CIRED
ROME, ITALY
12-15 JUNE 2023

The Impact of Forecasting Accuracy on the Economic Performance of Flexibility Provision

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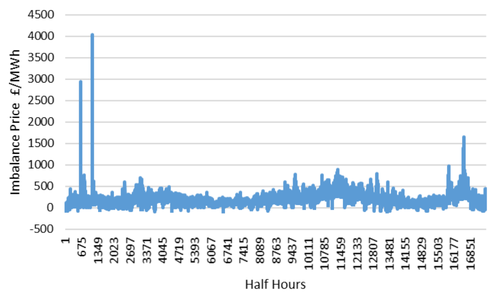
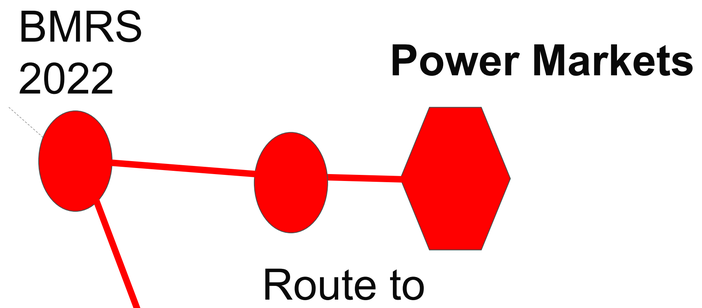
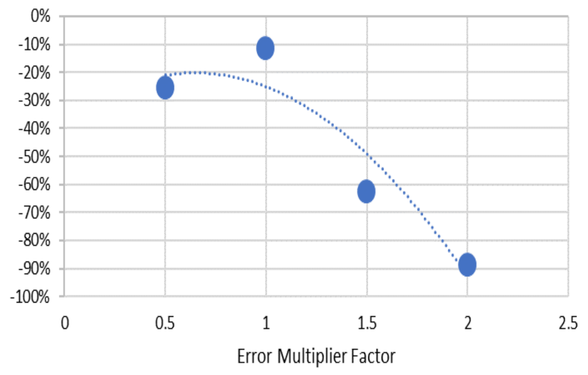
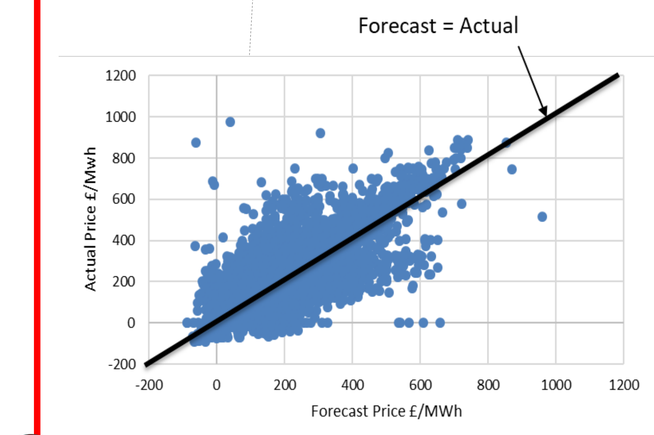
Introduction

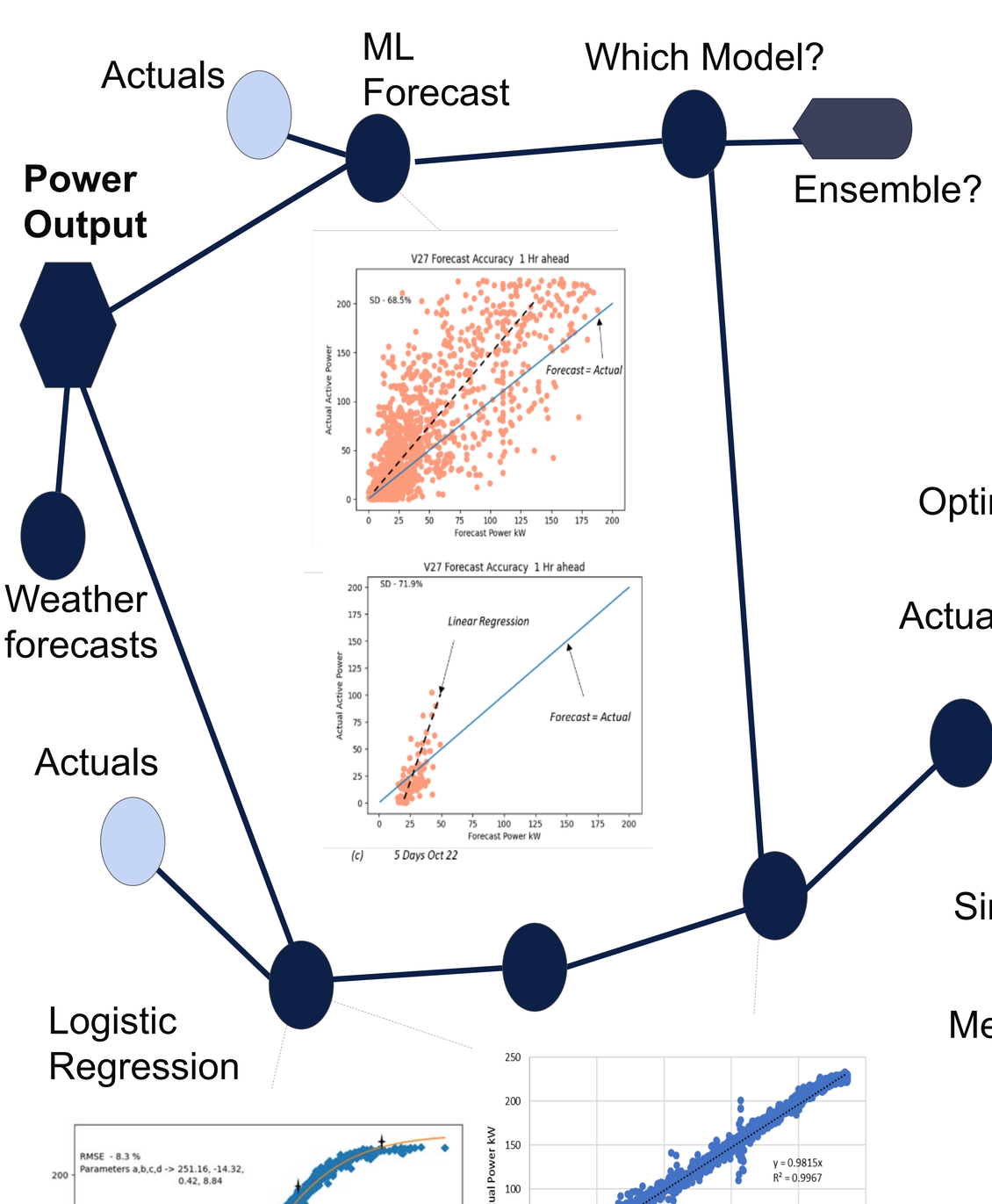
- ERA Learn/EU Horizon 2022 Project (SIES 2022).
- "Learning by Doing" project.
- Enhanced VPP+ Design – using multiple vector energy pools and optimization
- Energy Pools (Flexibility, Thermal, DSR, electrolyser, EV's, Wind, PV).
- ETC Demo site @ East Kilbride, Scotland.
- Used stored actual data + forecasts
- Focus of Paper – understanding impact of forecast errors on VPP performance.











Conclusions

- The current methodology results in revenues some 12% lower than a perfect forecast.
- Larger errors in absolute terms on wind and price inputs could result in errors >50%, which may prove unacceptable to a commercial aggregator.
- Price and Power out put forecasts are negatively correlated. Case dependent. Errors could have been as high as 20% if this was not the case.
- Future work to include:
  - risk management effects
  - the use of other optimization algorithms and heuristics and
  - the effect of errors with different asset combinations.

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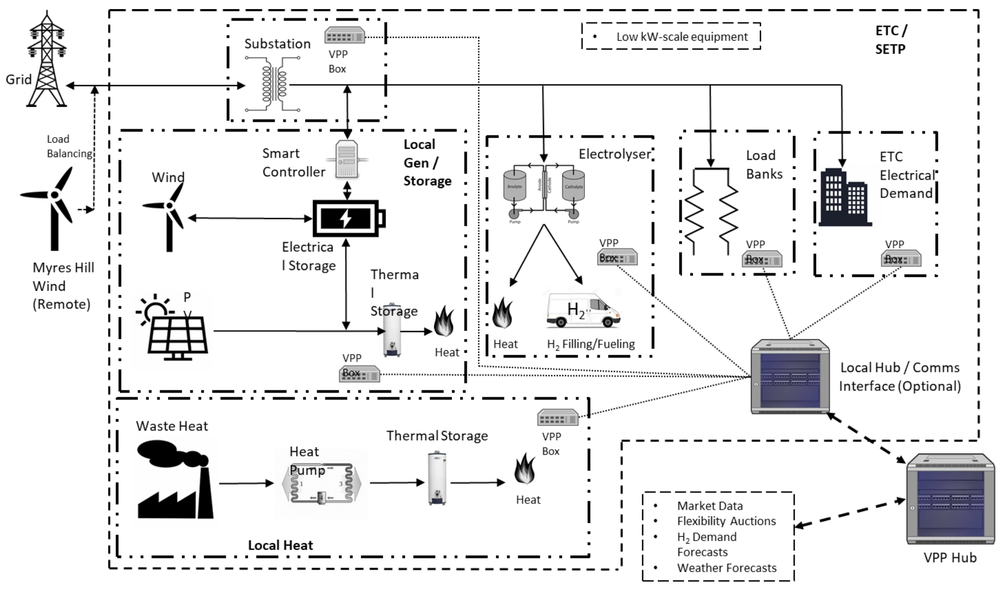
SMART INTEGRATED ENERGY SYSTEMS

SIES [Smart Integrated Energy Systems: Enhanced Virtual Power Plant VPP+ Energy Pool Integration for Local and Regional Resistance]

Project Overview

Aim

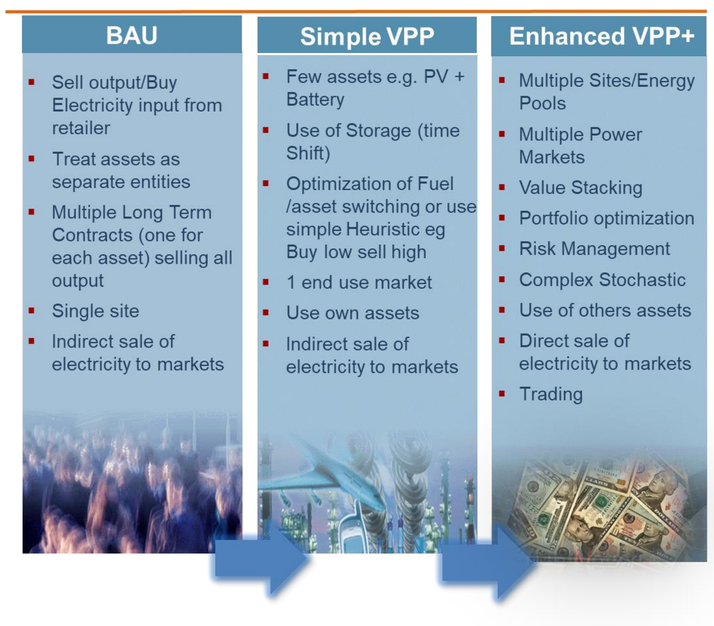
- ERA-Net's SIES 2022 project focuses on the technological and business related barriers and opportunities of how VPPs can function in flexibility markets.
- The SIES 2022 project aims to develop a digital energy utility management service (VPP) capable of managing local and regional energy systems and markets using a number of energy pools – use cases. E.g. ETC, finHorn .
- "Learning by doing" Project



Overview

- Number of Proposed Energy Pools (ETC [Myres hill & SETP], Community Energy , Strath Energy Centre , PNDC) – Heat DSR, HY2GO etc.]
- VPP ++ (connecting different types of assets including DSR), to maximize profits and provide support to an already congested grid;
- Algorithms to be developed for operation
- VPP Software under development
- Smart Transformer (ANM)

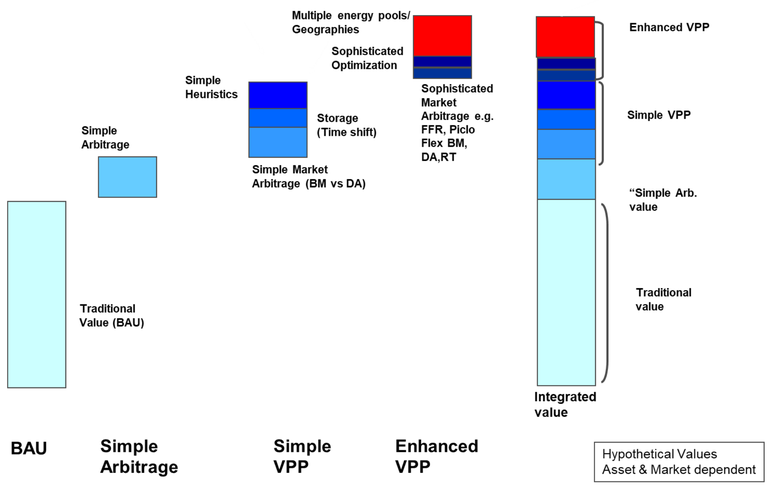
Business Model Spectrum



Business Models

- Key element of the project was to develop Business models for a VPP.
- By collating data, analyzing it and simulating different use cases – it has been possible to value these business models.
- Work is underway to develop heuristics that will identify which models work best and under what conditions

Value Stacking



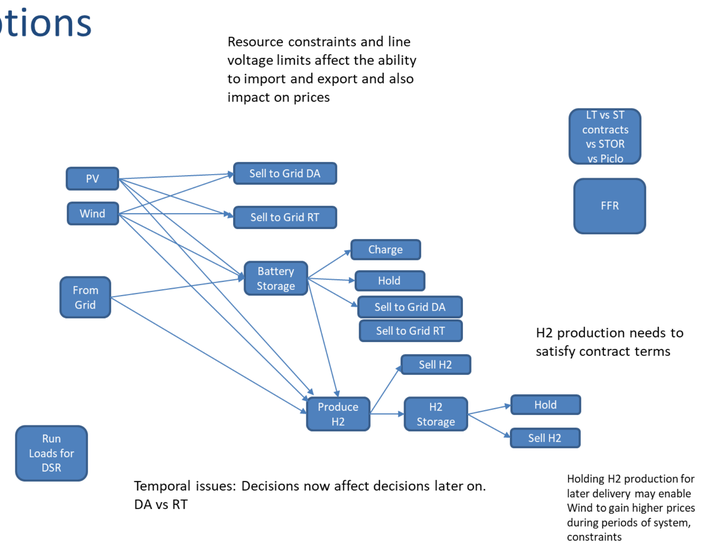
Markets, Value Stacking

- Although assessments shown herein assume a sale of flexibility services to one market, t is expected that VPP providers would sell to one more than one market.
- Some of these markets could be sold concurrently.
- This results in revenue streams that can be "stacked"

Decision Options

- At each time step – a decision has to be made about resources.
- Growing Complexity with more assets
- Plus assets are stochastic

Options



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Forecasting

Price Forecasts

- Using historical BMRS data from Elexon (2022), ForecastPro software has been used to formulate a BMRS forecasting model. This model has an R2 = 0.69 and
- Forecast BMRS prices are formulated from a variety of lagged prices and variables associated with the settlement period (1-48 half hours) and the month (1-12). See output
- "Post paper work shows that ML using XG boost can provide a better forecast although errors could be as large £200/MWh
- Figure 7 compares the forecast from ForecastPro with actual values. Errors for lower and high prices are less pronounced

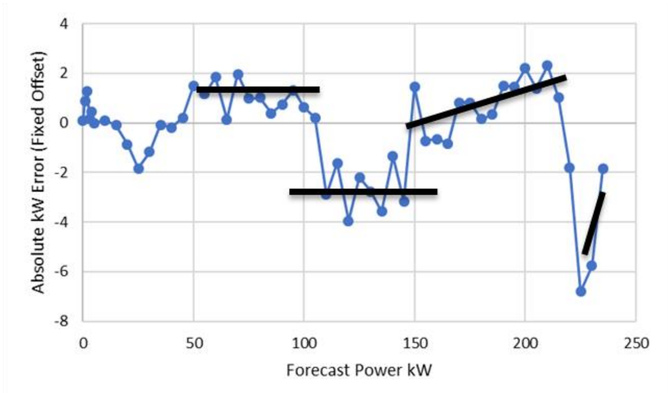
Wind Forecasts

- Max wind turbine output – 225kW
- Absolute errors (kW) of forecast wind output vs actual from VPP operation have been analysed and are presented below.
- Note Fixed Error
- Standard Deviation based error are higher at higher wind speeds

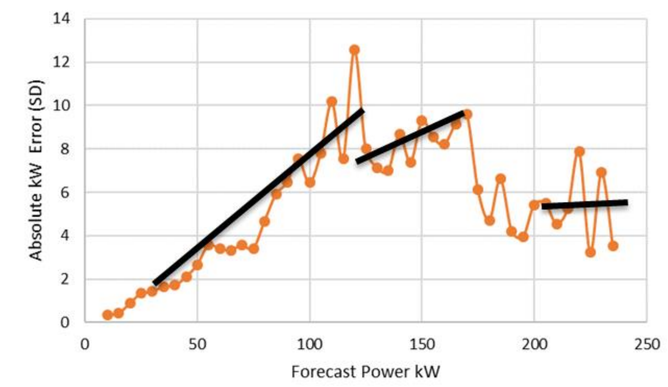
Wind Forecast Error Variability

- Forecast compared against actuals, over range of values.

Overall Error kW = Absolute Error (Fixed Offset)+ NormalInv(probability,mean = 0,Standdardeviation = Absolute Standard Deviation)

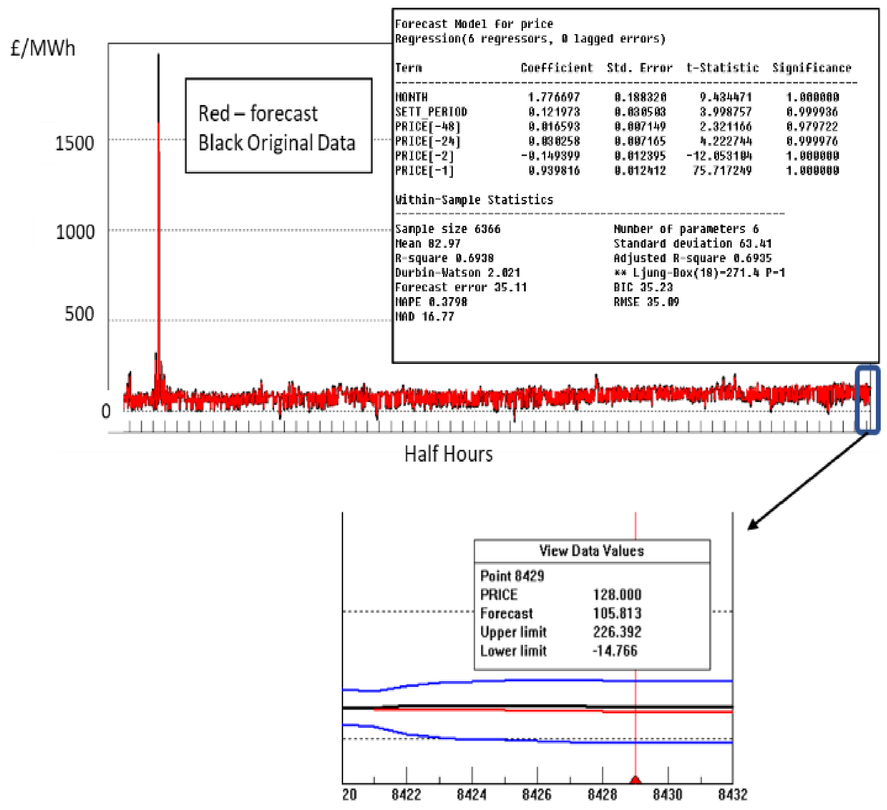


(a) Absolute Fixed Offset Error

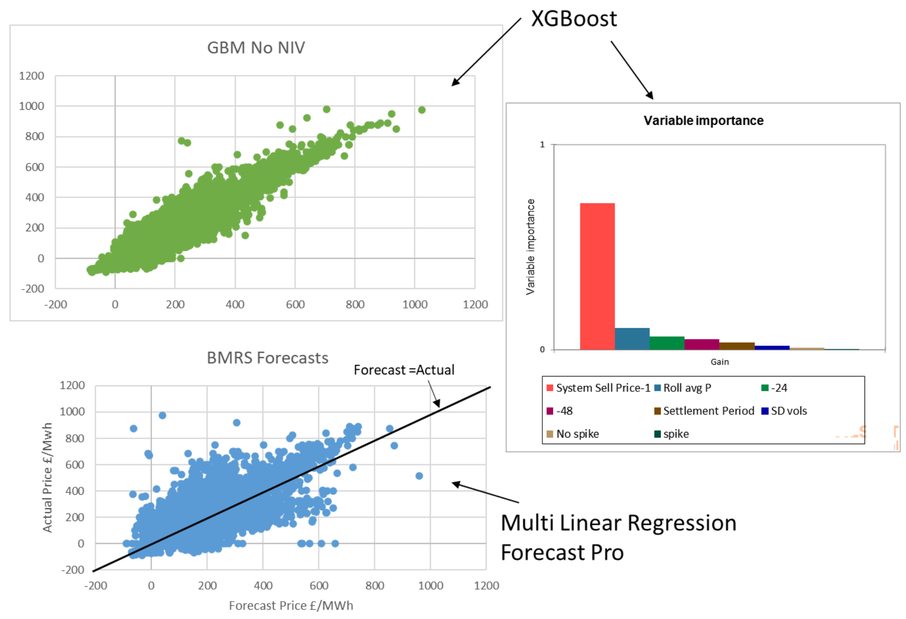


(b) Absolute Standard Deviation (SD) Error

ForecastPro output



XGBoost (ML) vs Forecast Pro (Multi-Linear) Price Forecasts



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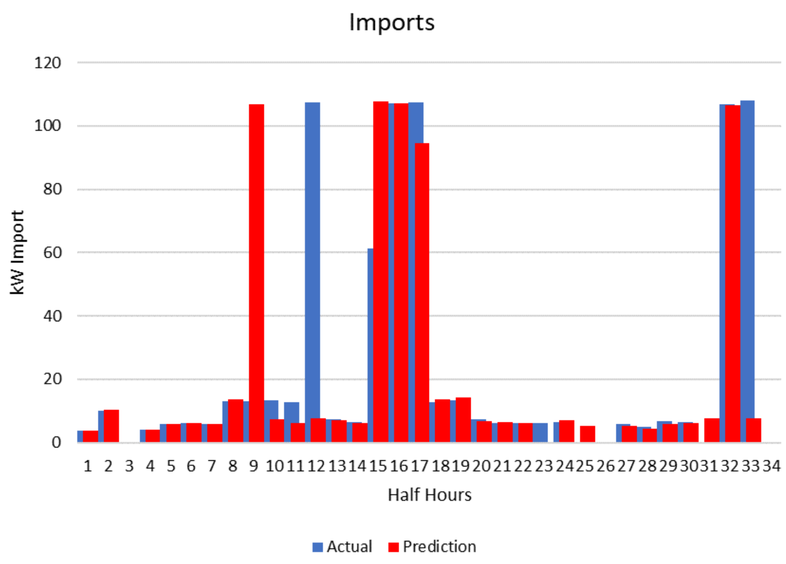
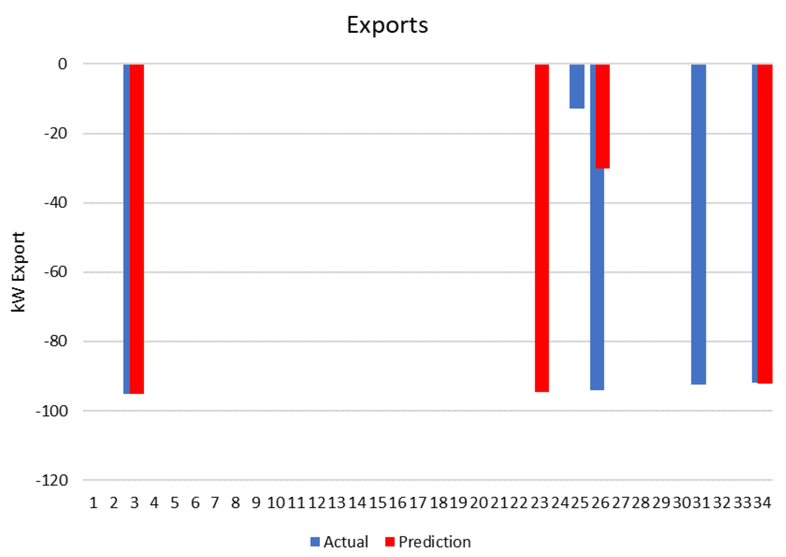
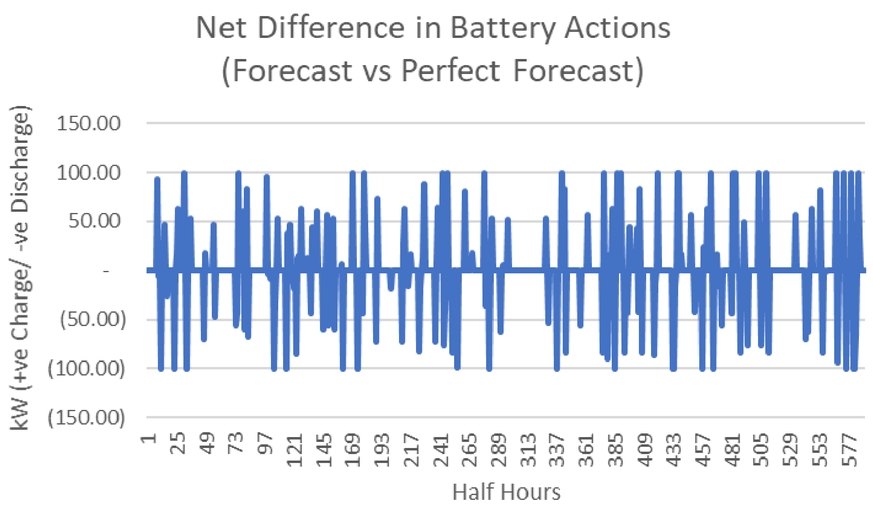
Output Results

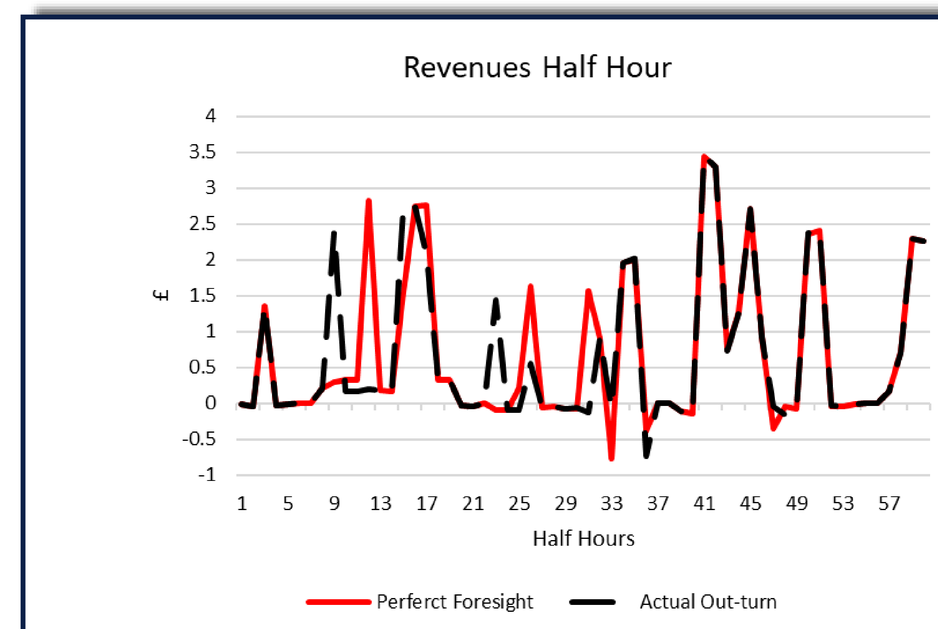
Forecasting Error Simulation Results

- More detail on results from simulation of forecast errors. Uses VPP platform to simulate schedule of assets.
- Optimization routine uses either forecast or actuals to determine schedule.
- Revenues are compared and errors derived









% Error in Revenues over Perfect forecast

Yearly Revenues

Case		Forecast	Perfect Foresight	Outturn	Disbenefit £ Impact on Reveune	%
Base Case		3,594	2,925	2,585	-340	-12%
Error x 0.5		3,879	2,925	2,179	-746	-26%
Error x 1.5		5,171	2,925	1,094	-1,831	-63%
Error*2		5,971	2,925	333	-2,592	-89%