Lessons from the UK's experience with renewables support

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Plan

- The UK' s renewables targets
- The Renewables Obligation (RO)
- Solar Experience
- Overall Costs of renewables (RES) support
- Contract for Difference (CfD) auctions
- Network regulation and distributed generation (DG)
- Innovation funding and DG integration

UK Renewables Targets

- UK committed to 15% target for renewables contribution to total final energy consumption in 2020 (2009/28/EC) (10.2% in 2017).
- Currently support regime only envisages 15.4% renewables in electricity by 2015-16. (27.9% in 2017)
- 2010 target of 10% for electricity from renewables (2001/77/EC). 7.3% was achieved.
- Clearly, targets are challenging but good progress in electricity…

Potential for Renewables in UK

Technology Category	Technology Detail	Annual Potential
Wind power	Onshore	50 TWh
	Offshore	100 TWh
Bioenergy	Biomass	41 TWh
Geothermal	Ground source heat pumps	8 TWh
Hydro	Large scale	5 TWh
	Small scale	10 TWh
PV	Retro fitted and Building integrated	>1 TWh
Marine	Wave energy	33 TWh
	Tidal barrage	50 TWh
	Tidal stream	18 TWh
Total		**~316 TWh**

Source: Jamasb et al., 2008. UK Generation 2017 = 336 TWh

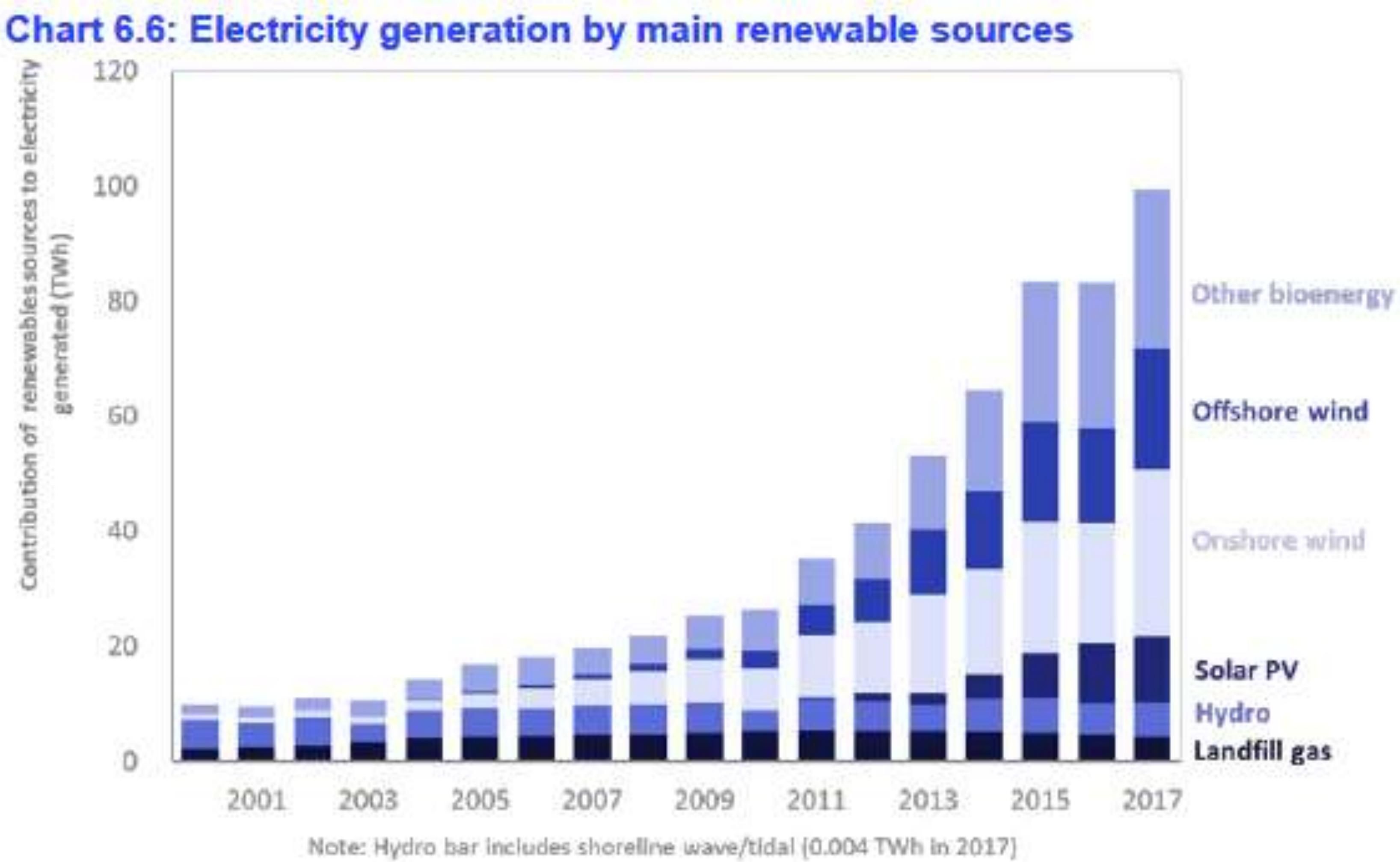
Cost of Specific Technologies in UK in 2013

- Onshore wind: 7.5-11.5 p / kWh
- Offshore wind: 13.1-20.8 p / kWh
- Domestic PV 19.2-30.5 p / kWh
- Biomass 10.6-11.7 p / kWh
- A Digestion 9.5 – 31.4p / kWh
- Large scale PV 11.4-13.1 p / kWh

- Memo: CCGT c.6.8p / kWh (inc. CO_2 price i.e. EUETS+CPS)

Sources: DECC (2013)
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_24_07_13.pdf

The UK renewable electricity transition…



Source: DUKES 2018, p.160.

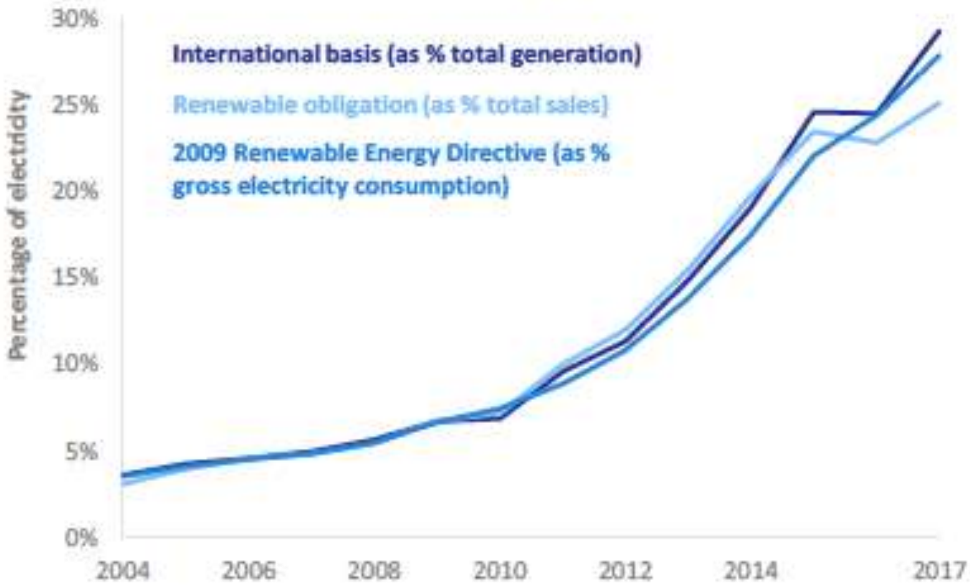
The UK renewable electricity transition…

Table 6D: Percentages of electricity derived from renewable sources

	2004	2010	2015	2016	2017
International Basis[1]	3.6%	6.9%	24.6%	24.5%	29.3%
Renewable Obligation[2]	3.1%	7.2%	23.5%	22.8%	25.1%
2009 Renewable Energy Directive[3]	3.5%	7.4%	22.1%	24.4%	27.9%

[1] All renewable electricity as a percentage of total UK electricity generation
[2] Measured as a percentage of UK electricity sales
[3] 2009 Renewable Energy Directive measured as a percentage of gross electricity consumption

Chart 6.8: Growth in electricity generation from renewable sources since 2004



Source: DUKES 2018, p.167.

UK experience with TGCs: RO Scheme

(see Pollitt, 2010)

- From April 2002
- Tradable Green Certificate (TGC) Scheme
- Annual targets for renewable generation for suppliers
- Must supply specified quantity of credits or face buyout payment
- Renewable generators receive price of RO certificate *plus* their share of buyout revenue.

Renewables share: UK Renewables Obligation

	Target renewable share in GB	% Delivery in UK	Nominal Buyout Price £/MWh	Total Cost £m
2002-03	3.0	59%	30.00	282.0
2003-04	4.3	56%	30.51	415.8
2004-05	4.9	69%	31.59	497.9
2005-06	5.5	76%	32.33	583.0
2006-07	6.7	68%	33.24	719.0
2007-08	7.9	64%	34.30	876.4
2008-09	9.1	65%	35.36	1036.2
2009-10	9.7	71%	37.19	1108.6
2010-11	10.4	72%	36.99	1285.4
2011-12	11.4	91%	38.69	1457.7
2012-13	12.4	92%	40.71	1991.3
2013-14	13.4	98%	42.02	2599.3
2014-15	14.4	99%	43.30	3114.2
2015-16	15.4	100%	44.33	3741.4

Total electricity expenditure in 2016 = £34.6bn

Note: Original renewable share targets shown, changed in 2009-10 to reflect banding.

RO Scheme

- Suppliers/retailers must present ROCs
- Renewable generators must be registered on the Renewables and CHP register at Ofgem to be awarded ROCs

https://www.renewablesandchp.ofgem.gov.uk/Public/ReportManager.aspx?ReportVisibility=1&ReportCategory=0

- 2014-15:
  - 71.3 million ROCs presented for 1MWh each
  - 99.1% of the total obligation.
  - Administratively set buy out price £43.30
  - The buyout revenue is recycled to suppliers of ROCs

- Each ROC was worth £43.65 (recycle value was £0.35 plus £43.30 buy-out price).

See: https://www.ofgem.gov.uk/environmental-programmes/renewables-obligation-ro

Rebanding of ROCs 1 April 09

Generation type	ROCs per MegaWatt hour
Landfill Gas	0.25
Sewage gas Co-firing of biomass	0.5
Onshore wind Hydro Co-firing of energy crops Energy from waste with CHP Co-firing of biomass with CHP Geopressure Standard gasification Standard pyrolysis	1
Offshore wind Biomass Co-firing of energy crops with CHP	1.5
Wave Tidal stream Advanced gasification Advanced pyrolysis Anaerobic digestion Energy crops Biomass with CHP Energy crops with CHP Solar photovoltaic Geothermal Tidal impoundment – tidal barrage Tidal impoundment – tidal lagoon	2

Offshore wind re-banded to 2 until 2014-15

Further re-banding has taken place since. See http://webarchive.nationalarchives.gov.uk/20121217150421/http://www.decc.gov.uk/en/content/cms/news/pn12_086/pn12_086.aspx

Current ROC bands: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/211292/ro_banding_levels_2013_17.pdf

Assessment of UK RES experience

- RO scheme unnecessarily expensive
- Unsolved problem is on-shore wind
- One analysis of 51 proposals (Toke, 2005a):
  - If planning officer objects than almost always refused.
  - If Campaign for Protection of Rural England (CPRE) object then local Parish council almost always rejects.
  - Wind Prospect achieve better local engagement.

Assessment of UK RES experience

- Local ownership of energy under-exploited (Szarka, 06)
- Issue of willingness to pay for off-shoring (Bergmann et al, 08)
- Planning reform only helps larger projects (>50 MW onshore (only 22, as of May 2013)
- Zoning (experience of Wales in 2005, Cowell, 07)
- Little evidence of transmission constraints
  - GB queue 13.2 GW in 2008
  - Ofgem only found 450 MW could be speeded up

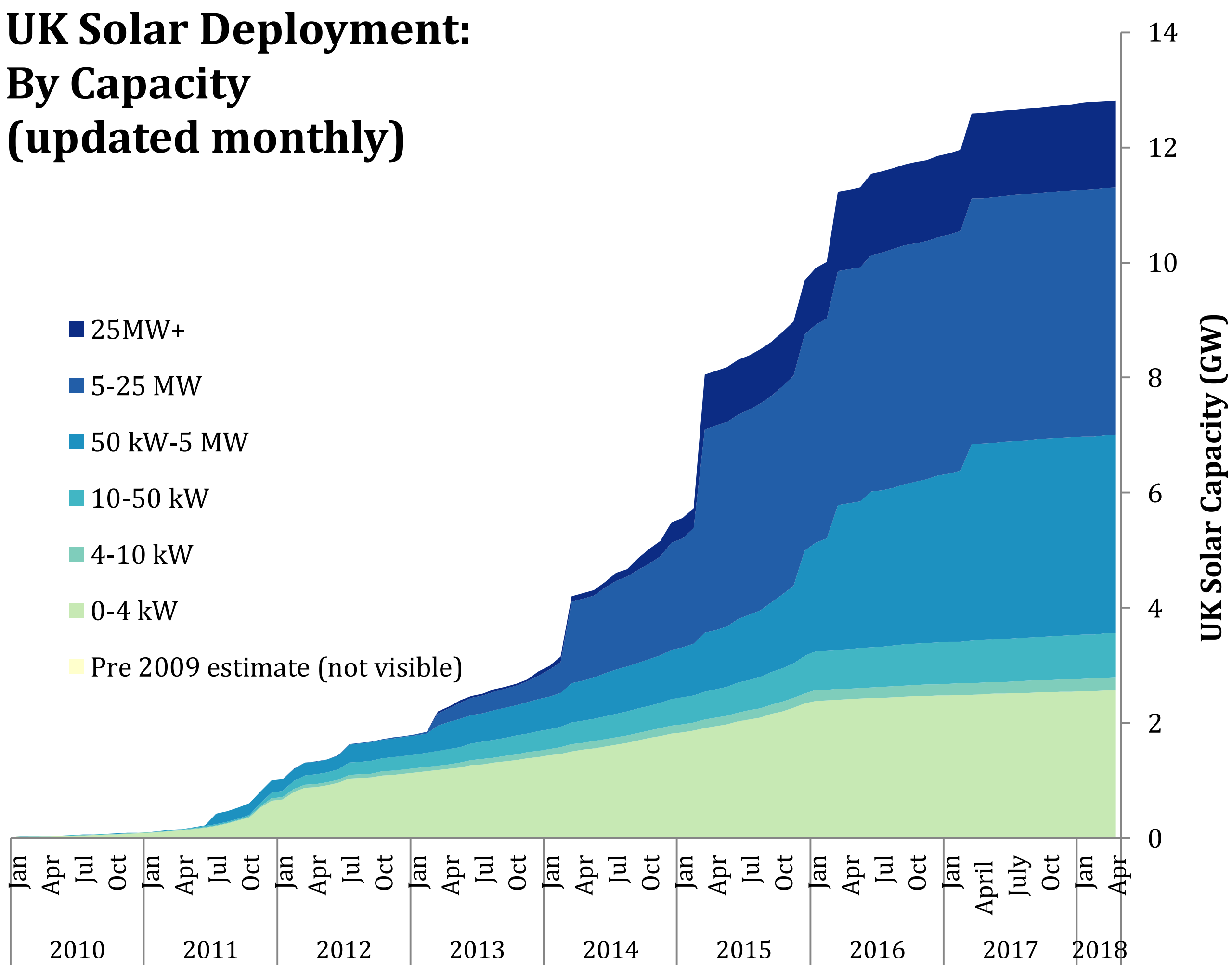
FITs: Solar in the UK!?

- The UK does have FITs for small generators, see:

https://www.ofgem.gov.uk/environmental-programmes/fit/fit-tariff-rates

- Very generous solar FIT introduced in April 2010 at 41.3p / kWh.
- Price of panels fell sharply on the world market making investment very profitable.
- Huge growth in solar PV installations through 2011.
- 1 GW of solar installed very quickly….
- Feed-in-Tariff halved at short notice (towards the end of 2011)…but challenged.
- Now 946,000 small (<50kW) installations and 3.6 GW (June 2018) with 12.8 GW total, up from 50 MW in 2010.

Solar in the UK!

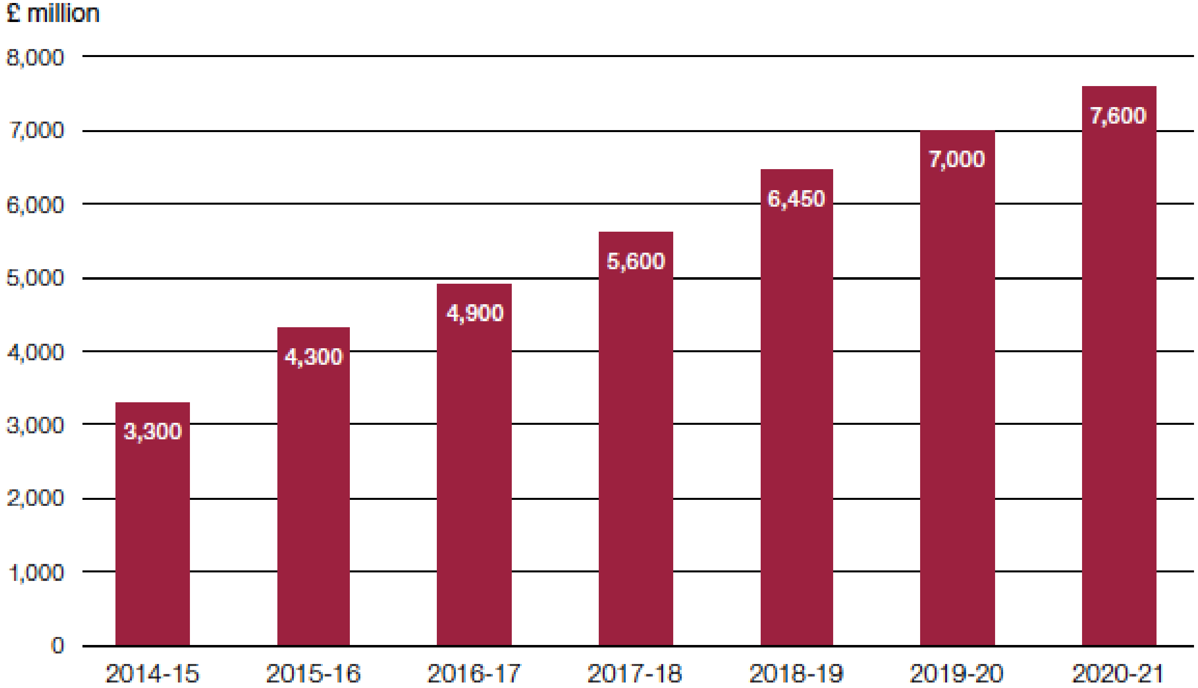


Source: https://www.gov.uk/government/statistics/solar-photovoltaics-deployment

The transition is costly…Official targets…

Figure 3

Levy Control Framework caps for electricity policies rise to 2020-21



Notes

1 The Department has published Framework caps to 2020-21 in 2011-12 prices.

2 The Department publishes Framework caps in nominal terms at the time of the relevant spending review or spending round. It has, however, estimated that the cap in 2020-21 will be £9.8 billion in nominal terms (i.e. 2020-21 prices).

Source: Department of Energy & Climate Change

Total annual expenditure on Electricity is c.£35bn.

Included:
FIT, ROCs, CfDs,
Warm Homes Discount.

Main demand measures Excluded.

July 2015 OBR projections suggest Overspend of £1500m in 2020-21.

Exceeding cap in 2014-15 but below 20% headroom.
Source: The Levy Control Framework, NAO 2013, p.16.

UK renewables policy very expensive

TABLE 7: THE CCC'S ESTIMATES OF LCF COSTS

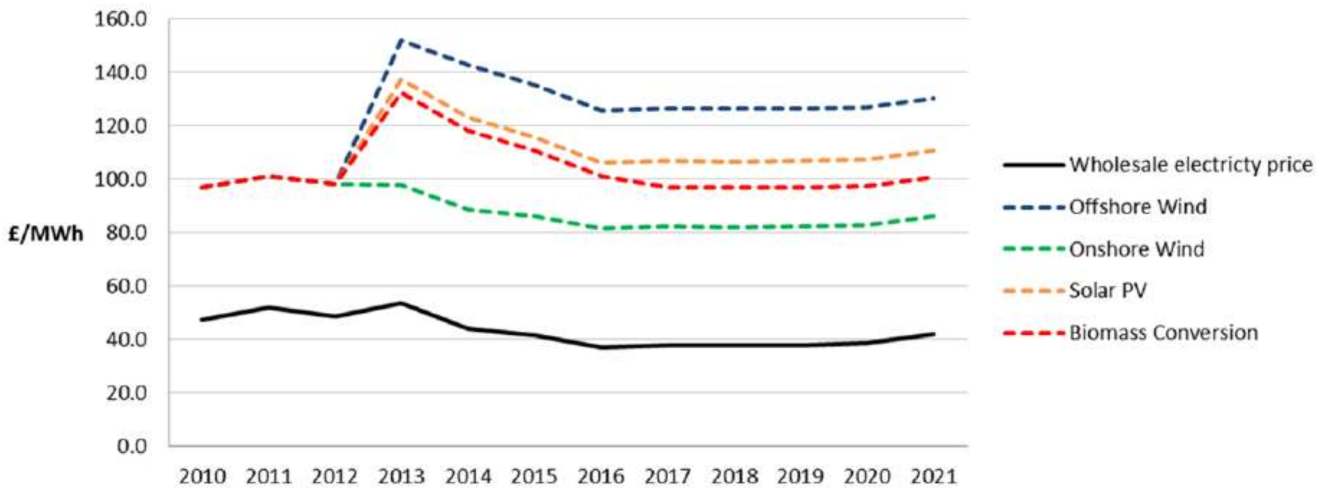
£ million	2016	2020	2030
Committed renewables to 2020	**5,511**	**8,832**	**7,298**
Small-scale FiTs (eg, rooftop solar)	1,123	1,207	1,207
Renewables Obligation	4,017	5,395	4,483
First CfD auction round	1	511	301
FIDeR CfD projects	370	1,719	1,307
Announced low-carbon projects beyond 2020			**1282**
September 2017 offshore wind auctions			307
Further funding announced for offshore wind			465
Hinkley Point C			510
Additional low-carbon generation in CCC's Fifth Carbon Budget scenarios			**864**
Offshore wind			317
CCS			797
Hinkley			0
Mature renewables (onshore, solar)			–559
Marine			310
Low Carbon Contracts Company (LCCC) administration costs		17	17
Total LCF costs	**5511**	**8849**	**9461**
% of total that is already committed	100%	100%	91%
% of total that is required for Fifth Carbon Budget	0%	0%	9%

Source: CCC.

Source: LCF = levy control framework
Helm (2017, p.56), Memo total electricity expenditure in 2016 = £34.6bn.

RO very generous

FIGURE 31: WHOLESALE PRICES VS RO SUPPORT



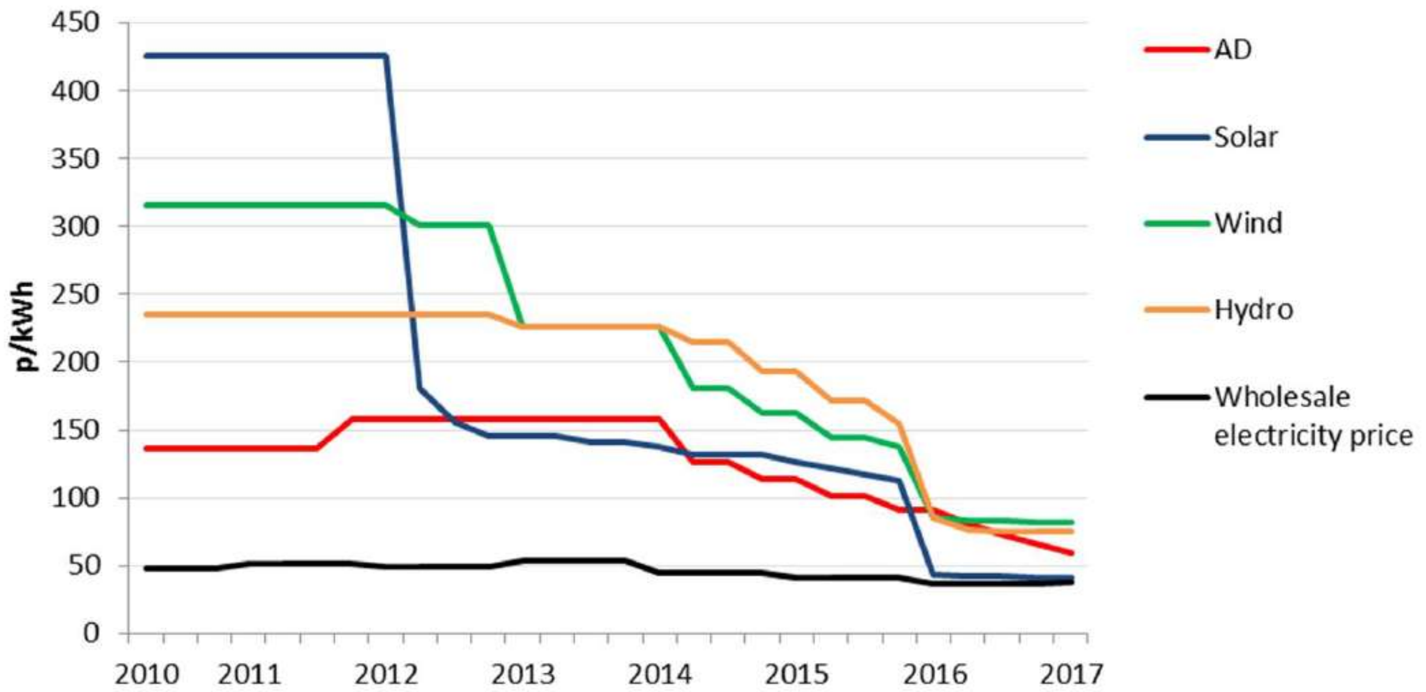
Sources: BEIS, from the support rates calculated using 2016/17 buy-out price and banding from Ofgem website: https://www.ofgem.gov.uk/publications-and-updates/renewables-obligation-ro-buy-out-price-and-mutualisation-ceilings-2017-18 and https://www.ofgem.gov.uk/system/files/docs/2017/03/ro_guidance_for_generators-130317.pdf; BEIS (2017), Energy and emissions projections 2016.

Notes: Support rates in 2016/17 prices; wholesale electricity prices in 2016 prices; support rates include the average wholesale electricity price (ie, they are not additional to the wholesale price).

Source: Helm (2017, p.100).

Small scale FIT payments initially very generous

FIGURE 32: WHOLESALE PRICES VS SSFIT GENERATION TARIFFS

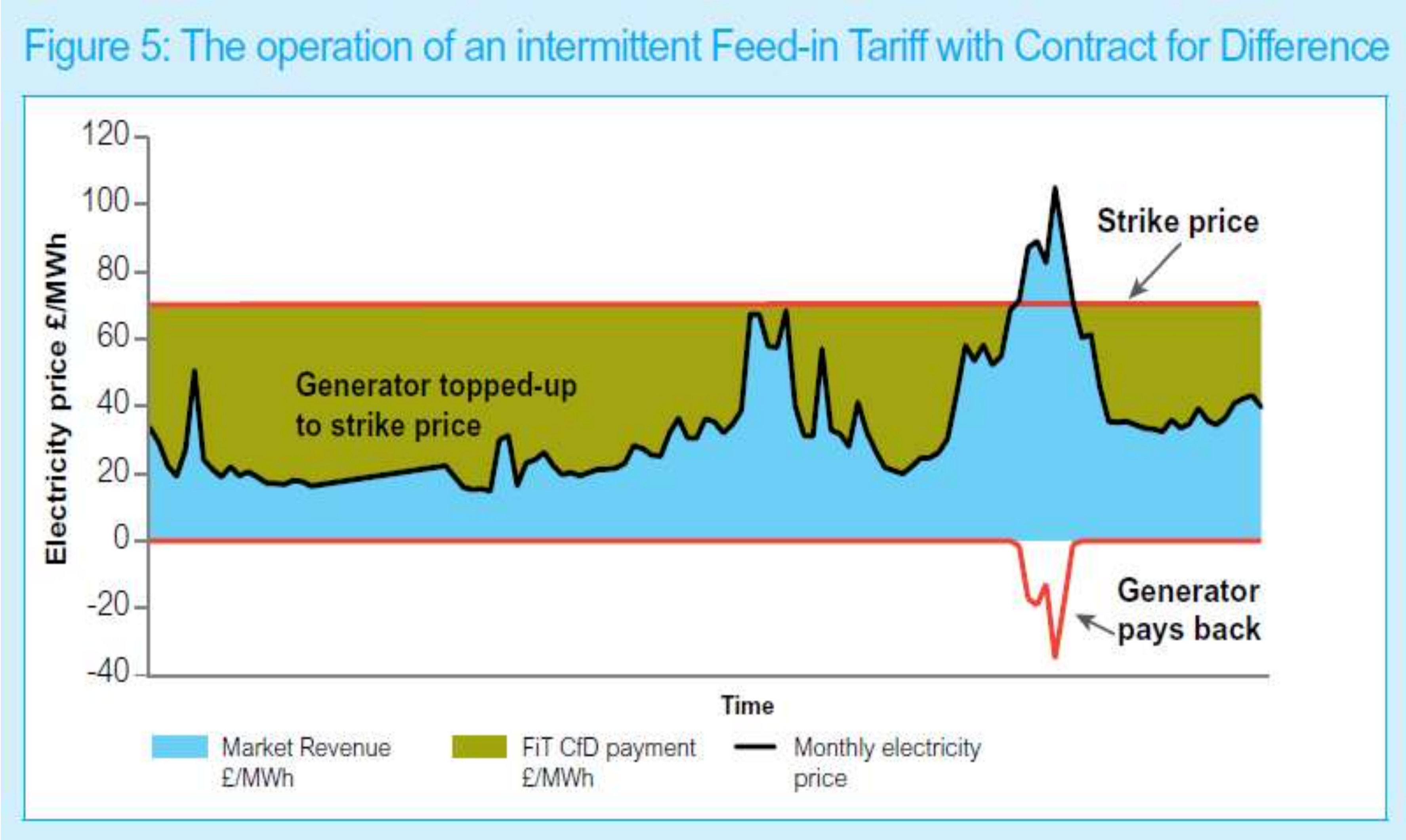


Sources: BEIS, from Ofgem tariff tables (2015/16 prices) and representative tariff bands; BEIS (2017), Energy and emissions projections 2016.

Notes: Tariffs in 2015/16 prices; Wholesale electricity prices in 2016 prices.

Source: Helm (2017, p.101).

A new funding mechanism: CfD-FIT



Source: DECC (2011), *Planning our electric future: a White Paper for secure, affordable and low-carbon Electricity, p.38.*

CFD auctions delivering big cost reductions for future

TABLE 12: SUMMARY OF AUCTION RESULTS: ALLOCATION ROUND 1

Maximum % Saving on Admin Strike Price for each technology as result of competition

Technology	Admin Strike Price (£/MWh)	Lowest Clearing Price (£/MWh)	Maximum % Saving on Admin Strike Price
Solar PV	120	50	58%
Onshore Wind	95	79.23	17%
EfW CHP	80	80	0%
Offshore Wind	140	114.39	18%
ACT	140	114.39	18%

NOTE - Given there are a number of different admin SP and clearing prices for each technologies, the above numbers are based on the maximum difference between clearing and admin SP

Source: BEIS, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407465/Breakdown_information_on_CFD_auctions.pdf.

Note: One solar contract has subsequently been terminated.

TABLE 13: SUMMARY OF AUCTION RESULTS: ALLOCATION ROUND 2

(E) % Saving on Administrative Strike Price for each technology as result of competition (2012 prices).

Technology	2021/22 Administrative Strike Price £/MWh	Clearing Price £/MWh	% saving
Advanced Conversion Technologies	125.00	74.75	40%
Dedicated Biomass with CHP	115.00	74.75	35%
Offshore Wind	105.00	74.75	29%

Technology	2022/23 Administrative Strike Price £/MWh	Clearing Price £/MWh	% saving
Advanced Conversion Technologies	115.00	40.00	65%
Dedicated Biomass with CHP	115.00	N/A	N/A
Offshore Wind	100.00	57.50	43%

Source: BEIS, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/643560/CFD_allocation_round_2_outcome_FINAL.pdf.

Auctions in Feb 2015 and Aug 2017.
Source: Helm (2017, p.104-5)

Renewables and the network

- Renewables do impose the need for more back up generation capacity. 1 GW of wind may be worth less than 0.1 GW of equivalent fossil generation in terms of guaranteed output.
- They can impose local transmission and distribution constraints.
- The cost of renewables should include these extra costs and it may be necessary to constrain renewables off the system at certain peak times.
- This requires an subsidy regime which does not incentivise generation no matter what – this might give negative power prices and be very electrically destabilising.
- Technically, integration of very high percentages of renewables difficult…

Extra Cost of Renewables to UK System

- What are extra costs of intermittency, at say 30%, energy vs CCGT?

- Reserve costs (perhaps £5 / MWh)
- Extra capacity costs (£4-7 / MWh for wind)
- Transmission and distribution system costs (£5-20 / MWh)
- System inertia
- Curtailment
- Reduced thermal efficiency

- Difficult to calculate due to double counting…

Source: Heptonstall et al. (2017). http://www.ukerc.ac.uk/programmes/technology-and-policy-assessment/the-costs-and-impacts-of-intermittency-ii.html

DG within RIIO

- Low carbon networks fund (LCNF) / Network Innovation Competition has supported DG innovation.
- Distributed Generation (DG) pays semi-shallow connection charges and use of system charges.
- Connection is competitive.
- Use of system charges are part of regulated revenue, so more DG does reduce demand charges.
- DG covered by incentive on connections engagement (maximum exposure c.-1%).
- No DG volume incentive.

Promoting Innovation towards renewables: UK's LCNF

- Setting up of 'Future Networks' units
- Collaborative Tier 2 projects, incl. suppliers, academics, OEMs and software solutions provider.
- For example (see Anaya and Pollitt, 2015a, b, c):

Flexible Plug and Play

Project Closed End date: December 2014 **Total funding:** £9.7 million **Funding from LCNF:** £6.7 million **Funding From UK Power Networks:** £2 million **Funding from project partners:** £1 million

- Showed net benefits of an interruptible connection for distributed generation (DG) of up to £1m per MW.
- Now a business as usual offer to new DG wishing to connect to UKPN distribution network.

ALSTOM
vodafone
FUNDAMENTALS
GE
DNV·GL
Imperial College London
IET The Institution of Engineering and Technology
Silver Spring NETWORKS
smarter grid solutions
UK Power Networks Delivering your electricity
UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group
WILSON TRANSFORMER

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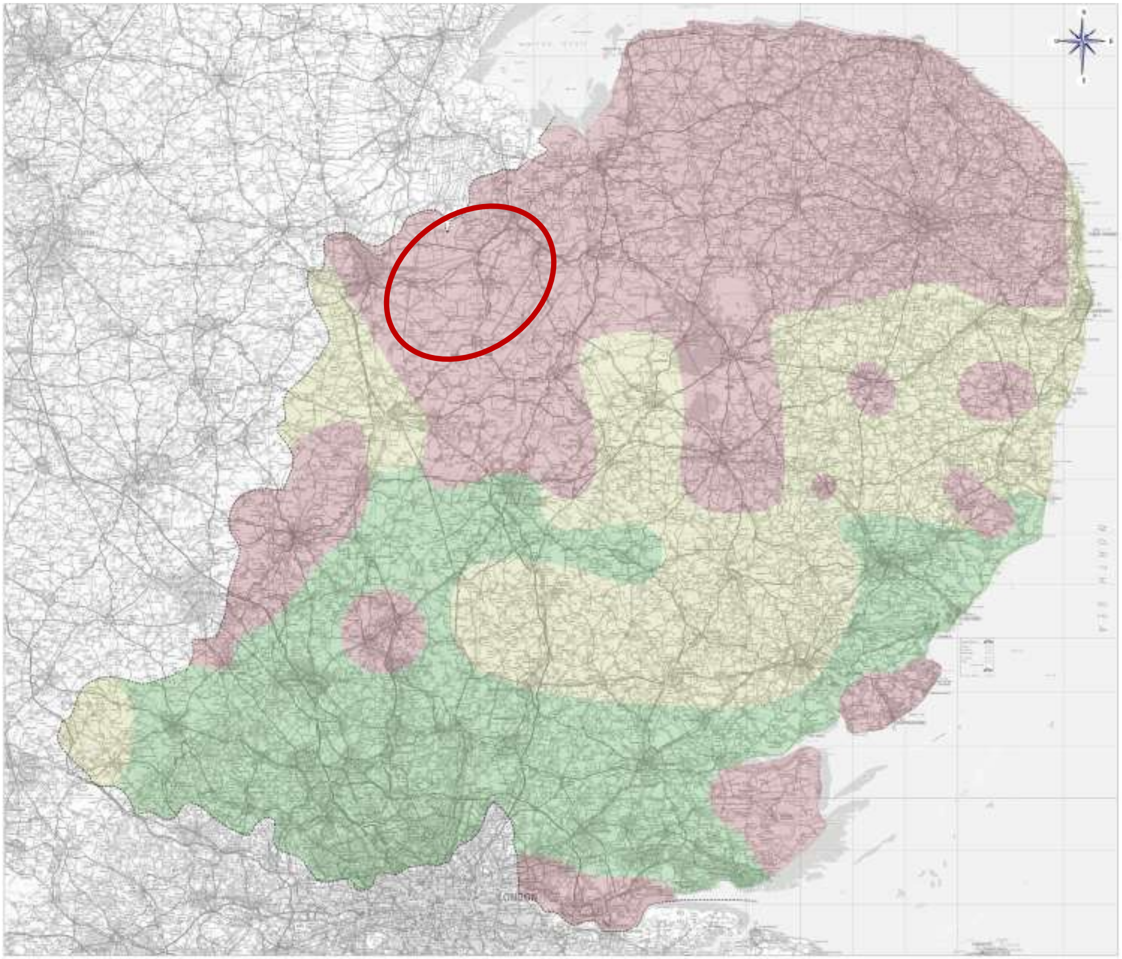
ALSTOM | vodafone | FUNDAMENTALS | GE | DNV·GL | Imperial College London | IET The Institution of Engineering and Technology | Silver Spring Networks | smarter grid solutions | UK Power Networks Delivering your electricity | University of Cambridge Electricity Policy Research Group | WILSON Transformer

Cost Benefit Analysis of Smart Connection : The case of UK Power Networks - FPP Project

Figure 4: Heat Map of East Anglia



Courtesy of UK Power Networks

Constraints (33 and 11kV):

(1) Reverse power flow limitations
(2) Thermal line limits

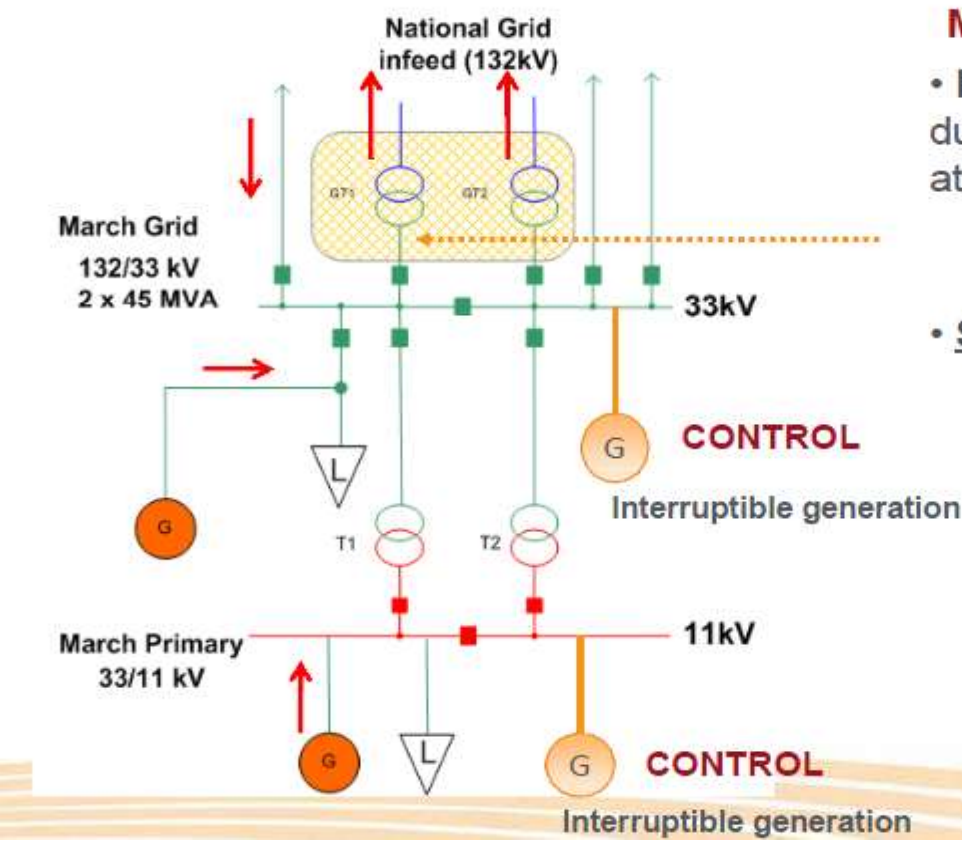
700 sq. km Trial Area circled in red.

Connection offers for smart connection with Pro Rata curtailment, with maximum quota.

- Highly utilised
- Capacity available
- Significant capacity available

Pricing network access to cope with DG

Figure 5: Reverse Power Flow Problem



MEASURE

- **Reverse power flow limitation** (N-1) due to legacy protection – currently set at 75% rating of the transformer

- Solutions:
  - ✓ Novel protection scheme
  - ✓ **Active Network Management**
  - ✓ IP Communications
  - ✓ Suitable **commercial & contractual framework**

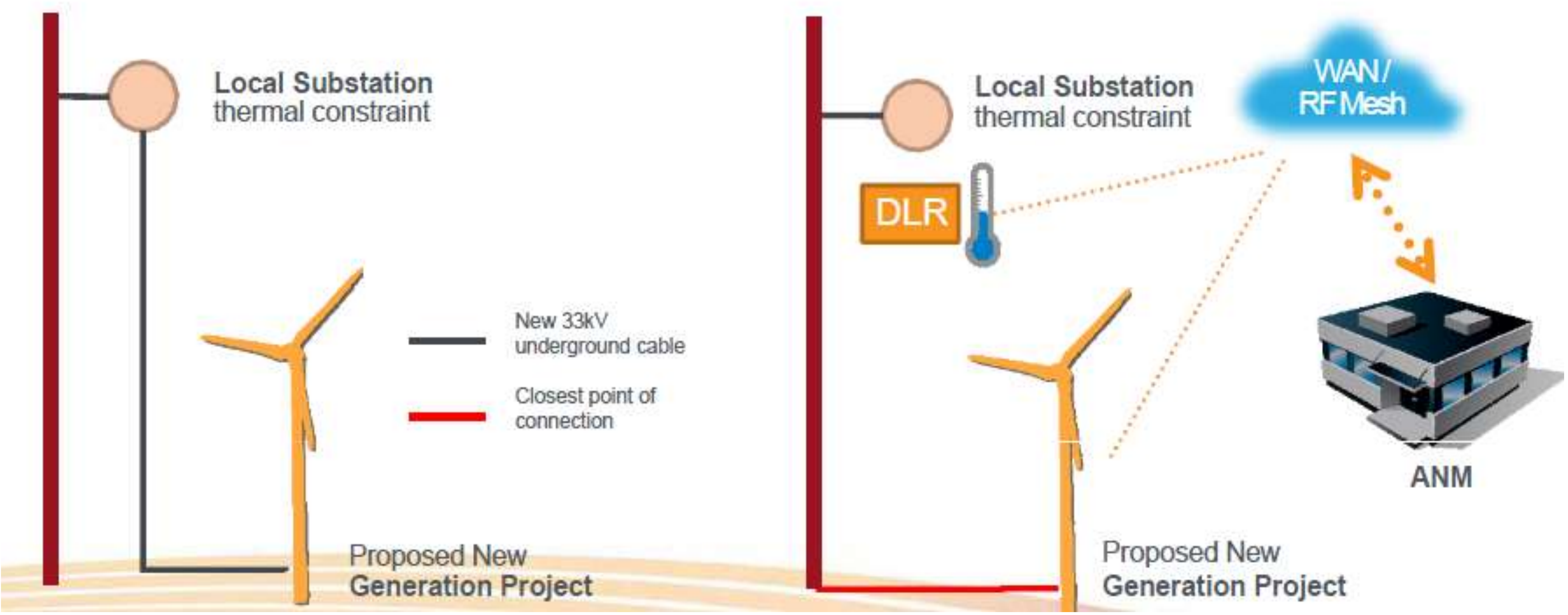
Courtesy of UK Power Networks

Pricing network access to cope with DG

Figure 6: Short (0.5 km) vs Long (15 km) connection

Business as Usual:
- Higher costs
- Longer lead times

Smart Solution:
- ✓ Smart Device – Dynamic Line Rating (DLR)
- ✓ Active Network Management (ANM) System
- ✓ Smart Commercial Arrangements



Courtesy of UK Power Networks

Business models for curtailment

- Definition of curtailment:
  - Any limitation that prevents the generator to export its maximum capacity to the distribution or transmission network.
- Rules for Allocation of Curtailment ('Principles of Access' or POA):
  - **LIFO (last in first out):** Generators are given a specific order for being curtailed (based on a selected parameter such as the connection date).
  - **Pro Rata:** Curtailment is equally allocated between all generators that contribute to the constraint.
  - **Market-Based:** Generators curtailed by offering a market price at which they will accept curtailment.

Total benefits from FPP trial

Table 6: Societal benefits

Parties	Type of benefit (£m) [1/]	Unit	S1	S2	S3
DG owners	Non-firm connections (going smarter)	£m	19.00	22.73	27.68
	Embedded benefits (generators)	£m	0.52	0.76	0.97
	(-) Smart connection incentive	£m	-0.23	-0.34	-0.42
DNO	DG incentives	£m	0.38	0.77	0.92
	Smart connection incentive	£m	0.23	0.34	0.42
Wider society	Embedded benefits (suppliers)	£m	0.60	0.67	1.05
	(-) DG incentives	£m	-0.38	-0.77	-0.92
Total benefits		£m	**20.11**	**24.16**	**29.70**
		£m/MW	1.39	0.87	0.89

[1/] Benefits from non-firm connections do not include embedded benefits.

* DG owners' benefits are net of the smart connection fee.

See Anaya and Pollitt, 2015c.

FPP conclusions (Anaya and Pollitt, 2014, 15b,c,d,e)

- Substantial societal benefits from smart connection arrangements over conventional alternative for all generators below maximum available network capacity.
- Pro-Rata curtailment may encourage too much connection behind a constraint boundary.
- Towards maximum available network capacity, smaller generators might prefer to share reinforcement costs over smart connection.
- There is substantial value from smarter connection if it accelerates connection and early reinforcement.
- This implies Pro-Rata may be better than LIFO in medium run.
- ***Smart commercial arrangements need further investigation, as the savings in costs and the benefit to DG acceleration appear to be substantial.***

Overall Comments

Target setting – largely ad hoc (20-20-20 sounds good) and without much attention to cost of each technology, but now improving.

Policy framework – UK has tried everything, but CfD auctions a great success, relative to RO and FiT, but don't index to inflation.

Regulation – Evolving to reflect increasing importance of reducing network cost of DG, now need to incentivise flexibility properly.

Green finance – Not an issue if funding sufficiently generous, role for government limited to credibility of income guarantees.

RES cost – much largely outside control of UK, except where innovation in funding mechanism can expose lower costs and attract more players in, reveal new solutions. However in future higher percentage of system costs may be local.

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Regulating electricity networks in GB: RPI-X to RIIO

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October 2018

Plan

- How network charges are determined
- The role of the regulator
- RPI-X to RIIO
- How RIIO has been working
- A critique of RIIO

REGULATED NETWORK CHARGES DETERMINATION

How are network charges determined in GB?

- The total level of revenue allowed to be recovered is set by the regulator for both transmission, system operation and distribution related charges.
- Approved tariff methodologies then apportion this total among different customer groups to set individual prices.
- The basics of the process by which total revenue for transmission and distribution are derived are similar, we consider this first.
- The UK uses ex ante regulation and sets base revenue formula and associated quality of service incentives for a fixed period in advance. This gives rise to strong incentives to perform against these.
- We consider the basic approach to transmission and distribution regulation first, before discussing transmission, system operation and distribution charges separately.

Who Regulates Networks?

Department of Business, Enterprise & Industrial Strategy

Government Policy

Gas and Electricity Markets Authority

Regulates Electricity & Gas Industries

Competition and Markets Authority

'promote competition for the benefit of consumers, both within and outside the UK'

'aim is to make markets work well for consumers, businesses and the economy'

Role of Regulator

- Independent Regulatory Agency with list of statutory duties
- Fixed term appointment of CEO
- Board including executives and independents

- Primary functions:
  - Promotion of competition and non-discriminatory access (as agent of competition authority)
  - Regulation of level and structure of network charges (oversees periodic price control review process)

- Independence to ensure investor interest protected and arbitrary government interference more costly

The Regulator is …

- A creature of legislation (Electricity Act, Gas Act, Competition Act)
- Independent of government
  - Although members appointed by Secretary of State for Energy, the regulator answers to Parliament
  - It has an authoritative independent voice from economic analysis of interests of consumers
  - This is a key safeguard for company shareholders:
    - E.g. Future governments may want to renationalise companies and sequestrate private investment, but an independent regulator identifies detriment to consumers of reneging on commercial agreements
- Subject to appeal
  - Companies and affected 3rd parties can appeal decisions to the Competition & Markets Authority (also independent of government) or seek judicial review of process
- Duty bound to consider the need for licensees to fund obligations upon them
  - Not a guarantee that any company costs will be covered but an assurance that efficient costs will be covered
- For monopolies, a simulator of competition (with rewards as well as penalties)

Electricity Network Utilities in the UK

- 1990: 12 Electricity Distribution in England and Wales companies privatised (with transmission)
- 1991: 2 Scottish T&D cos privatised.
- 1993: 1 Northern Ireland T&D co privatised.
- 1995: National Grid separately floated.

- By 2014: 7 Distribution groups remain, of which 5 are owned as stand alone network entities.

Regulatory timeline

- Distribution price control reviews reset prices in:
- 1995, 2000, 2005, 2010, 2015, 2023
- Transmission price control reviews reset prices in:
- 1993, 1997, 2001, 2007, 2013, 2021

Until 2010, Price-cap (RPI-X) regulation in GB

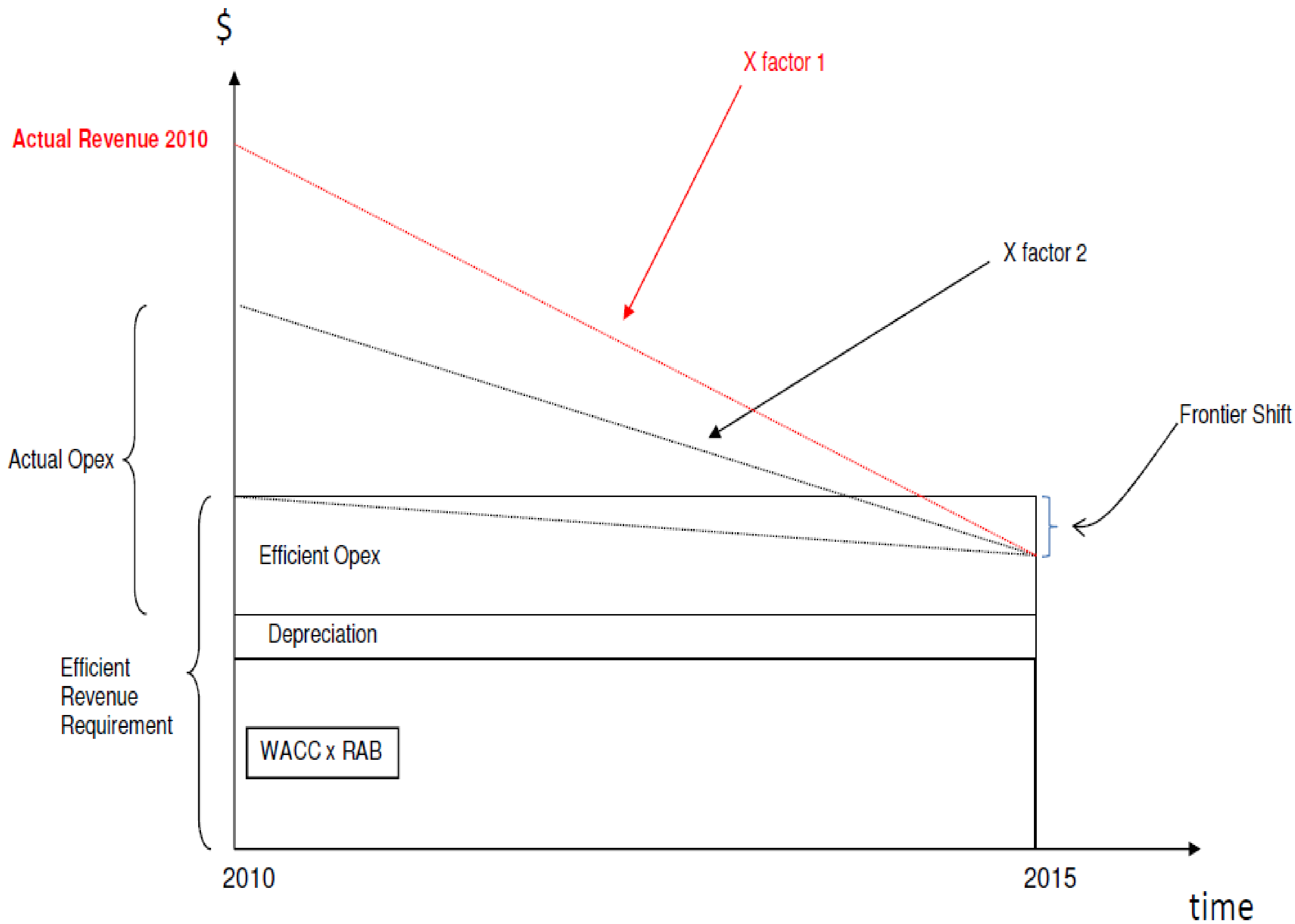
- Explicitly designed to avoid gold-plating of rate of return regulation used in US.
- Designed by Littlechild for BT
  - transition to competitive unregulated market
  - mimics effect of competition
- Regulator collects data from utility
  - forecast efficient operating costs O_t
  - asset value, investment plans $\Rightarrow B_t$
  - Depreciation D_t
  - demand forecasts
- Determines revenue required:

$R_t = O_t + rB_t + D_t$, r is av. cost of capital

Basic Characteristics of OFGEM RPI-X approach in GB

- 5 year control period for each of electricity distribution, gas distribution and transmission of electricity and gas.
- Initial consultation document issued 18 months before end of current price control period.
- Several subsequent documents with responses invited each time. Responses placed in library unless marked confidential
- Final document within 6 months of end of current control period.
- Company has a month to appeal to competition authority (MMC/CC) if unhappy with proposals at this stage.

Regulated Revenue over a price control period



Key Factors in Process

- Regulatory Asset Base (RAB)
  - Establishing initial value difficult
- Weighted Average Cost of Capital (WACC)
  - Depends on risk factor and gearing ratio
- Operating expenditure (OPEX)
  - May be subject to CAPEX trade-off
- Capital expenditure (CAPEX)
  - Requires carefully auditing if separately regulated

Benchmarking

- objective: to set $\underline{R}$ = efficient costs
- Need: set of comparable companies, and enough data to identify important cost drivers
- Identify efficiency frontier
- determine distance of company from frontier
- X_i set to catch up frontier
- predict rate of movement of frontier

The price setting process by regulator

- Key role for benchmarking costs
- Identify comparator group of firms
- Identify range of efficiency measurements
- Identify inputs, outputs and environmental variables
- Collect data on consistent basis
- Conduct analysis
- Generate efficiency differences
- Generate efficient cost predictions for each firm
- Set X from difference between actual and efficient costs

Incentives for investment

- benchmarking used for opex, hard for capital
- Investment plans ⇒ RAB_{t+i} ⇒ price path
  - e.g. use of *K* factors for water

⇒ Utility overstates investment plans
  - delay investment until end of price control period
  - if RAB updated ⇒ rate-of-return regulation?
  - If RAB based on benchmarks ⇒ under-invest?
- Solution: ex ante allowance with cost sharing.

Need to monitor quality with price caps

Ex-Ante (Incentive) Regulation

- Best simulation of competition
- Strong incentives to outperform ex ante allowances:
  - Companies can improve returns to shareholders within period
  - Revealing information for regulators to better set allowances and pass efficiencies to consumers in next period
- Removes regulatory uncertainties and overheads inherent in ex-post regulation (and risks of regulatory micromanagement)
- Gives scope for innovation in opex, capex and financing costs together with internalised outputs

- But tricky to set:
  - Future uncertainties (especially in externalities)
  - Information asymmetry

Background to change to RPI-X in 2010

- Changing circumstances (Pollitt,08a):
  - Investment needs rising (annualised):
  - Electricity distribution (+48%, 05-10 vs 00-05)
  - Electricity transmission (+79%, 00-05 vs 07-12)
  - Gas transmission (+23%, 02-05 vs 07-12)
  - Gas distribution (+30%, 02-07 vs 08-13)
- Network tariffs driven by capex not opex
- Network capex driven by subsidised renewables
- UK RPI-X@20 review areas: (Ofgem, 09a):

–Customer Engagement

–Sustainability

–Scale and scope of innovation

Figure 1: Components of the RIIO model

RIIO

Revenue

- Constraint on revenue set up front to ensure:
  - Timely and efficient delivery
  - Network companies remain financeable
  - Transparency and predictability
  - Balance costs paid by current and future consumers

=

Incentives

- Deliver outputs efficiently over time with:
  - Focus on longer term, including with eight year control periods
  - Rewards and penalties for output delivery performance
  - Symmetric upfront efficiency incentive rate for all costs
  - Use uncertainty mechanisms where add value for consumers

\+

Innovation

- Technical and commercial innovation encouraged through:
  - Core incentives in price control package
  - Option of giving responsibility for delivery to third parties
  - Innovation stimulus gives support and 'prizes' for innovation, building on Low Carbon Networks Fund (LCN) fund

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Outputs

- Outputs set out in licence
- Consumers know what they are paying for
- Incentives on network companies to deliver
- Outputs reflect enhanced engagement with stakeholders

RIIO vs. RPI-X

RPI-X

- ~~5 year price control~~
- Allowance framework set up-front
- Uncertainty Mechanisms
- Capex, Opex and Repex
- Funding for innovation
- Strong efficiency incentives

RIIO

- 8 year price control
- No change in allowance framework
- More uncertainty Mechanisms
- It’s now all about Totex
- Yes to innovation funding, but broader
- Strong efficiency incentives, but greater focus on outputs and stakeholders
- With a greater importance on accurate data

RIIO is more of an evolution of RPI-X than a revolution

PROGRESS WITH RIIO

RIIO-T1: Electricity and Gas transmission 2013-21

- SPT and SHETL transmission fast tracked in April 2012 (against Dec 12 for NGET).
- Considerable 'customer challenge'.
- National Grid allowed large increases in revenue over period (+30% by 2021).
- Network Innovation Allowance of up to 0.7% of revenue established.
- Output measures, with incentives attached: safety, reliability, availability, customer satisfaction, connections, environmental, wider works.
- Incentives relatively small and several 'reputational'.
- Hardly revolutionary, but some look generous…

Expected ranges of Return on Regulated Equity

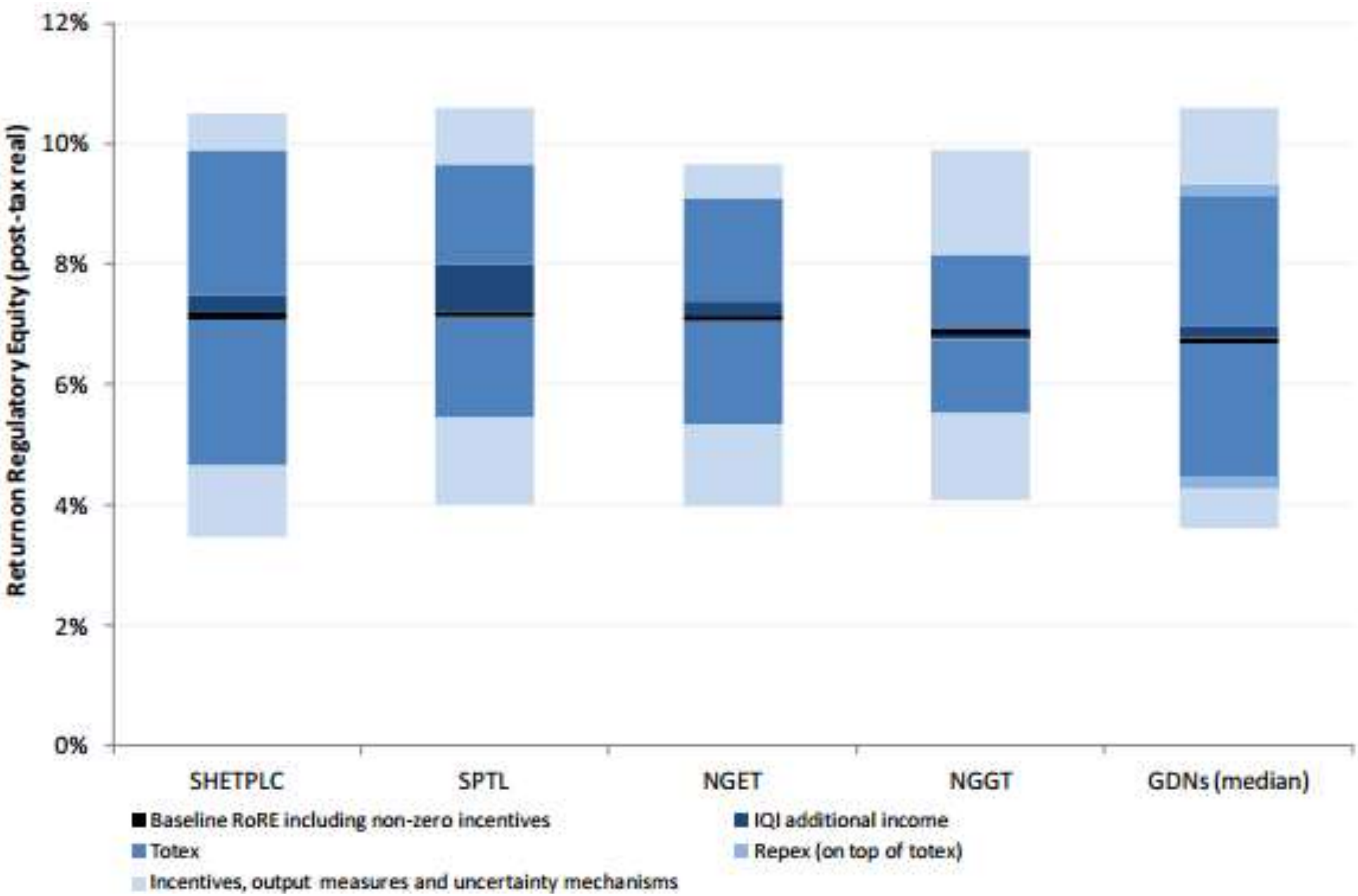


Table 3.1 – NGET's outputs and incentive parameters for RIIO-T1

Category	Output	Incentive
Safety	Compliance with safety obligations set by the Health and Safety Executive (HSE).	Statutory requirements. No financial incentive.
	Supported by measures of asset health, condition and criticality with agreed targets and impacts on RIIO-T2 funding.	A penalty/reward of 2.5% of the value of any over/under delivery of network replacement outputs.
Reliability	Primary output based on Energy Not Supplied (ENS).	Incentive rate of £16,000/MWh[27] which is based on an estimate of the value of lost load (VoLL).[28] A collar on financial penalties limiting the maximum penalty to 3% of allowed revenues.
Availability	Prepare and maintain a Network Access Policy (NAP).	Reputational incentive. Potential financial incentives if relevant during development and update of NAP.
Customer Satisfaction	Develop customer/stakeholder satisfaction survey.	Up to +/-1% of allowed revenue.
	Effective stakeholder engagement.	Up to 0.5% of allowed revenue via a discretionary reward scheme.
Connections	To meet existing legal requirements.	General enforcement policy.
Environmental	SF_6 – Baseline target calculated annually with best practice 0.5% leakage rate for new assets installed.	Differences to baseline subject to a reward/penalty based on the non-traded carbon price for carbon equivalent emissions.
	Losses – Publish overall strategy for transmission losses and annual progress in implementation and impact on transmission losses.	Reputational incentive.
	Business Carbon Footprint (BCF) – Publish BCF accounts at business level annually over RIIO-T1.	Reputational incentive.
	EDR Scheme – measures to focus on aspects of the roles of the TOs and SO not explicitly captured in RIIO-T1 incentives.	Positive reward available if achieve leadership performance across different scorecard activities.
	Visual amenity – to efficiently meet planning requirements for new infrastructure and deliver visual amenity outputs by mitigating impacts of existing infrastructure when it is located in designated areas.	Reputational incentive in the context of its performance in the utilisation of two mechanisms: (1) baseline and uncertainty mechanism funding for additional cost of mitigation technologies required for development consent (2) initial expenditure cap of £500m to reduce the impact of existing infrastructure in designated areas.
Wider works (new investment)	Baseline wider works outputs of approximately 7,250MW of additional transmission transfer capacity funded baseline funding. Best view wider works outputs (approximately another 22,150MW) are to be funded through flexible baseline (with volume driver to adjust allowances if delivery turns out to be different) and SWW arrangements for potentially a further 7,900MW of transmission capacity).	NGET's scheduled baseline and SWW outputs will be subject to timely delivery standards. For best view wider works (ie non SWW), NGET required to meet NDP criteria and take forward timing and phasing of WW outputs that are in best interests of consumers.

Source: Ofgem (2012), *RIIO-TI Final Proposals for National Grid Electricity Transmission and National Grid Gas*, Ref. 169/12, London: Ofgem, p.22-23.

RIIO-T1: Electricity and Gas transmission 2013-21

- Questions raised:
  - Would largest companies (NGET) ever be fast tracked?
  - Incentives to be really innovative and make smart investments (rather than propose new lines) still unclear?
  - Benchmarking relative to international comparators abandoned and hence the introduction of competition looks necessary?
  - Incentive rates very similar (NGET = 47%, SPTL and SHETL = 50%) and also degree of estimated over prediction of investment still high?

RIIO-ED1: Energy distribution 2015-2023

Table 1: Summary of assessment of DNOs' business plans

DNO Group	licensee[10]	Process	Outputs	Resources – efficient costs	Resources – efficient finance	Uncertainty and risk
Western Power Distribution	WMID	Green	Green	Green	Green	Green
	EMID	Green	Green	Green	Green	Green
	SWALES	Green	Green	Green	Green	Green
	SWEST	Green	Green	Green	Green	Green
Electricity North West Ltd	ENWL	Green	Green	Amber	Green	Green
Northern Powergrid	NPgN	Green	Green	Amber	Green	Green
	NPgY	Green	Green	Amber	Green	Green
UK Power Networks	LPN	Green	Amber	Red	Green	Green
	SPN	Green	Amber	Amber	Green	Green
	EPN	Green	Green	Red	Green	Green
SSE Power Distribution	SSEH	Green	Red	Amber	Green	Red
	SSES	Green	Amber	Amber	Green	Red
SP Energy Networks	SPD	Amber	Red	Red	Green	Amber
	SPMW	Amber	Red	Red	Green	Amber

Source: Ofgem letter 22 November 1013, p.4.

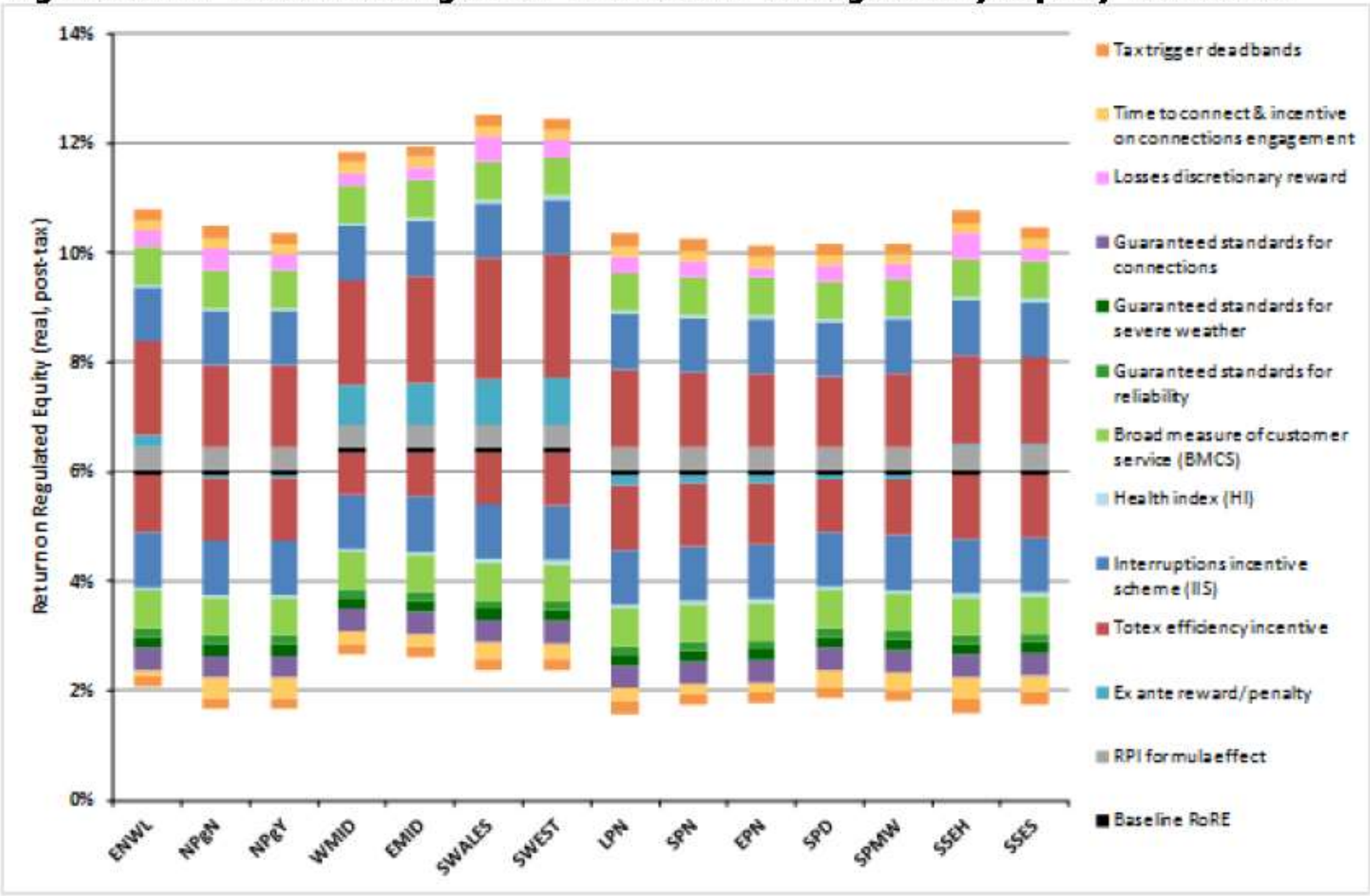
WPD fast tracked in February 2014, slow track decisions expected December 2014.

RIIO-ED1: Energy distribution 2015-2023

- Questions raised:
  - Is there pressure on the regulator to fast track at least one firm, even if some parts of business plan are unsatisfactory?
  - Unclear what use is being made of benchmarking (it is discussed but use of results is now less clear than in DPCR5)?
  - The sum total of the output performance incentives look high and could give significant outperformance windfall?
  - Individual company incentive rates very similar (for slow track 53-57%, though 70% for WPD) and degree of estimated over prediction still high?

RIIO-ED1 Potential Incentive Impacts

Figure 5.1: Plausible ranges for the return of regulatory equity for DNOs[35]



Real post tax returns. Source: Ofgem (2014), RIIO-ED1 Draft Determinations for Slow Track Electricity Distribution Companies, London: Ofgem, p.44.

WPD's output incentives

Table 1.2: Summary of WPD's outputs

Outputs	
Safety	Compliance with the Health & Safety Executive
Customer satisfaction	Target: WPD accepts our target setting methodology.[16] This means that in order to perform well under this incentive WPD will need to deliver a level of service to all customers that is well above the current industry average and will compare favourably against other industries where similar metrics are used. Incentive: WPD's performance will be assessed against a customer satisfaction survey, a complaints metric and an assessment on the quality of stakeholder engagement. Depending on how well they perform WPD could face the rewards or penalties in table 1.4.
Connections	Target: WPD accepts our target setting methodology for the Time to Connect incentive[17] (for smaller connection customers) and our approach to assessing their responsiveness to larger connections customers through the Incentive on Connections Engagement. This means that in order to perform well under these incentives WPD will need to improve connection times for smaller customers and engage with larger customers to ensure it is meeting their needs. Incentive: WPD's performance will be assessed against the time it takes to issue quotes/make new connections and an assessment on the quality of its engagement with connection customers. Depending on how well they perform WPD could face the rewards or penalties in table 1.7.
Environment	WPD forecasts that it will spend £7.7m to underground 55km of lines in designated areas. It will reduce its business carbon footprint by 5 per cent and SF6 leakage by 17 per cent. It will take a holistic approach to network investment to reduce losses and will continue its current revenue protection services, and address electricity theft in conveyance and unmetered supplies in line with any licence obligations. We expect WPD to review and strengthen its losses reduction strategy, based on robust cost benefit analysis, at an early opportunity.
Reliability	Target: WPD has set tougher targets for three of its DNOs than those calculated through our methodology. We set out WPD's reliability targets in table 1.9. Incentive: WPD accepts the incentive rate setting methodology we set out in the strategy decision. Depending on how they perform against the targets, WPD could face rewards or penalties in table 1.10. WPD has agreed with our proposed amendments to the guaranteed standards and relevant annual revenue exposure caps. Table 1.10 shows these values. Overall exposure across both IIS performance and the relevant guaranteed standards will be capped annually at the level in table 1.10.
Social	WPD has a comprehensive strategy which sets out its intention to adopt the British Standard of Inclusive Provision and implement a strategy to improve its understanding of consumer vulnerability. WPD will also improve the service provided for vulnerable customers and help to address fuel poverty through partnerships with regional agencies

Source: Ofgem, *Decision to Fast Track Western Power Distribution*, 28 Feb 2014, p.9-10.

RIIO and Revenue

- Most revenue is still clearly 'base revenue' and performance incentives similar to before.
- Totex benchmarking (also in DPCR5) is desirable but needs to be handled carefully
  - Incentive rates are misleading as getting an allowance on capital expenditure for 40 years is still more desirable than a 4-8 year opex saving.
- Incentives to earn 'smart' energy service revenues still the subject of trialing within innovation projects.
  - Unclear incentives to propose radical reductions in long term capex to benefit of consumers.

RIIO and length of price control

- This is largely a red herring.
- Length of price control is actually about the trade-off between length of monopoly right and sharing of benefits.
  - With 'smart' technology it is not clear that price controls need to be longer, as we could be moving to shorter pay back periods for investment.
- With a four year break point in the middle of an 8 year review, actually the price control period has effectively been shortened.
  - We already went down this route with London Underground and with Water in England and Wales where mid-term reviews became the significant review.

RIIO and Performance Incentives

- The attempt to define outputs to be incentivised explicitly is clearly a welcome development.
- This is an evolution of what happened under RPI-X where there were significant attempts to incentivise quality of service (reliability) of the network and of customer responses.
- However this does include explicit new incentives for safety, conditions for connection, environmental impact and social obligations.

RIIO and innovation provisions

- The RPI-X@20 review identified the decline in R+D expenditure by networks as a significant problem (see Jamasb and Pollitt, 2008, 2011).
- This was substantively addressed in DPCR5 (which was ongoing at the same time as RPI-X@20).
  - This established the Low Carbon Networks Fund, with up to £100m per year (or 2.5% of revenue).
- RIIO develops this (now three pots – NIA, NIC and IRM) but makes the exact quantity of the company innovation fund (NIA) subject of negotiation.
- However only allowing DNO/TO led projects is a major weakness of all the innovation fund rules.
- But also, collaborative private RD+D is possible, e.g. eFIS EV project in Milton Keynes (Miles, 2014) led by Arup and Mitsui.

RIIO and Negotiated Settlements

- Negotiated settlements could result in an agreed price control business plan to be presented to the regulator as in the US.
- It could result in agreements on required investments and performance incentives as in airport regulation in the UK.
- In RIIO it does neither of these.
- Clearly fast track approval is a theoretically dubious concept given the relative costs of regulatory mistakes versus the modest benefits of fast tracking.
  - The issue is not the speed of agreement but the degree of market based challenge, this might take longer than conventional regulation.

Concluding thoughts RIIO

- RIIO is an evolution of RPI-X not a revolution.
- Energy services *could* be much more competitive in the future (though there is a lot of technological optimism around this).
- Regulation *of* monopoly will be less important/difficult than regulation *for* competition in energy networks.
- However regulation needs to get better to make this possible: the experience of telecoms regulation slowing technology rollouts is not encouraging.

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