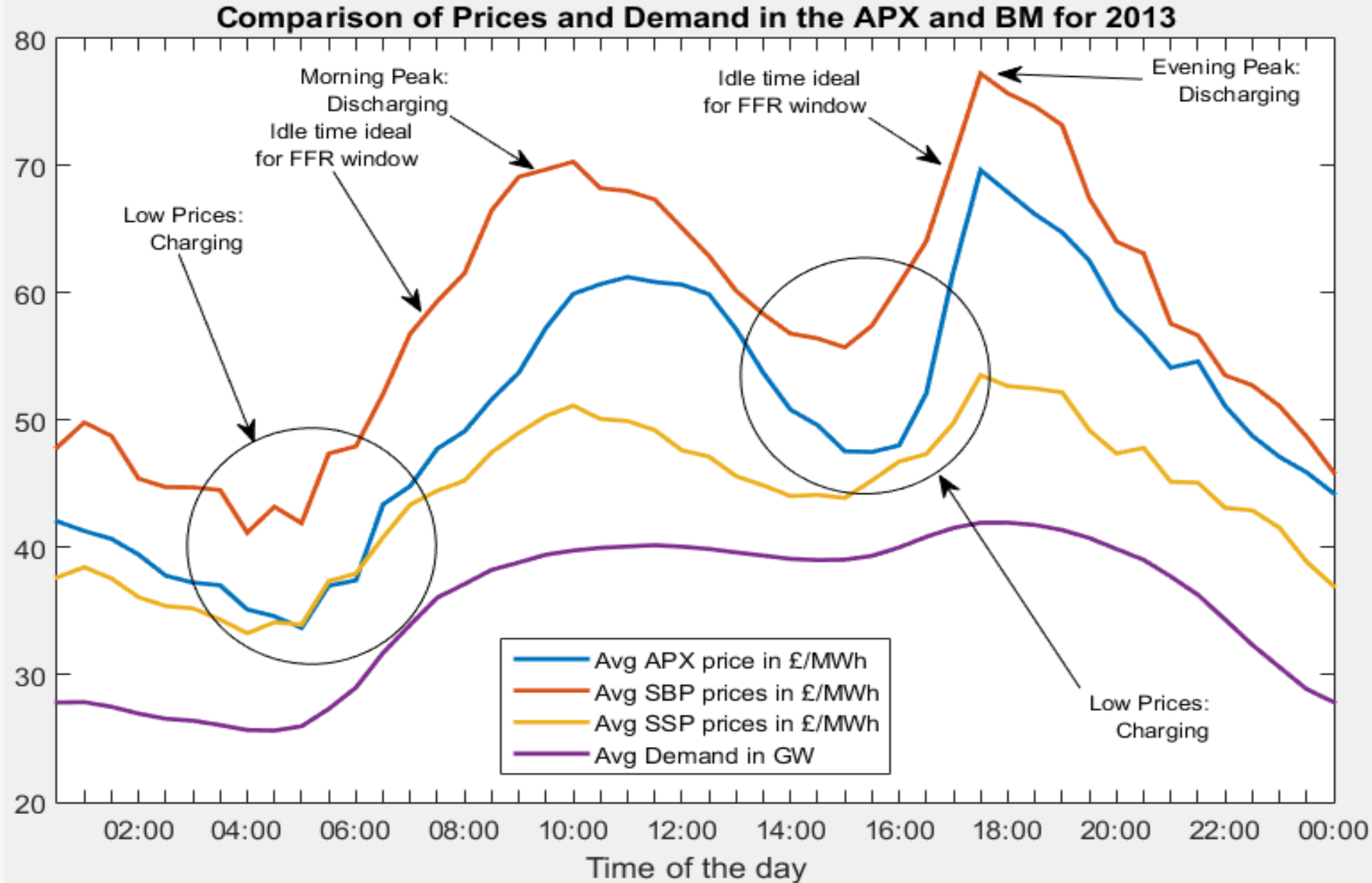


- Optimisation horizon 24 hours – throughout 2013
- Perfect foresight assumed
- Mixed integer linear programming problem
- Implemented in Matlab

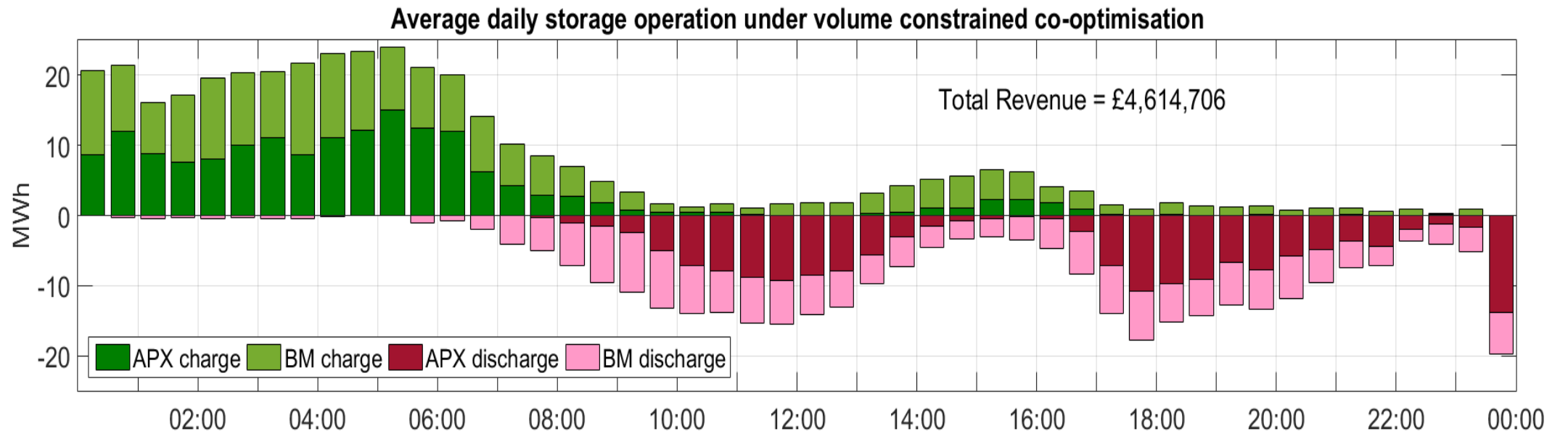
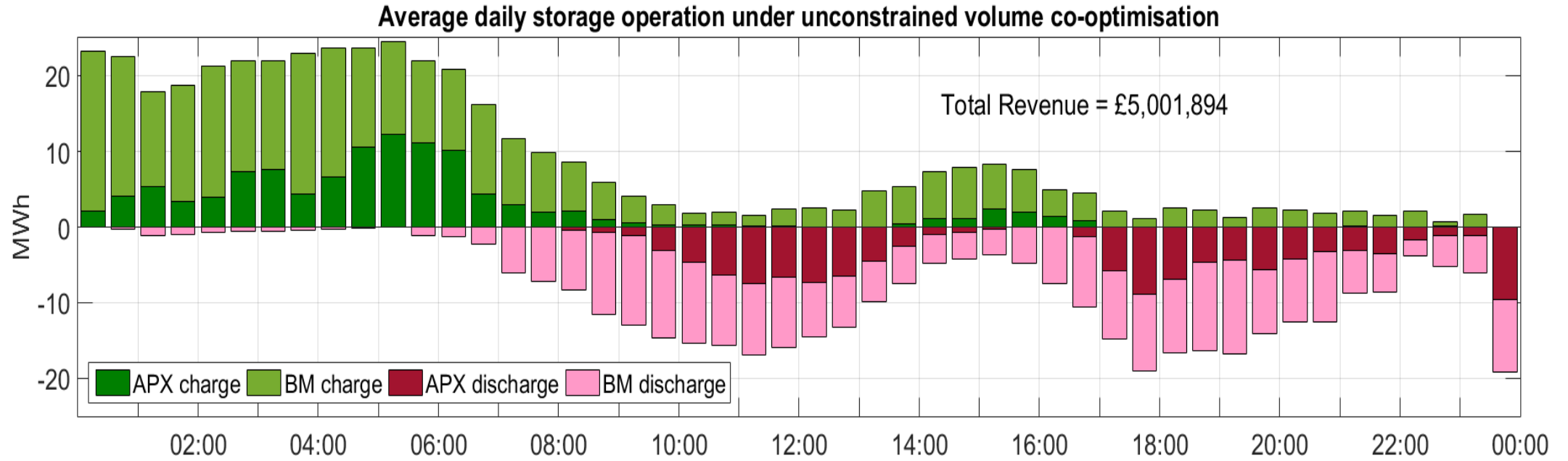
Storage and market parameters

- Power Capacity: 50 MW
- Energy Capacity: 600 MWh (12 hours)
- Charge & Discharge efficiency: 90% (81% roundtrip)
- FFR availability payment: £5/MW/h
- Time resolution: 30 mins.

How prices influence storage operations

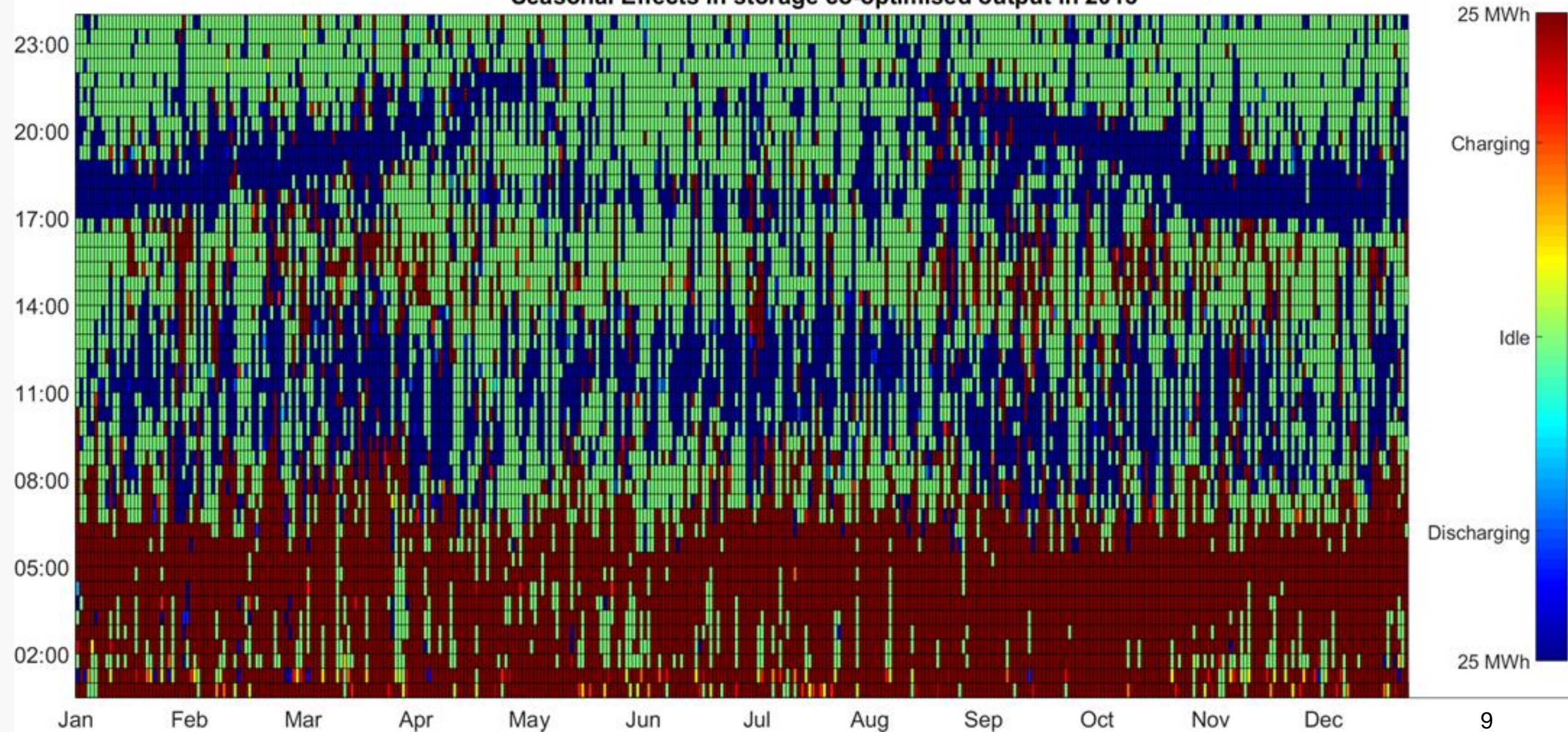


Average storage schedule under co-optimisation



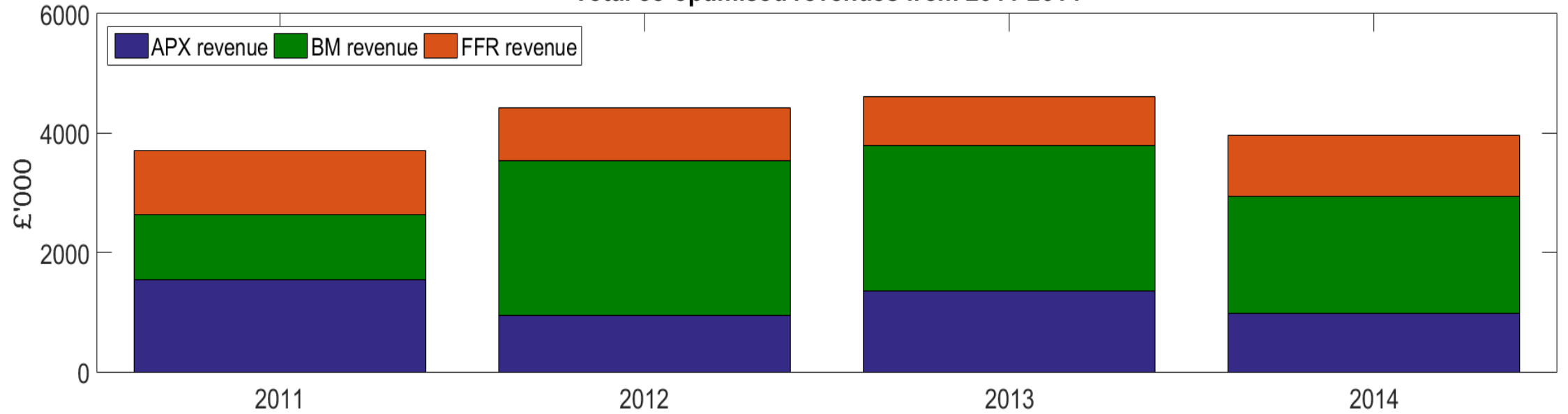
Storage operation throughout 2013

Seasonal Effects in storage co-optimised output in 2013

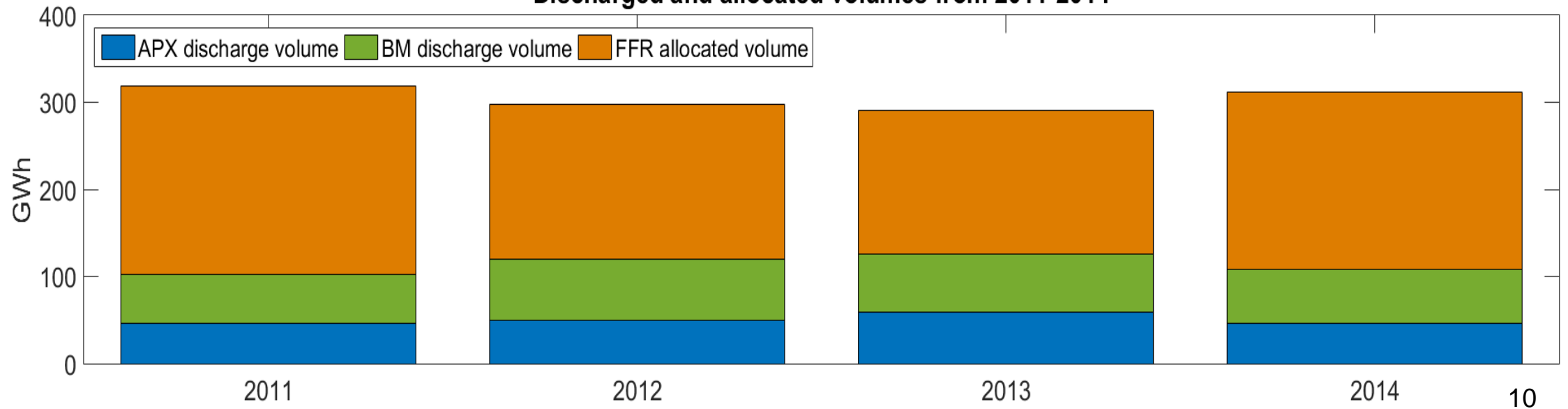


Annual Variability of storage value from 2011-2014

Total co-optimised revenues from 2011-2014

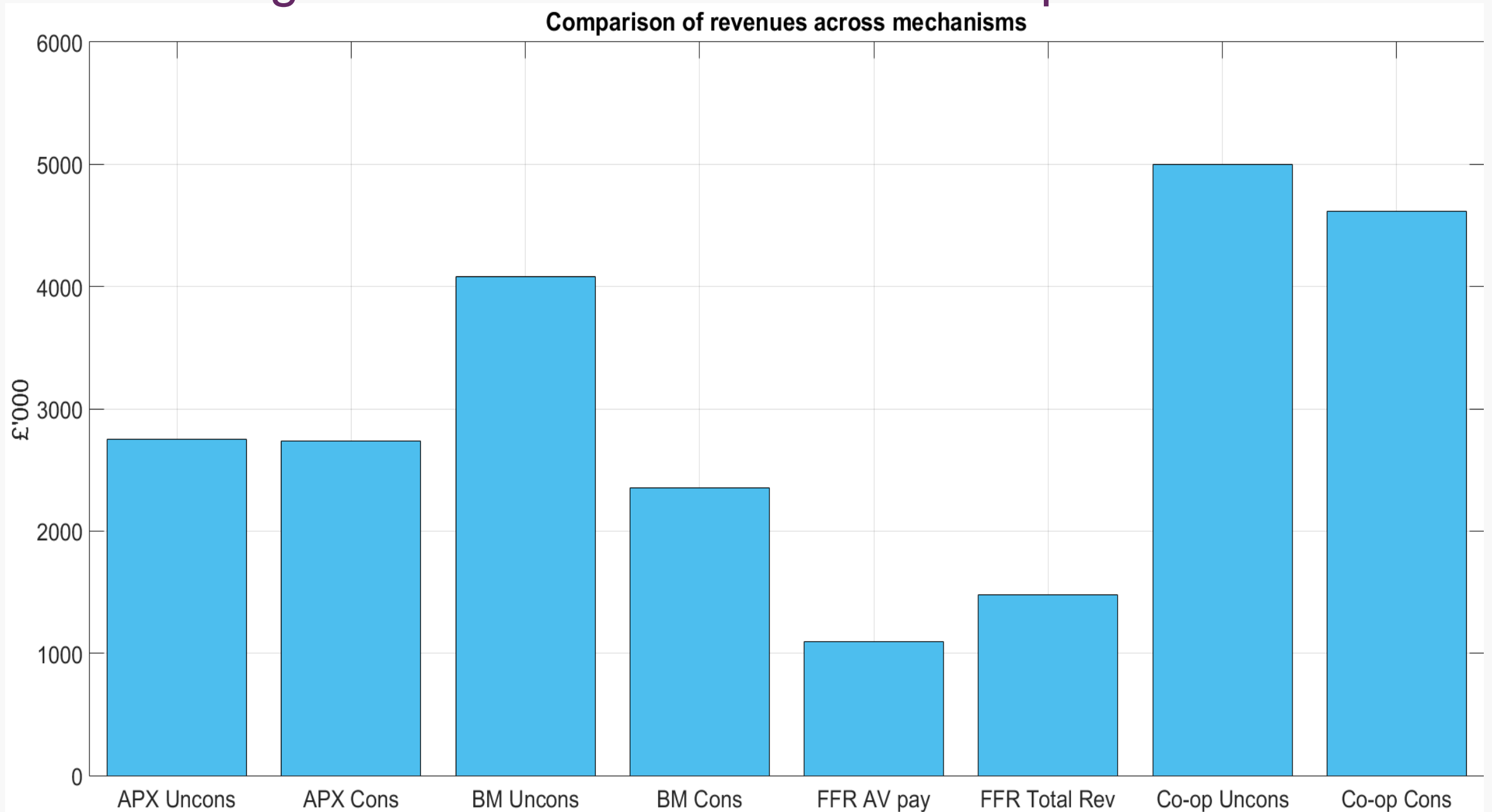


Discharged and allocated volumes from 2011-2014



Single revenue mechanism vs Co-optimisation

Comparison of revenues across mechanisms



Summary:

- Seasonal effects strongly present in storage operation and revenues.
- Volume constraints drastically affects BM revenues but hardly APX revenues due to market liquidity.
- However Co-optimisation revenues less sensitive to volume constraints in one market as compensation effect occurs.
- Further synergies with FFR – service can be offered during idle times.
- Compared to single revenue mechanisms, co-optimisation dramatically improves profitability.

Current & Future Work

- Strategies to capture co-optimised value.
- Economic appraisal of specific storage technologies.
- Value of storage in the future ? Esp. wind impact.

END

- Thank you
- Questions ?
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