Historic paths and future expectations: The macroeconomic impacts of the offshore wind technologies in the UK

By

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Agenda

1 Introduction

2 The UK Context

3 Simulation Strategy

4 Results

5 Conclusions

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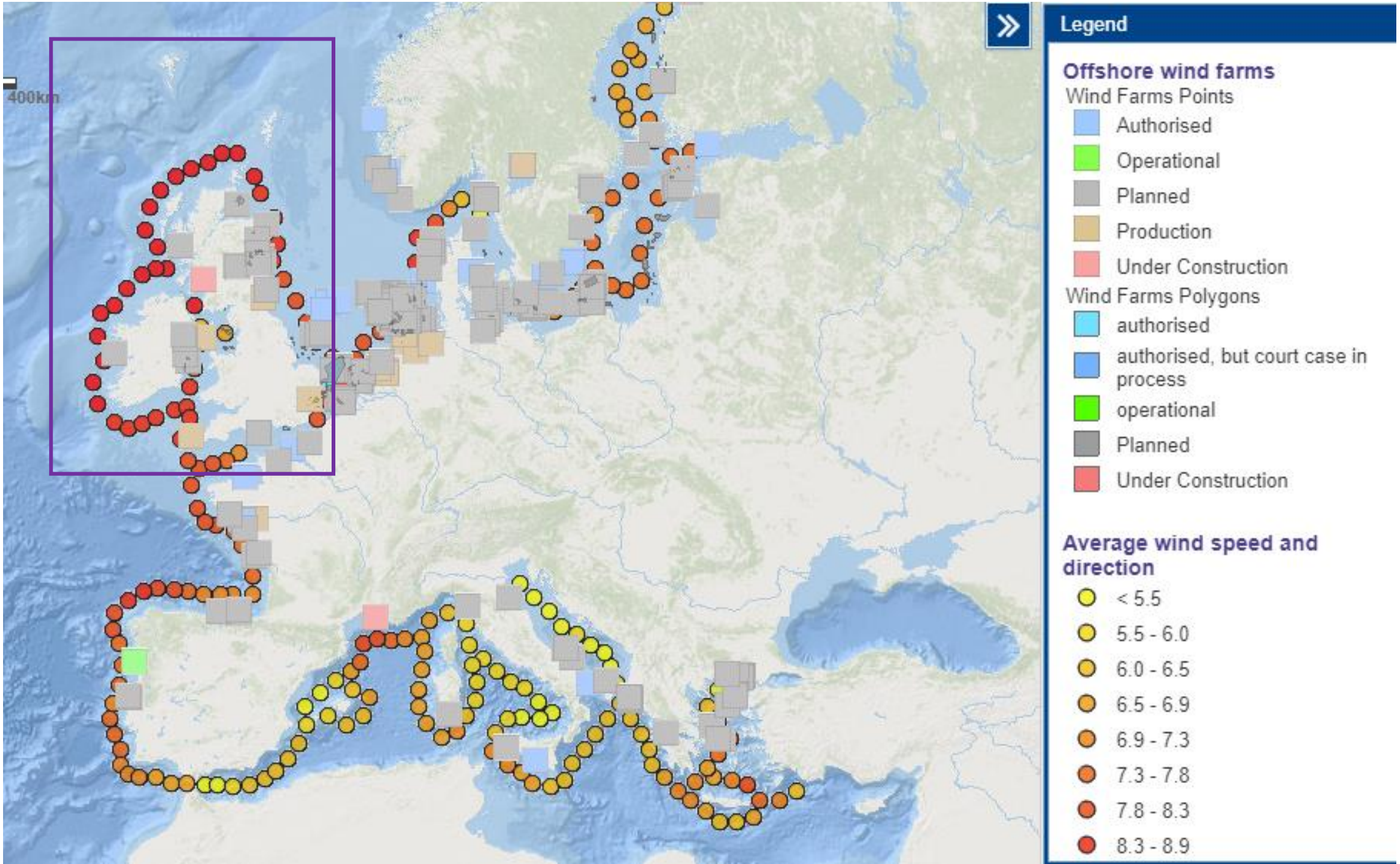
400km
Legend
Offshore wind farms
Wind Farms Points
Authorised
Operational
Planned
Production
Under Construction
Wind Farms Polygons
authorised
authorised, but court case in process
operational
Planned
Under Construction
Average wind speed and direction
< 5.5
5.5 - 6.0
6.0 - 6.5
6.5 - 6.9
6.9 - 7.3
7.3 - 7.8
7.8 - 8.3
8.3 - 8.9

Introduction (cont.)

Multi-level/Multi-objectives policies

Objectives (UK & Devolved):

- Jobs/Economic Development
- Transition to low-carbon electricity
- Energy Security

UK is the largest adopter of OSW

(40.8%, or 5.2GW in 2016)

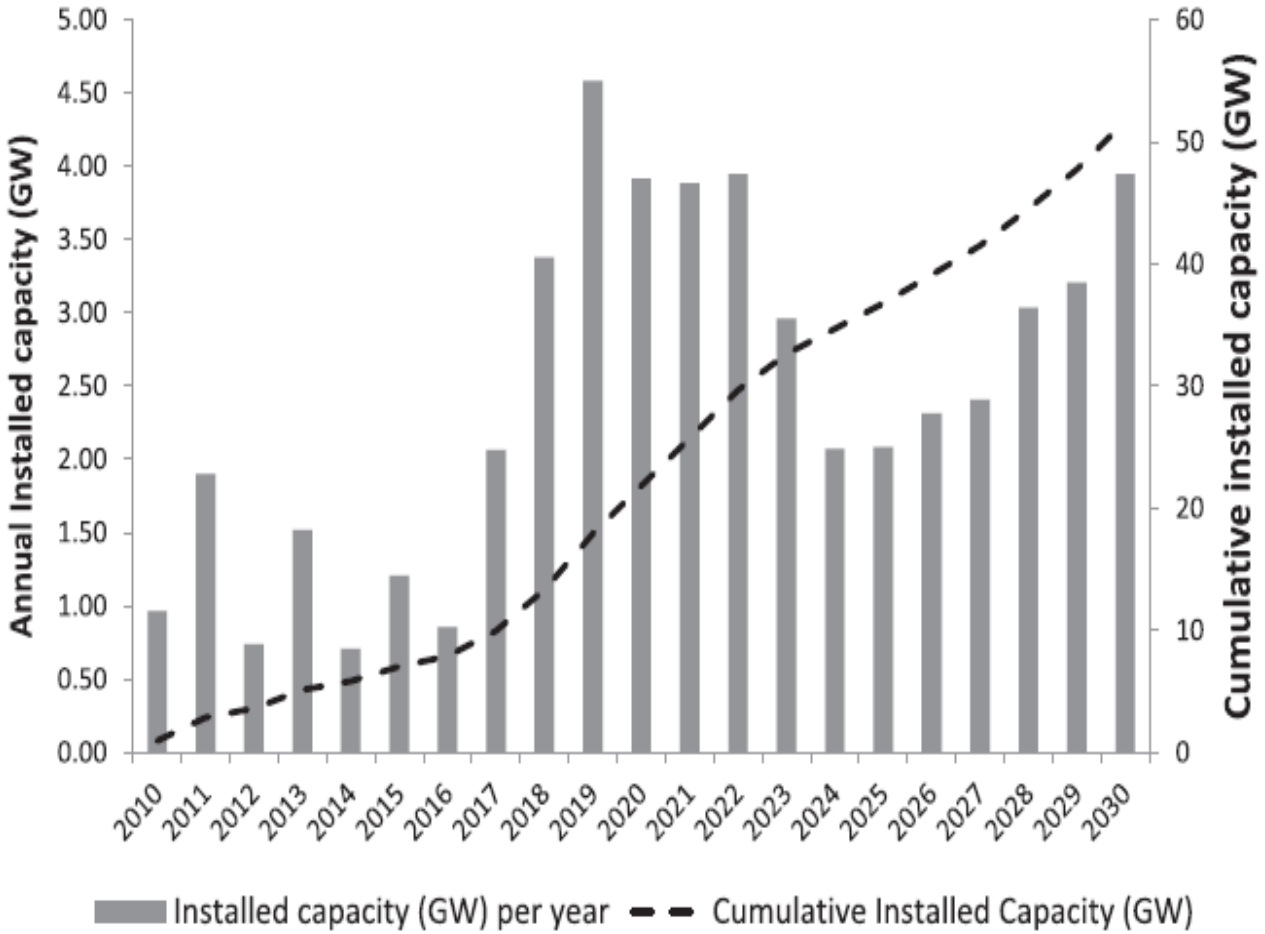

Fig. 1. Offshore Wind capacity projections in the UK (source: DECC, 2011 and 2013).

Introduction (cont.)

Multi-level/Multi-objectives policies

Levels: Nation & (or vs.) Devolved (e.g. Scotland)

- State structure still new.
- ‘Value’ of projects sometimes in contrast: Megalopolis paradigm.
- Industrial development requires infrastructure (in competition).

Courtesy of: Solarize

Introduction

Previous Studies have quantified economic impacts under various assumptions:

- *CEBR (2012)*: 40,000 FTEs by 2020, 60,000 by 2030 (use of sector-specific multipliers). Main assumption: EU will reckon UK authority over North Sea and will pay for electricity infrastructure to import UK-made power.

- *Lecca et al. (2017):* UKENVI-expanded – to achieve CEBR assumptions, costs need to fall significantly, reducing FTEs in the process.

- *Gilmartin and Allan (2015):* Large 'legacy' effects on Scottish economy, but results sensitive to local content assumptions.

Introduction

- **<u>Same overall message: local content and supply chain are the key assumptions</u>**
- <u>Issue 1</u>: How do we make assumptions on local content?
- <u>Issue 2</u>: If path-dependency is correct, what would happen if investors remembered (or foresaw) about past policy paths within a country?

<u>To paraphrase Hagerstrand: What about History in Regional Sciences?</u>

Courtesy of: Solarize

Objectives

1. Provide an overview of policy path of OSW in the UK and in other competing countries to inform a CGE model (UKENVI).

2. Model economic impacts informed by analysis under 2 scenarios UKENVI:

    1. *Contamination across sectors (OWP to OSW) in terms of local content.*
    2. *Anticipatory behaviour (or 'memory') of investors adjusting to historically unstable support towards renewables*

3. Formulate a few policy and modelling considerations.

Courtesy of: Solarize

Issue 1: local policies, local content

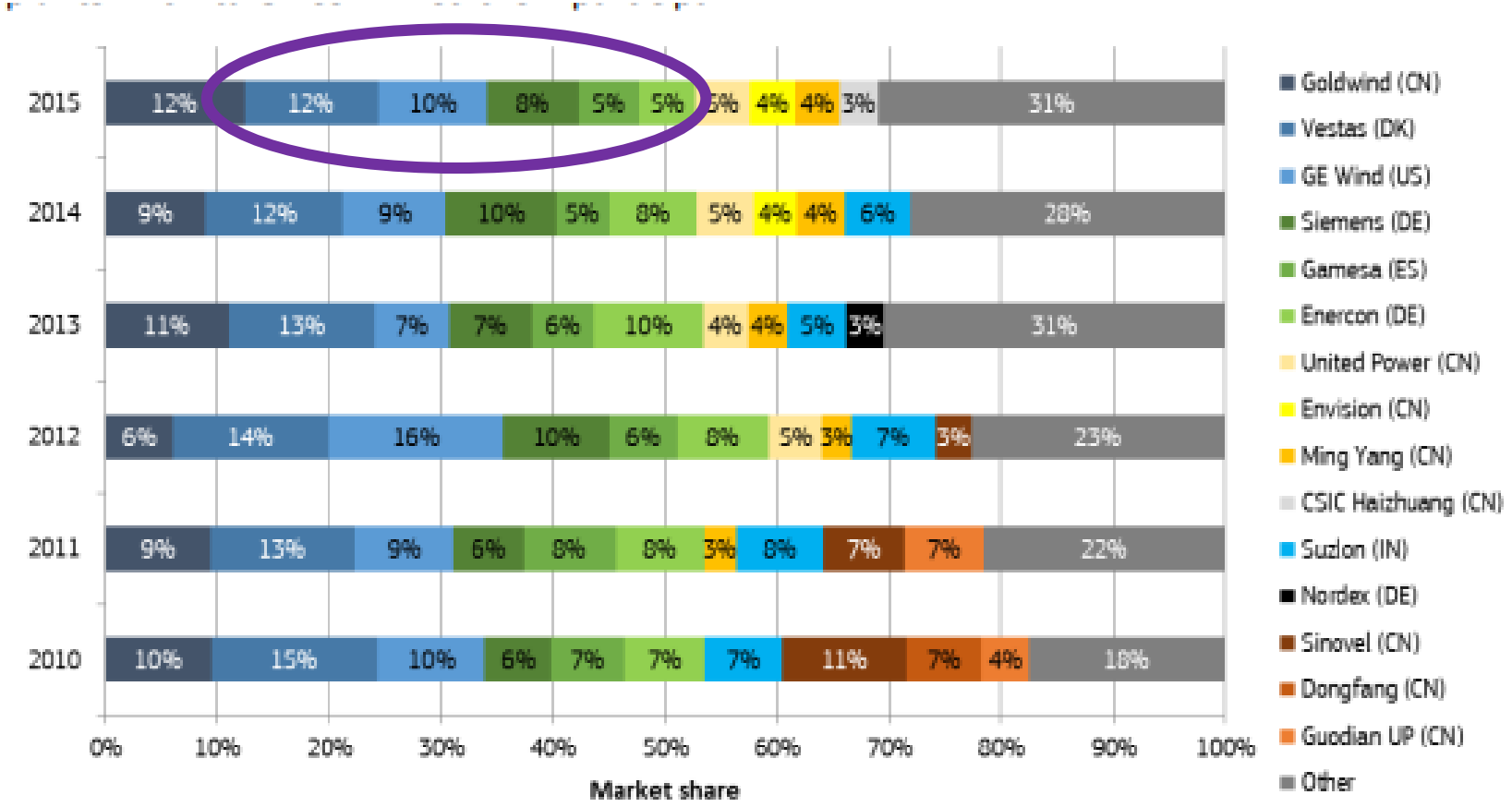

Figure 4 Evolution of the Top 10 turbine manufacturers 2010-2015
Source: BTM Consult for 2010-2014 and JRC data for 2015. Senvion, formerly called REpower, was part of the Suzlon group from 2010 to 2014 and it is therefore included as Suzlon during that period.

Issue 1: local policies, local content

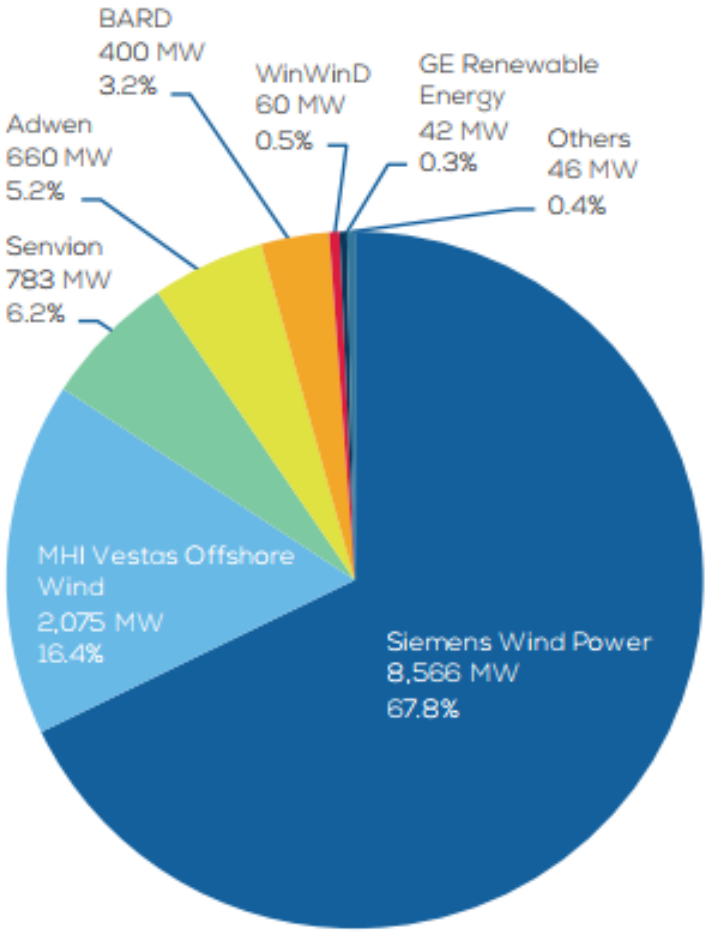

FIGURE 17
Wind turbine manufacturers' share at the end of 2016 (MW)

Siemens Wind Power is the leading offshore wind turbine supplier in Europe with 67.8% of total installed capacity.

MHI Vestas Offshore Wind (16.4%) is the second biggest turbine supplier, followed by Senvion (6.2%), Adwen (5.2%), and BARD (3.2%).

Source: WindEurope

Issue 2: path dependency

1970s
- Oil shock an initial OSW development
- Lost decade

1989-1998
- NFFO introduced to support nuclear
- Wind Power expands again (mainly D&D)

2002/10-2015
- ROCs support wind energy
- First true OSW expansion
- Additional support of FIT (2010)
- Community energy expands

2015-2017
- Contracts for difference in place: Round 1 & 2
- Prices 'per technology'
- Conflicts between devolved and central government
- BREXIT

- Changes in support schemes every 7/8 years.
- Support policies always directed to deployment, never towards supply chain.
- No local content requirement.
- Some support for R&D (diminishing in later years).
- Current uncertainty due to Brexit and CfDs (all price-based, not 'output based').

Other countries

Table 1
(Irena, 2013a, 2013b, 2013c, 2013d; BP, 2016).

	Strategy	Installed capacity (2014)	% of wind in total electricity consumption (2015)	National companies
DK	– Feed-in tariffs (1991) – constant R & D development (1970s onward) – export-oriented (US market) – social and political support	4778 MW (BP data)	42%	- Vestas
DE	– feed-in tariffs (1991) – constant R & D development (1970s onward) – export-oriented – strong social and political support after 1986 Chernobyl	40,500 MW (BP data)	12.9%	– Siemens – Enercon – Nordex – Senvion – E.on – Dong
ES	– feed-in tariff (1991) – Local Content Requirement on a local, not national level – promoted joint ventures with foreign companies (Vestas) – export-oriented policy from 2001 (Gamesa goes public) – social support	22,987 (BP data)	18.9%	- Gamesa
UK	– NFFO, then ROCs, Feed-in-Tariff only from 2013 - CfDs – no development of local industry for onshore wind; creation of the Offshore Renewable Energy Catapult for offshore wind, research centre (2013) – until recently no social support	12,808 (PB data)	11%	N/A

Other countries (cont.)

Hard-content/Extra market

Export-support

Soft-content

State ownership/golden share

UKENVI

- UKENVI model (details: Allan et al., 2007; Lecca et al., 2014 & 2017). Large numerical, GAMS-based CGE of UK economy, based on national SAMs.

- 25 macro-sectors of UK economy, of which 13 energy sectors. Distinction between transmission and generation of electricity.

- 2 trade links: Rest of European Union (REU) and Rest of World (ROW) where an Armington (1969) link determines the amount of imports and exports to and from the UK. Under this assumption, domestic and imported goods are imperfect substitutes and respond to changes in relative prices.

- Under myopic expectations, consumption is simply determined as a fixed share of current income while investments follow a simple adjustment rule, according to which the additional level of investment is determined by the gap between the desired level of capital and the actual level of capital.

Scenario 1: from OWP to OSW

- Cross-contamination between sectors (OWP to OSW).
- Use of DECC projections on CAPEX and OPEX to compensate for increased UK impact.
- ORE Catapult expenditure analysis provided link between CAPEX/OPEX and macro-sectors.
- Baseline: CAPEX 19% OPEX 76% local content.
- New Scenario: CAPEX to reach 68% local content at 4% increases between 2020-2030.
- The simulation performed is a combined temporary demand- (OPEX) and supply-side (CAPEX, as subsidies to investments) shocks.

Scenario 2: non-myopic investors

- The usual dynamic framework used implies that economic agents make decisions based on the present, abstracting for future events.
- What if the present is dictated by the past?
- Non-myopic agents seek now to maximize lifetime utility function (agents) or present value of cash-flow (firms).

Baseline

Fig. 3. The impact on GDP and employment.

Scenario 1: Results

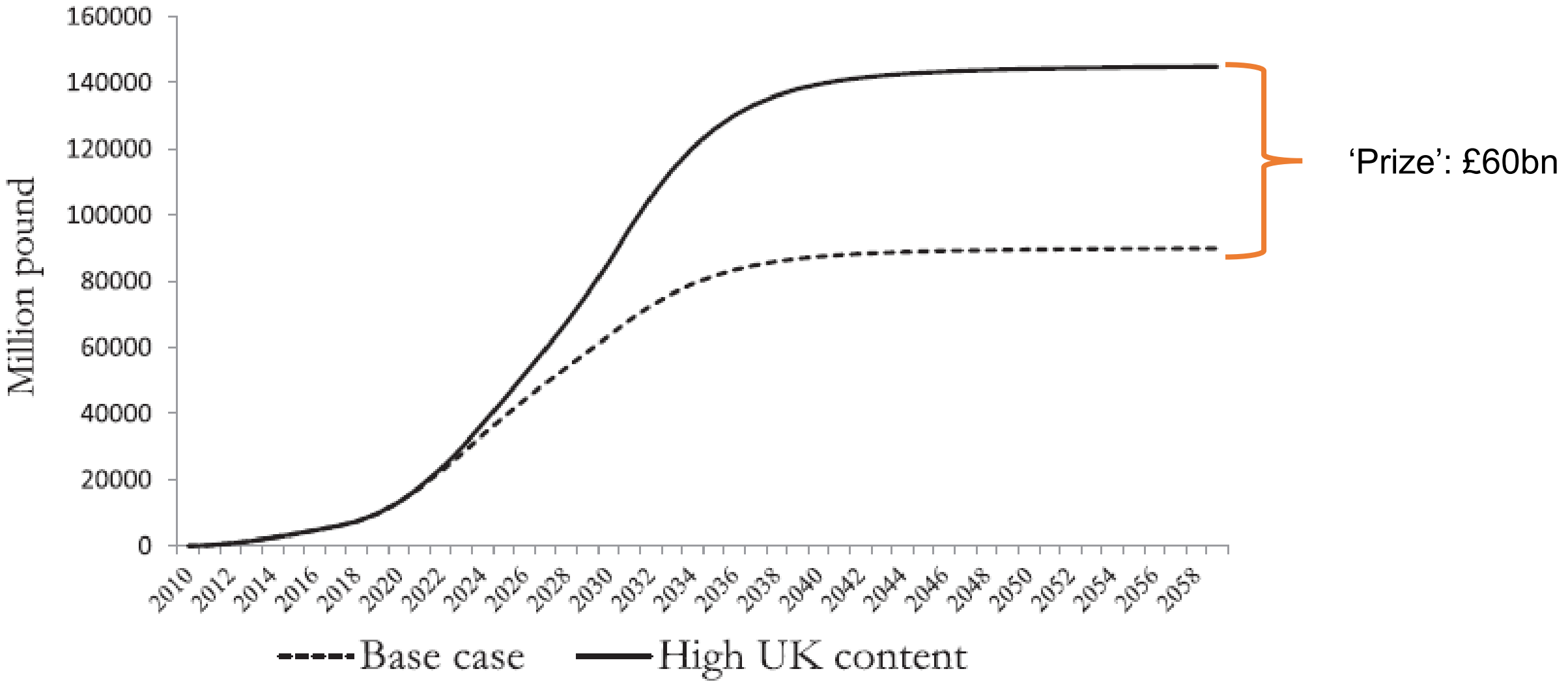

Fig. 6. GDP cumulative deviations from base year values, Millions under two different assumptions about UK content.

Scenario 2: Results

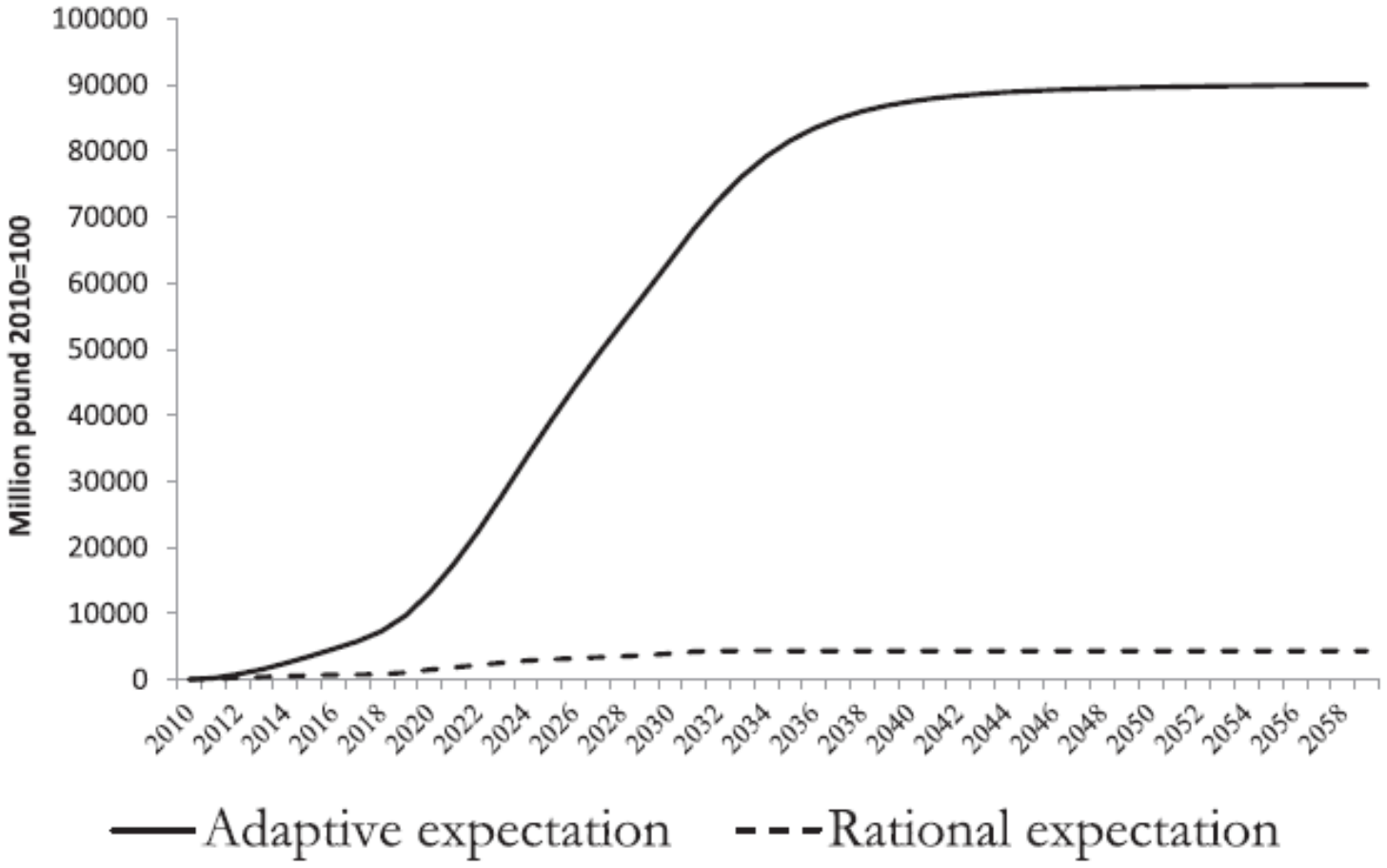

Fig. 7. Cumulative GDP under myopic and forward looking agents.

The ability to foresee uncertainty generates a sensible gap.

Subsidies supported by the CfDs scheme are remarkably important to facilitate investments in the OSW in particular, new low carbon generations in general.

Subsidies as ‘Peacemakers’, more so than actual financial enablers.

Conclusions

1. Uncertainty is the largest factor in diminishing the economic impact of OSW.

2. The ‘prize’ for nationalization is substantial (ca. $70bn over 10 years).

3. This prize is unlikely to be attained by 2020 due to the current policy climate, lack of institutional capacity, and lack of institutional resources in light of Brexit.

4. Linking economic, geopolitical and environmental policies might reduce uncertainty, thus unlocking greater benefits to the UK economy.

5. Methodologically, merging using a transdisciplinary Nexus generates more stable and realistic assumptions.

Q&A

Comments are welcome

Thank you!

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Marine Energy Research Innovation and Knowledge Accelerator

Marine Alliance for Science and Technology for Scotland

UKENVI

- UKENVI model (details: Allan et al., 2007; Lecca et al., 2014 & 2017).
- Large numerical, GAMS-based CGE of UK economy, based on national SAMs.

- Within each temporal period, the production and consumption structures are characterized by hierarchical Constant Elasticity of Substitution functions with Leontief and Cobb-Douglas as special cases.

- 25 macro-sectors of UK economy, of which 13 energy sectors.

- Distinction between transmission and generation of electricity.

- 2 trade links: Rest of European Union (REU) and Rest of World (ROW) where an Armington (1969) link determines the amount of imports and exports to and from the UK. Under this assumption, domestic and imported goods are imperfect substitutes and respond to changes in relative prices.

UKENVI

- Between periods, consumers and investors can alternatively adopt forward-looking or myopic expectations.
- Individuals optimise their lifetime utility function of consumption subject to a lifetime wealth.
- Household saving rate is exogenous in the model.
- Under myopic expectations, consumption is simply determined as a fixed share of current income while investments follow a simple adjustment rule, according to which the additional level of investment is determined by the gap between the desired level of capital and the actual level of capital.

UKENVI

- Fixed government consumption and no change in taxes & no natural population change in the model (ex casus) .
- Labour supply is fixed to base-year value. However, labour is mobile across sectors through a unified labour market.
- The type of wage setting installed in the model is represented by a long-run wage curve where the real wage is inversely related to the unemployment rate
- Equilibrium in the commodity markets is sufficient to guarantee equilibrium also in the payments account since we are not considering money as a commodity

Scenario 1: from OWP to OSW

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Scenario 2: non-myopic investors

- The usual dynamic framework used implies that economic agents make decisions based on the present, abstracting for future events.
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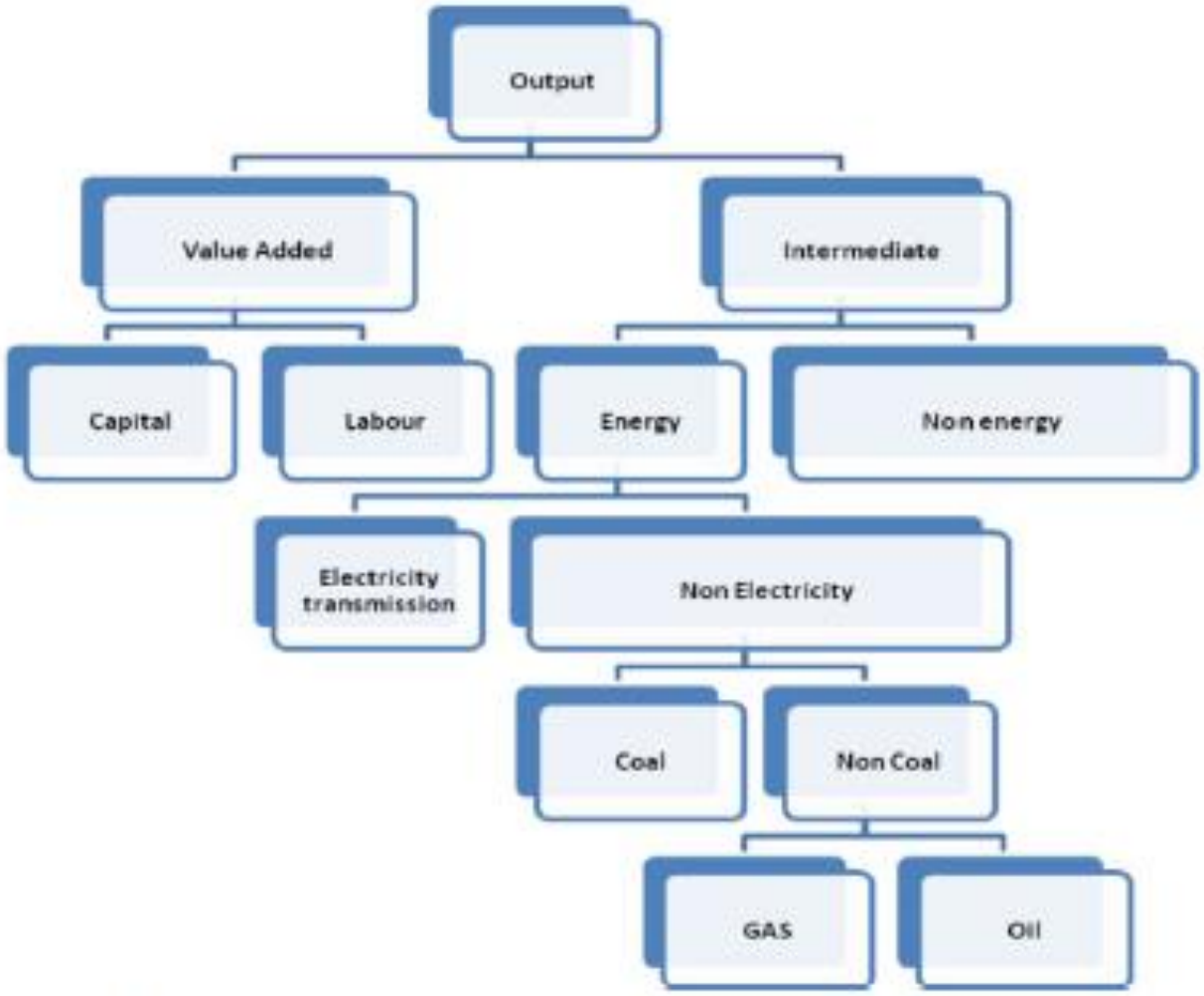

Fig. B1. General Production structure (except the electricity supply sector).

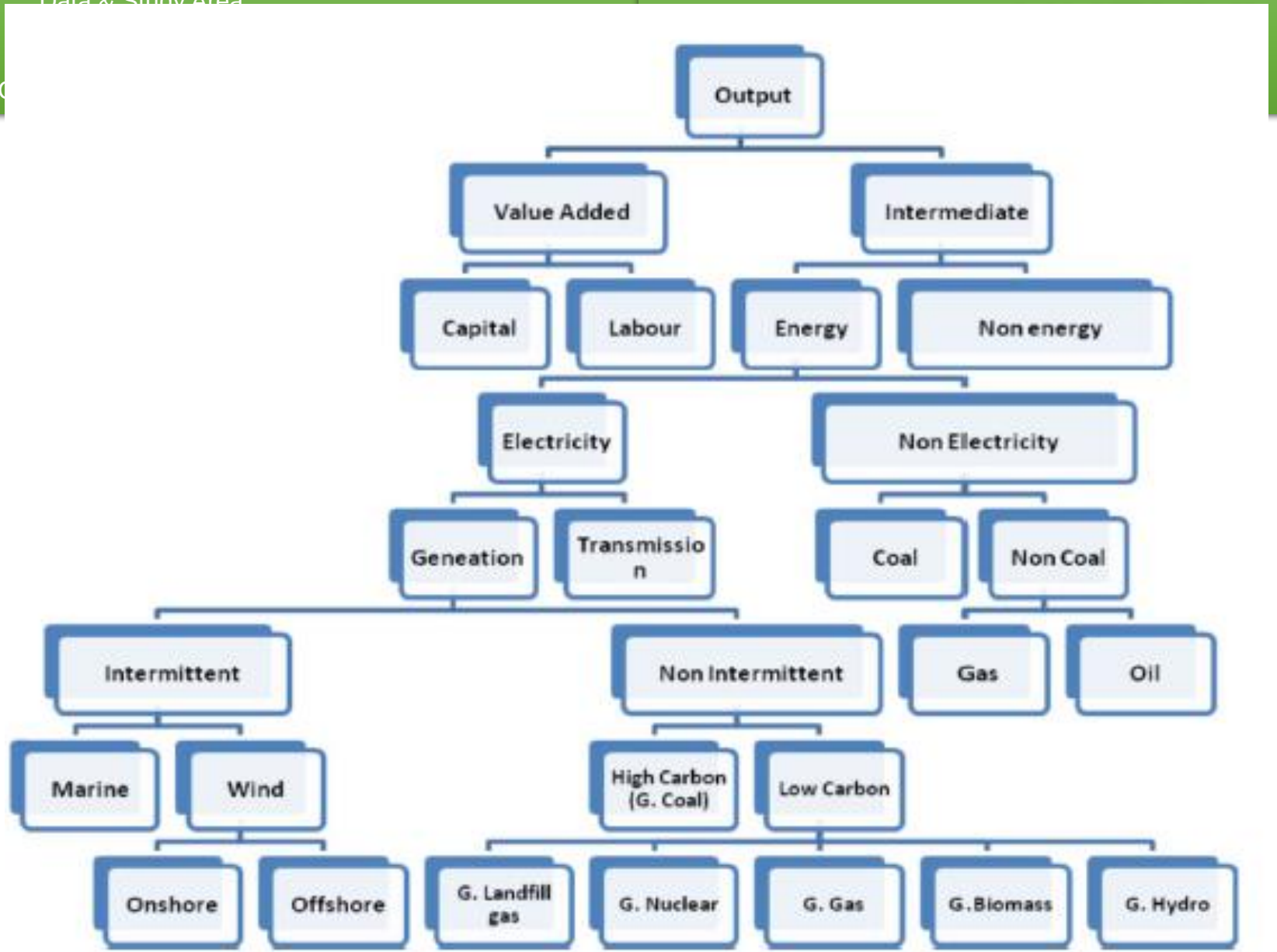

Fig. B2. Production structure for the electricity supply sector.

UKENVI

Table B1.
Sector decomposition of UKENVI.

25 sectors	Sector Title	123 sectors
1	Coal Mining and quarrying	4
2	Gas Mining and quarrying	5, 86
3	Coke ovens, refined petroleum and nuclear fuel	35
4	Other traded e.g. Food and drink	6–19, 21–31, 34, 36–38, 77–80
5	Pulp and Paper	32–33
6	Glass and Ceramics	49–50
7	Clay, cement, lime and plaster	51–52
8	Iron and Steel; non-ferrous metals	53–56
9	Generation - Coal	85
10	Generation -Gas + Oil	85
11	Electricity distribution and supply	85
12	Generation - Nuclear	85
13	Generation - Hydro	85
14	Generation - Biomass	85
15	Generation - Wind	85
16	Generation - Wind Offshore	85
17	Generation - Other	85
18	Generation - Marine/solar	85
19	Agriculture; Forestry and fishing	1–3
20	Water	87
21	Construction	88
22	Other Manufacturing and wholesale retail trade	20, 39–48, 57–76, 81–84, 89–92
23	Air Transport	96
24	Other Transport	93–95, 97–99
25	Services	100–123

UKENVI

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24	Other Transport	93–95, 97–99
25	Services	100–123

Table B2.
Elasticities of substitution in UKENVI model.

Selected calibrated shares	
Value added/total production	0.5
Capital/labour ratio	0.6
Investment/GDP ratio	0.1
Export/GDP ratio	0.3
Import/GDP ratio	0.3
Depreciation rate	0.15
Interest rate	0.04
Elasticities of substitution in production	
Intermediate-Value Added	0.3
Energy and non-energy	2.0
Electricity and non-electricity	2.0
Oil and non-oil	2.0
Low and high carbon	5.0
Transmission and generation	0.3
Intermittent and non-intermittent	5.0
Between non-intermittent	5.0
Wind and marine	5.0
On and off shore wind	5.0
Between non-energy	0.3
Trade elasticities	2.0
Elasticities in consumption	0.3
Constant elasticity of marginal utility	1.2

Baseline

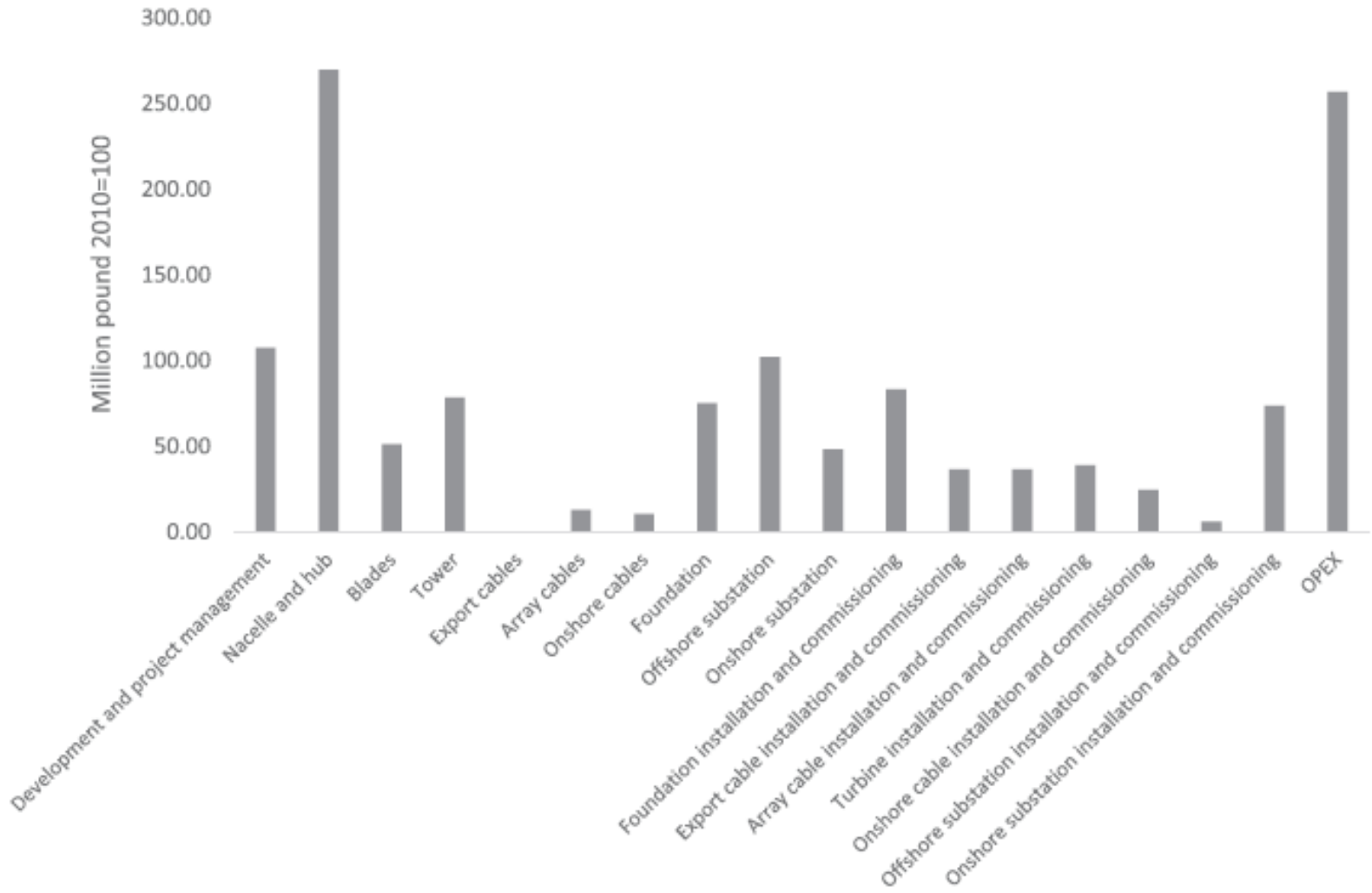

Fig. 2. Costs by category of expenditures, annual average 2010–2030.

Baseline

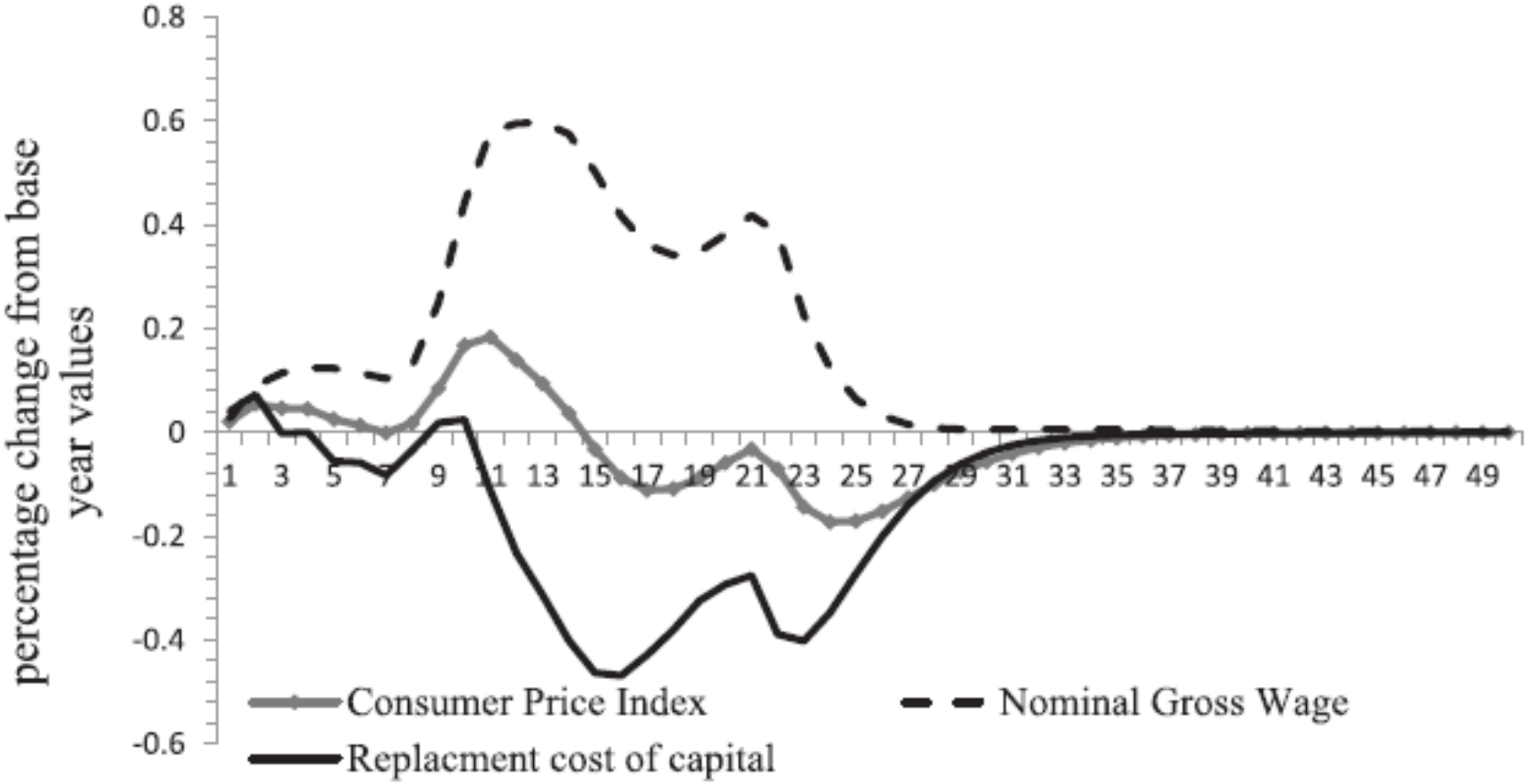

Fig. 4. The behaviour of selected prices.