The Importance of Energy Storage Flexibility at High Wind Penetrations

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Introduction

- Bulk storage in systems with high wind power penetrations can increase system flexibility, while reducing wind curtailment and system operational costs
- The flexibility of a storage plant impacts on its value and its potential role in power systems with high penetrations of variable renewables
- It is essential that markets incentivise and reward flexibility from all sources

Objective:

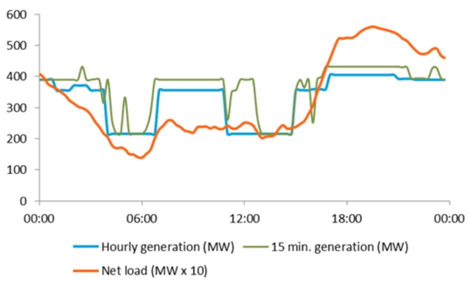
- **Identify important energy storage (ES) characteristics and explore how operating constraints impact on the value of ES**

Methodology

- Use power system modelling tool (PLEXOS) to assess potential operational cost savings generated by additional storage on a future Irish system with varying levels of flexibility
- Assess the impact on cost savings when operation of the storage unit is constrained
- Model Generic storage plant (A – F) with varying levels of plant flexibility, including the following characteristics:
  - Efficiency
  - Minimum generation / charging levels
  - Reserve capability
  - Daily start limit

Plant	η %	Min. Gen. (MW)	Min. Charge (MW)	POR (MW)	SOR (MW)	TOR (MW)	Daily Start Limit
A	90	0	0	100	100	100	~
B	80	0	0	100	100	100	~
C	80	0	0	40	75	75	~
D	80	25	60	40	75	75	~
E	80	50	100	25	50	50	~
F	80	50	100	25	50	50	3

- Analysis performed at a 15 minute resolution – important for capturing plant cycling activity at high wind penetrations



Results:

- Cost saving highly dependent on plant flexibility (Plant F ≈ 60% Plant A cost savings)
- Variable charging rates of significant value (Plant E ≈ 78% Plant D cost savings)
- The storage plant's characteristics have a large impact on conventional plant behaviour (plant starts and ramping)

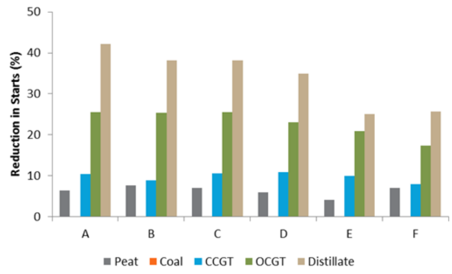


Fig. 1 Reduction in conventional plant starts (%)

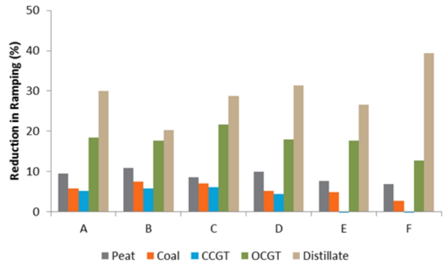


Fig. 2 Reduction in conventional plant ramping (%)

- Storage plant operations strongly influenced by the plant's flexibility
- Reserve provision capability is highly correlated to operating cost savings potential
- Less flexible plant will be cycled more frequently to provide maximum cost savings

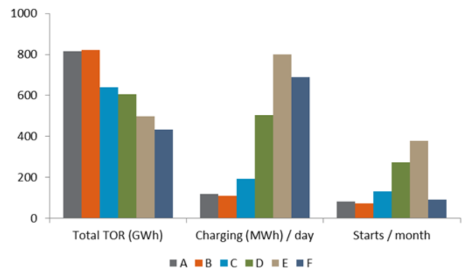


Fig. 3 Storage plant operation: reserve, charging load and starts

Optimal Dispatch at High Wind Penetrations

- At high wind penetrations, net load variability and uncertainty increases
- Flexible plant have a less variable daily dispatch profile

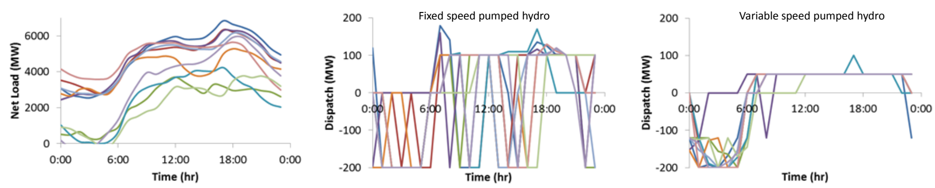


Fig. 4 Net load (7.5 GW wind), pumped hydro dispatch, flexible pumped hydro dispatch (10 different days)

- With rising shares of wind, creating optimum storage plant dispatches becomes increasingly challenging, particularly for less flexible plant which has implications in terms of cost reductions and profit maximisation

Conclusions

- **Energy storage can reduce plant cycling and improve the efficiency of the system as a whole, with significant operating cost savings**
- **It is essential that market mechanisms are in place which allow the full potential of the storage plant's flexibility to be accessed**

Next Steps

- Focus on capturing the cost of wind generation / price uncertainty both in terms of potential operating cost savings and storage plant profitability

Acknowledgement

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