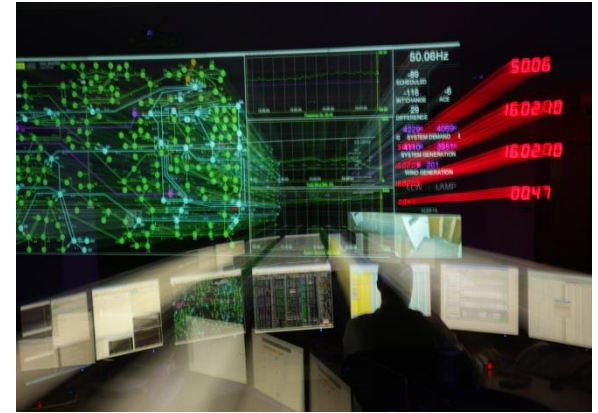


Modelling Future Energy Policy Scenarios under different Electricity Market Structures



By

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20th May 2015



OUTLINE

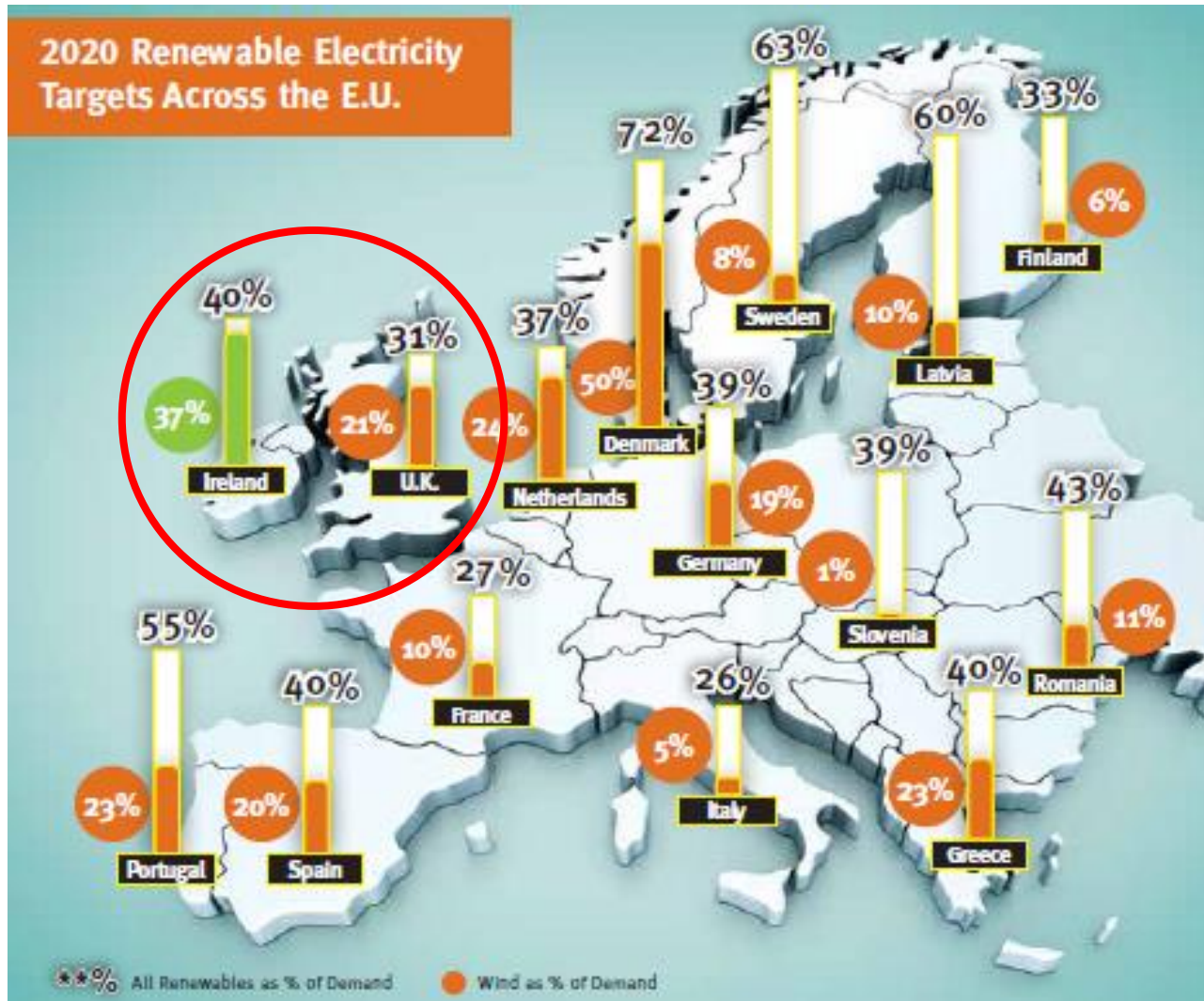
- Background
- Motivation
- Market structures
- Methodology
- Results
- Further work & Considerations



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BACKGROUND

- Transition to high levels of renewables is inevitable due to EU 20-20-20



Source: Eirgrid 2013

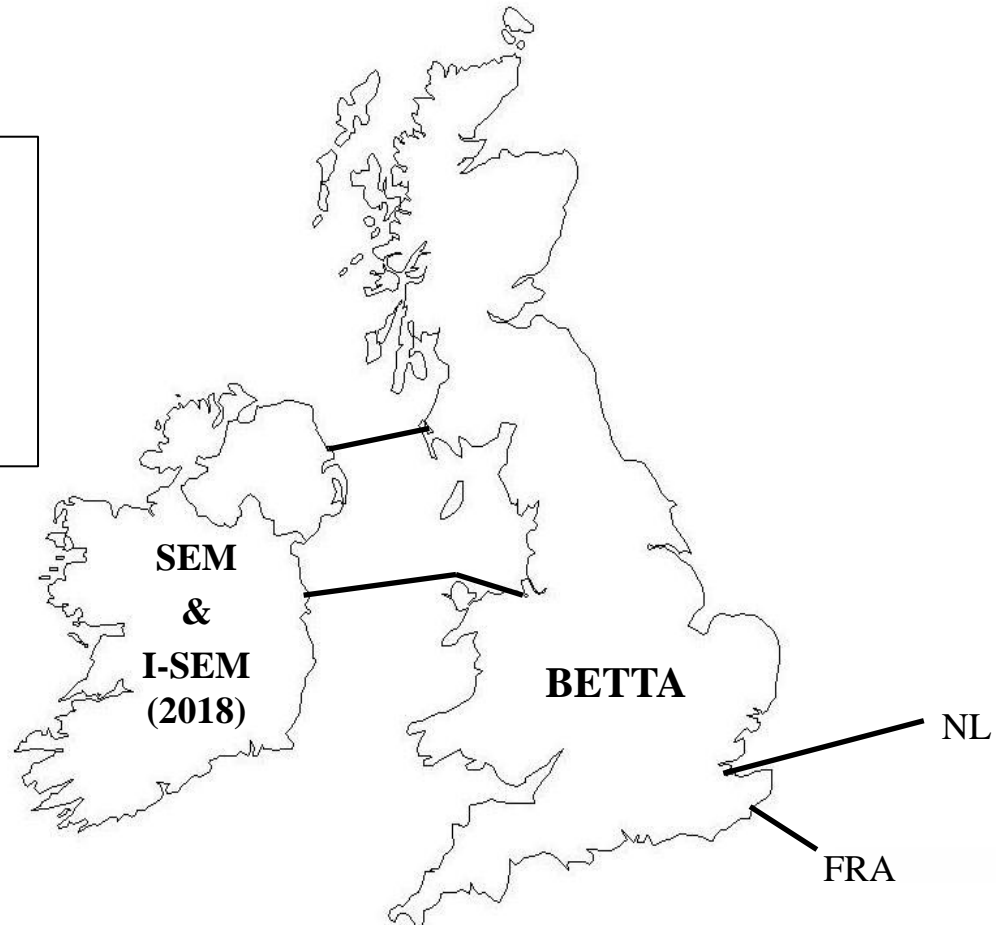
MOTIVATION

- EU Energy Policy is influencing the transformation of the Irish power system and electricity market
- Aim to assess various future energy policy scenarios under different electricity market structures

Single Electricity Market (SEM)

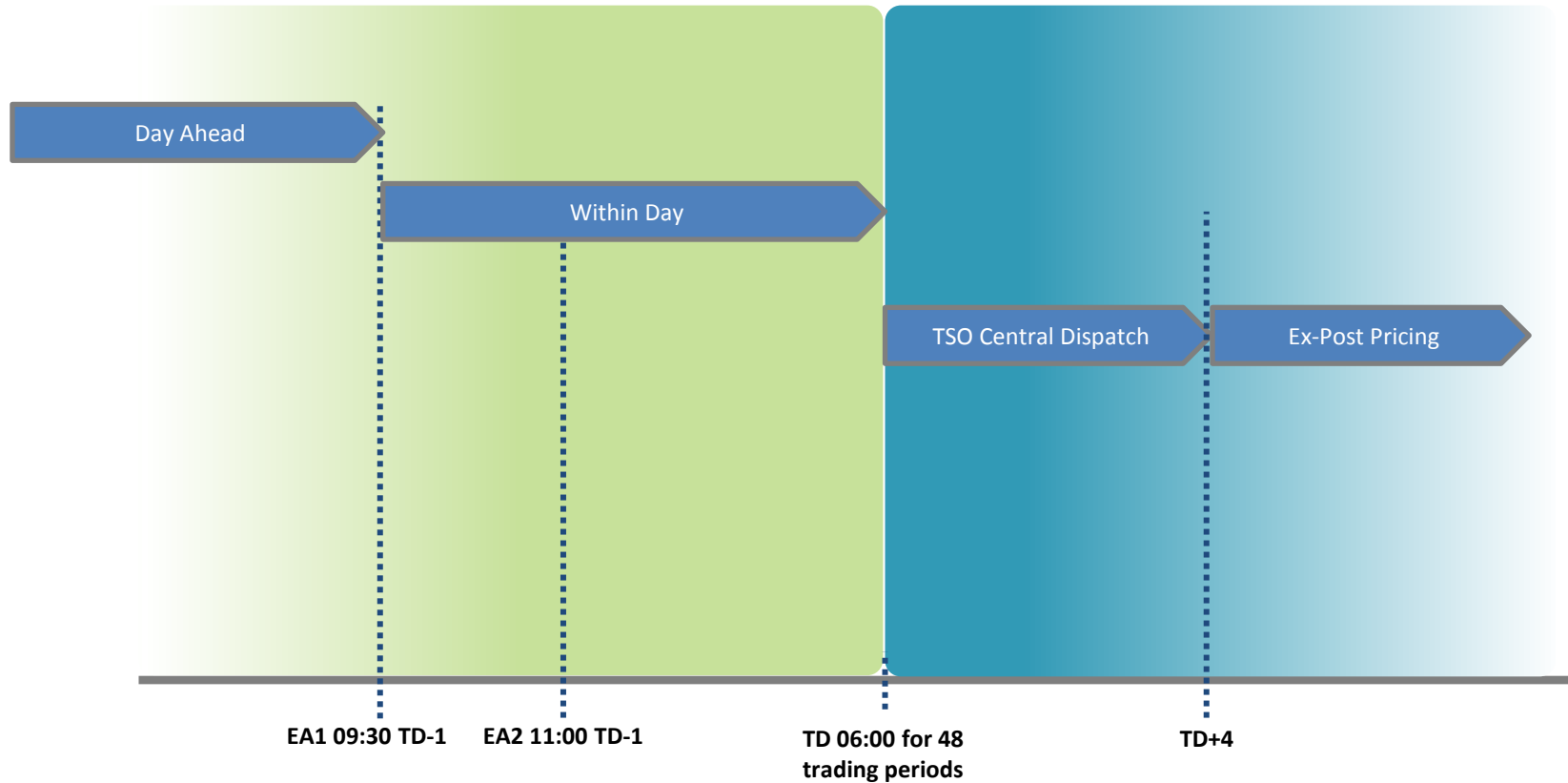
Integrated-Single Electricity Market (I-SEM)

British Electricity Trading and
Transmission Arrangements (BETTA)



MARKET STRUCTURES

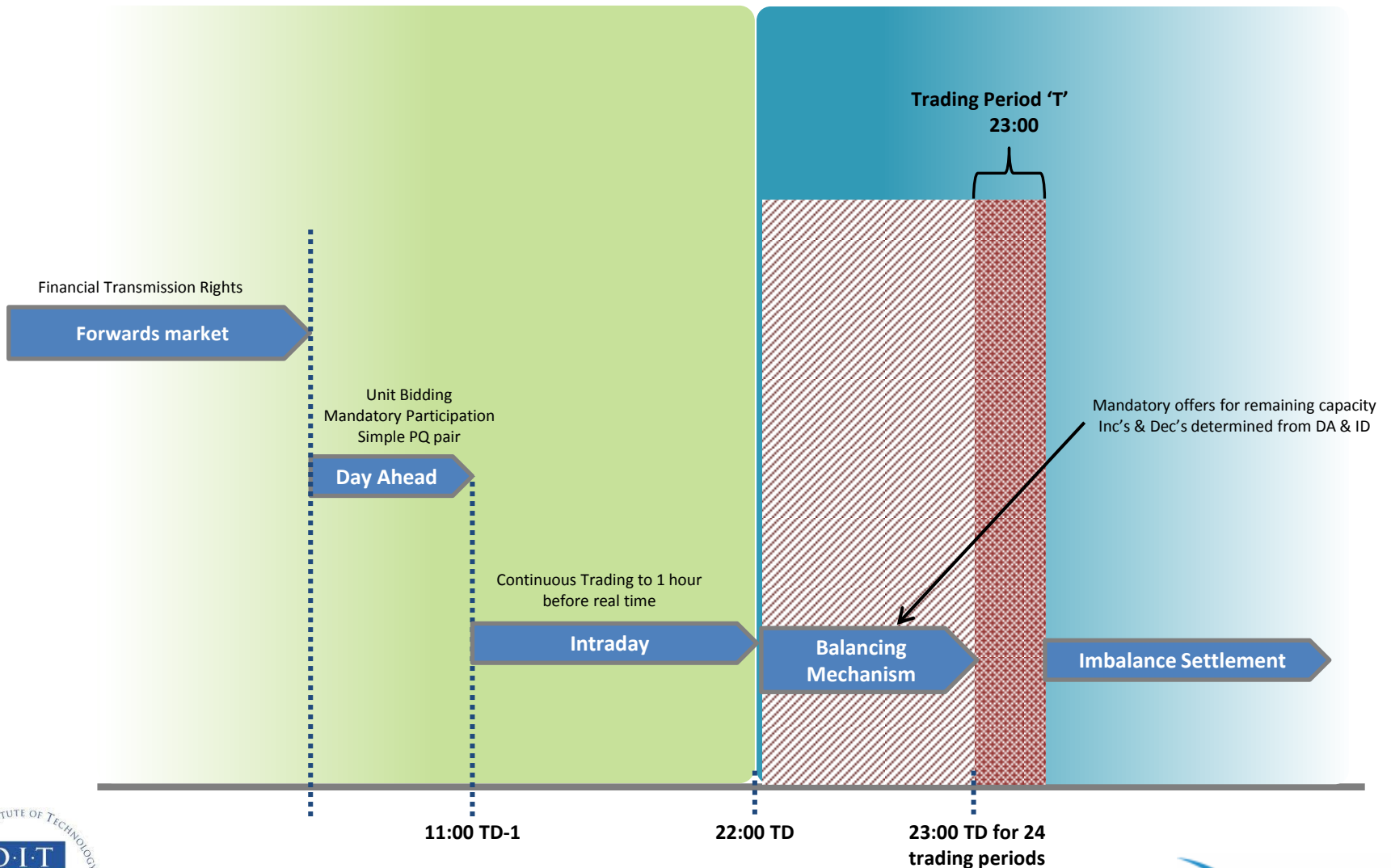
Current SEM structure



- **NB:** No forecast risk to wind & no concept of balance responsibility (i.e. ensure forecast \approx actual)

MARKET STRUCTURES

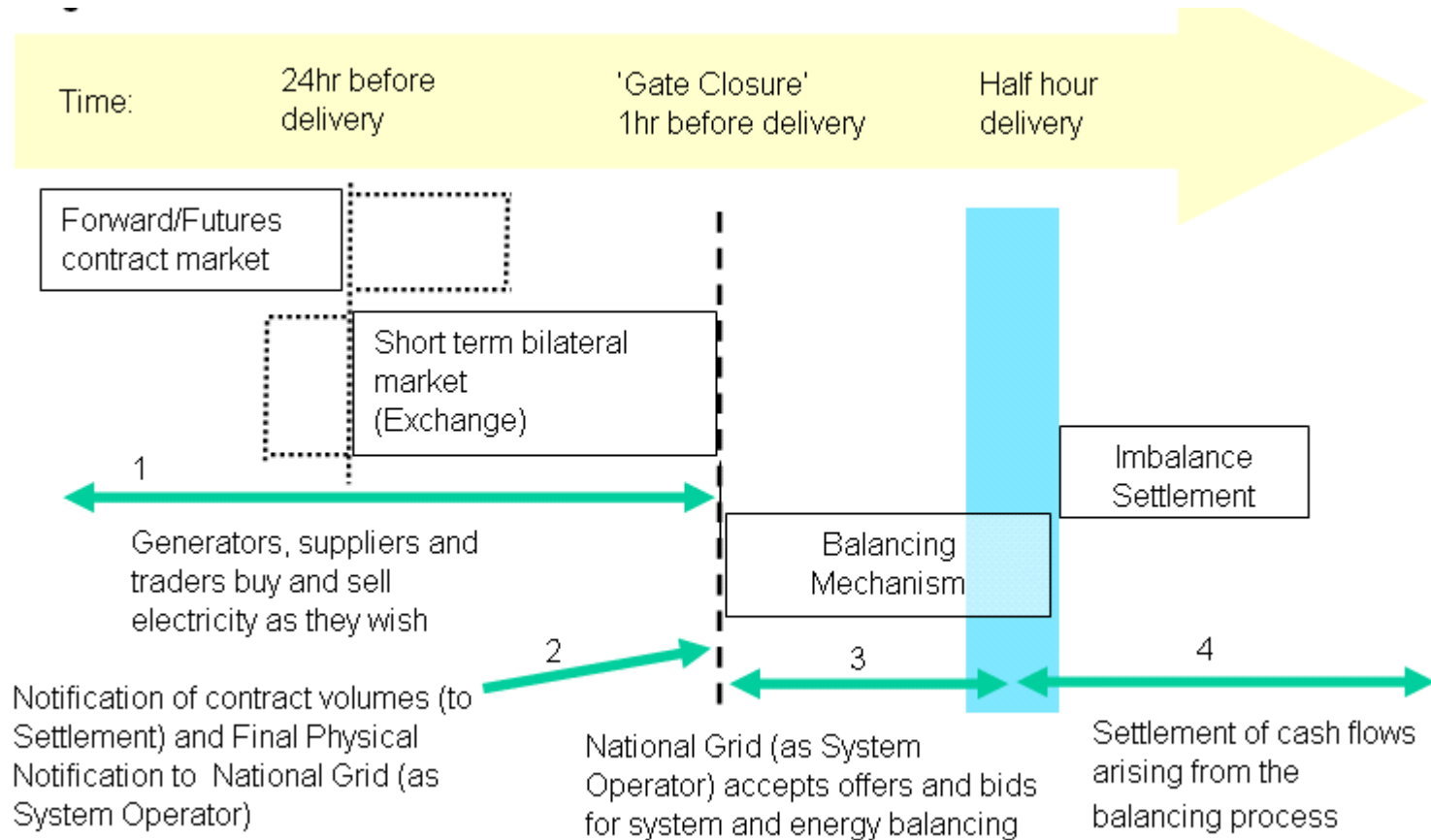
Proposed I-SEM structure by 2018



- **NB:** Forecast risk to wind & must be balance responsible

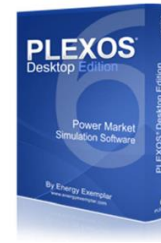
MARKET STRUCTURES

Current BETTA structure (but under redesign)

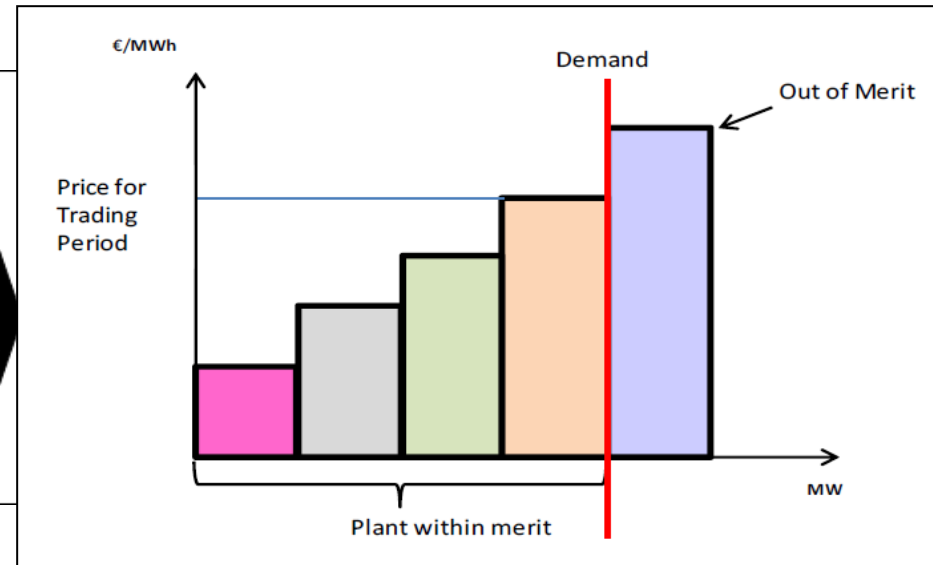
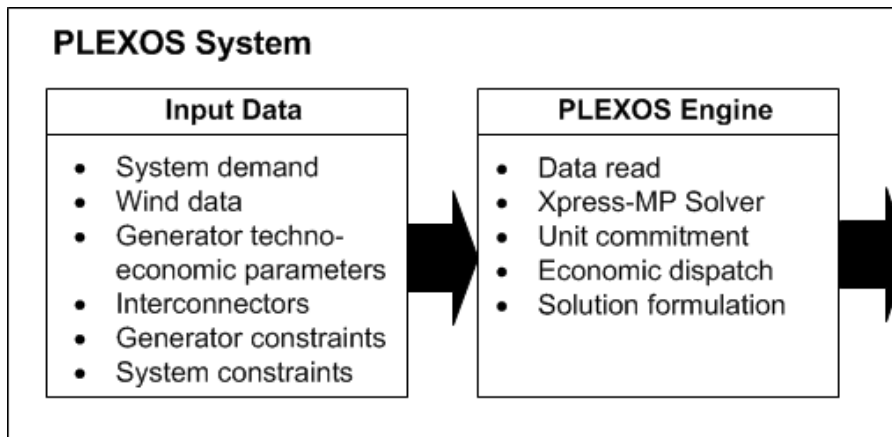


Source: National Grid 2009

METHODOLOGY



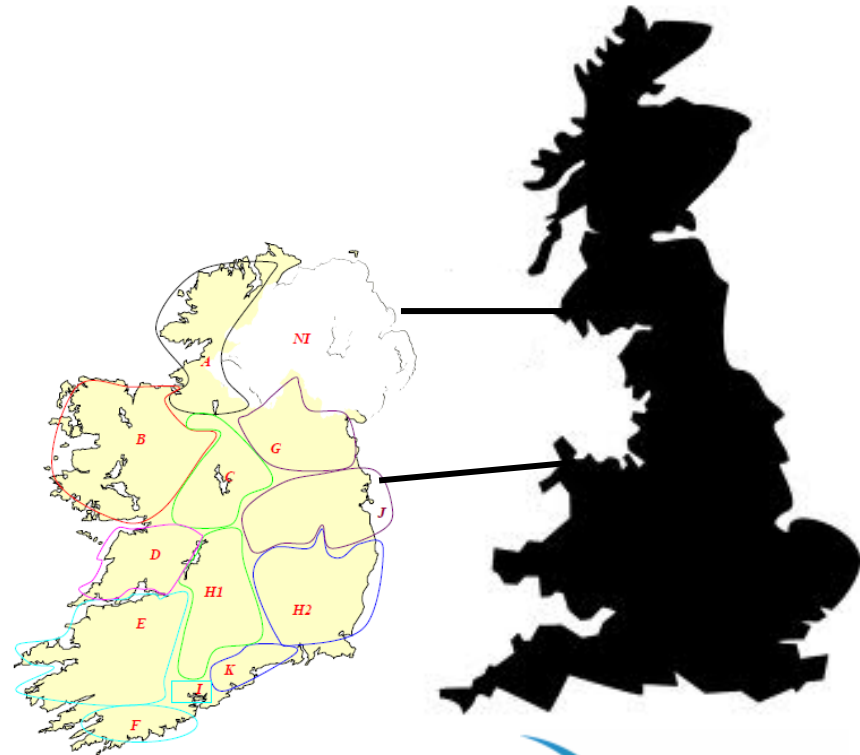
- How do I model the different market structures?
- PLEXOS is an integrated energy software tool and is used by utility companies, TSOs, energy consultants & regulatory authorities for:
 - Market Analysis: Day ahead generation scheduling (Unit Commitment and Economic Dispatch) to minimize cost or maximize profit
 - Transmission/Network Analysis



- **NB:** Box (1987) wrote that "essentially, all models are wrong, but some are useful"

METHODOLOGY

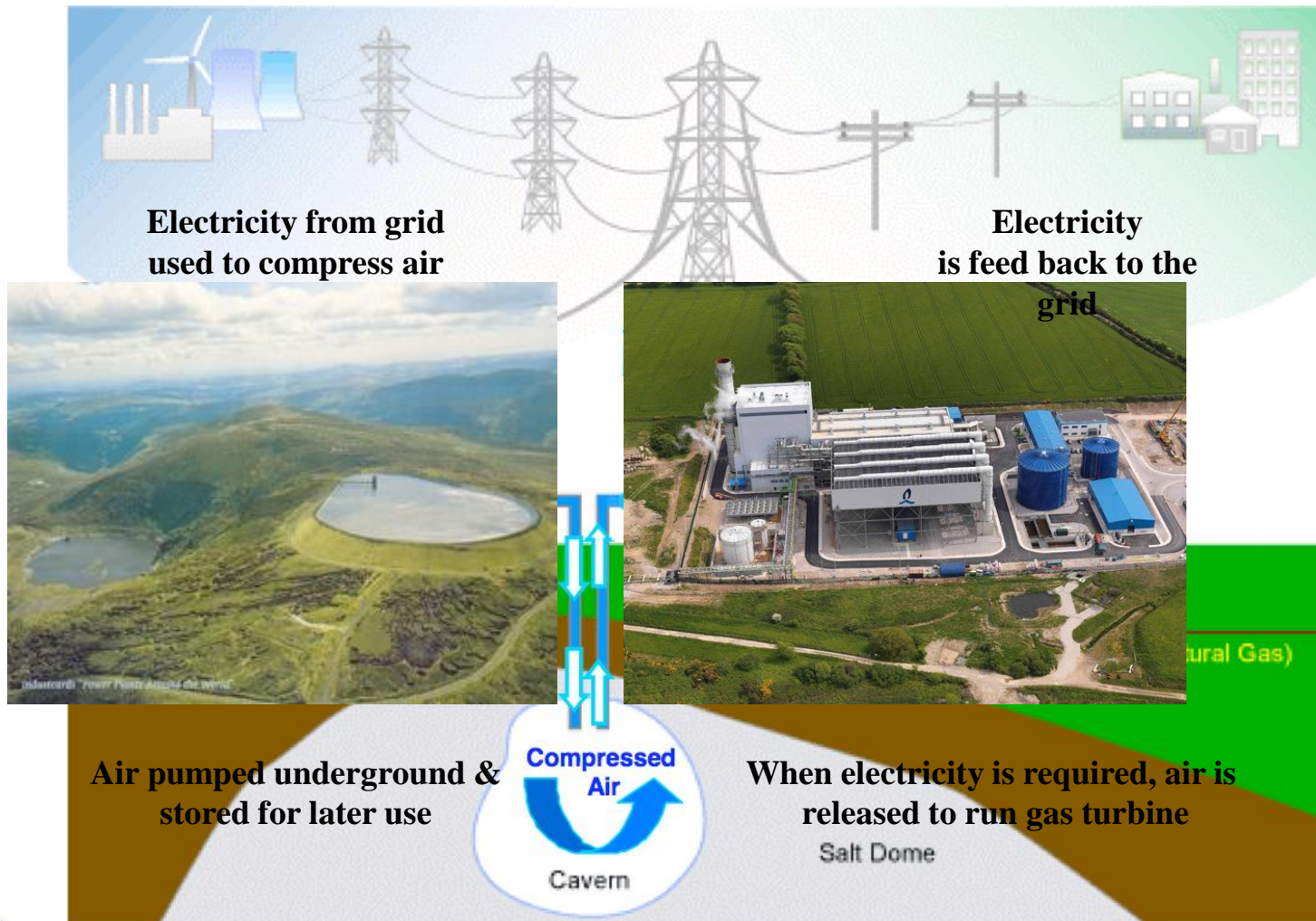
- Wind is modelled in aggregated form, 13 regions, 5,211 MW in 2020
- System demand based on EirGrid's 2020 median demand forecast
 - Peak demand 7,300 MW
 - Valley demand 2,500 MW
- Total dispatchable capacity 8,700 MW
- Interconnectors
 - Moyle, 450 MW & 410 MW
 - East-West, 500 MW
- Reserve requirements as per TCGs
- SNSP limit $\leq 75\%$
- Great Britain represented as single GT or detailed representation



Source: CER 2011

METHODOLOGY

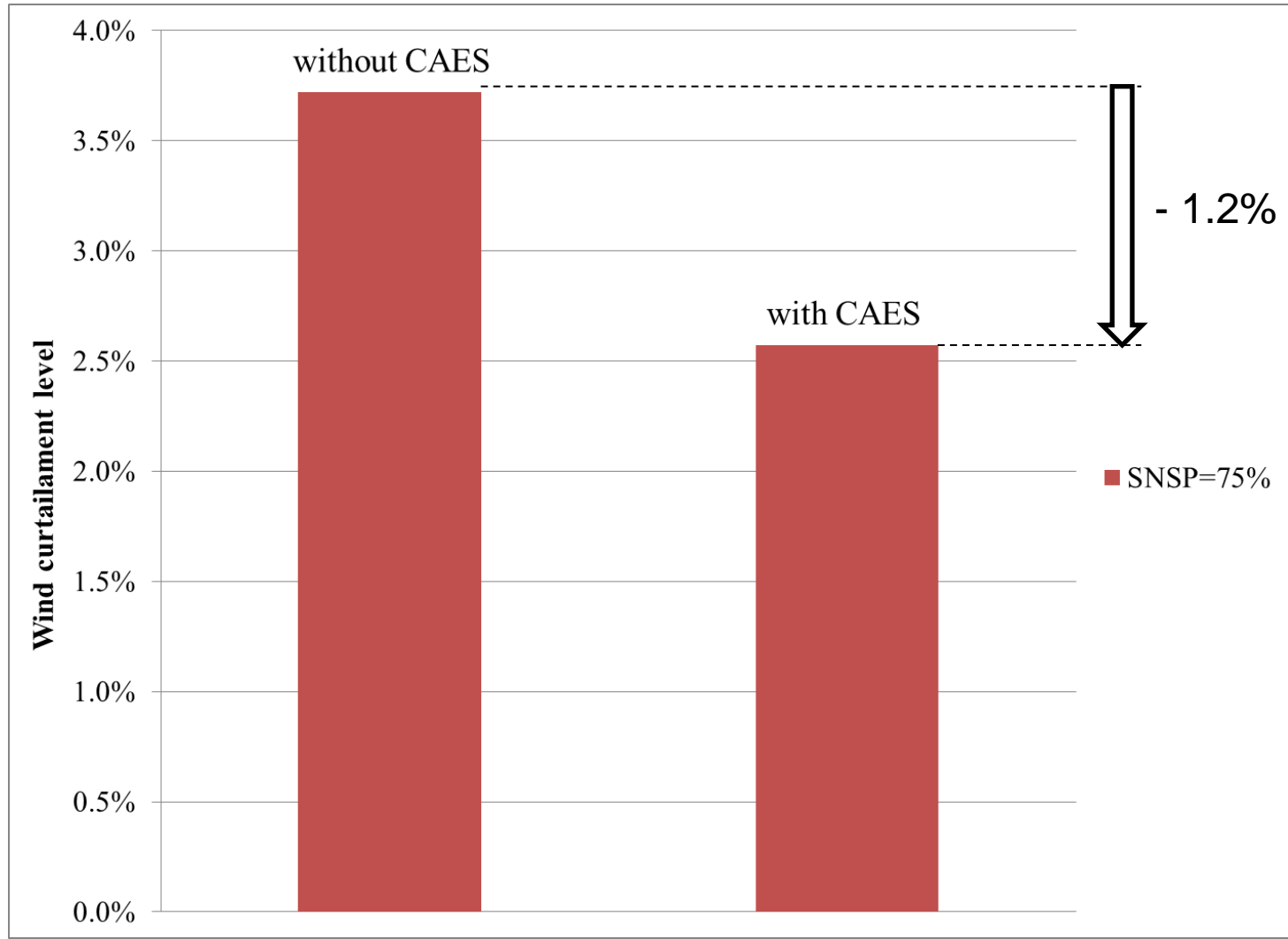
Compressed Air Energy Storage (CAES)



Source: Succar 2005

RESULTS – SEM & CAES

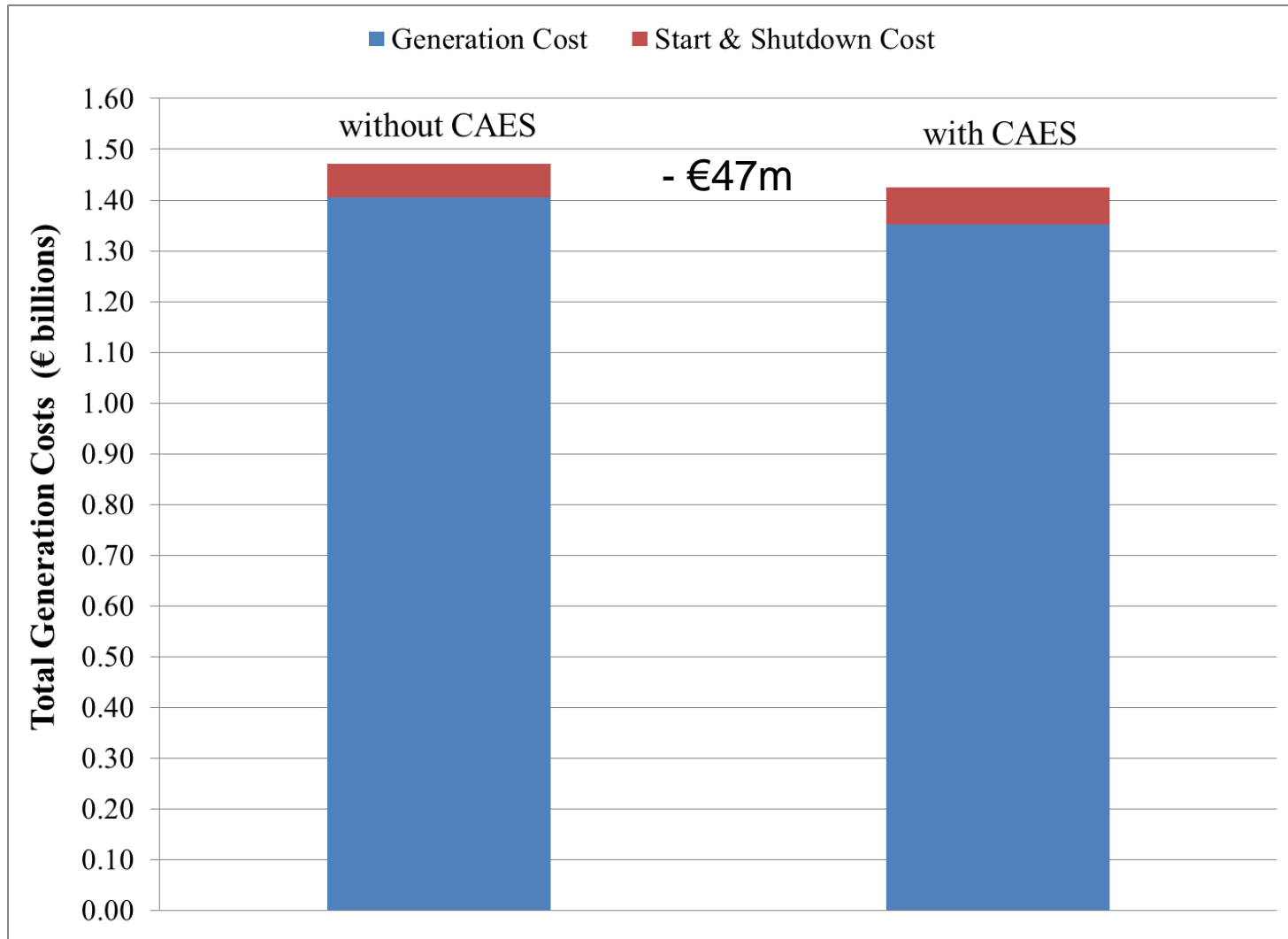
Wind curtailment levels in 2020



Source: Cleary, B., Duffy, A., O Connor, A., Conlon, M., and Fthenakis, V. (2015) Assessing the Economic Benefits of Compressed Air Energy Storage for Mitigating Wind Curtailment, IEEE Transactions on Sustainable Energy, vol. PP, no.99, pp.1,8.

RESULTS – SEM & CAES

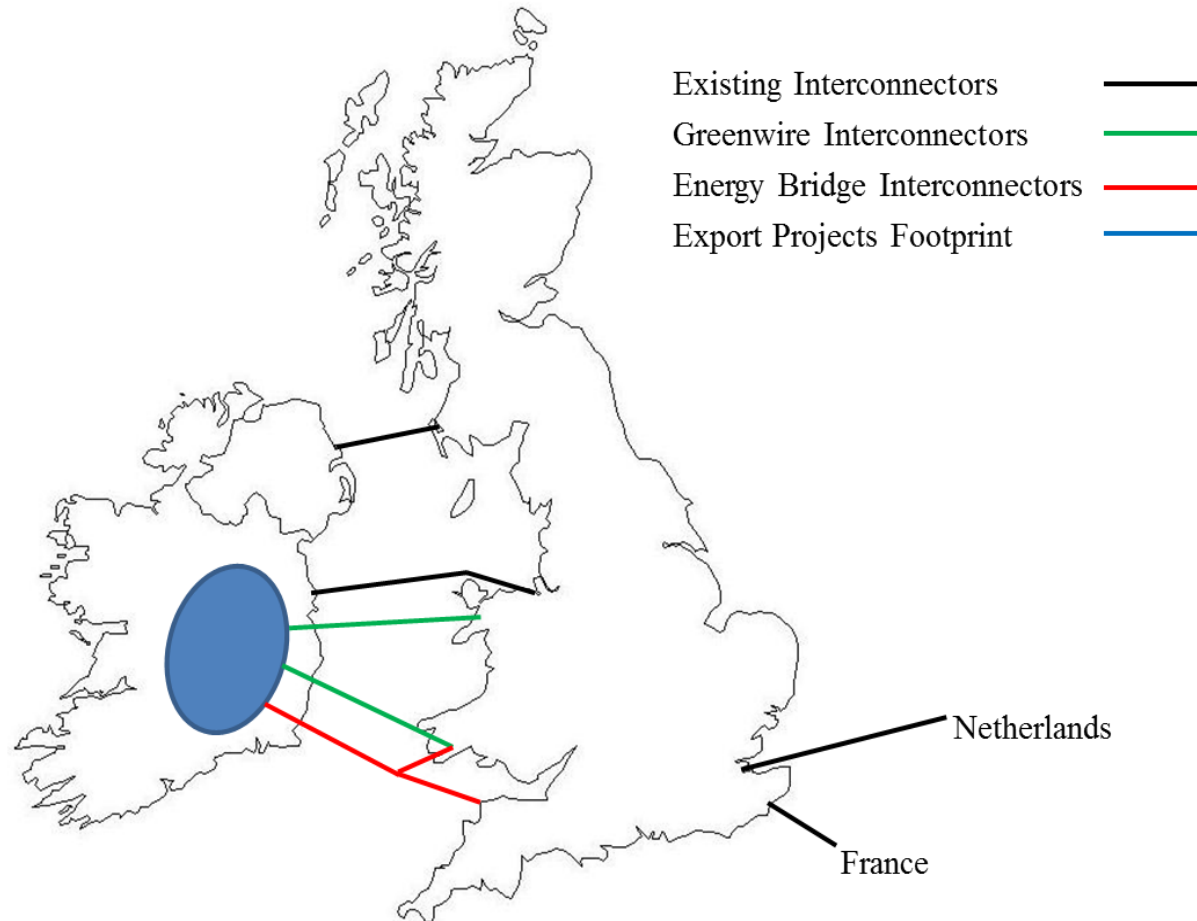
Total Generation costs in 2020



Source: Cleary, B., Duffy, A., O Connor, A., Conlon, M., and Fthenakis, V. (2015) Assessing the Economic Benefits of Compressed Air Energy Storage for Mitigating Wind Curtailment, IEEE Transactions on Sustainable Energy, vol. PP, no.99, pp.1,8.

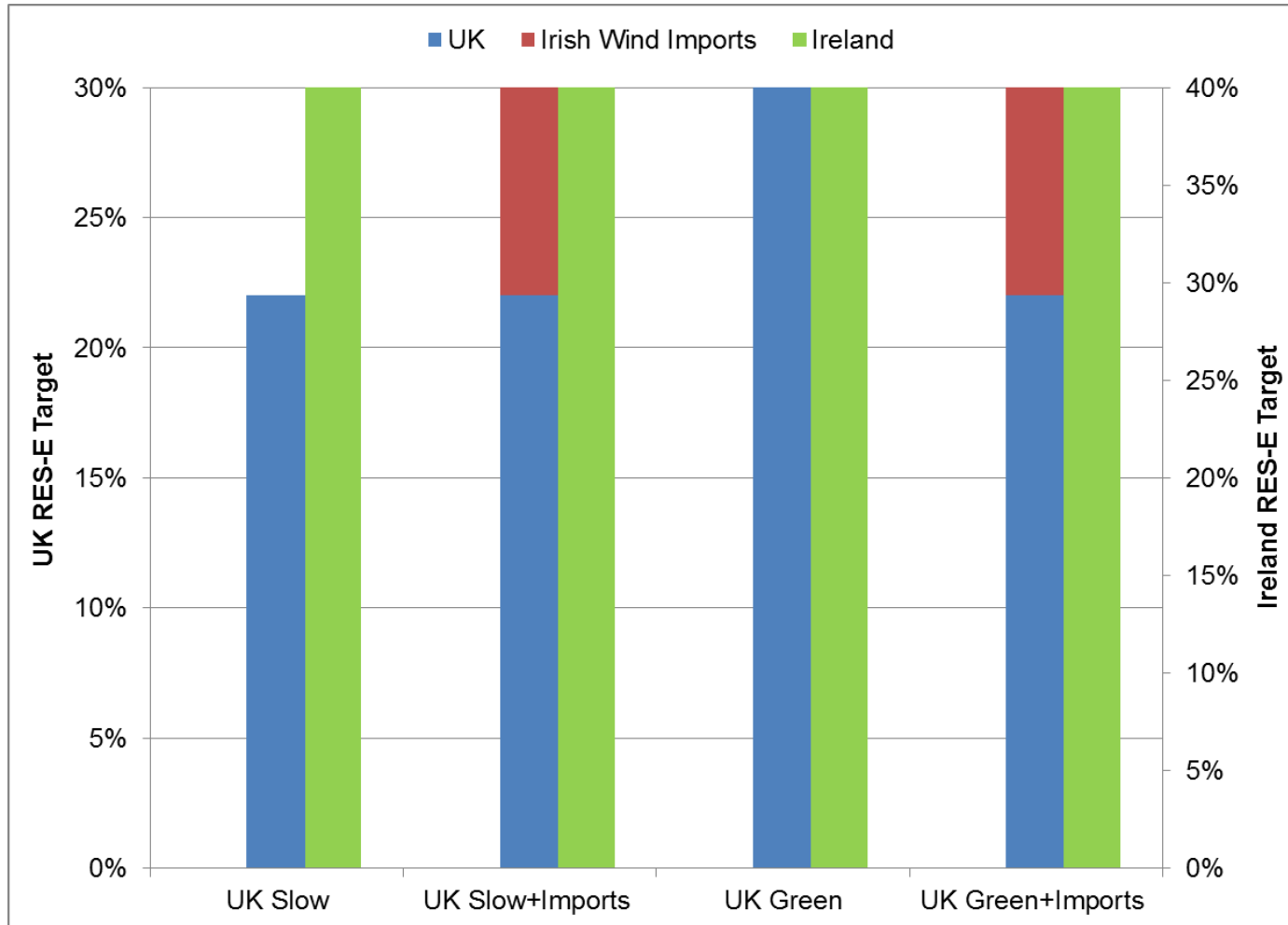
RESULTS – SEM & BETTA

- Irish Midlands Wind Energy Export Projects – 6.2 GW onshore & 3.8 GW offshore



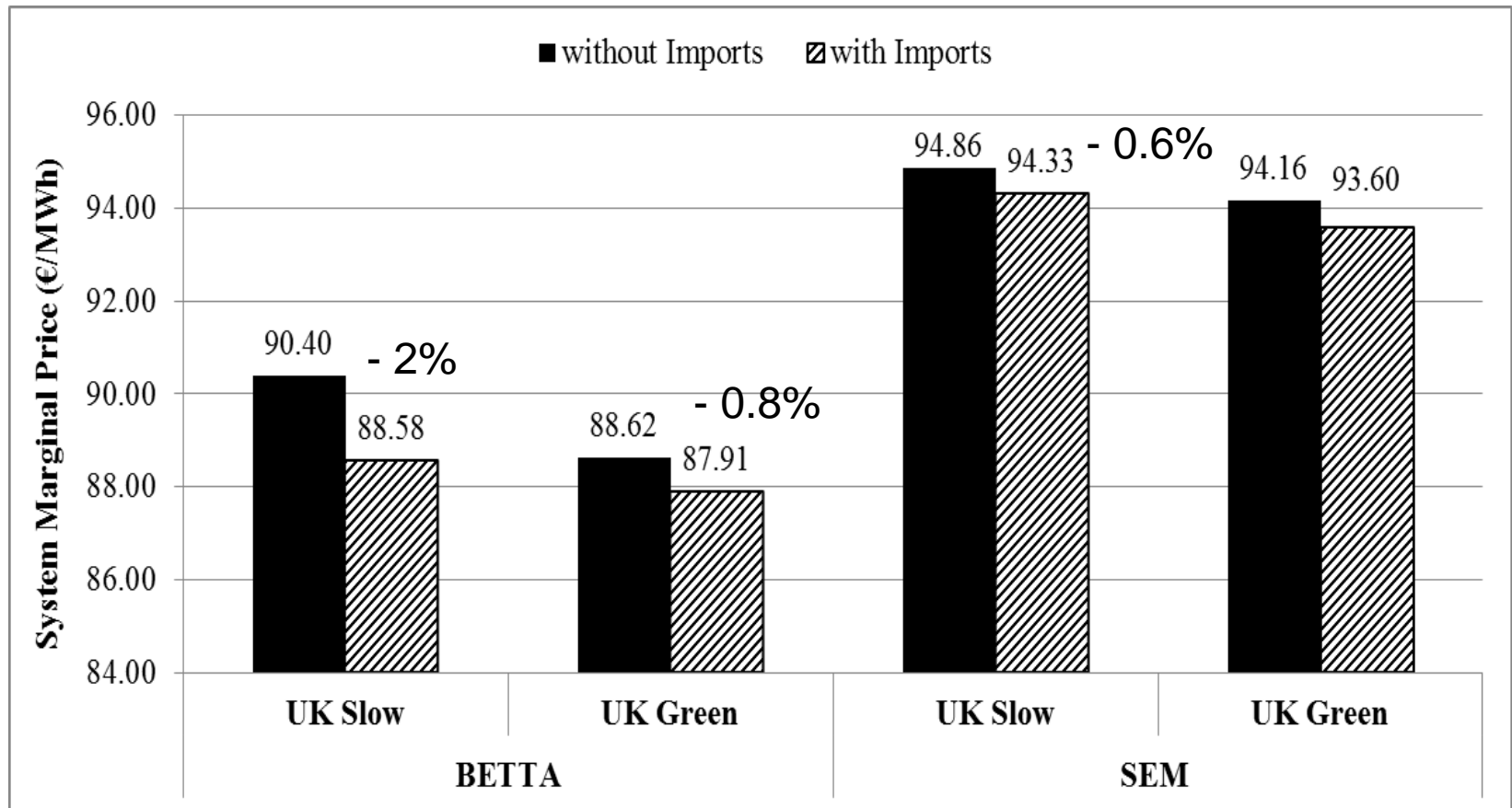
RESULTS – SEM & BETTA

- Model scenarios



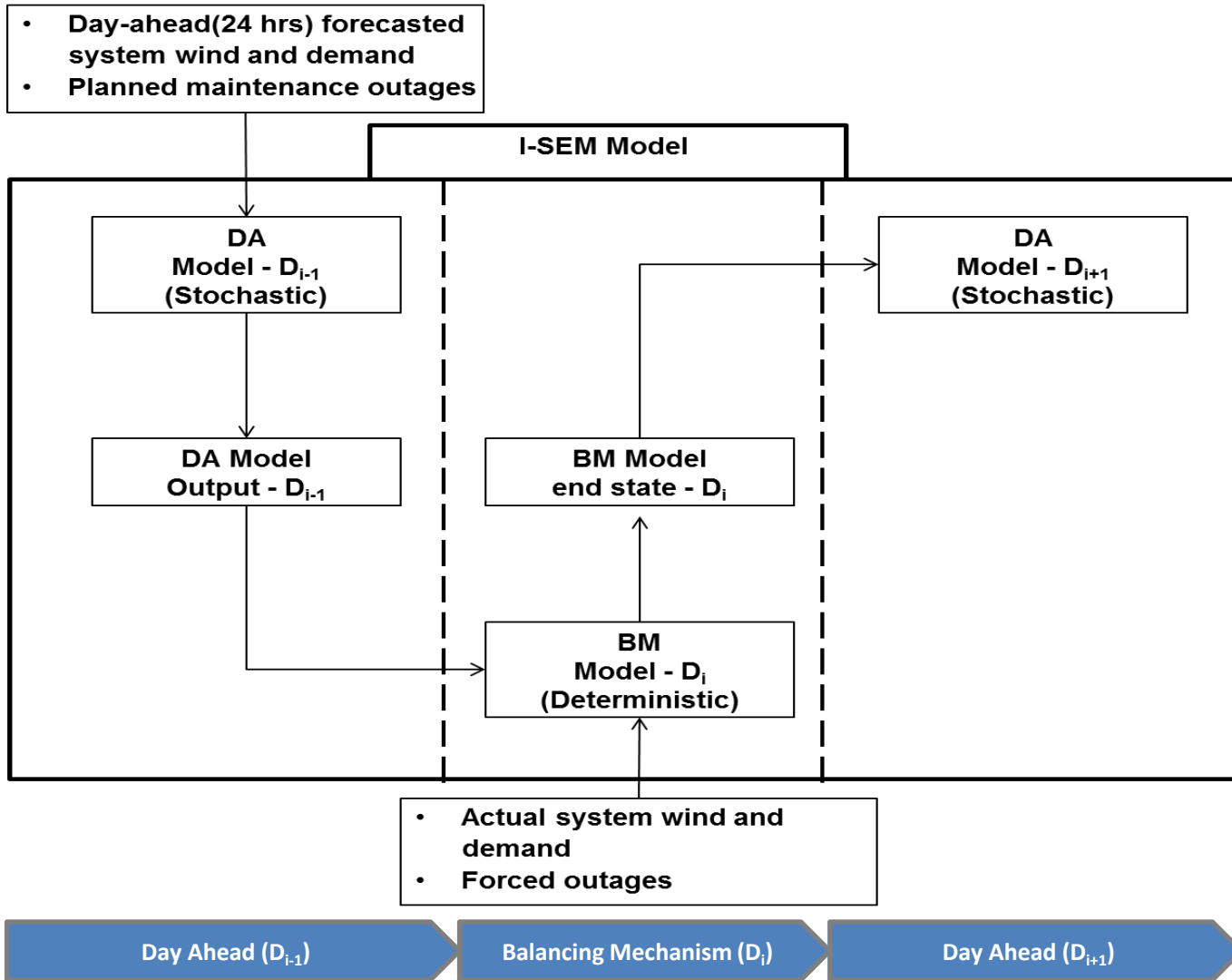
RESULTS – SEM & BETTA

Annual load-weighted average wholesale system marginal prices in 2021



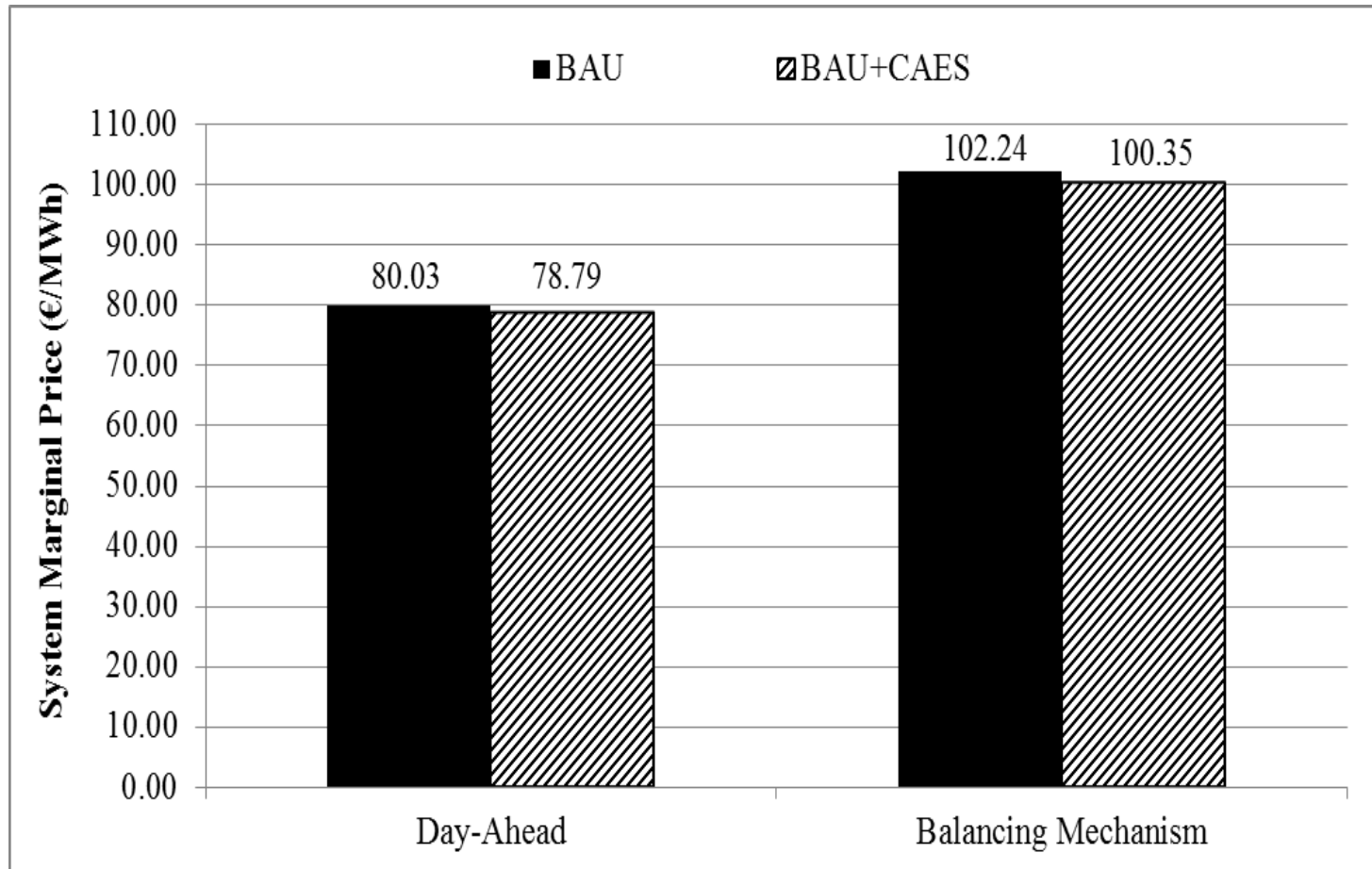
Source: Cleary, B., Duffy, A., Bach, B., Vitina, A., O'Connor, A., Conlon, M. Estimating the economic and environmental impacts of large scale wind energy exports from Ireland to Great Britain. *Energy Policy* (Under Review).

RESULTS – I-SEM & CAES



RESULTS – I-SEM & CAES

Annual average wholesale system marginal prices in 2020



Source: Cleary, B., Duffy, A., A., O'Connor, A., Conlon, M. Assessing the future economic performance of wind generation in conjunction with compressed air energy storage in the new proposed Irish electricity market. *Economic and Business Letters* (Under Review).

FURTHER WORK & CONSIDERATIONS

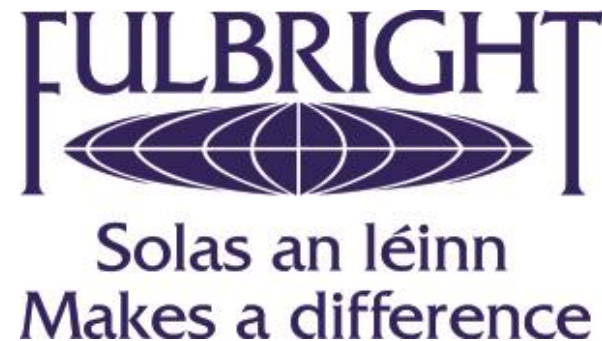
- Further work:
 - I-SEM model sensitivities:
 - Wind forecast error – system wide & time shifting effects
 - Demand forecast error
 - Fuel & Carbon prices (low, medium & high)
 - Generator Incremental & Decremental prices
- Considerations for further research:
 - Pre-2020:
 - Data centres(900-1400MW), batteries, flywheels
 - Carbon floor price in BETTA
 - Post-2020: Peat plants, Moneypoint coal plant, new interconnector to France (700MW), offshore wind, solar, biomass, tidal/wave, embedded/distributed generation
 - 2030 RES-E targets

ACKNOWLEDGEMENTS

- Dublin Institute of Technology for funding this research through the Fiosraigh Dean of Graduate Student's Award 2011



Supported by



QUESTIONS

