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
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
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

Electricity from grid used to compress air

Electricity is feed back to the grid

Air pumped underground & stored for later use

When electricity is required, air is released to run gas turbine

Source: Succar 2005
METHODOLOGY

Electricity Grid

Pumped Storage Pump

Compression Mode

Pumped Storage Generator

Storage

Energy Ratio = \frac{kWh_{in}}{kWh_{out}} = 0.7 \text{ – } 0.85

Electrical In

(kWh_{in})

Constraints

Fuel In

Generation Mode

Gas Generator

Electricity Out

(kWh_{out})

Electricity

Grid
RESULTS

270MW CAES plant operation over a typical 7 day week
RESULTS
Generation comparison for year 2020

- Gas: -13%
- Coal: -7%
- Peat: 1%
- Distillate Oil: 48%
- Hydro: -2%
- Pumped Storage: 4%
- Wind: 15%
- Wave: -0.3%
- Waste: 1%
- Great Britain: 1%
- CAES: 0%
RESULTS

2020 Wind curtailment levels

without CAES

with CAES

- 1.2%

SNSP=75%
RESULTS

Generation costs for year 2020

- €47m
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


ACKNOWLEDGEMENTS

• Dublin Institute of Technology for funding this research through the Fiosraigh Dean of Graduate Student’s Award 2011
QUESTIONS

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