Modelling Future Energy Policy Scenarios

By

Brendan Cleary
PhD Researcher
BA, BAI, MSc, CEng MIEI

School of Civil & Building Services Engineering & Dublin Energy Lab, Dublin Institute of Technology, Dublin, Ireland

Prof. Aidan Duffy, Dublin Institute of Technology
Dr. Alan O'Connor, Trinity College Dublin
Prof. Michael Conlon, Dublin Institute of Technology
Prof. Vasilis Fthenakis, Columbia University

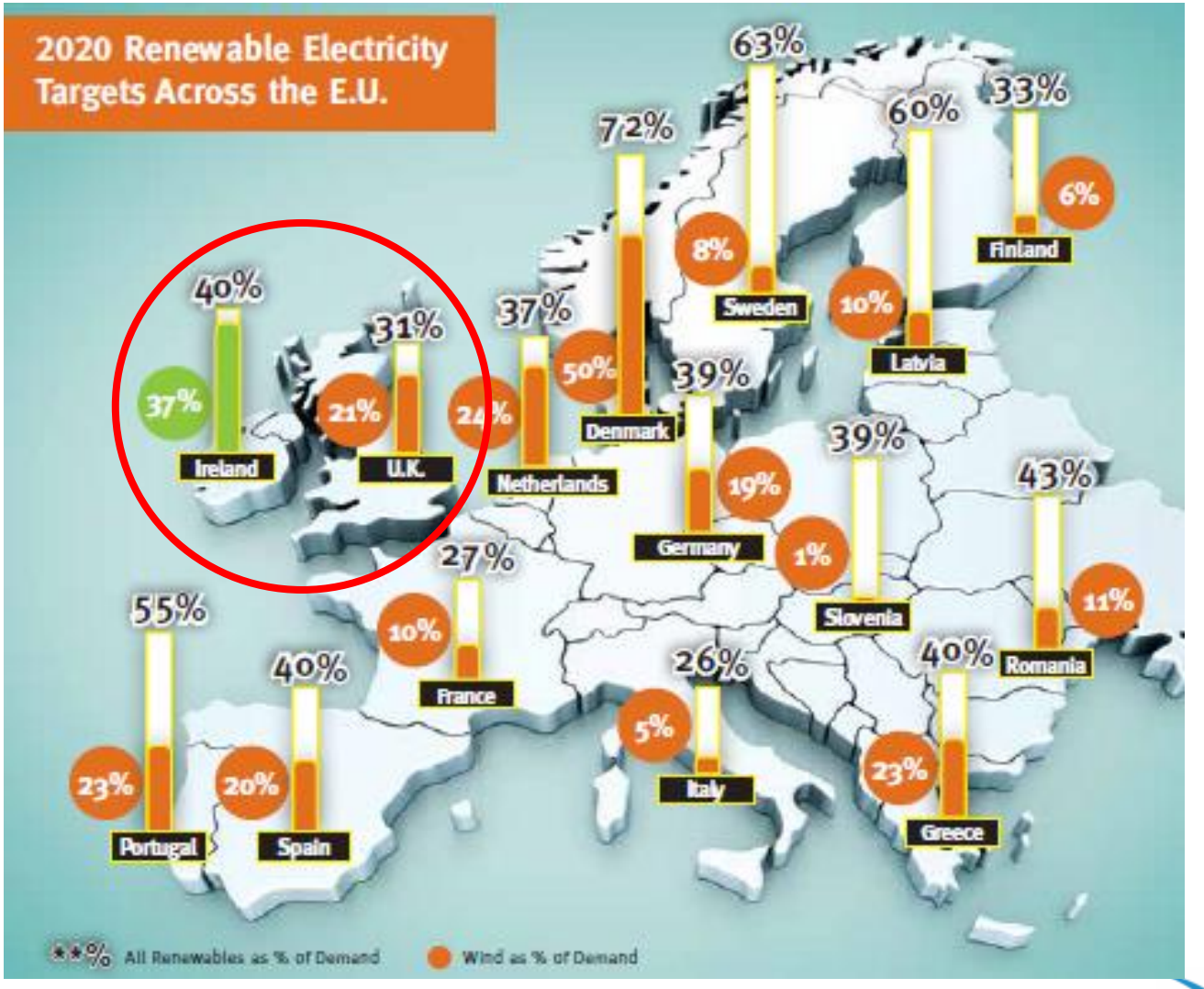
6th June 2014

OUTLINE

- Background
- Motivation
- Objectives
- Methodology
- Results
- IEA Task 26 – Cost of Wind Energy

BACKGROUND

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



Source: Eirgrid 2013

MOTIVATION

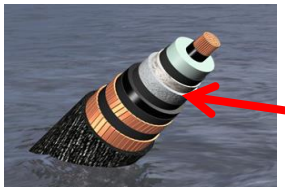
- EU Energy Policy is influencing the transformation of power systems
- System flexibility issues will become more frequent and hence a system wide transformation is required

Grid Infrastructure

Fast Acting Generators

Energy Storage

Demand Side Management



OBJECTIVES

- Model and analyse two future energy policy scenarios:

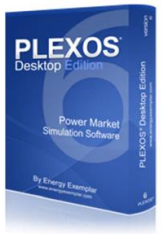
    1. Compressed Air Energy Storage (CAES)

        - To investigate and compare two scenarios; one without CAES and a second with CAES as an additional generator in the 2020 Irish power system

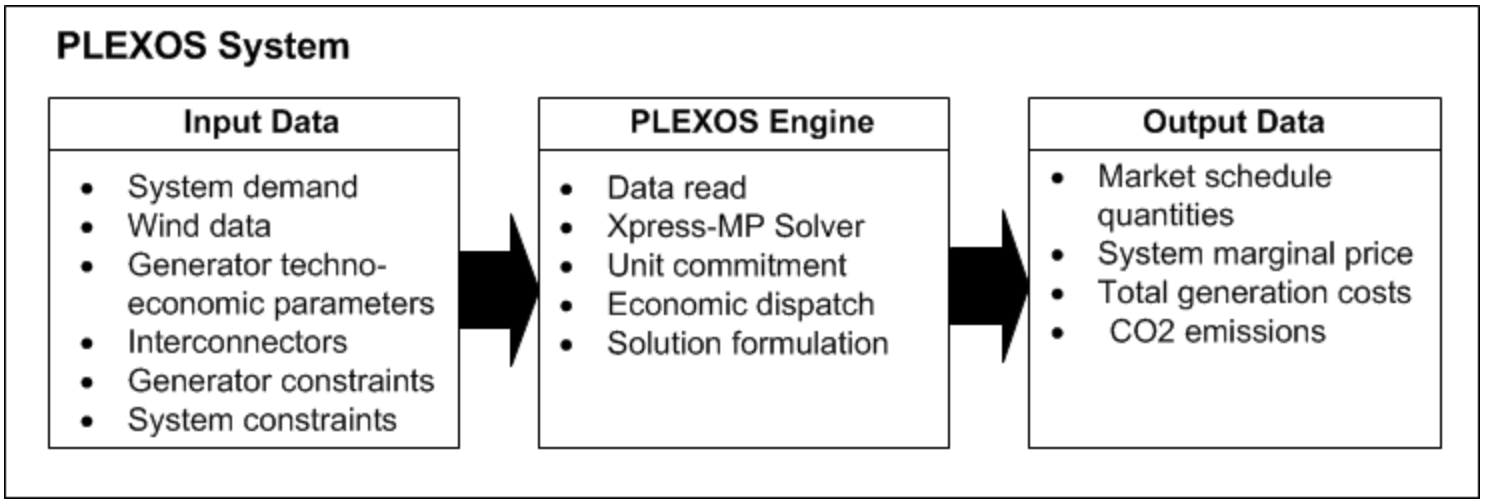
    2. Irish Midlands Wind Energy Export Projects

        - To determine the effects of the export projects in the Irish and British electricity markets in terms of wholesale electricity prices, total generation costs and CO_2 emissions

METHODOLOGY

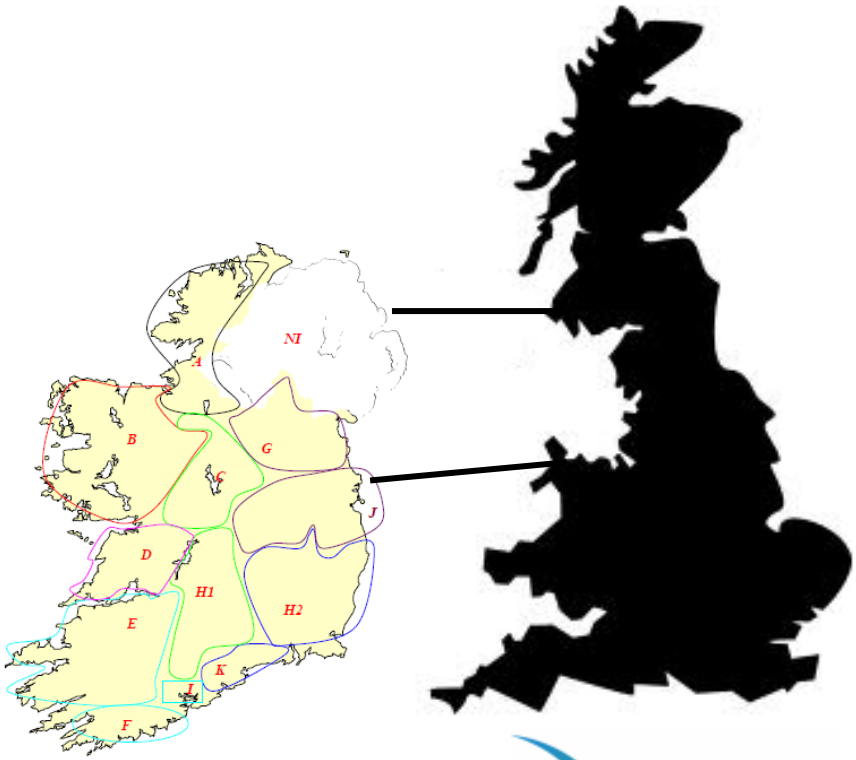


- Using PLEXOS to model the Irish and British systems
- The Regulatory Authorities (CER) provide annual publically available PLEXOS models
- Modified the 2011 validated forecast model to reflect the years investigated
- Eirgrid All-Island GCS 2012-2021, DUKES 2013 and National Grid 2013



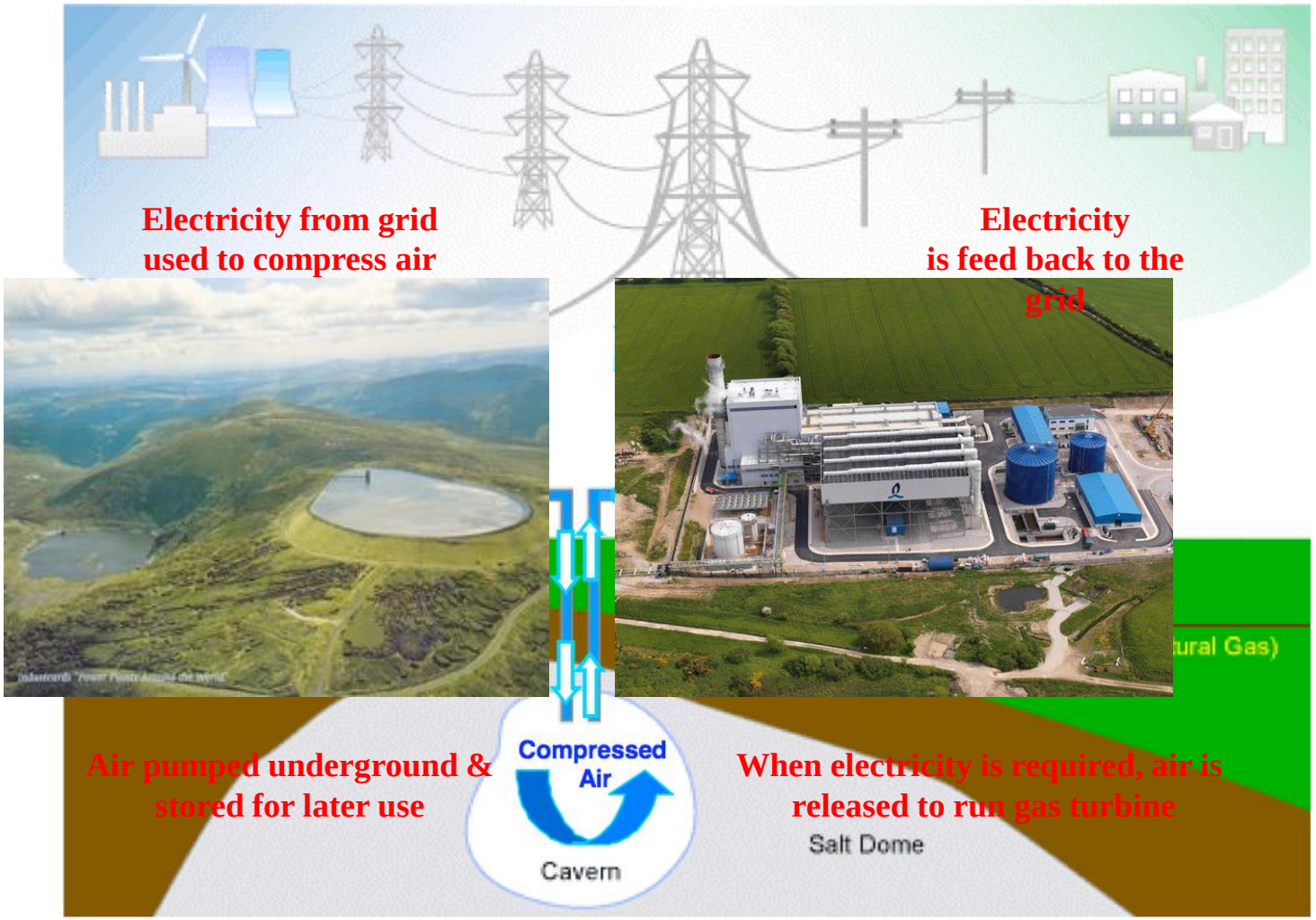
METHODOLOGY

- Wind is modelled in aggregated form, 13 regions, 5,211 MW
- 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 ≤ 75%
- Great Britain represented as single GT



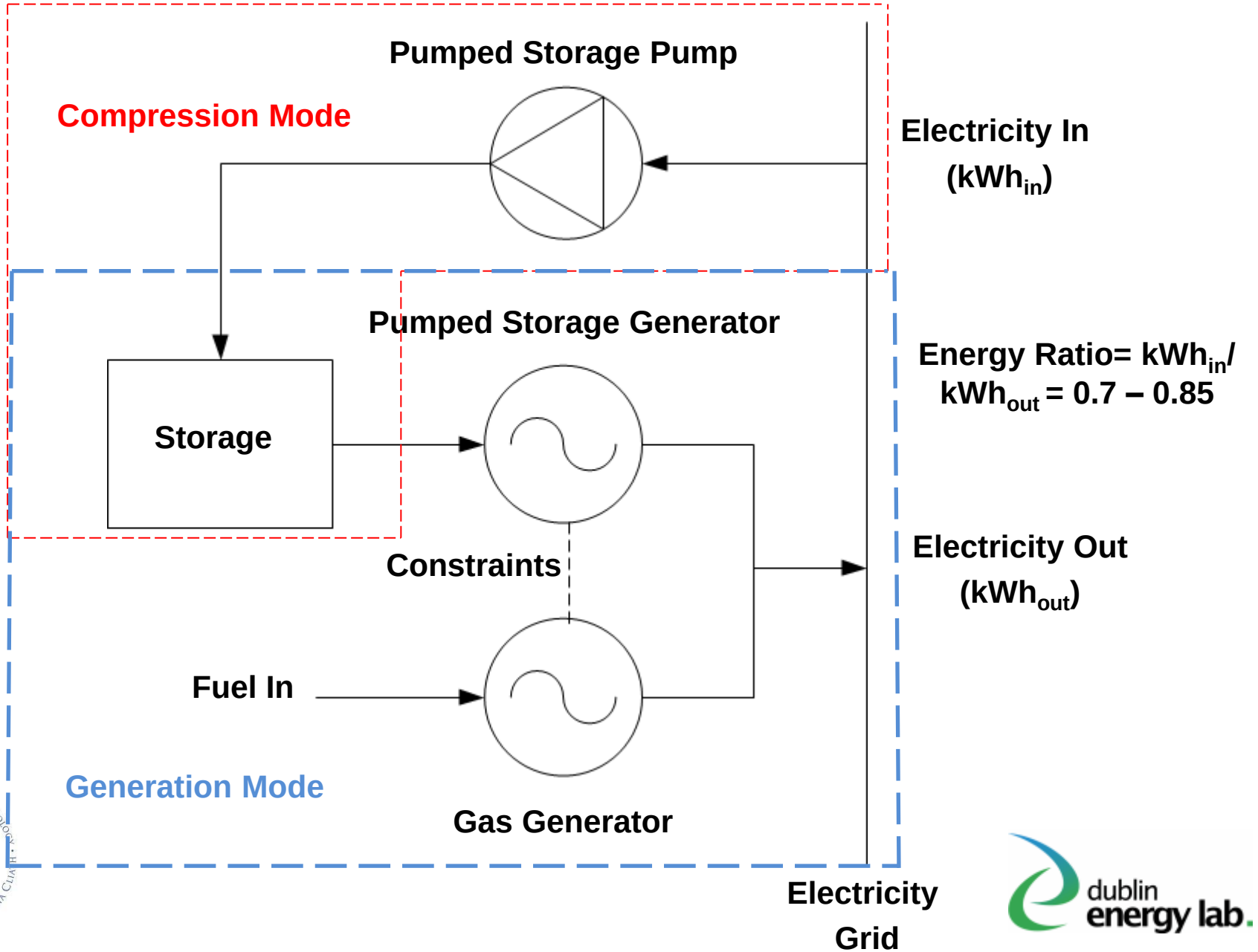
Source: CER 2011

METHODOLOGY



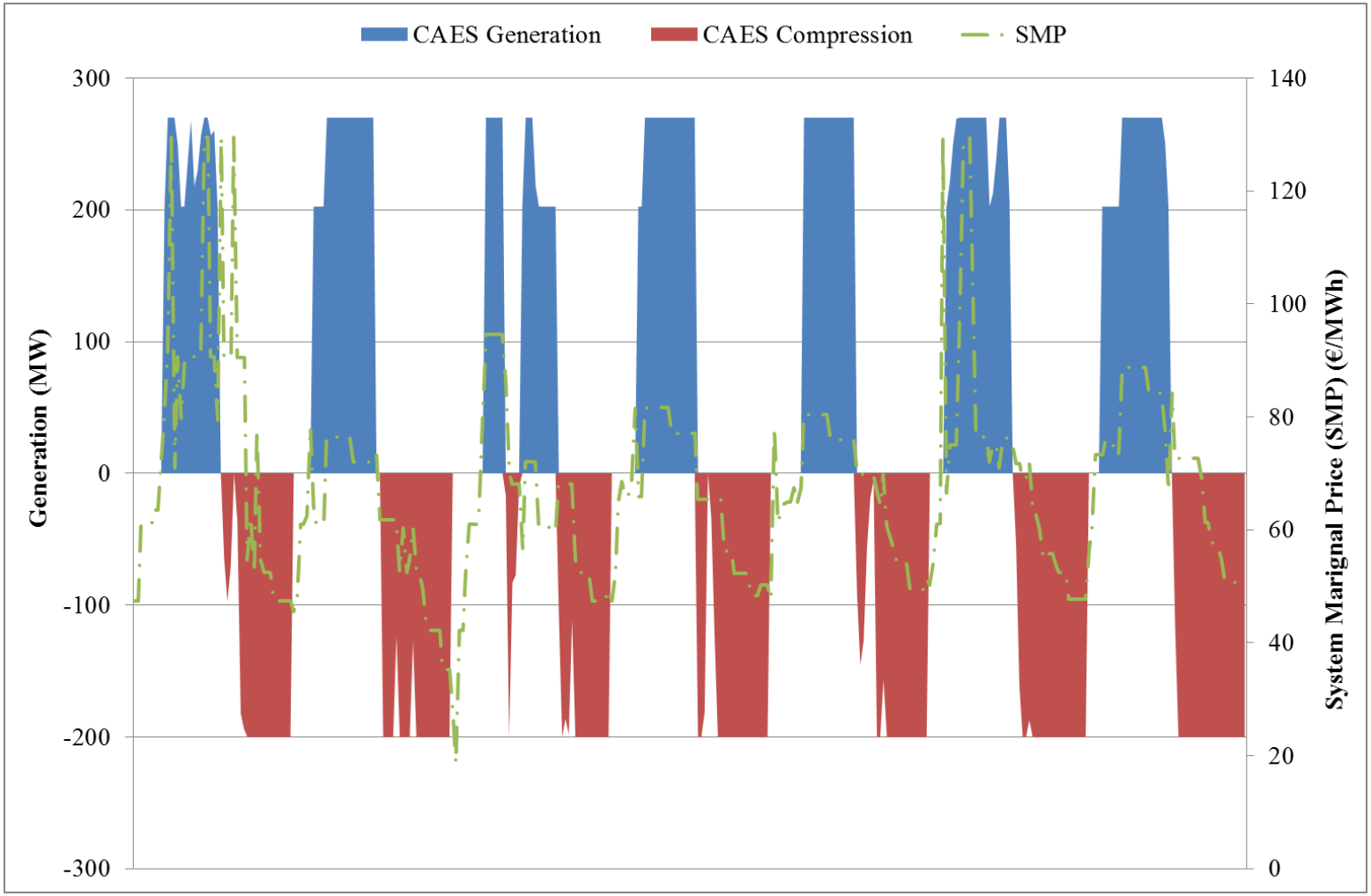
Source: Succar 2005

METHODOLOGY



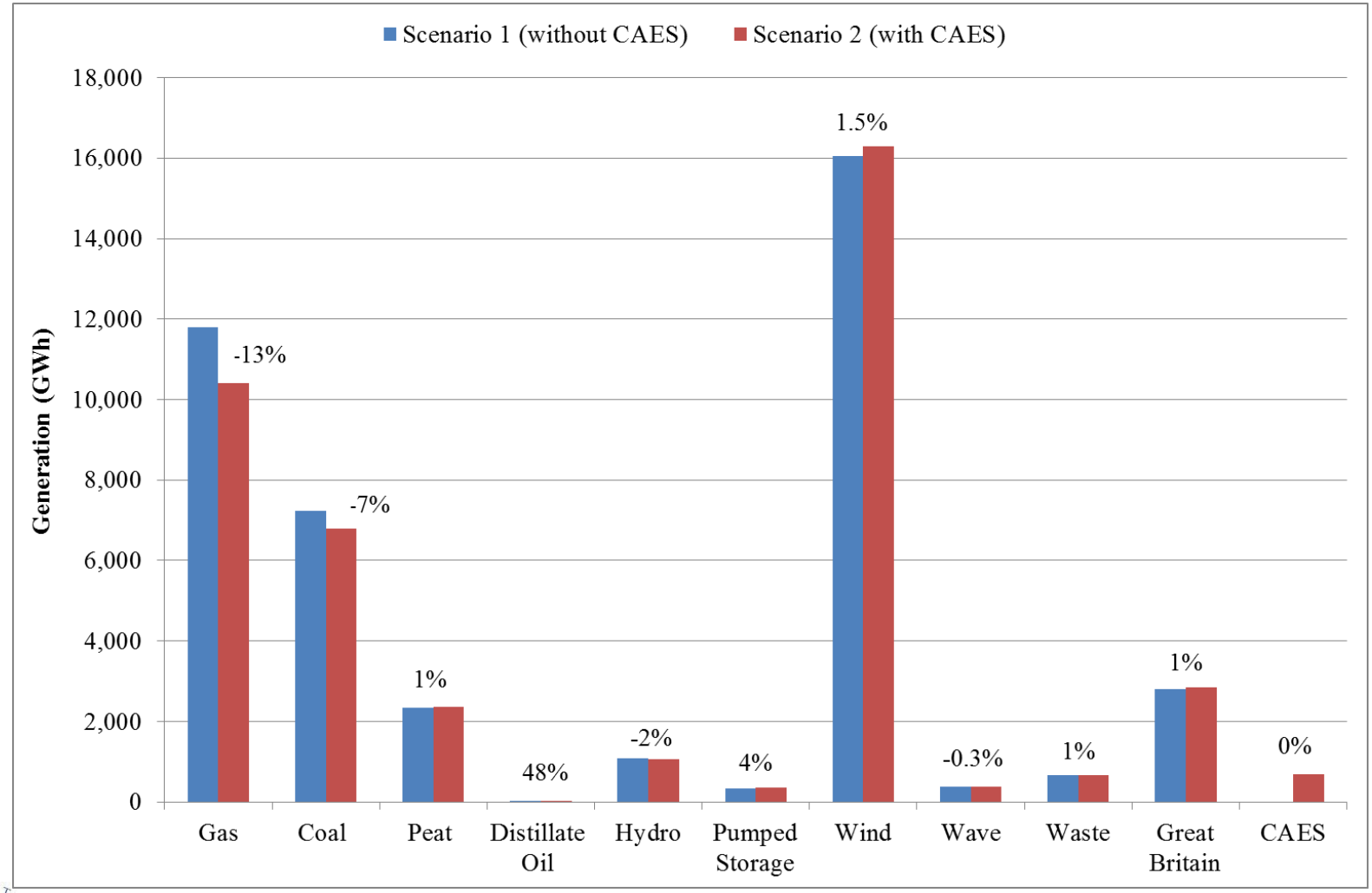
RESULTS

270MW CAES plant operation over a typical 7 day week



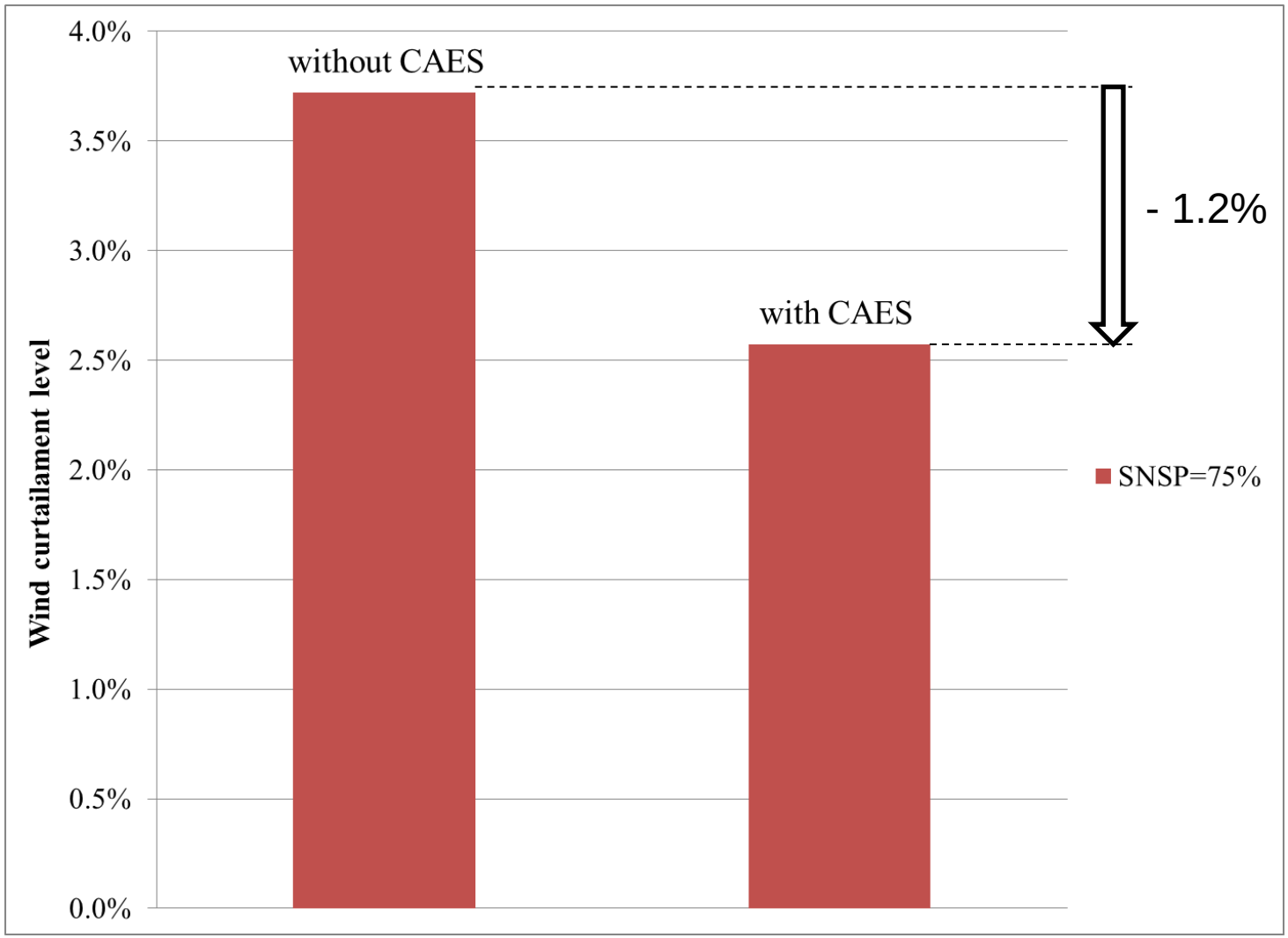
RESULTS

Generation comparison for year 2020



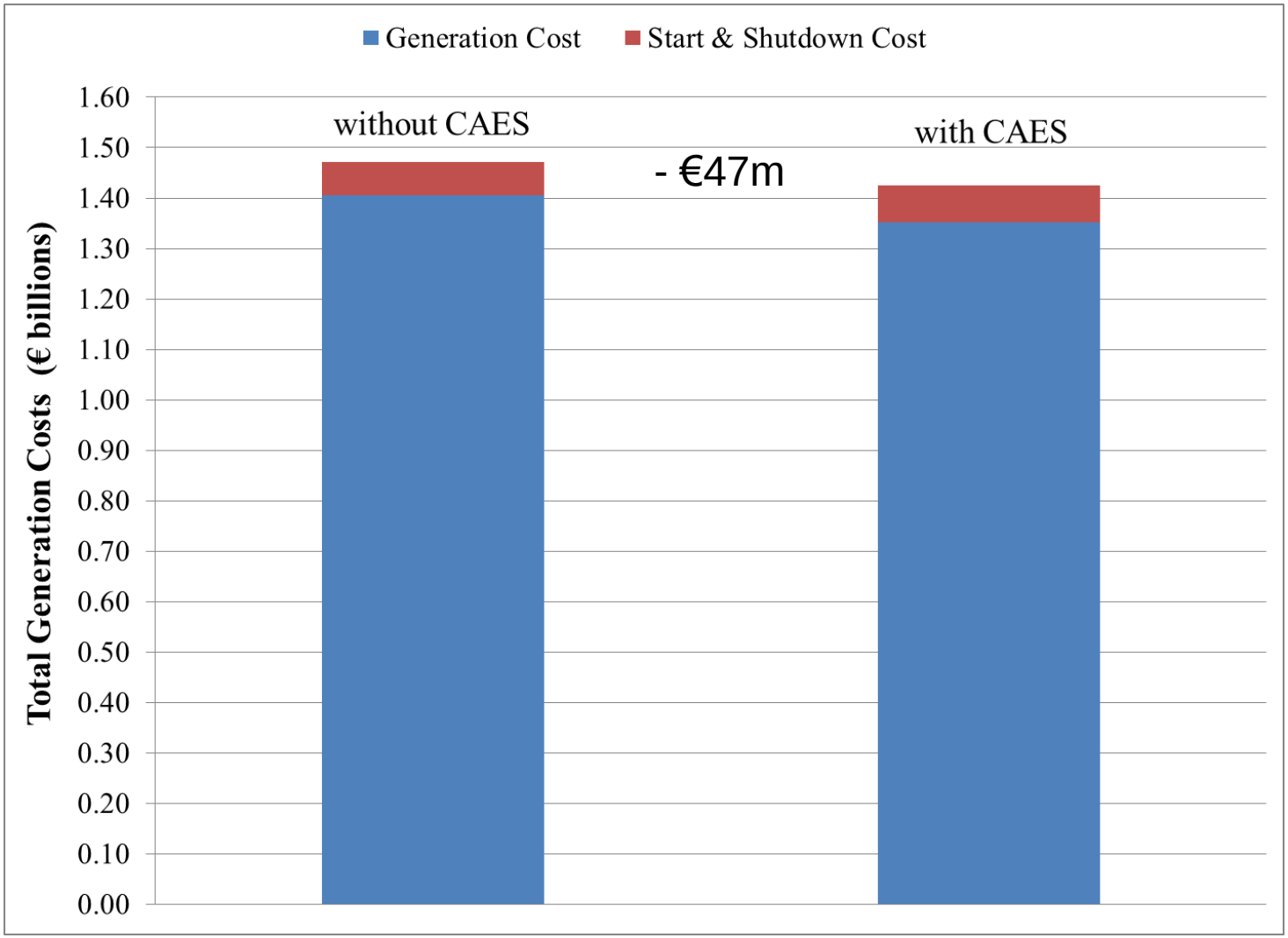
RESULTS

2020 Wind curtailment levels



RESULTS

Generation costs for year 2020



IEA TASK 26

- Participate in the International Energy Agency (IEA) Task 26 – Cost of Wind Energy

- Multi-national study on the levelised cost of wind energy with participating countries including: Ireland, Denmark, Germany, Netherlands, Norway, United States (NREL) and the European Commission (JRC)

- Addressed by three work packages:

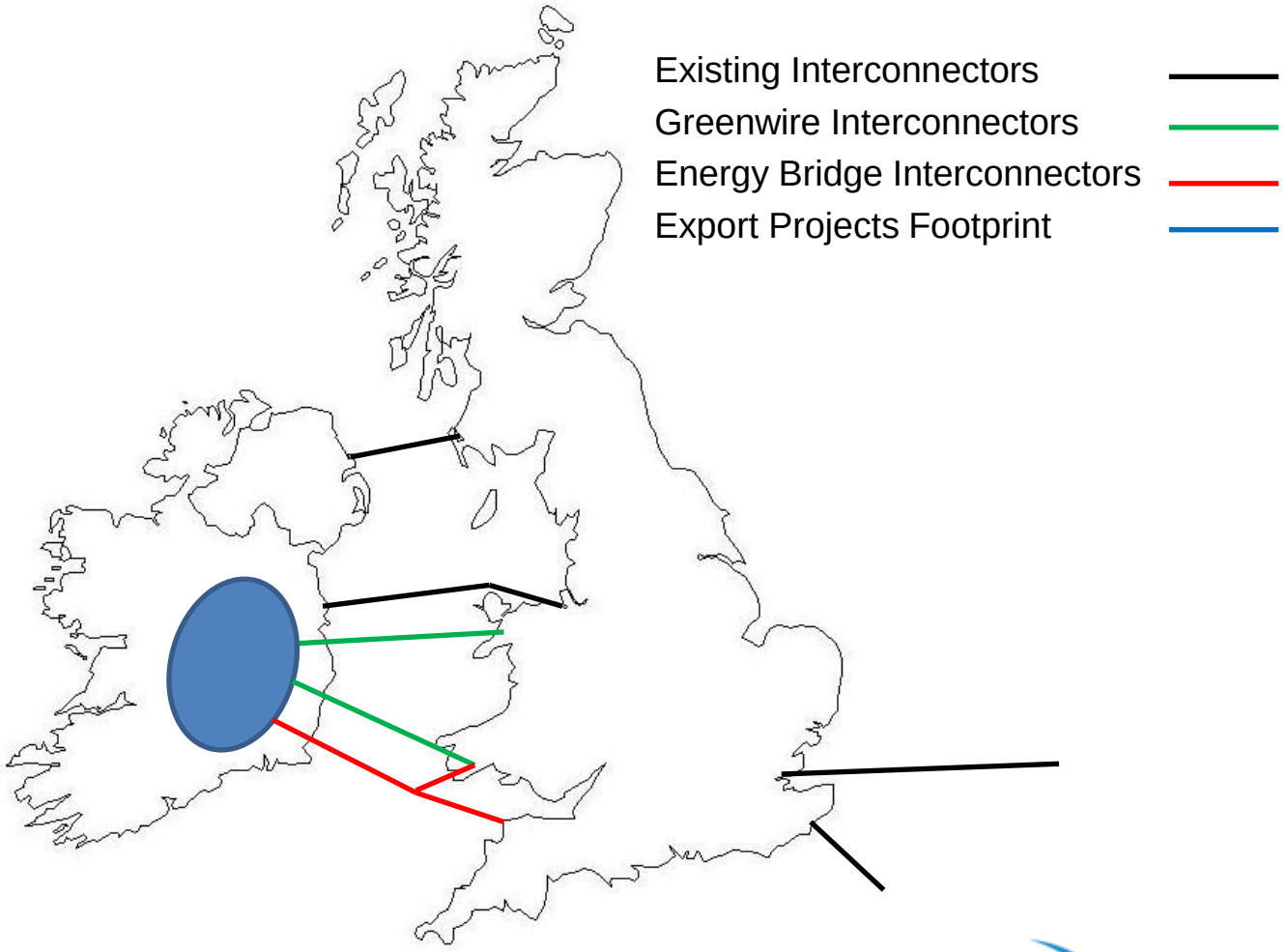
  - WP1: Analysis of land-based wind technology cost drivers and differences among participating countries with current data

  - WP2: Estimate cost of offshore wind energy and identifying major cost drivers in each participating country

  - WP3: Explore methods and application of methods to understand the future cost of wind energy and value of wind energy in the electric system

TASK 26 - COLLABORATION

- Irish Midlands Wind Energy Export Projects – 6.3 GW onshore & 3.8 GW offshore



TASK 26 - COLLABORATION

- Methodology:

1. Build detailed 2012 models of the Irish and British systems using PLEXOS (DIT) and Balmorel (Ea)

2. Validate PLEXOS and Balmorel outputs with actual market data

3. Modify and extend the 2012 models to reflect the year 2021

4. Include with and without wind energy export project scenarios in both 2021 models

5. Verify the PLEXOS and Balmorel outputs relative to each other

PUBLICATIONS

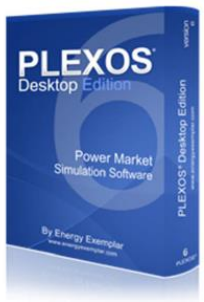
- Cleary, B., Duffy, A., O'Connor A., Conlon, M., and Fthenakis, V. (2014), Assessing the Economic Benefits of Compressed Air Energy Storage for Mitigating Wind Curtailment, IEEE Transactions on Sustainable Energy Special Issue on Large Scale Grid Integration and Regulatory Issues of Variable Power Generation, In Review.

- Cleary, B., Duffy, A., O'Connor A., Conlon, M., and Fthenakis, V. (2013), Assessing the benefits of compressed air energy storage on the 2020 Irish Power System, 48th Universities Power Engineering Conference, 5-6th September 2013, Dublin, Ireland.

- Assessing the economic impacts of the Irish midlands wind energy export projects in the British Isles, Working Paper.

ACKNOWLEGDEMENTS

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



ENERGY exemplar

Supported by

seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

ENTERPRISE IRELAND

FULBRIGHT

Solas an léinn

Makes a difference

DUBLIN INSTITUTE OF TECHNOLOGY · D·I·T · INSTITIÚID TEICNEOLAÍOCHTA ÁTHA CLIATH ·

dublin energy lab.

QUESTIONS

Email: brendan.cleary1@mydit.ie
Tel: +353 86 6009117