



STORAGE & SYSTEMS CONFERENCE

13 JUNE 2018 GLASGOW

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Innogy Renewables UK



Neal Rafferty

Head of Energy Utilities, Markets
and Network Policy
Scottish Government

Scotland's Energy Strategy

The Importance of Storage

Challenges and Opportunities

Neal Rafferty

Energy and Climate Change Directorate



Scottish Government
Riaghaltas na h-Alba
gov.scot



- **Scottish Energy Strategy**
 - *Vision and ambition*
 - *Structure and priorities*
 - *Link to Climate Change Plan*
- **Storage in Scotland**
 - **Current footprint / successes**
 - **Challenges and opportunities**



What is the Energy Strategy's purpose?

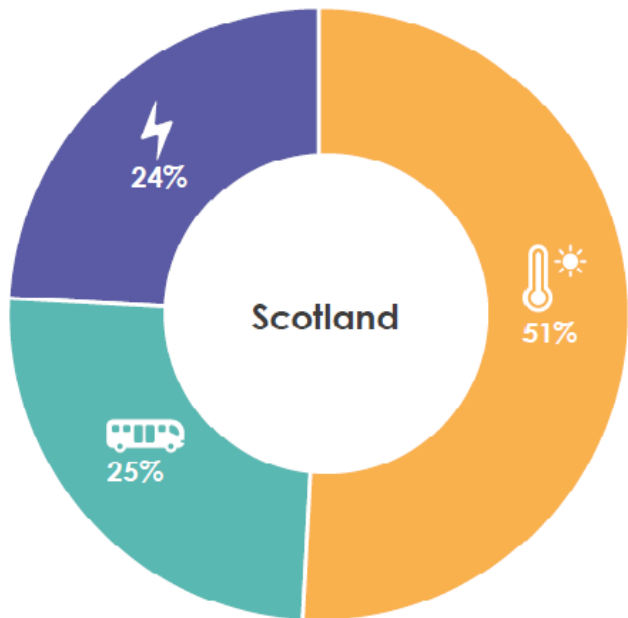
Scotland's Energy Strategy...

- Explains Scotland's current and potential future energy system
- Guides future decisions of the Scottish Government
- Establishes a 2050 vision for energy in Scotland...

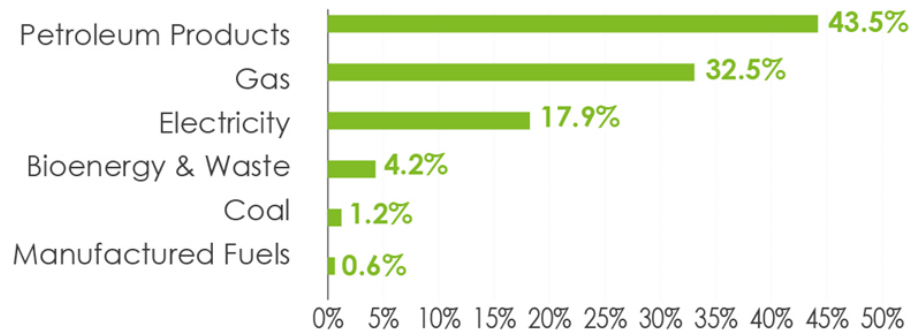


Developing a whole system view

Final Energy consumption

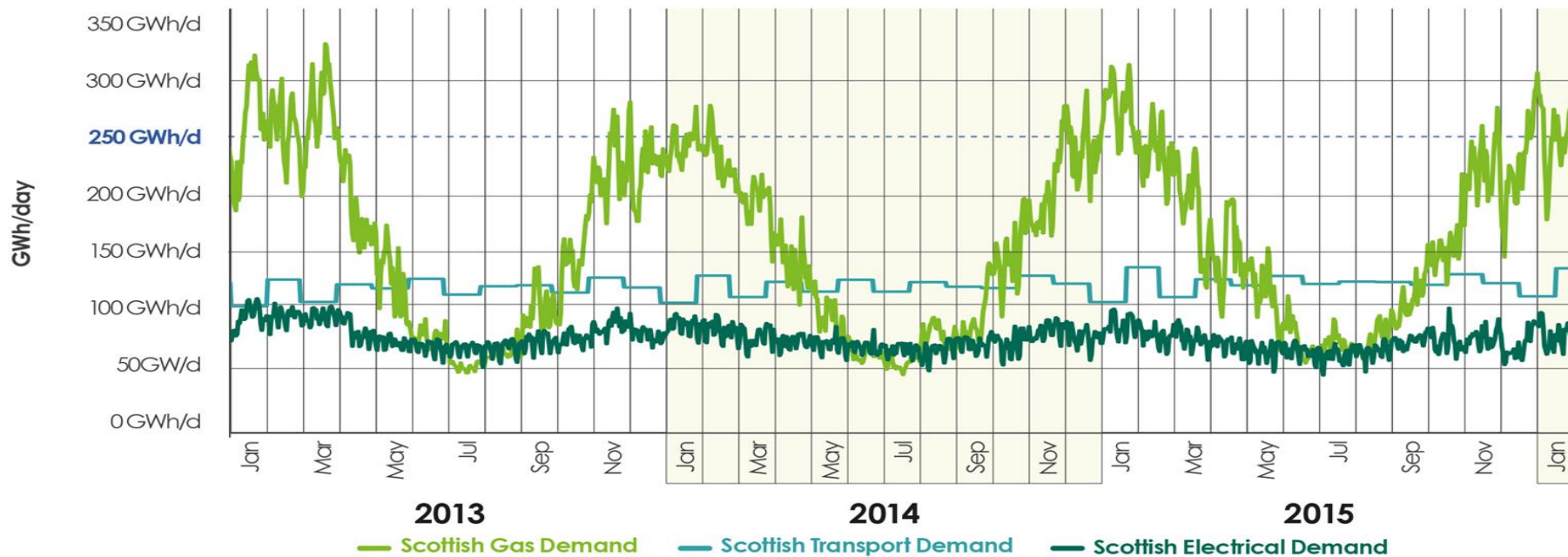


Energy consumption by fuel type



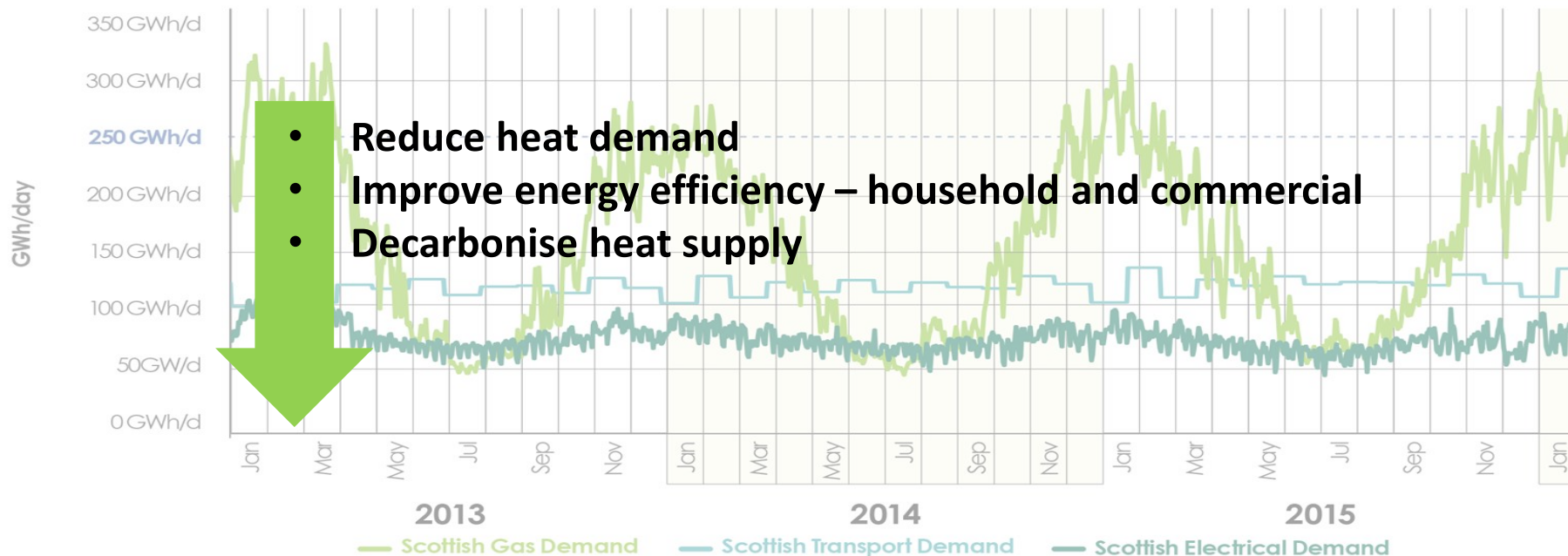
Charting a new course – developing a ‘whole system’ view

Yearly pattern of energy use - Scotland



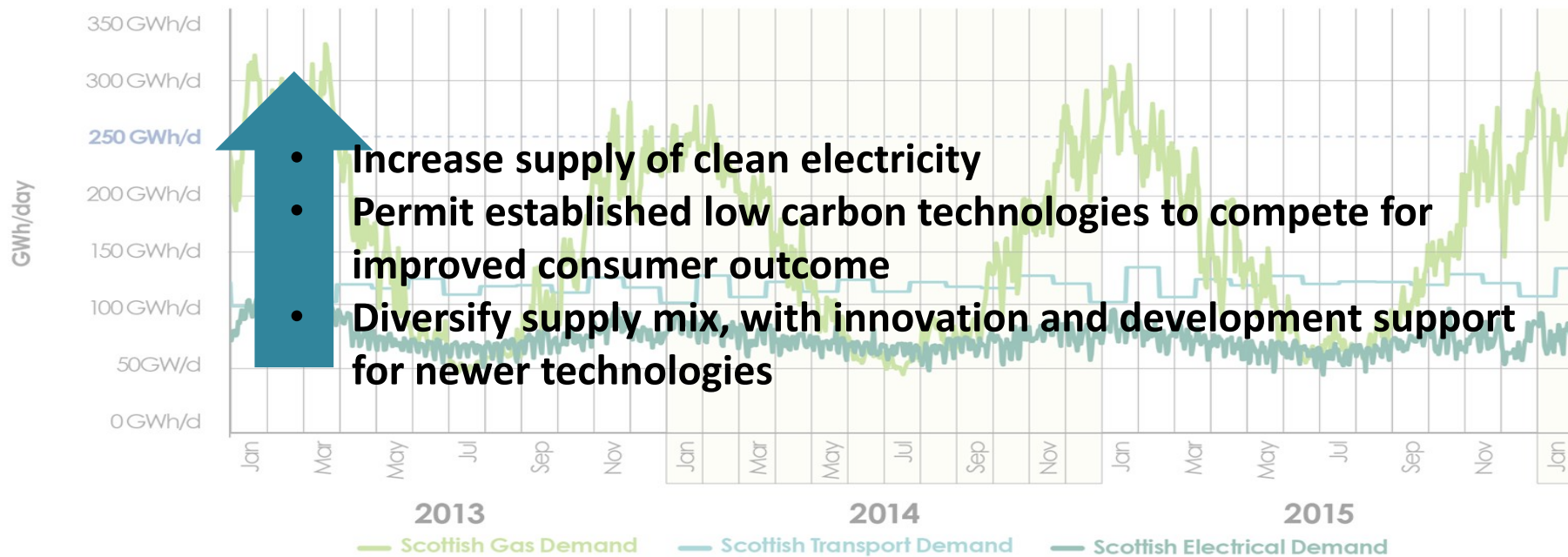
Charting a new course – strategic imperatives

Yearly pattern of energy use - Scotland



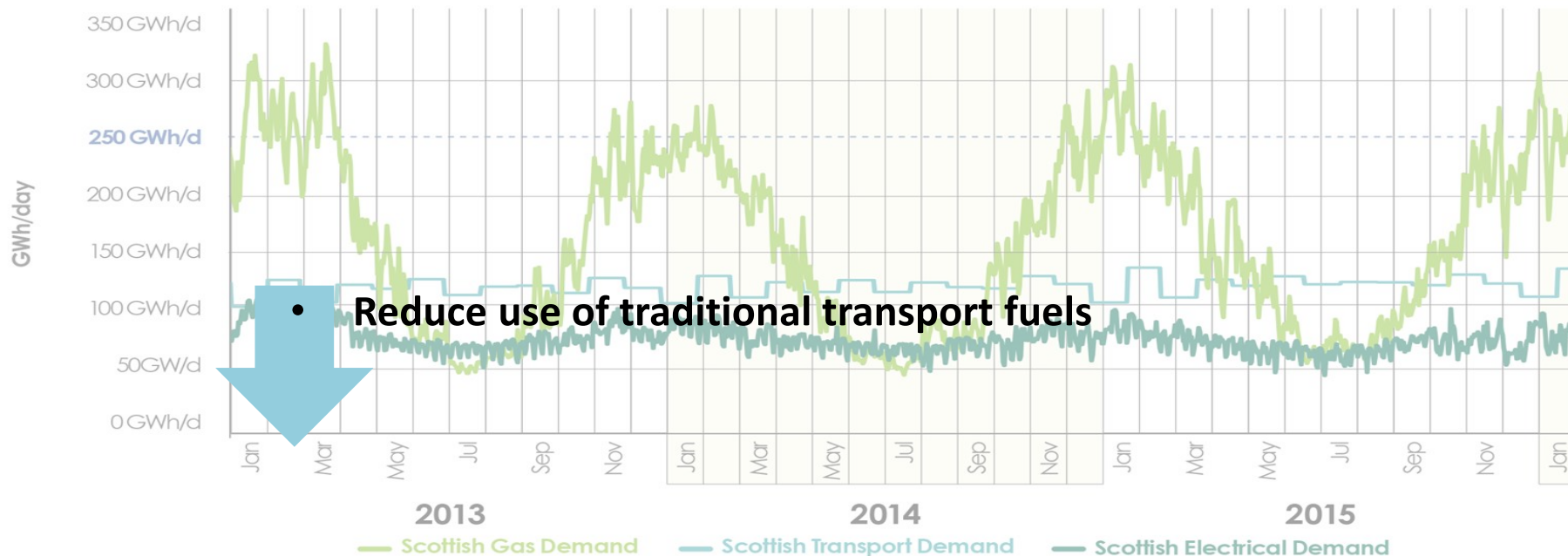
Charting a new course – strategic imperatives

Yearly pattern of energy use - Scotland



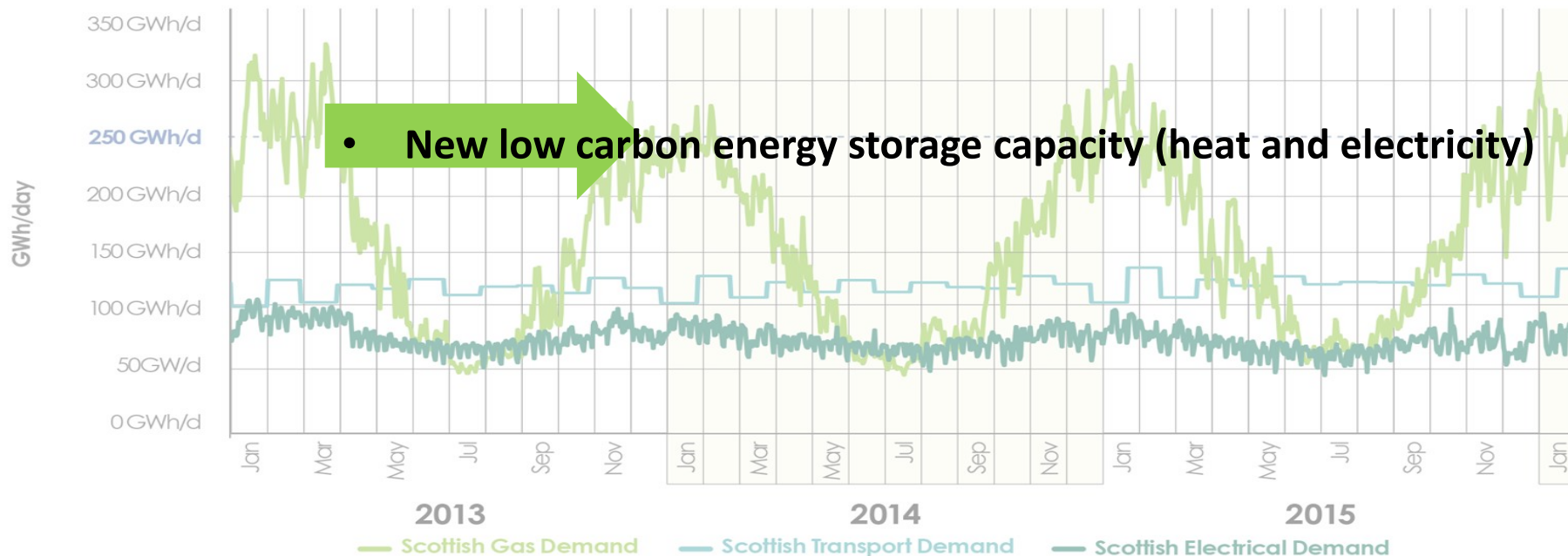
Charting a new course – strategic imperatives

Yearly pattern of energy use - Scotland



Charting a new course – strategic imperatives

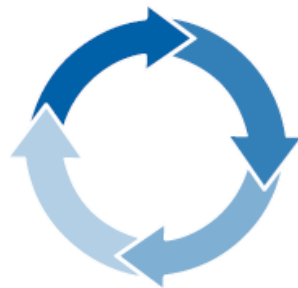
Yearly pattern of energy use - Scotland



Guiding themes



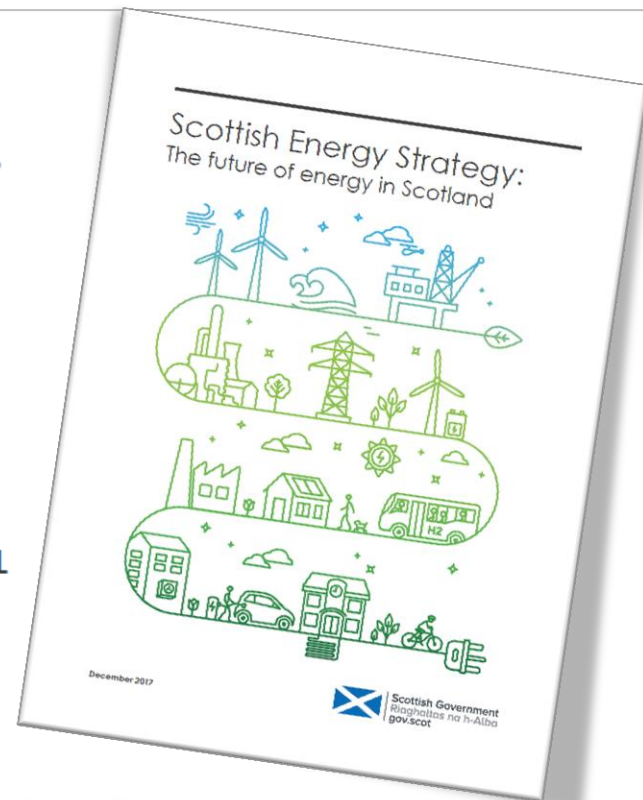
**AN INCLUSIVE
ENERGY TRANSITION**



**A WHOLE-SYSTEM
VIEW**



**A SMARTER
LOCAL ENERGY MODEL**



Scotland's energy priorities



Consumer engagement and protection



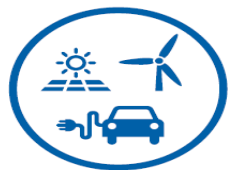
Energy efficiency



System security and flexibility



Innovative local energy systems



Renewable and low carbon solutions

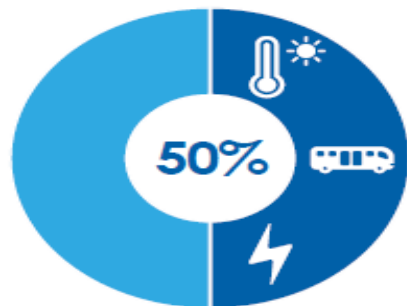


Oil and gas industry strengths



2030 whole-system targets

The Strategy sets two new and ambitious targets for 2030:



THE EQUIVALENT OF
50% OF THE ENERGY
FOR SCOTLAND'S
HEAT, TRANSPORT
AND ELECTRICITY
CONSUMPTION TO
BE SUPPLIED FROM
RENEWABLE SOURCES



AN INCREASE BY **30%** IN THE PRODUCTIVITY
OF ENERGY USE ACROSS THE SCOTTISH
ECONOMY



The Strategy considers two indicative scenarios for the energy system in Scotland in 2050:

- An electrified future
 - A hydrogen future
- Both scenarios consistent with Scotland's climate targets and informed by sector specific analysis and 'TIMES' modelling
 - Designed to help us understand what infrastructure and behaviours might be required under different future scenarios



Next steps

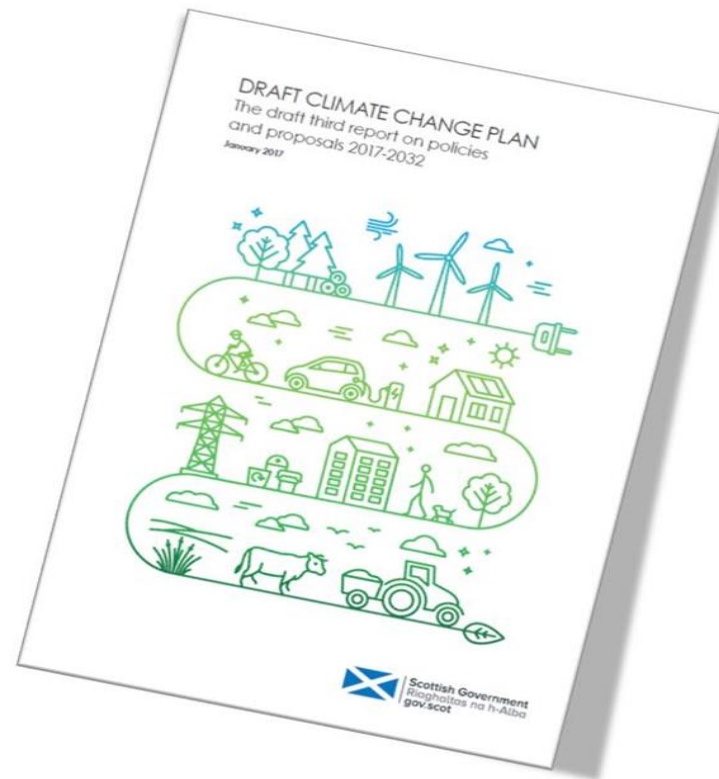
- Further detail in sector Route Maps, technical papers, and additional policy documents in the coming years
- Energy Efficient Scotland Programme – May 2018.
- We will publish an Annual Energy Statement to ensure we are tracking progress
- Will adapt our approach in response to major trends and developments at UK, European and Global levels



Scotland's Emissions Reduction Targets

Scotland's Climate Change Plan / Draft Bill

- Requirement of the Climate Change (Scotland) Act 2009
- Policies and proposals for reducing emissions by **66% by 2032** across all sectors
- Allocates emission reductions across economy (TIMES)
- Describes “on the ground” changes that Scottish Government will take forward with its partners
- **Draft Plan published 28 February 2018**
- **Draft CC Bill published 24 May 2018 – 90% reduction by 2050**



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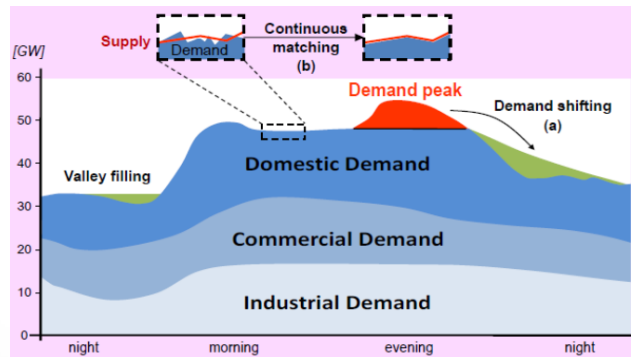
Storage in Scotland

- 2 out of 4 Pumped Storage Hydro schemes in the UK are based in Scotland.
- Kirkwall is home to the first large grid connected battery in the UK.
- SG has supported a number of innovative hydrogen storage projects.
- Scotland is becoming a leading storage R&D nation.



Key Challenges

- Regulatory issues
- Technical immaturity resulting in high manufacturing costs
- Location constraints due to the suitable topography requirements
- Adaptation of the circular economy model
- Competition against other forms of grid flexibility



Regulatory and Market Changes



- Co-location advancements
- Modified generation licence for storage to prevent double counting
- System flexibility services
- Permitted development rights consultation
- RII0-2 price control

Opportunities

- Economic benefits
- Unlocking renewable potential
- Smoothing intermittent generation and shaving peak demands
- Supporting constrained grid areas
- Maintaining the security of supply
- Increasing the number of domestic prosumers

Conclusions

- Storage will have a major influence on our future energy system.
- SG agrees that storage is a strategically important issue, and will continue to support innovation and deployment in this area.
- Our Energy Strategy outlined SG's support to a whole-system, holistic approach instead of picking the winners.
- All future energy scenarios predict growing energy storage capacity.
- Case for planning and deploying storage on an area-by-area basis?

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Andrew Burgess
Deputy Director, Systems &
Networks
Ofgem

Our changing energy system: the state of play

Andy Burgess

Deputy Director, Systems and Networks

Scottish Renewables Conference

13 June 2018

Ofgem's priorities for the energy transition

The maximum number of consumers are engaged in buying energy products
– either directly or through automated services

The market allows diverse players to enter across the market – allowing new optimisation of services (e.g. integration of electric vehicles), new and different products for consumers to improve service/ lower costs

Those who are disengaged are able to share the benefits of increased efficiency – either through default arrangements – for example regulated tariffs or 'opt out' competition (e.g. collective switching)

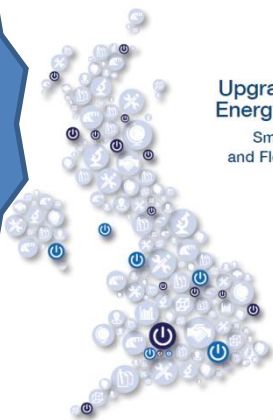
Vulnerable consumers are **protected – on the price they pay and against poor conduct by** energy companies

Where monopoly services exist – the regulatory system drives the maximum possible benefits for consumers

- Evolution of RIIO framework
- The joint Smart Systems and Flexibility Plan with the UK Government
- Targeted charging review
- Access reform
- Innovation link
- Separation of system operator role and development of whole systems approach
- Future retail markets

Smart Systems and Flexibility Plan with UK Government

Joint 29 point plan: under way, most done by 2019



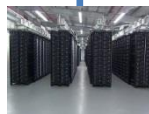
Upgrading Our Energy System
Smart Systems and Flexibility Plan

Building our Industrial Strategy

Removing barriers to smart technologies

Regularity clarity and fair charges

Define storage in regulation, planning reform, health&safety standards, innovation funding, **deliver a storage licence, unbundling rules, update network charges, enable colocation with renewables.**



Smart homes and businesses

Infrastructure and system enablers

Deliver smart meters, **half hourly settlement**, smart appliance standards, cyber security, EV legislation, **consumer protections**, Crown Commercial Service support for DSR, DSR trial funding, **Power Responsive**.



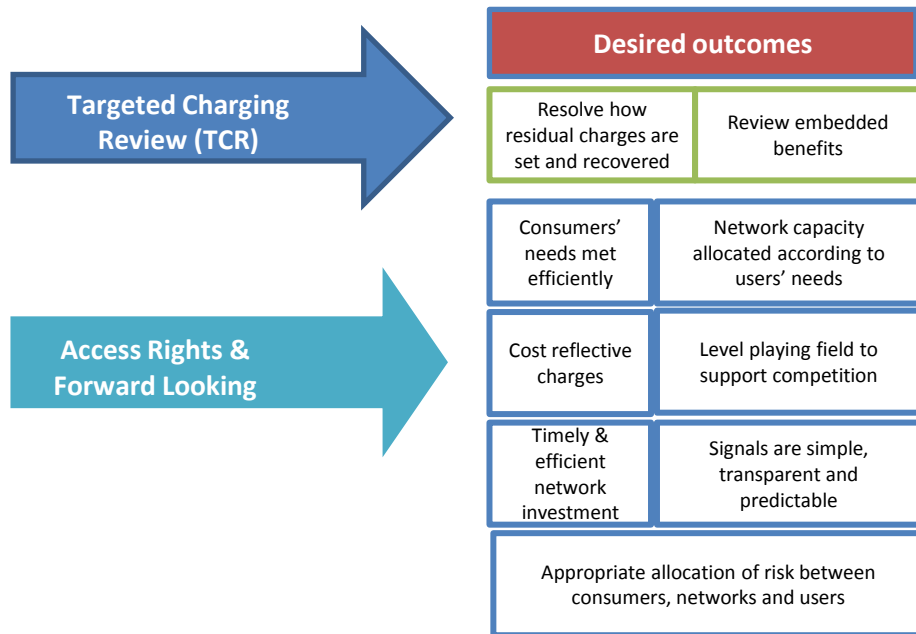
Markets that work for flexibility

Access to markets and new markets

DSO/TSO evolution, SO incentives, Capacity Market amendments, rule changes; BM access of aggregators, SO simplification of Ancillary Services, ENA Open Networks project, TCR, Access reforms,, network standards, trial funding, Smart Systems Forum



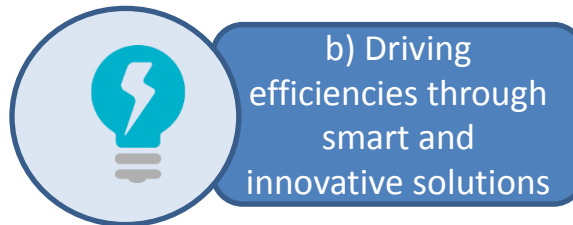
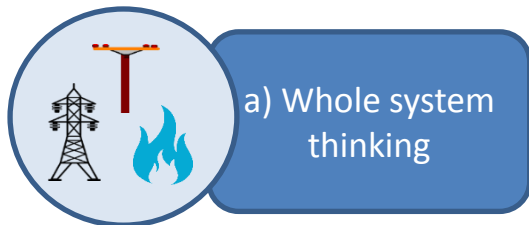
New network access and charging arrangements



What do system and network operators need to achieve?

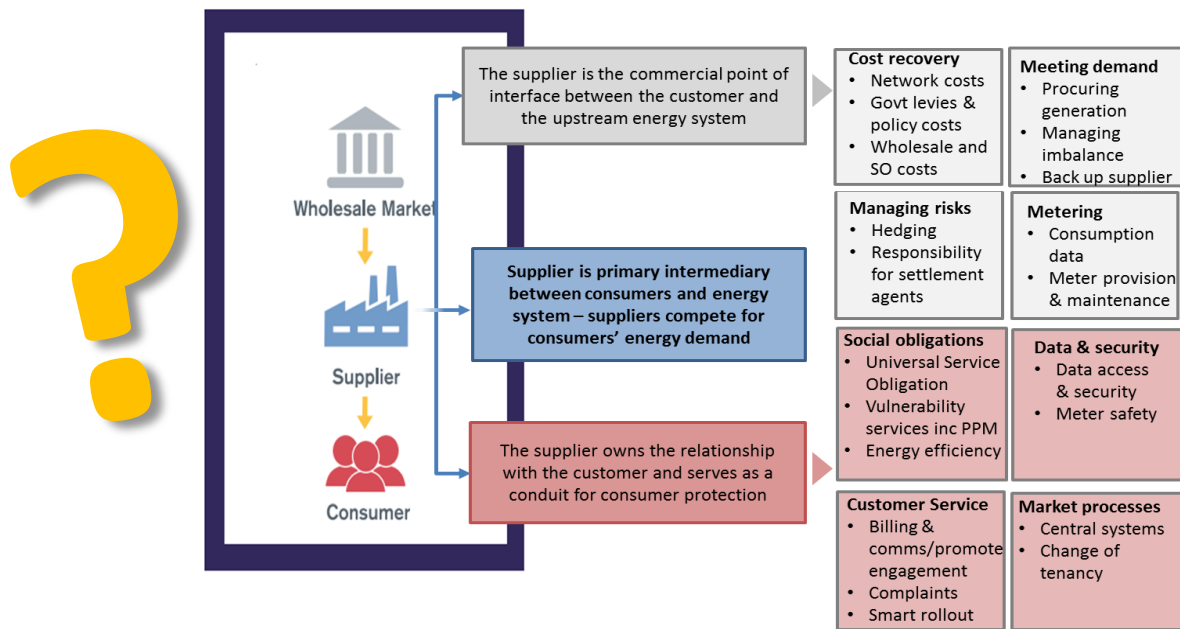
We need system and network operators to proactively respond to the energy system transition, to ensure opportunities aren't missed and costs aren't higher than they should be.

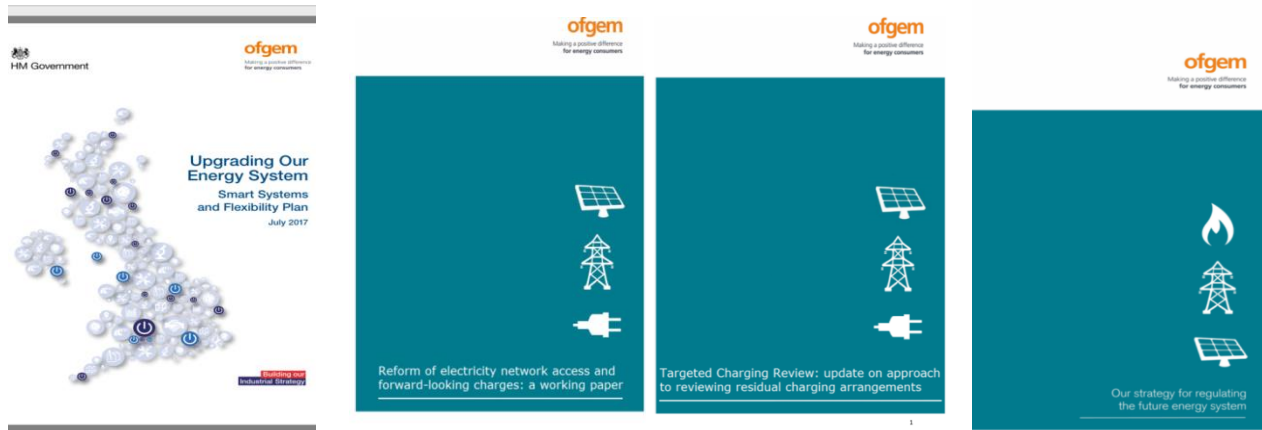
Their roles need to evolve in the following ways:



The supplier hub

Do all these things need to be provided exclusively by a traditional supplier?





- <https://www.ofgem.gov.uk/publications-and-updates/upgrading-our-energy-system-smart-systems-and-flexibility-plan>
- <https://www.ofgem.gov.uk/publications-and-updates/our-strategy-regulating-future-energy-system>
- <https://www.ofgem.gov.uk/publications-and-updates/targeted-charging-review-update-approach-reviewing-residual-charging-arrangements>
- <https://www.ofgem.gov.uk/publications-and-updates/reform-electricity-network-access-and-forward-looking-charges-working-paper>
- <http://www.chargingfutures.com>



Marc Smeed
Principal Consultant
Xero Energy

OPEN NETWORKS



- Define the role and functions of a 'Distribution System Operator' (DSO) and **who** is best to deliver these functions.
- What is a DSO?
- Most DSO functions are either not DNO functions or significant extensions of existing functions.

PASSIVE

DNO

- Network Operation
- Investment planning
- Connections & rights
- System def' & restoration
- Service provision
- Charging

ACTIVE

DSO

- **System coordination – new function**
- Network Operation – extended function
- Investment planning – extended function
- Connections & rights – extended function
- System def' & restoration – extended function
- **Service/Market facilitation – new function**
- Service provision – extended function
- Charging – extended function

- DNO's response to Ofgem/BEIS policy.
- Game plan for DNOs going into RII0-ED2

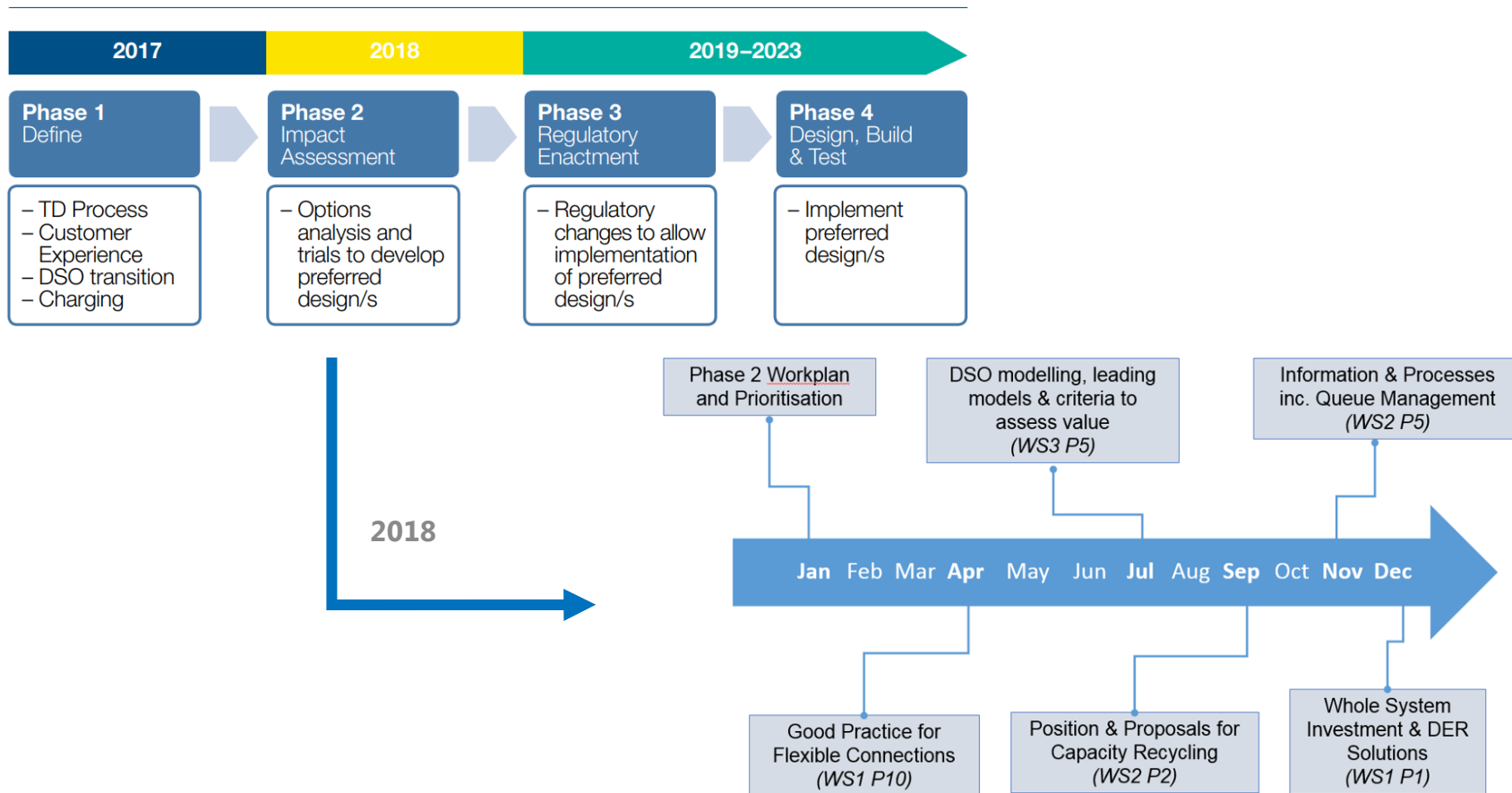
How do the DNOs measure up?

- DNO self-evaluation (based on current DNO best practice)
- 1 -> 5 (lower to higher competence)



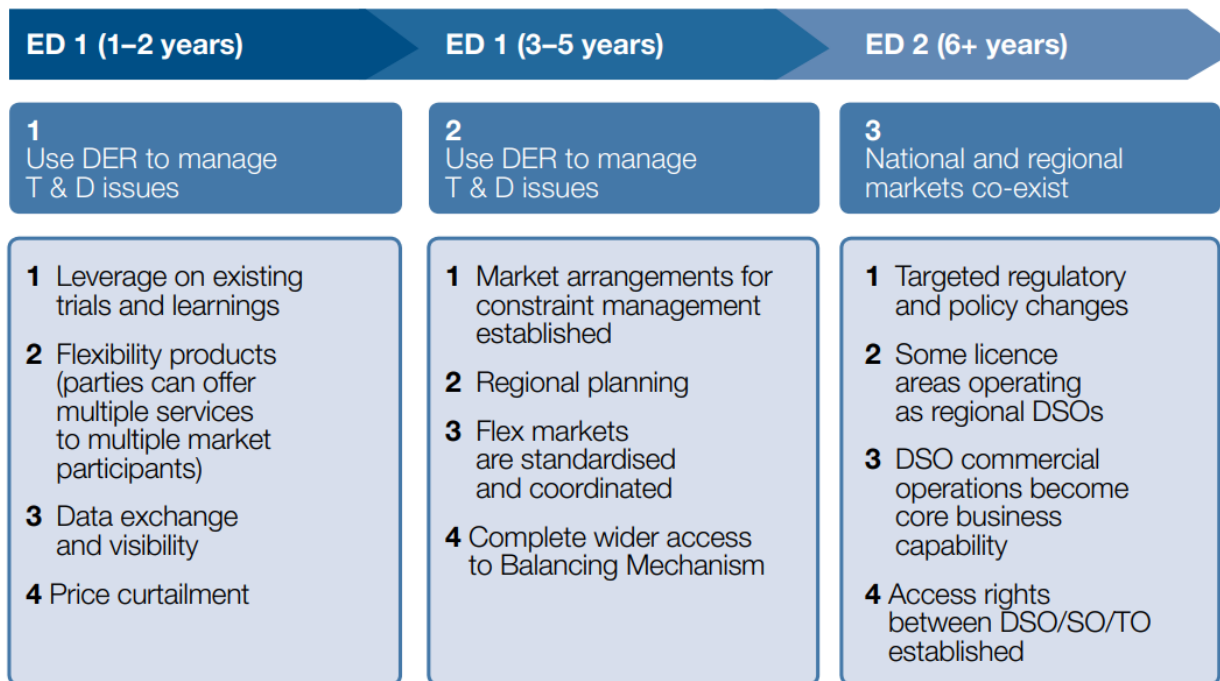
- Four objectives of the project that have resulted in four workstreams.
- Workstream 1 : T-D processes
 - Develop improved **T-D processes** around connections, planning, shared TSO/DSO services and operation. **Regional NOA process**
- Workstream 2 : Customer experience
 - Assess the gaps between the **experience our customers** currently receive and what they would like, and identify any further changes to close the gaps within the context of a 'level playing field' and common T & D approach. **Queue management, information provision...**
- Workstream 3 : DNO to DSO
 - Develop a more detailed view of the required transition from **DNO to DSO** including the impacts on existing organisation capability. **SGAM modelling**
- Workstream 4: Charging
 - Consider the **charging** requirements of enduring electricity transmission/distribution systems. **Charging Futures / Targeted Charging Review**

What's the status?

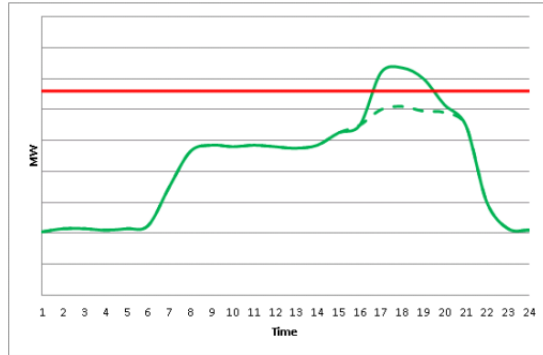
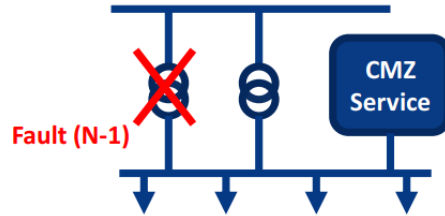


What does it mean for storage?

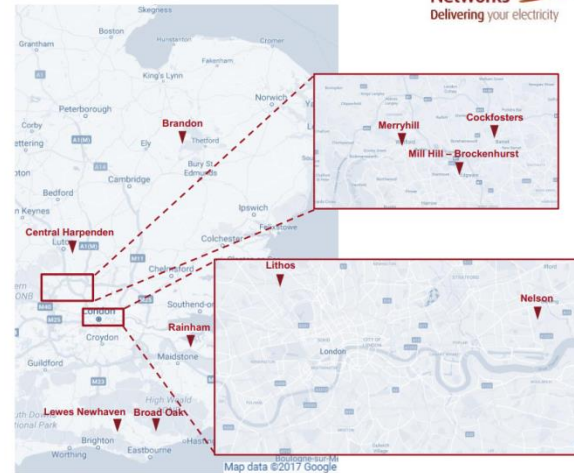
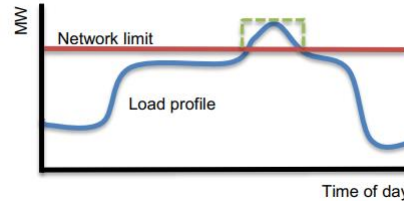
- In the short term (next year or two), nothing.
- In the medium-long term (2020+), opportunities to provide services across transmission and distribution



- › Peak lopping
- › Voltage control



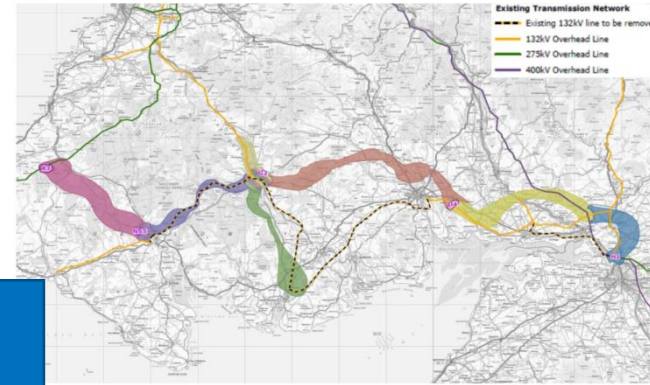
- › SSEN CMZ – FEB 2017 ITT
- › UKPN tender – AUG 2017 EoI
- › + various others....



- › Network constraint management – generation driven

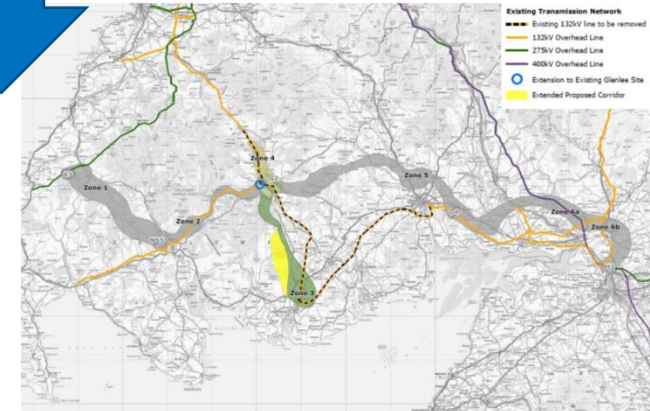
2015

- › £300M+
- › **175km** new 275/400kV steel tower
- › 4 no. new substations

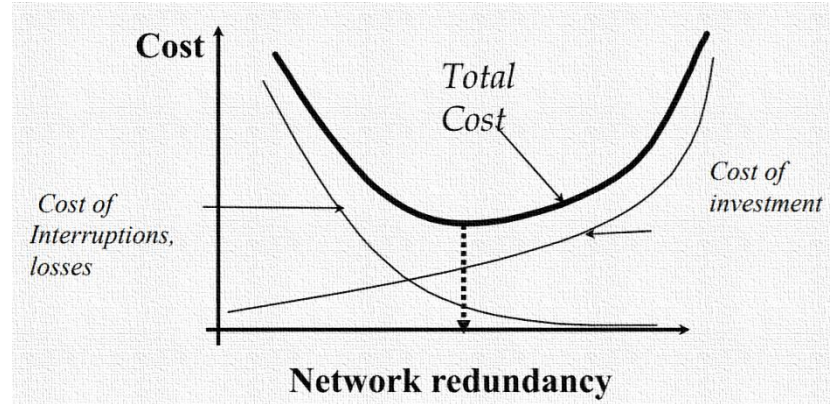


2016

- › £ < 100M
- › Rebuild of existing tower lines
- › Refurb existing substations



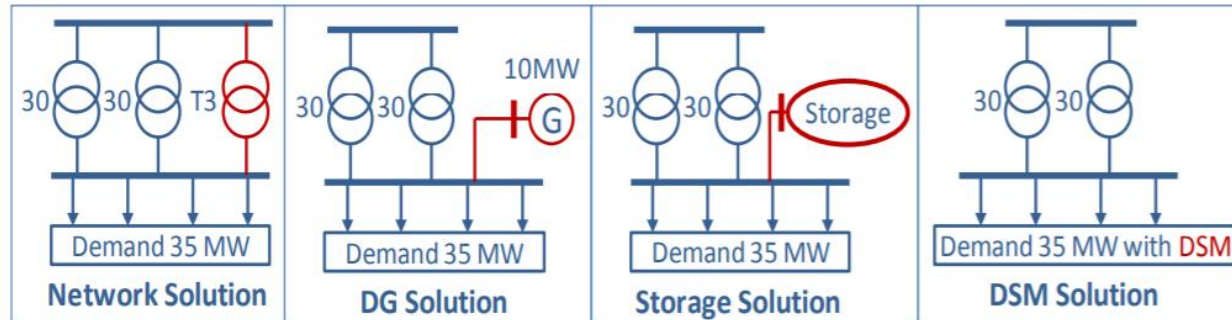
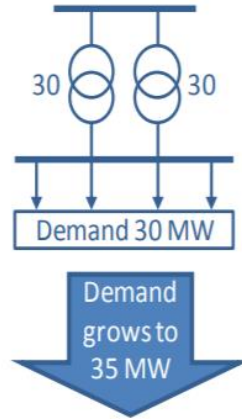
- › DNO network investment planning is the key to unlocking this market.
 - New gen connections
 - New demand connections
 - Network reinforcement
 - Network refurb?



Source: ENA

- › Barriers to CBA
 - Data
 - Data management
 - Data - cost of services
 - Scenario planning processes
 - Cost and risk signals to DNOs – distribution ANM schemes (risk on generator) Vs transmission Connect and Manage (risk on SO)

Can you really trust non-network solutions?



OK

?

?

?

Claire Spedding

Head of Business Development
National Grid

Service Markets and the Ongoing Reform

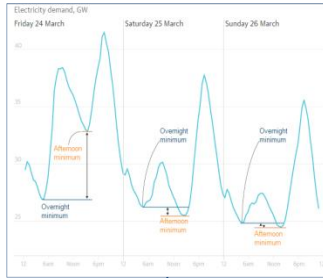
Claire Spedding

Head Of Business Development,
National Grid Electricity System Operator



The Electricity Industry is Changing nationalgrid

Mar '17



May '17



Mar '18



Apr '17

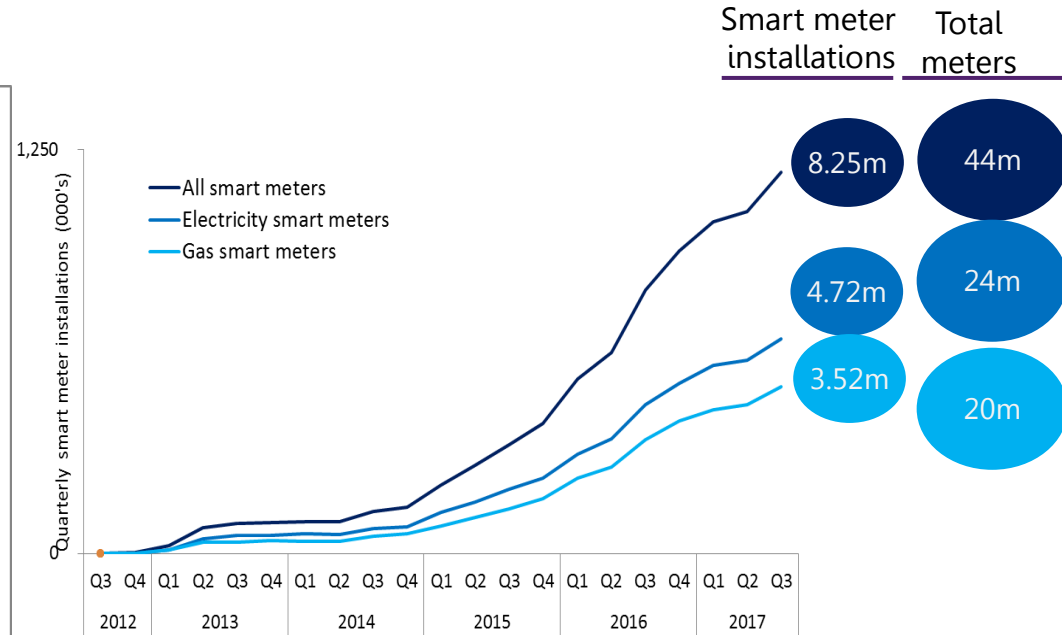
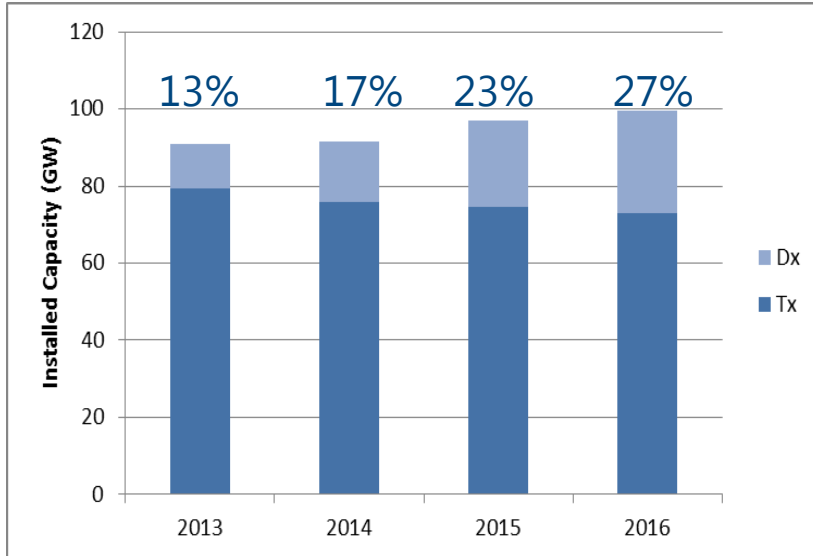


Jun '17



Apr '18

Decentralisation and digitisation



SNaPS & Product Roadmaps



- ◆ System Needs and Product Strategy
- ◆ Frequency Response and Reserve
- ◆ Reactive Power
- ◆ Restoration

Stage 1

Rationalise existing product suite through removal of obsolete products.

Stage 2

Simplify remaining services through standardisation and greater transparency of T&Cs, procurement windows and assessment methods.

Stage 3

Develop **improvements** in services in conjunction with industry.

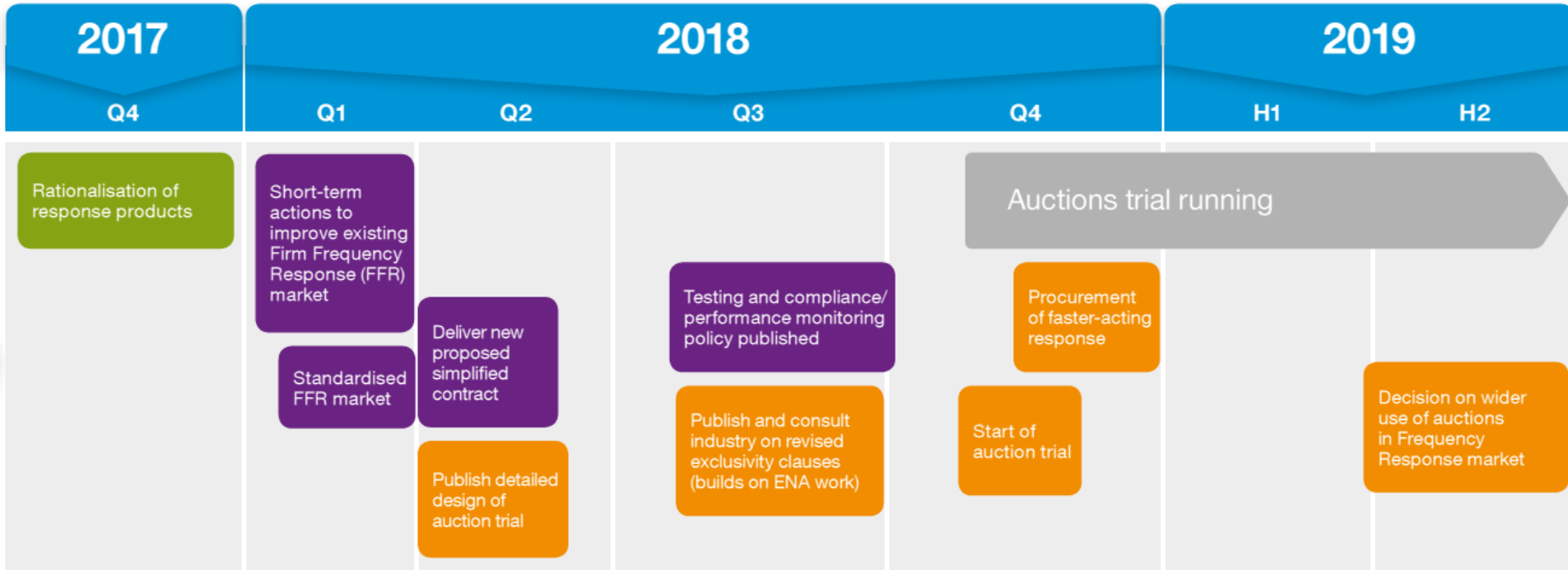
Principles

Our procurement decisions will be transparent and our methodology and needs will be clear to the market ahead of time

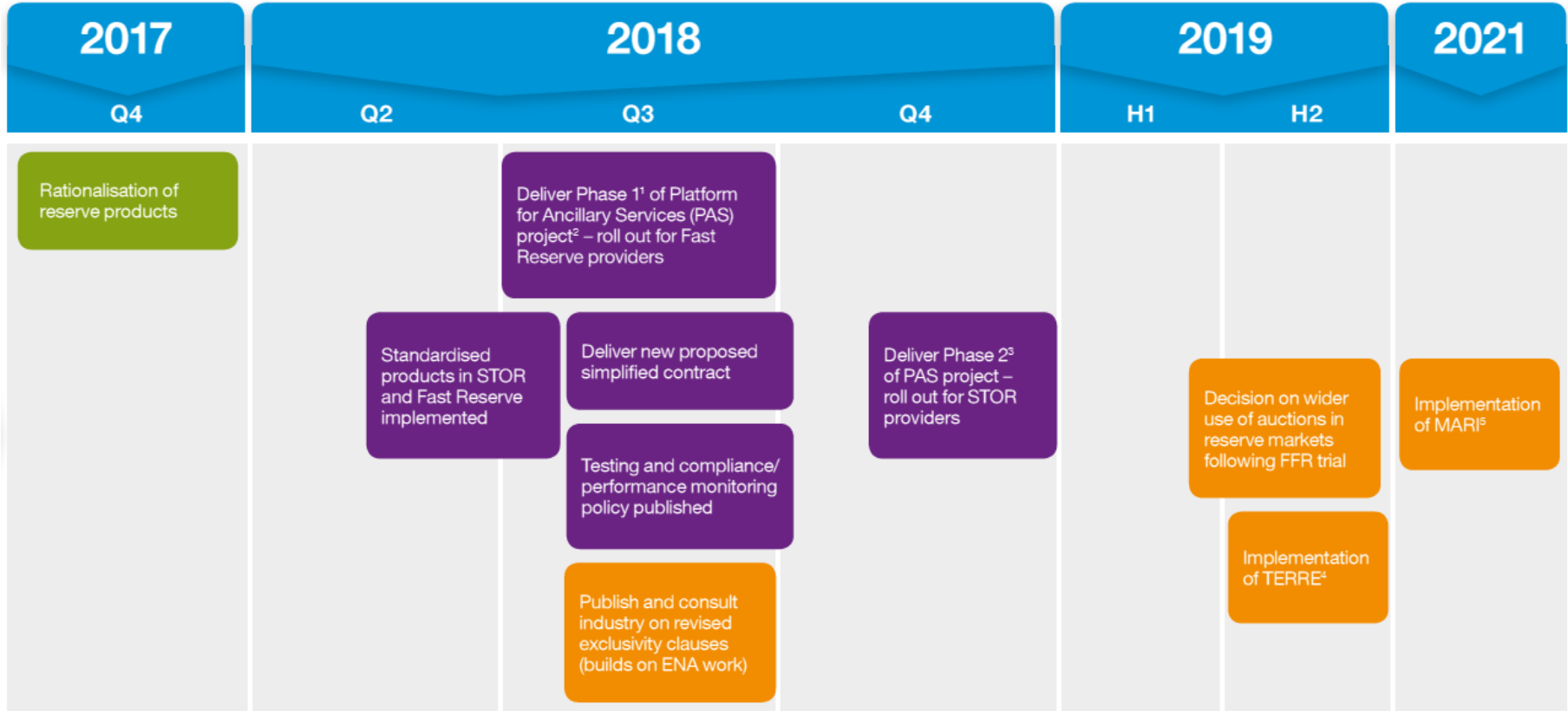
The design of our products, the way we procure, and the contractual arrangements will increase competition in provision of services to the SO

Our products will be designed to balance both operational requirements and the technical ability of provider assets while maintaining system security

Frequency Response - Roadmap



Reserve - Roadmap



Reactive Power - Roadmap

2018/19		2019/20		2020/21		2021/22
Q3	Q4	H1	H2	H1	H2	All year
Raise a CUSC modification for removal of ERPS*	Deliver changes to the MBSS that provide greater transparency of costs and actions					
Raise ORPS** concerns with CUSC Issues Standing Group						
Publish an invitation for Expressions of Interest for provision of Reactive Power service in South Wales	Work with network owners to design an approach for efficient Reactive Power flows between networks		Work with network owners to implement previously designed approach for efficient Reactive Power flows between networks			
	Work with industry to determine the future role for Reactive Power and design more competitive commercial services					Roll-out of new approach to Reactive Power services***

Restoration - Roadmap

2018/19			2019/20		2020/21		2021/22
Q2	Q3	Q4	H1	H2	H1	H2	All year
Work with industry on provision from new technologies, and on use of new restoration approaches (e.g. whole electricity system approaches)						Trial of market approach for Black Start procurement in one region*	
Improve metrics to provide more transparency on costs and capacity requirements							
Develop a combined services methodology and contract structure							
Develop and evolve a market approach for Black Start procurement							

More Information

- ◆ Annual financial reporting on balancing services (Procurement Guidelines Report): <https://www.nationalgrid.com/uk/electricity/market-operations-and-data/transmission-licence-c16-statements-and-consultations>
- ◆ Future of Balancing Services: <https://www.nationalgrid.com/uk/electricity/balancing-services/future-balancing-services>
- ◆ Power Responsive campaign: <http://powerresponsive.com/>



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reNEWS 

The slide features decorative purple geometric shapes in the corners. A large purple triangle is in the top right corner. In the bottom left corner, there are several overlapping purple shapes, including a large triangle and a smaller rectangle, creating a layered effect.

Paul Jordan

Director of Business Development
Energy Systems Catapult



Ioanna Ketsopoulou

Researcher

The UK Energy Research Centre

UKERC

UK Energy Research Centre

Security of UK Energy Futures

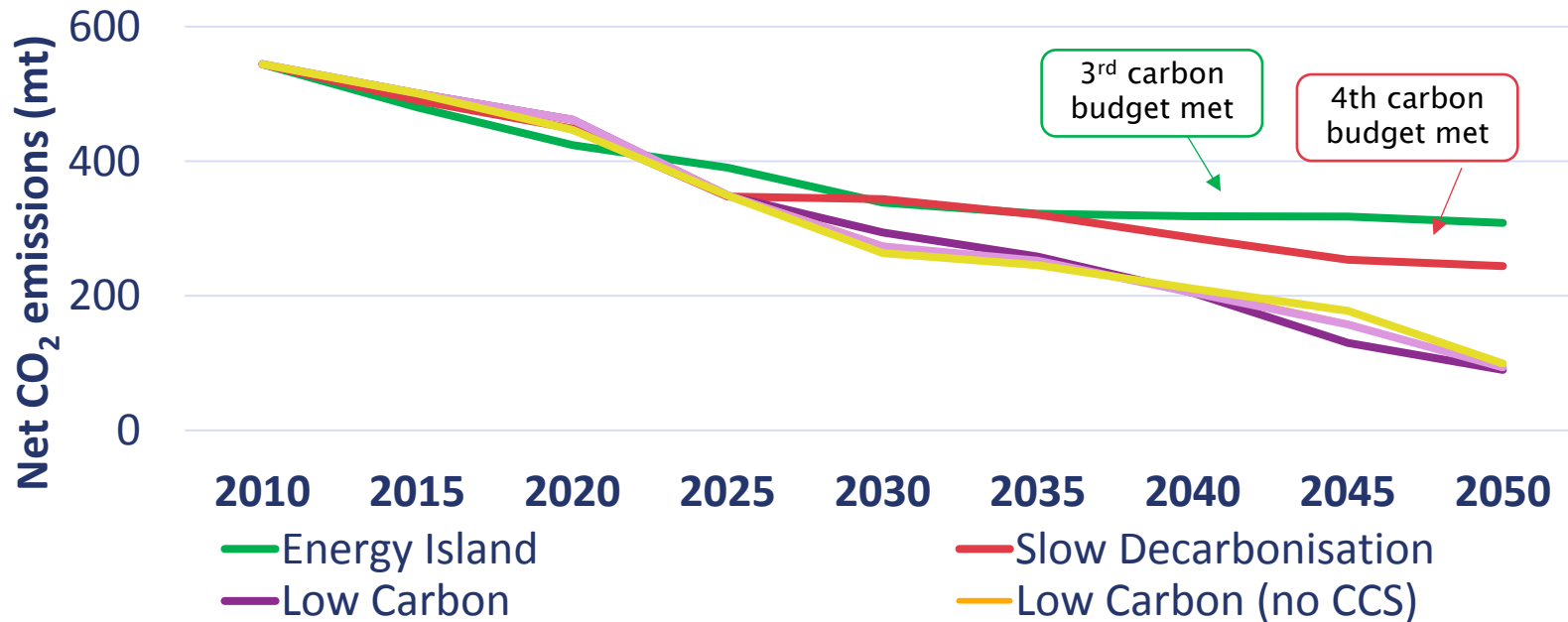
Ioanna Ketsopoulou (with Jim Watson, Modassar Chaudry, Simon Tindemans, Matt Woolf & Goran Strbac)

13th June 2018

Outline

- 2018 UKERC scenarios
- Assessing energy security: a dashboard approach
- Security assessment: selected results
- Conclusions

2018 UKERC energy scenarios



2018 UKERC energy scenarios

Each scenario also has a narrative, including:

- Economic policy and the role of the state
- National and international climate policy
- International trade and the relationship with the EU
- Fossil fuel prices
- Environmental awareness
- Technological change

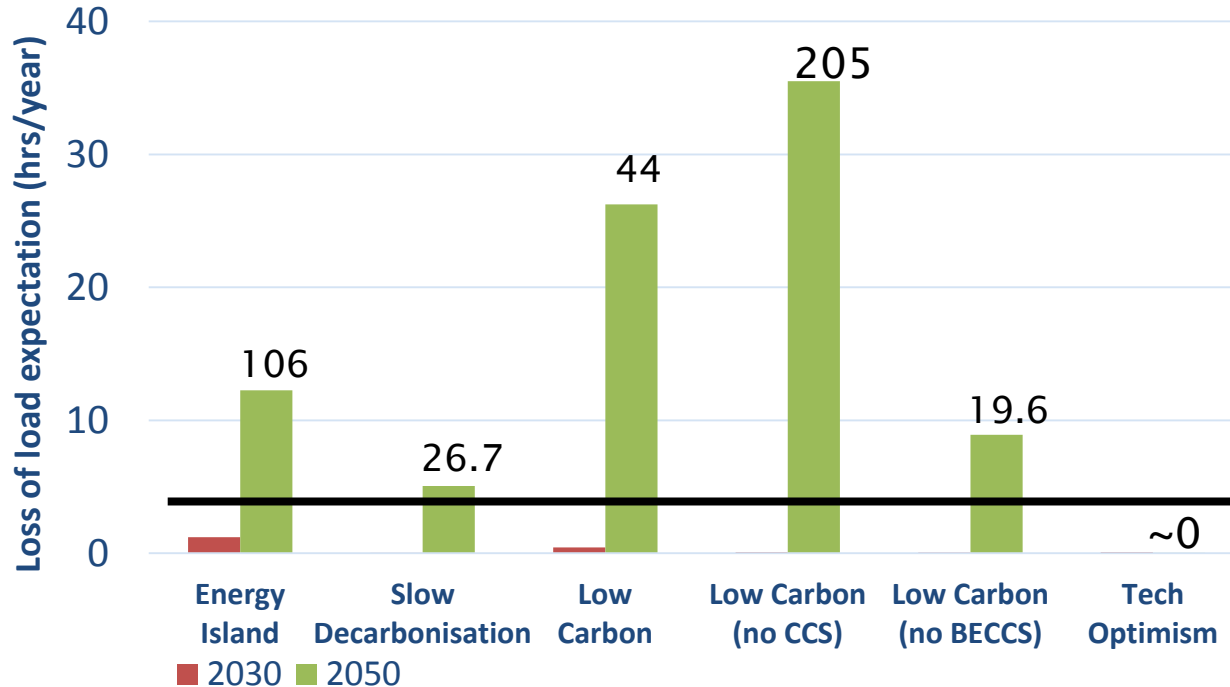
Assessing energy security

A dashboard approach



Reliability indicators

Electricity: loss of load expectation

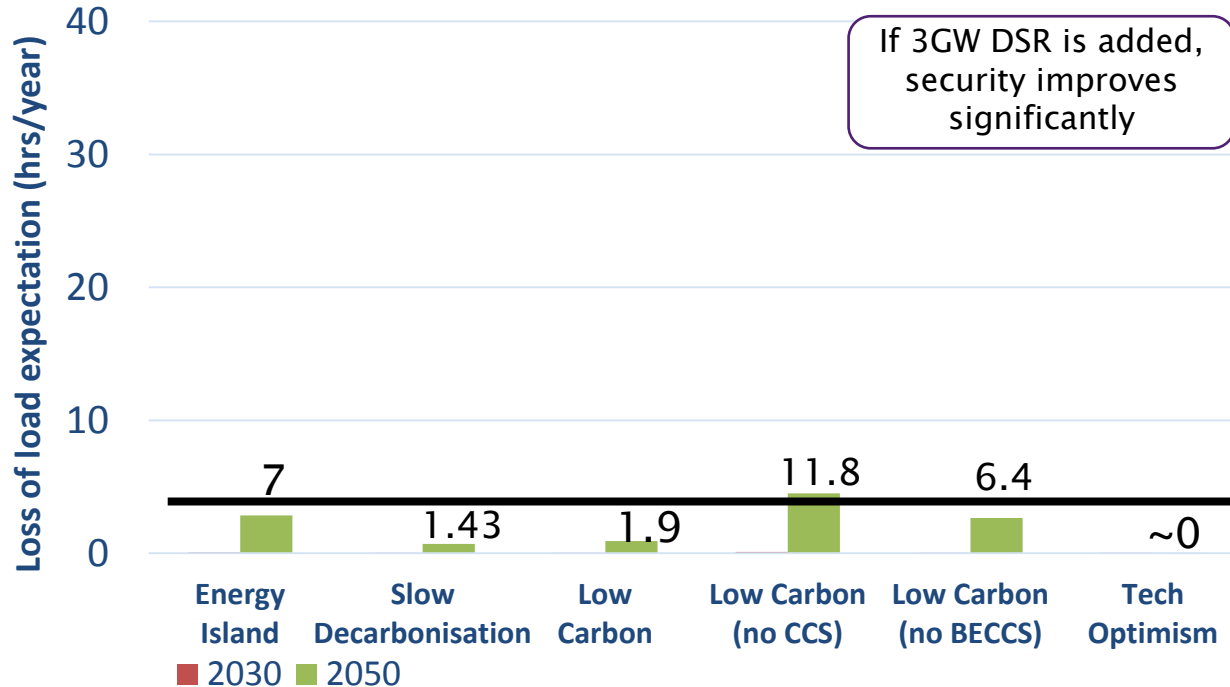


Security standard (LOLE): 3 hours per year
Expected energy unserved in 2050 (GWh)

- LOLE in all scenarios in 2030 are below the 3 hr/year target
- Large differences in LOLE and EEU for the scenarios in 2050
- Large LOLE values are due to combination of low de-rated capacity margins, type of generation (renewables), reliability of plants etc

Reliability indicators

Electricity: loss of load expectation

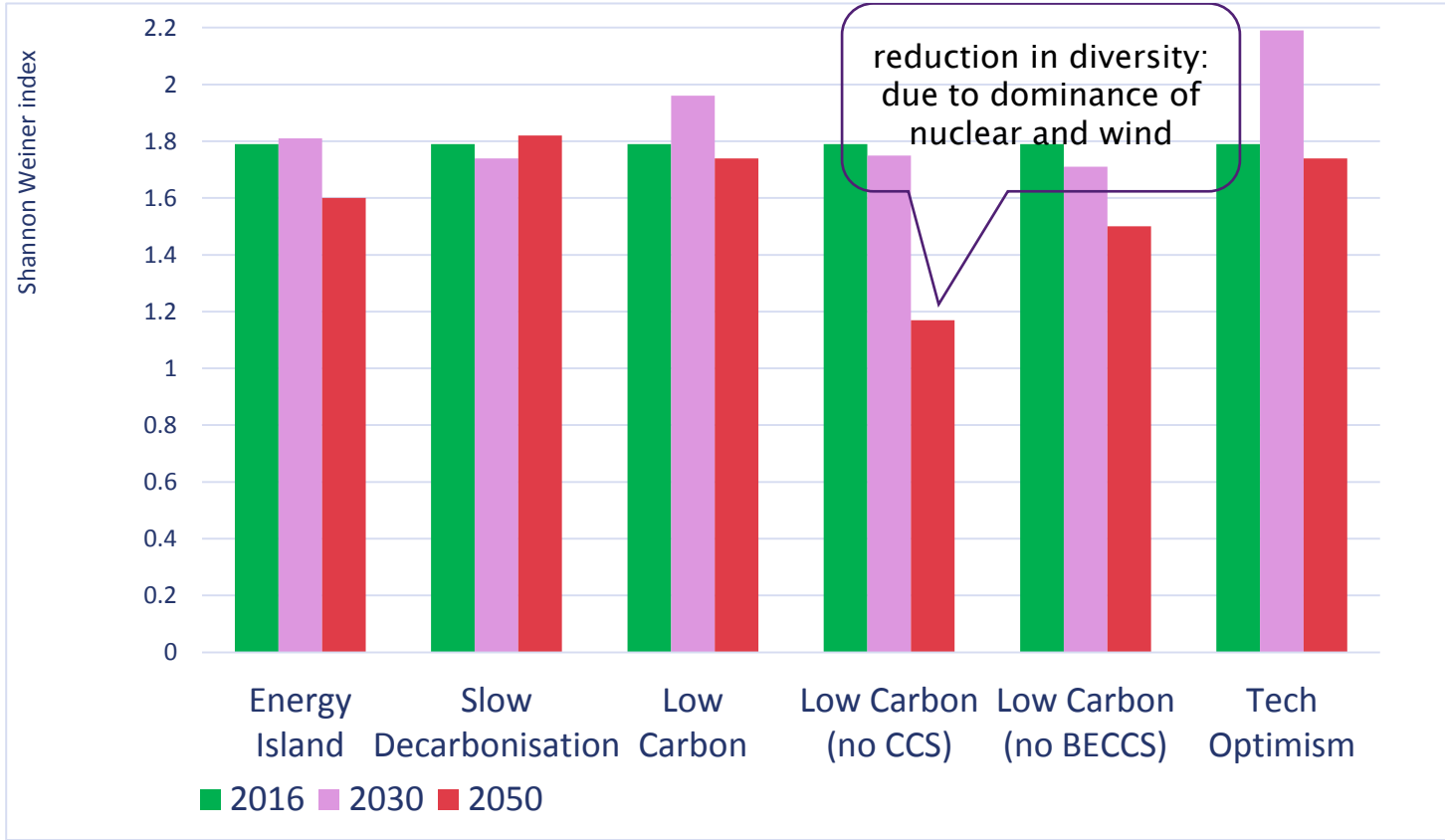


Security standard (LOLE): 3 hours per year
Expected energy unserved in 2050 (GWh)

- 3GW of DSR was assumed
- Nearly all LOLE values across all scenarios in 2050 are below the 3 hr/year target
- EEU in the Low Carbon (no CSS) scenario drops from 205 to 11.8GWh
- DSR frees up capacity (generation; demand) and thus reduces bottlenecks across the system.
- A LOLE of 8-10 hr/year ~ 99.9% system reliability

Availability indicators

Electricity diversity



Summary dashboard

2050 vs 2016

	Energy island	Slow decarb	Low carbon	Low carbon (no CCS)	Low carbon (no BECCS)	Tech optimism
Energy diversity	↑	↑	←	↑	↑	←
Electricity diversity	←	↑	↑	↓	←	↑
Public opposition (elec)	←	↓	↓	↓	↓	↓↓
Oil imports	↓↓	↑	←	↓	↓	↓
Biomass imports	↓	↑	↑	↑	↑	↑
Gas imports	↓	↑	↑	↓↓	↑	←
Gas LOLE	←	↑	↑↑	←	←	←
Electricity LOLE	↑	↑	↑↑	↑↑	↑	↓↓
Interconnector capacity	←	↑	↑	↑	↑	↑

Conclusions

- The relationship between decarbonisation and energy security is not straightforward
- *Technology Optimism* and *Energy Island* have fewer 'red lights' than other scenarios:
 - *Technology Optimism* meets statutory carbon targets, and has lowest final energy demand
 - *Energy Island* misses climate targets from 3rd carbon budget; restricts imports; includes coal revival
- *Slow Decarbonisation* and three of the *Low Carbon* scenarios could have higher risks
 - Electricity and gas system reliability inadequate in some cases without further interventions

Conclusions

- Gas and electricity system reliability can be improved significantly through DSR and storage
- Important to interpret our results with care:
 - Some indicators are only partial proxies for specific risks (e.g. risk of public opposition; extent of flexibility)
 - Energy imports can be a misleading indicator: share of demand plus diversity of sources / routes matter too
 - Impact of electricity storage is likely to be underestimated due to energy systems model limitations
 - Detailed analysis of costs in 2030 and 2050 is difficult
- Some important risks have not been assessed: e.g. climate change impacts and cyber security

UKERC

UK Energy Research Centre

Thank you!

@UKERCHQ

www.ukerc.ac.uk



Charles Moore
Energy and Policy Analyst
Sandbag

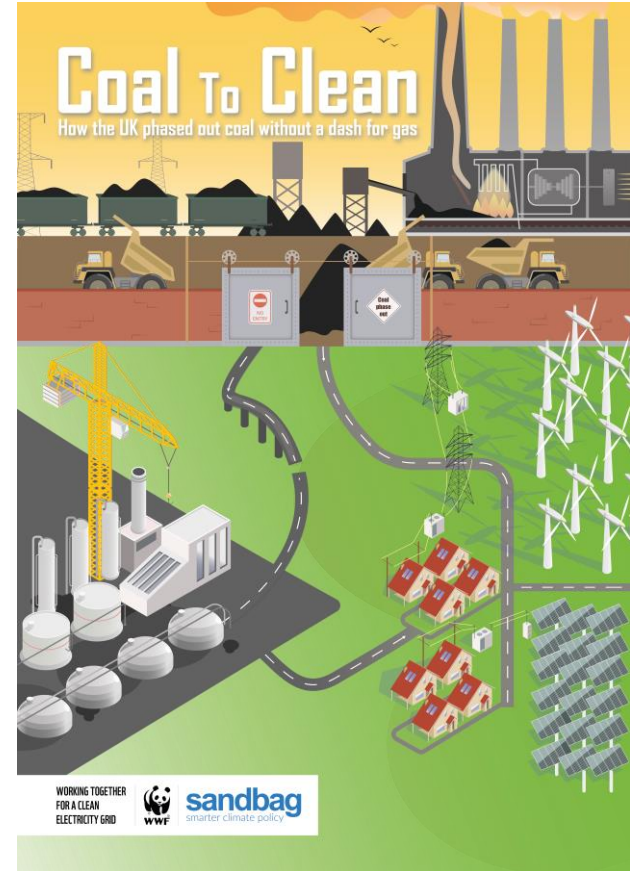
Coal to Clean

Storage & Systems Conference 2018

Charles Moore – Energy & Policy Analyst
[@sandbag.org.uk](mailto:charles@sandbag.org.uk)

Key Questions:

- Is it possible to phase-out coal without building new large gas plants?
- If so, what type of capacity will replace coal to ensure the lights stay on?
- Are enough renewables being built to replace coal without increasing gas use?
- What do the running hours of each part of the legacy gas fleet look like in 2025?



Most of the firm capacity required to replace coal has already been contracted

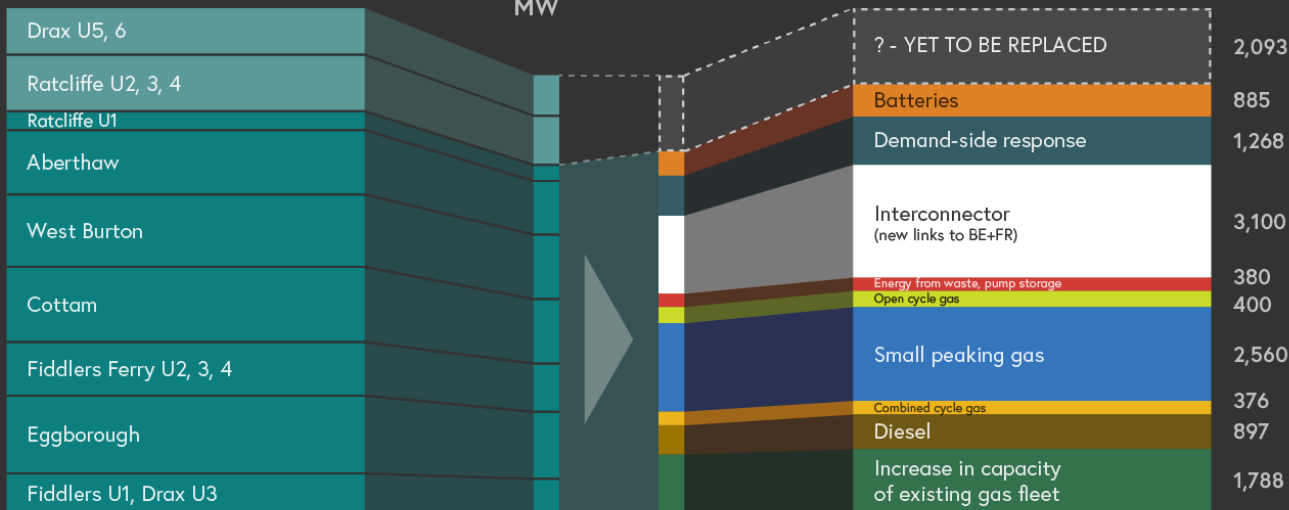
7 coal plants need to be replaced by 2025...

5 coal plants have already been replaced

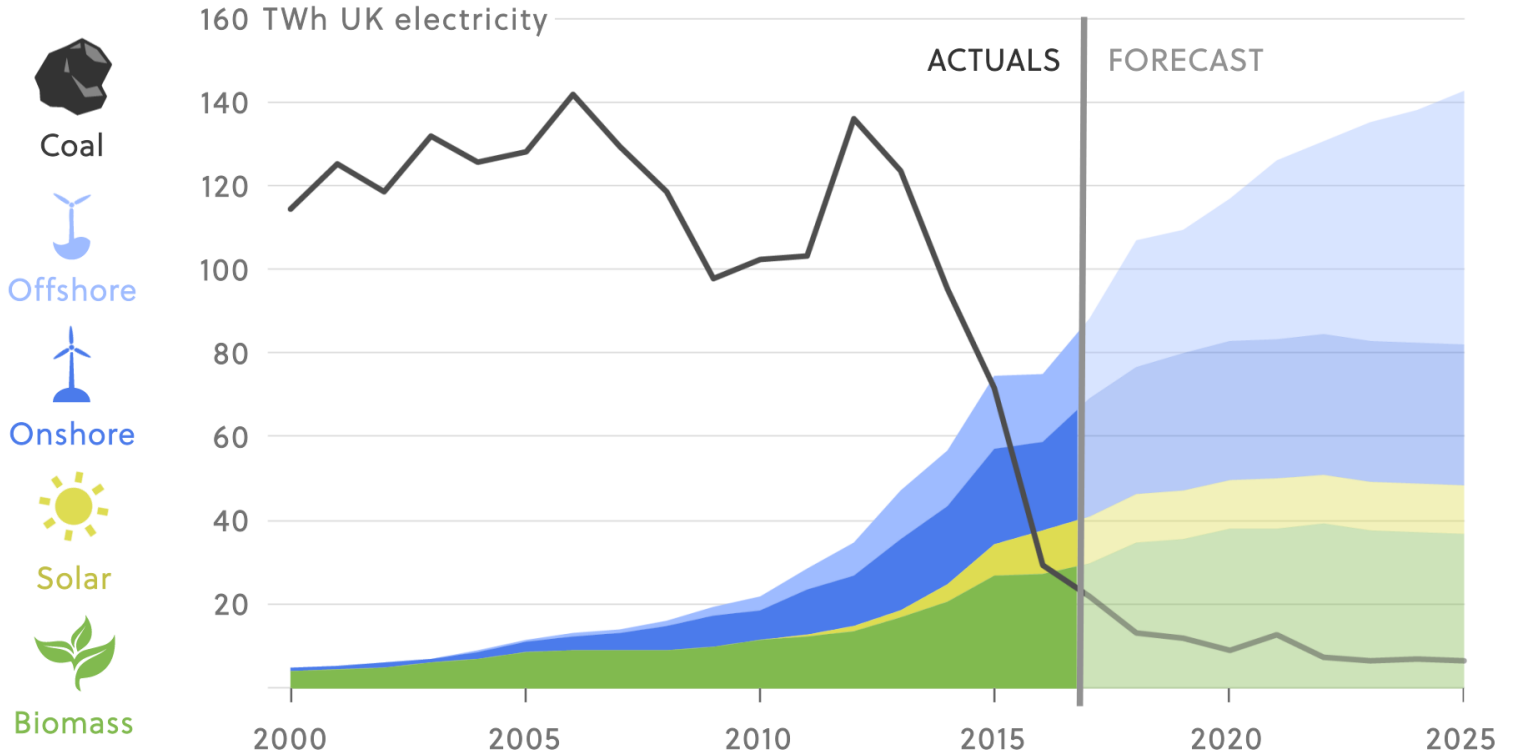
13,747 MW

11,654 MW

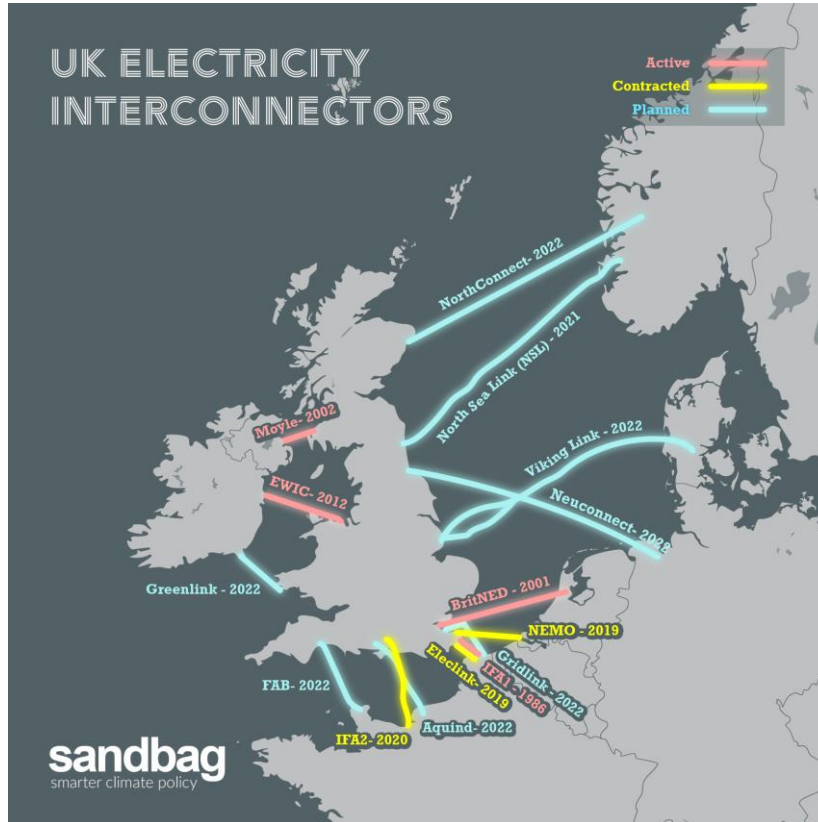
REPLACED
MW



By 2025 electricity generated from renewables will surpass coal's peak this century



The role of interconnection will grow substantially by 2025



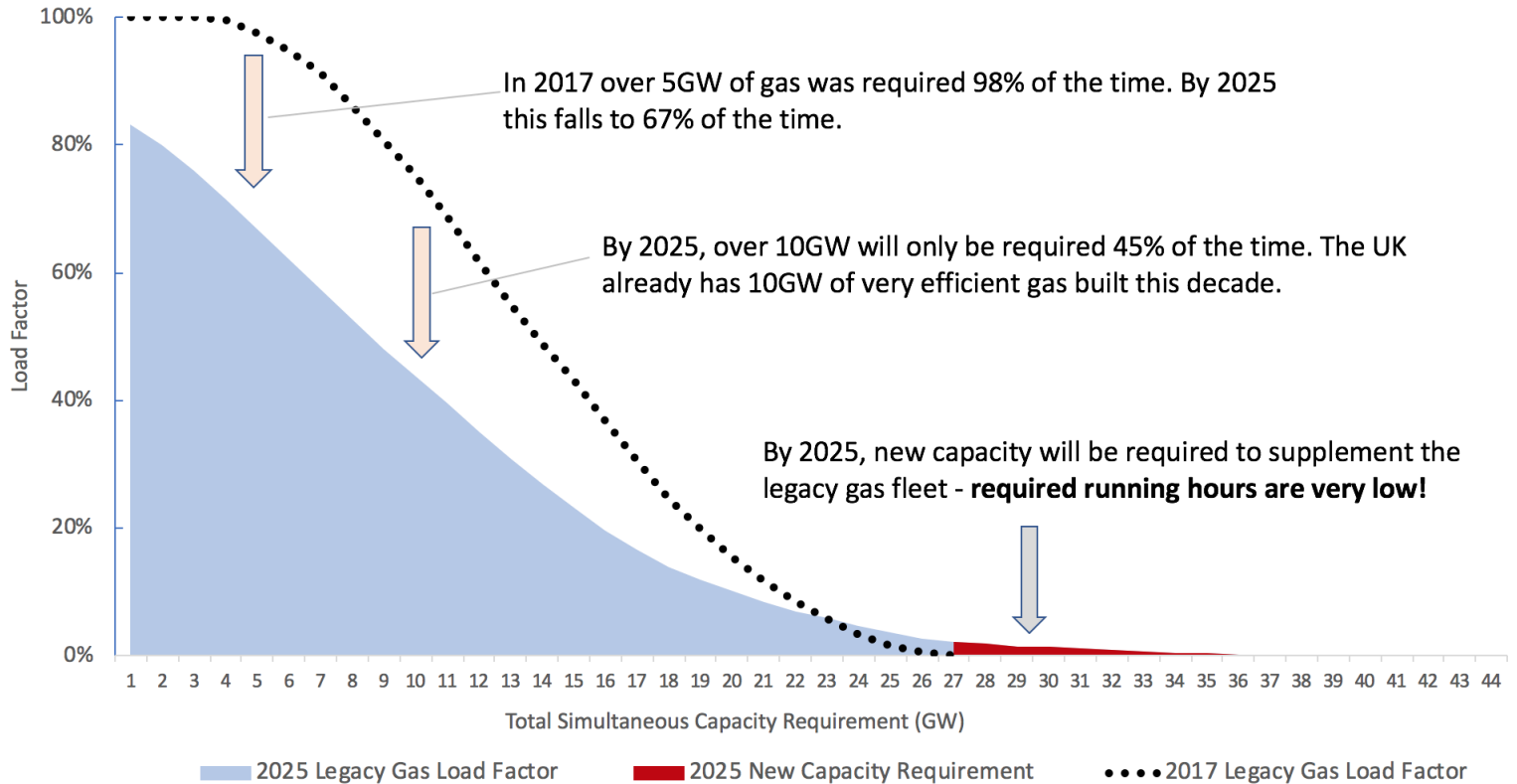
> 15 GW

Interconnectors planned or under construction. (11 GW with Cap & Floor)

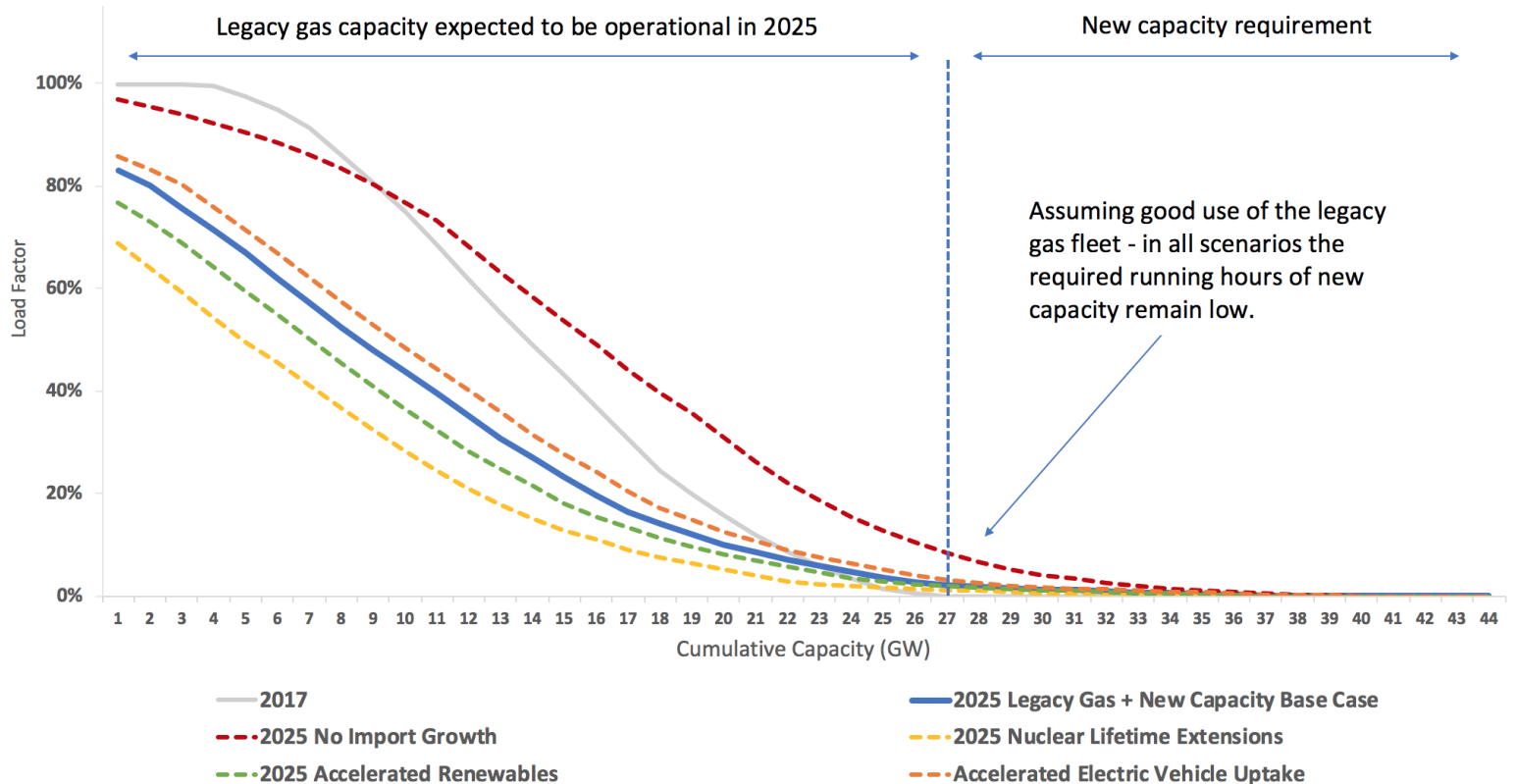
22%

Forecast contribution to UK 2025 electricity supply

The UK already has all the baseload capacity it is likely to need



Current UK baseload capacity looks adequate under a wide range of scenarios



Conclusions:

- **The UK's coal phase-out, announced in 2015, does not require any new large gas plants.**
- Given good use of the existing gas fleet – the UK already has all of the baseload capacity it needs.
- The review of the Capacity Market ***should not*** promote new build large gas – this would be a poor use of public money.
- New capacity is required to ensure the lights stay on during periods of low renewables output – but required running hours are low.
- Renewables growth ensures that gas use will not rise as a result of the coal phase-out, in fact, existing gas fleet running hours are likely to be significantly lower in 2025 due to the forecast rise in imports.



Thomas Edwards

Senior Modeller

Cornwall Insight

Security of Supply – Is the Capacity Market working?

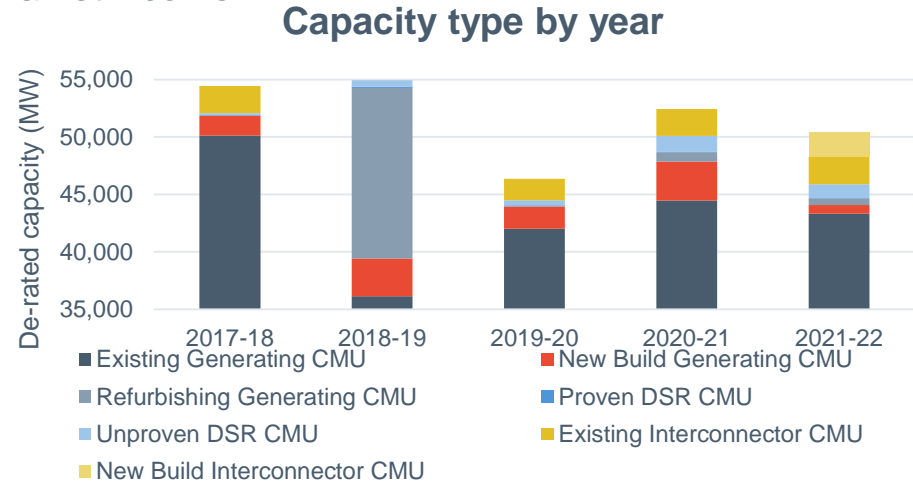
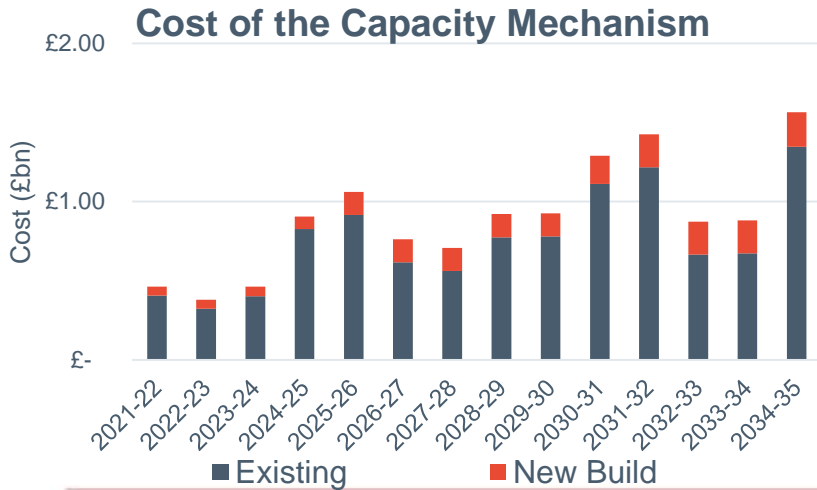
13 June 2018

Tom Edwards



What does the Capacity Market do (and not do?)

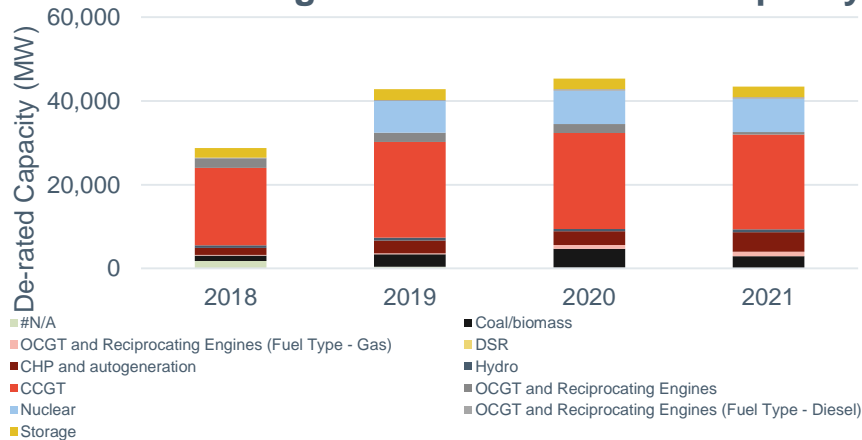
- Flagship security of supply policy
- Competitive, technology neutral, auction to meet a Loss of Load Expectation target
- Providers paid a £/kW fee annually for their de-rated capacity
- Providers must deliver against a system stress event obligation
 - can never be penalised more than capacity market income



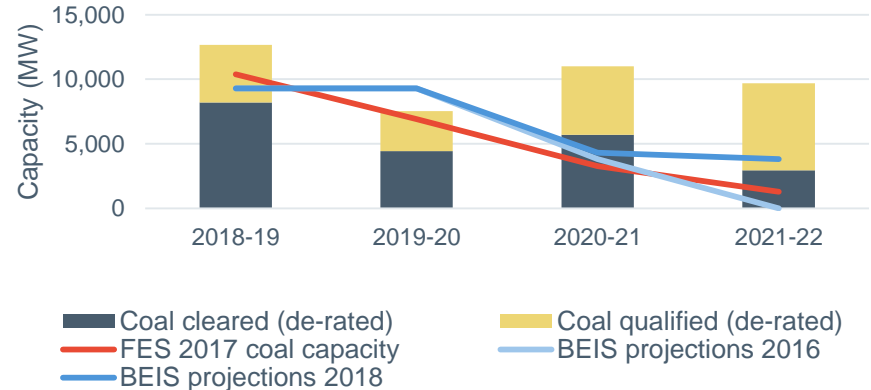
Existing Capacity

- Existing capacity competes against new build capacity
 - can only ever receive a one year agreement
 - cannot exit above £25/kW
- Does this crowd out new-build or provide genuine cost savings?
 - does this extend the life of coal?

Existing Generation De-Rated Capacity



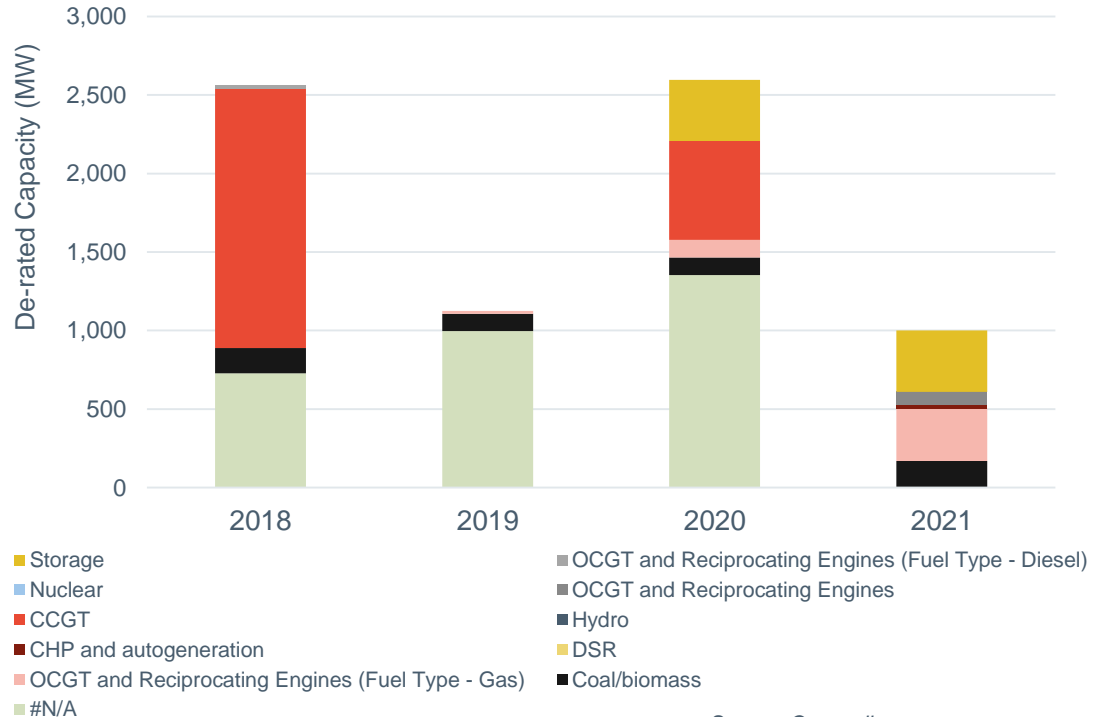
Coal success in the Capacity Market



New Build

- New build supported by agreements up to 15 years
 - must spend at least £255/kW and not be commissioned
- The Capacity Market has bought over 5GW of new build capacity
 - majority of this small scale distribution connected engines > 3.5GW
 - over 1GW storage

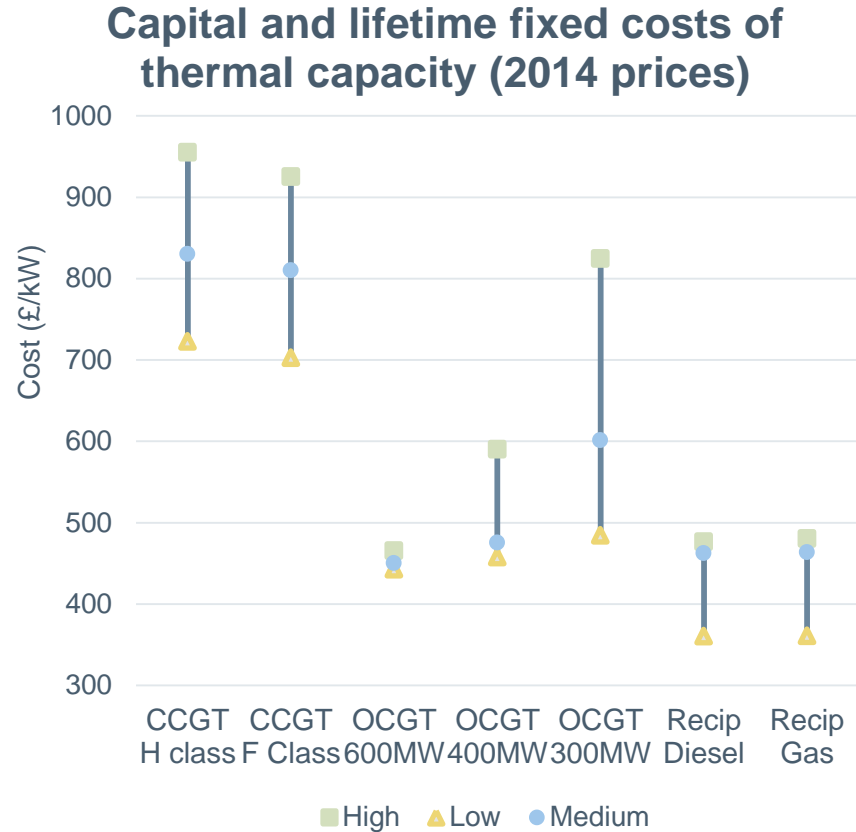
New-Build Generation De-Rated Capacity



Source: Cornwall
Insight

New Build - Thermal

- Most successful new build capacity is embedded reciprocating engines
 - cheaper
 - access to embedded benefits
- Some new build CCGT has come forwards
 - Kings Lynn A
 - Spalding
 - Keadby – without agreement signed!

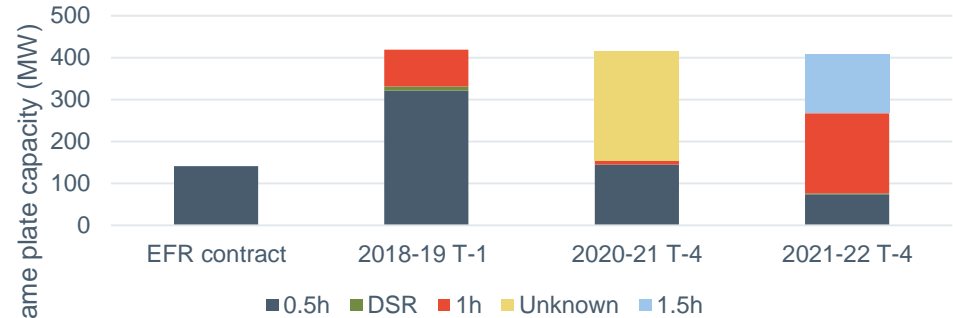


Source: BEIS Generation Costs report

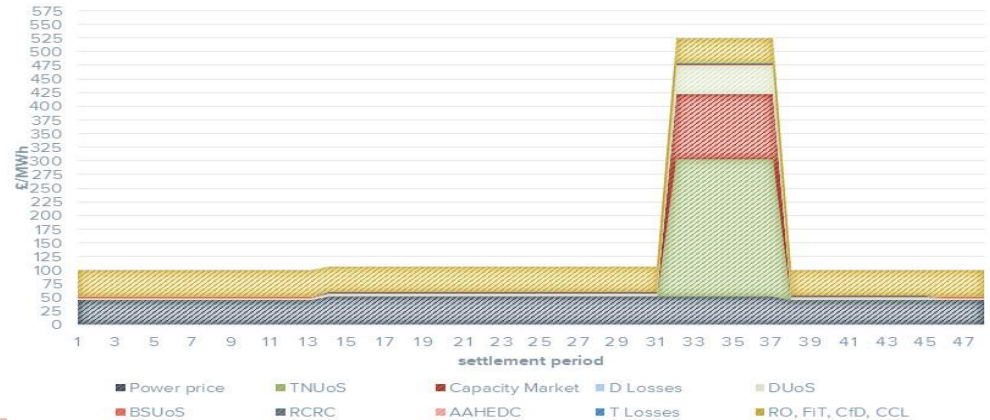
New Build - Storage

- Battery business case improvement
 - expanding requirement for flexibility and increasingly volatile power prices
 - falling technology costs
- Also facing headwinds
 - de-rating changes within the Capacity Market
 - embedded benefits
- Moving towards co-location and behind the meter
 - TCR headwinds

Battery capacity in CM auctions by duration

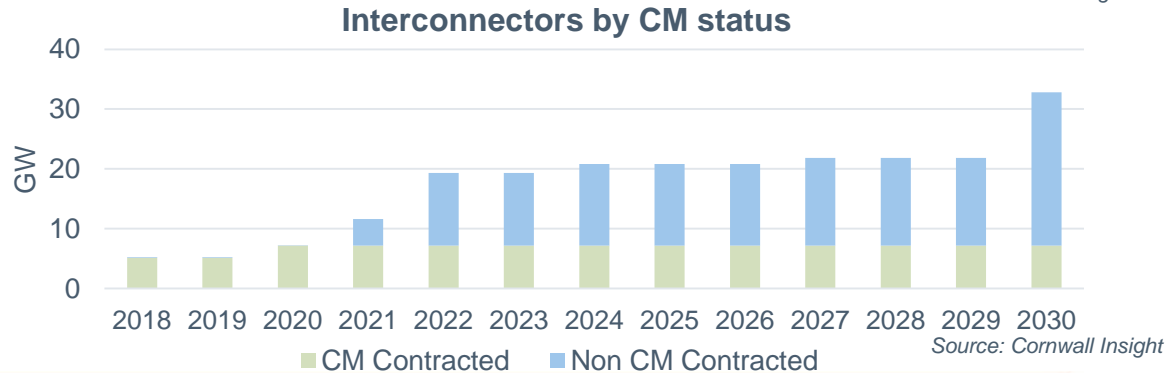
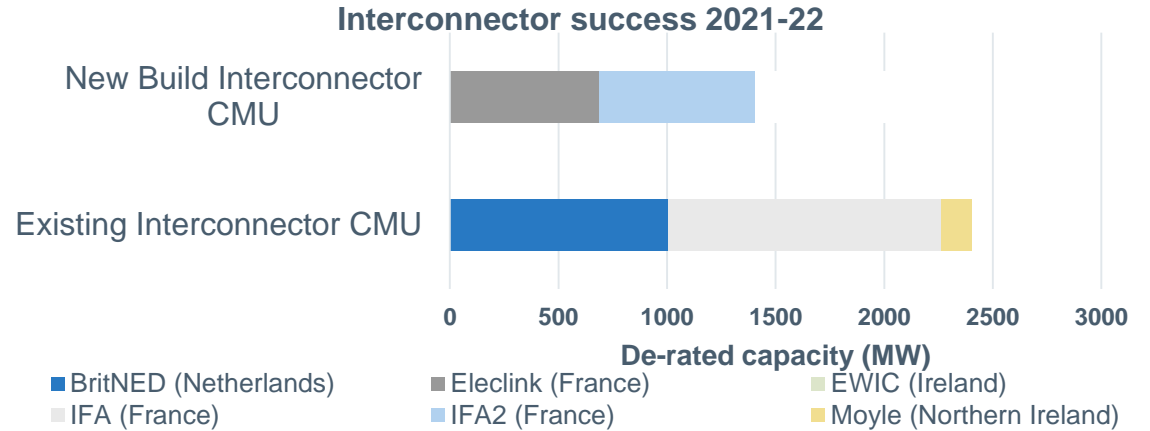


Time of Use tariff UKPN-E 2020-21



New Build - Interconnectors

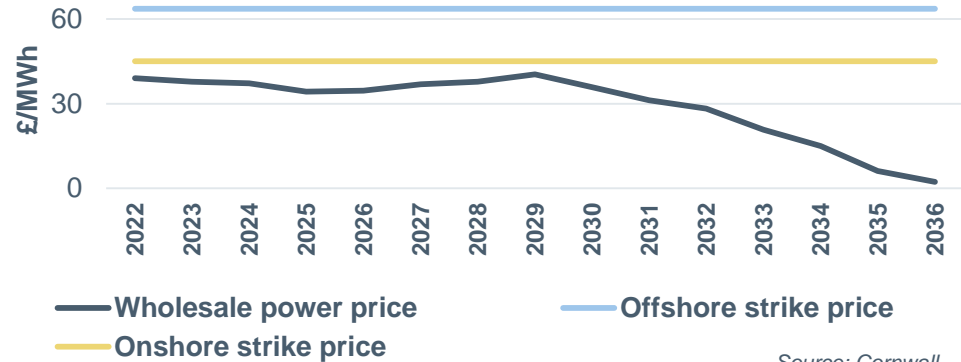
- EU requirement for non-GB capacity to compete
 - interim approach to allow interconnectors to participate
- Cap and Floor mechanism supports
- Debates over appropriate level of interconnection
- By 2022 there could be over 17GW of interconnection
 - 10GW cap and floor 7GW merchant



New Build - Renewables

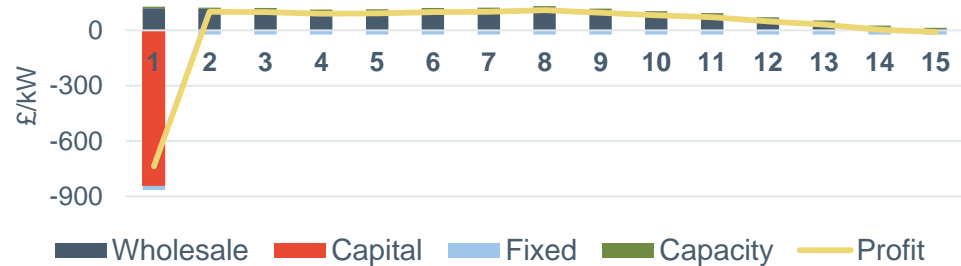
- Renewables are not excluded from current CM design if unsubsidised
 - no de-rating factors
- Innogy tried to qualify a wind farm for 2021-22
- Rule change raised to include wind and solar
 - Ofgem considering for 2023-24
- De-rating factors crucial
 - for example Grid uses EFC of 17% in its outlook reports
 - 5% for solar in Irish CRM

Wholesale power price and strike prices



Source: Cornwall Insight

Onshore wind in the Capacity Market



Source: Cornwall Insight www.cornwall-insight.com

Is the Capacity Market working?

- Recent results have shaken confidence in the mechanism
 - are low clearing prices here to stay?
 - our estimates range between £8.4/KW and £31/KW in the upcoming decade
- Developers have had to get more comfortable with volatile revenues
 - Ancillary services
 - BM
 - Cashout
- Alternative routes to market
 - behind the meter
 - corporate PPAs
- Capacity delivered has been peaking and flexible
 - more value going forwards in short-term markets
- Interconnectors and CfDs increasingly take on baseload space in the market
- Prices should rise eventually when nukes and coal retire
 - but what replaces it?

Tom Edwards

Senior Modeller

T.Edwards@Cornwall-
insight.com



An impartial view


Our opinions are based on facts,
never biased or influenced by others

An expert view

Our analysis leverages the collective
expertise of our team in
comprehensive research, insight and
training

An integrated view

Our research and insight integrates
every aspect of the market to best
cover an increasingly complex energy
world



Charles Wood
Policy Manager
Energy UK



Chris McKaig

Outage & Emergency Planning

Manager

Scottish & Southern Electricity

Networks

SSEN Distributed Generation Owner/Operator Forum

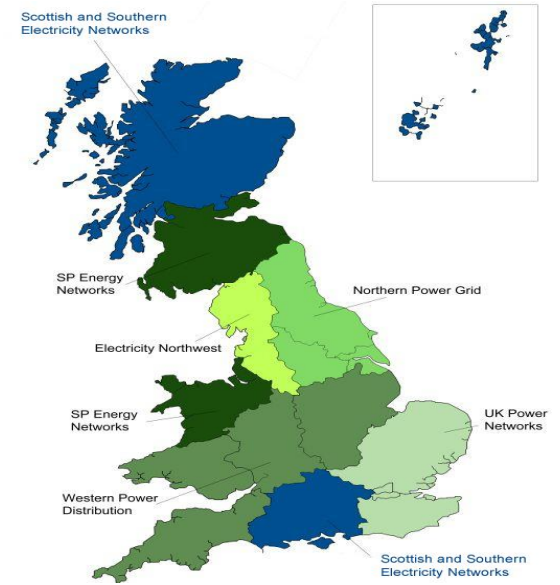
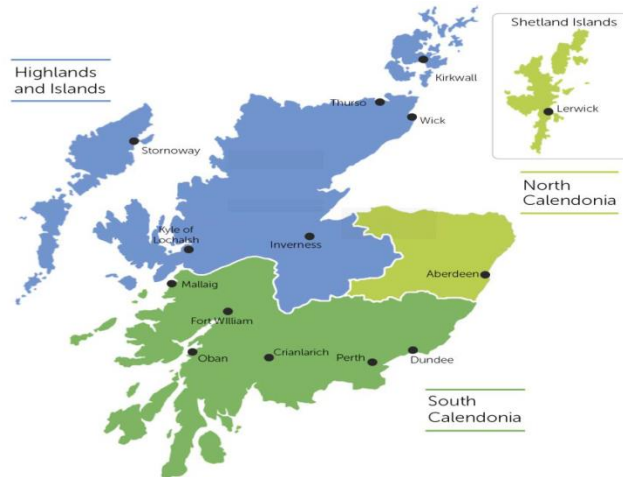
May 2018



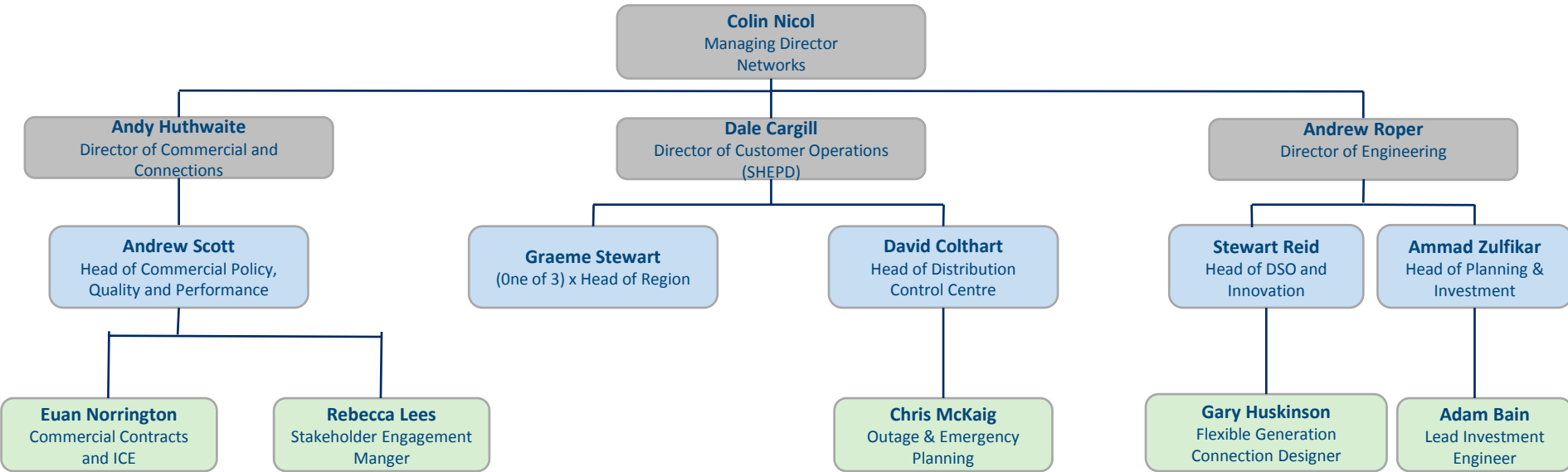
Scottish & Southern
Electricity Networks

Our operating area

- Over 4,000 employees, working from 85 depots and offices in the heart of the community.
- 130,000km of overhead lines and underground cables 106,000 substations
- Over 100 subsea cables, powering island communities
- 3.7m customers served by our networks across central southern England (over 2.9m) and the north of Scotland (780,000)



SSEN Leadership Team



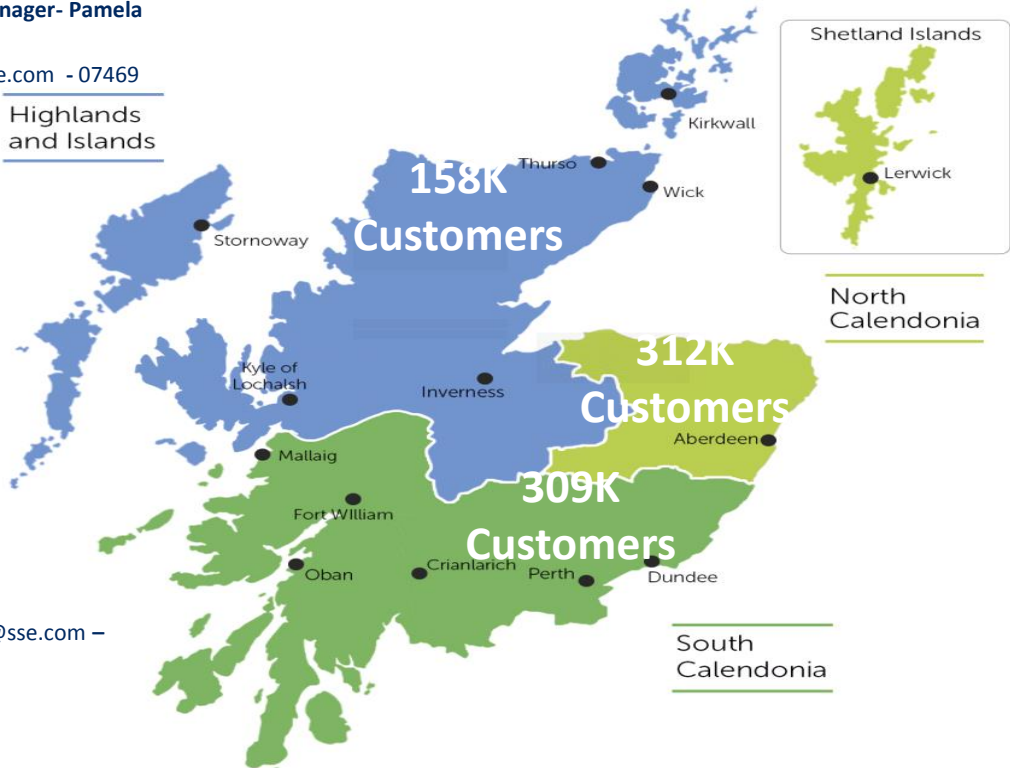
Head of Region - Colin Pirie

E-mail: colin.pirie@sse.com - 07767 852305

Customer Relationship Manager- Pamela Harvey

E-mail: pamela.harvey@sse.com - 07469 411432

Highlands and Islands



Lead Customer Relationship Manager- Chris McKaig

Email: chris.mckaig@sse.com - 07876837186

Head of Region - Neil Wilson

E-mail: neil.wilson@sse.com - 07767 852098

Customer Relationship Manager- Shona Horne

E-mail: Shona.horne@sse.com - 07500912566

Head of Region - Graeme Stewart

E-mail: graeme.stewart@sse.com - 07825 843868

Customer Relationship Manager- Samantha O'Connor - 07584 313059

SHEPD Outage Planning –

E-mail: Distribution.Outages@sse.com – 0345 070 7370

Looking Back / Looking Forward

Chris McKaig



Scottish & Southern
Electricity Networks

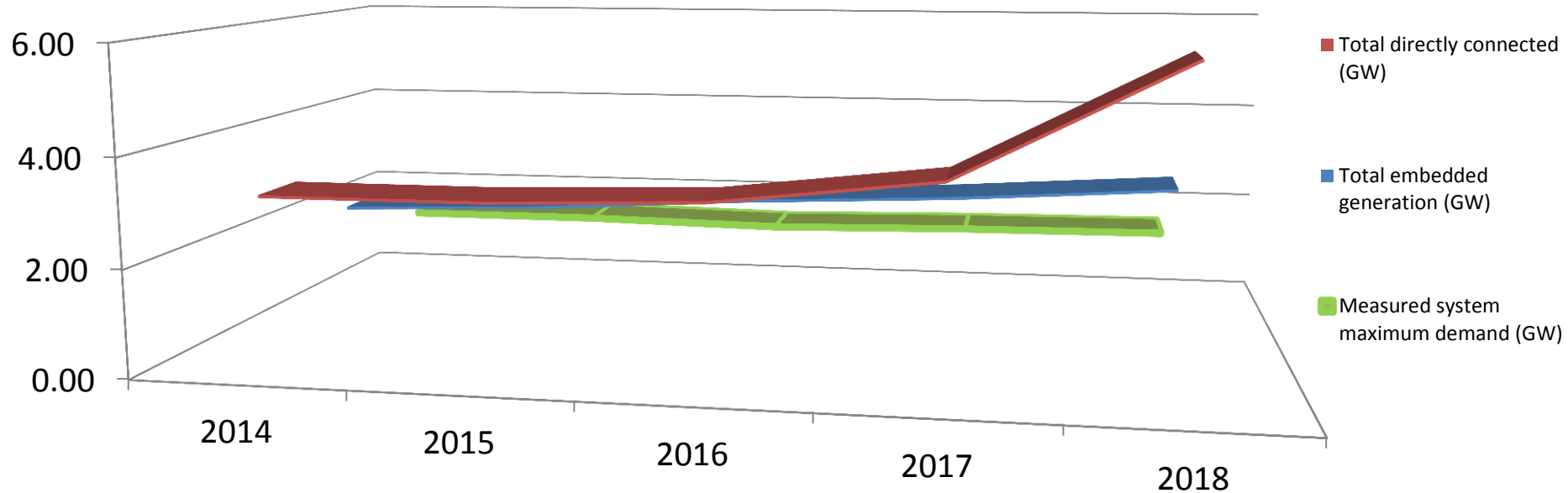
Looking Back

2017/18 Progress and updates

- 7000 planned outages delivered
- 2328 HV faults Number of customers affected is down by 18%
- 882 Constraints issued
- 80 Complaints / Enquiries handled in relation to constraints
- 927 Transmission Outages – 700 planned year ahead KPI 22%

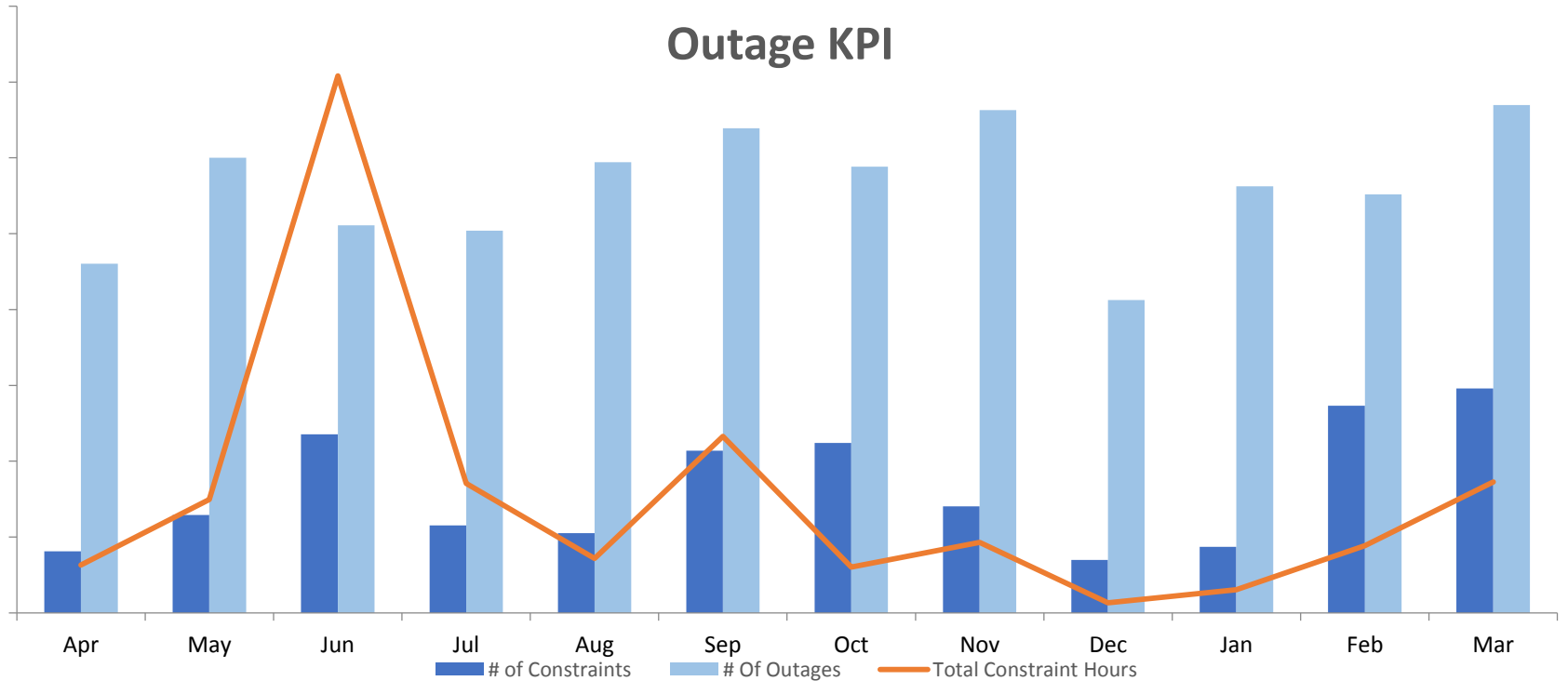
Growth of Renewable Generation

Energy Profile



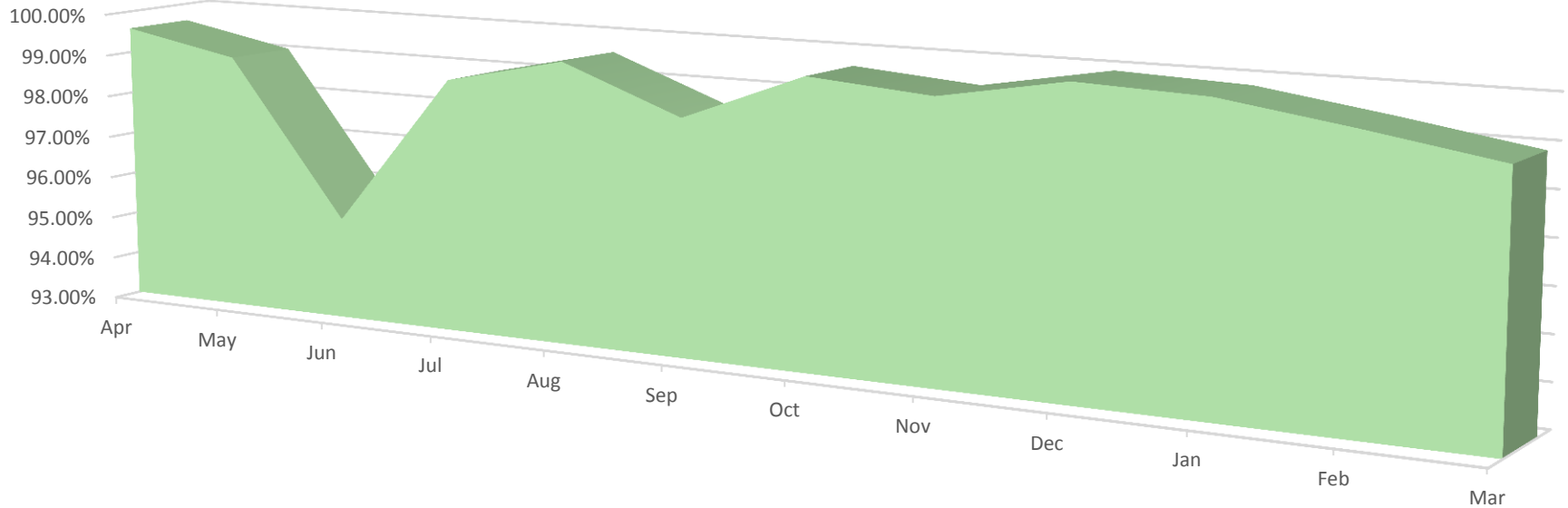
Looking Back Report

Outage KPI



Looking Back Report

Generation Network Availability



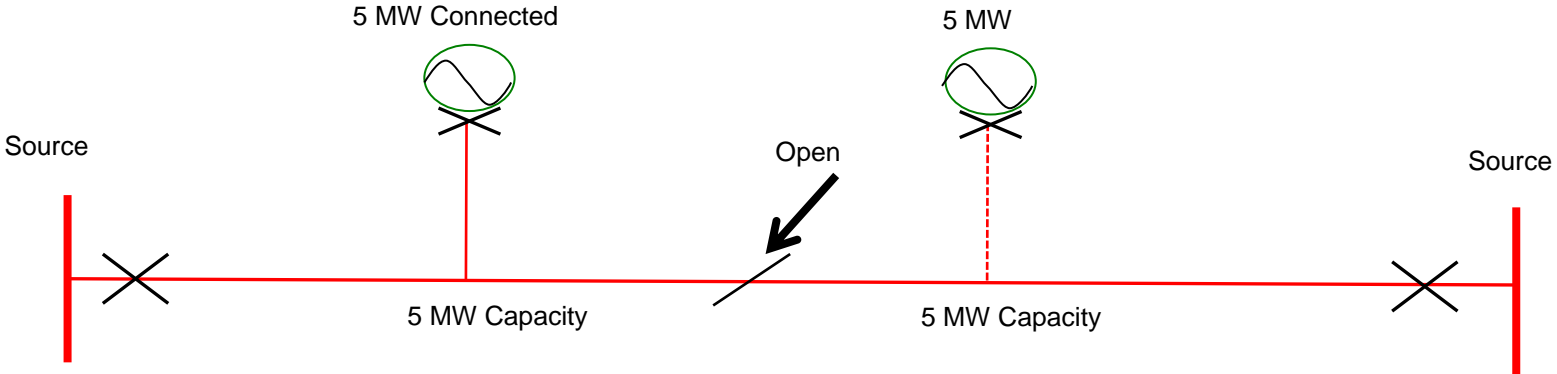
2017/18 Financial Year

Looking Forward

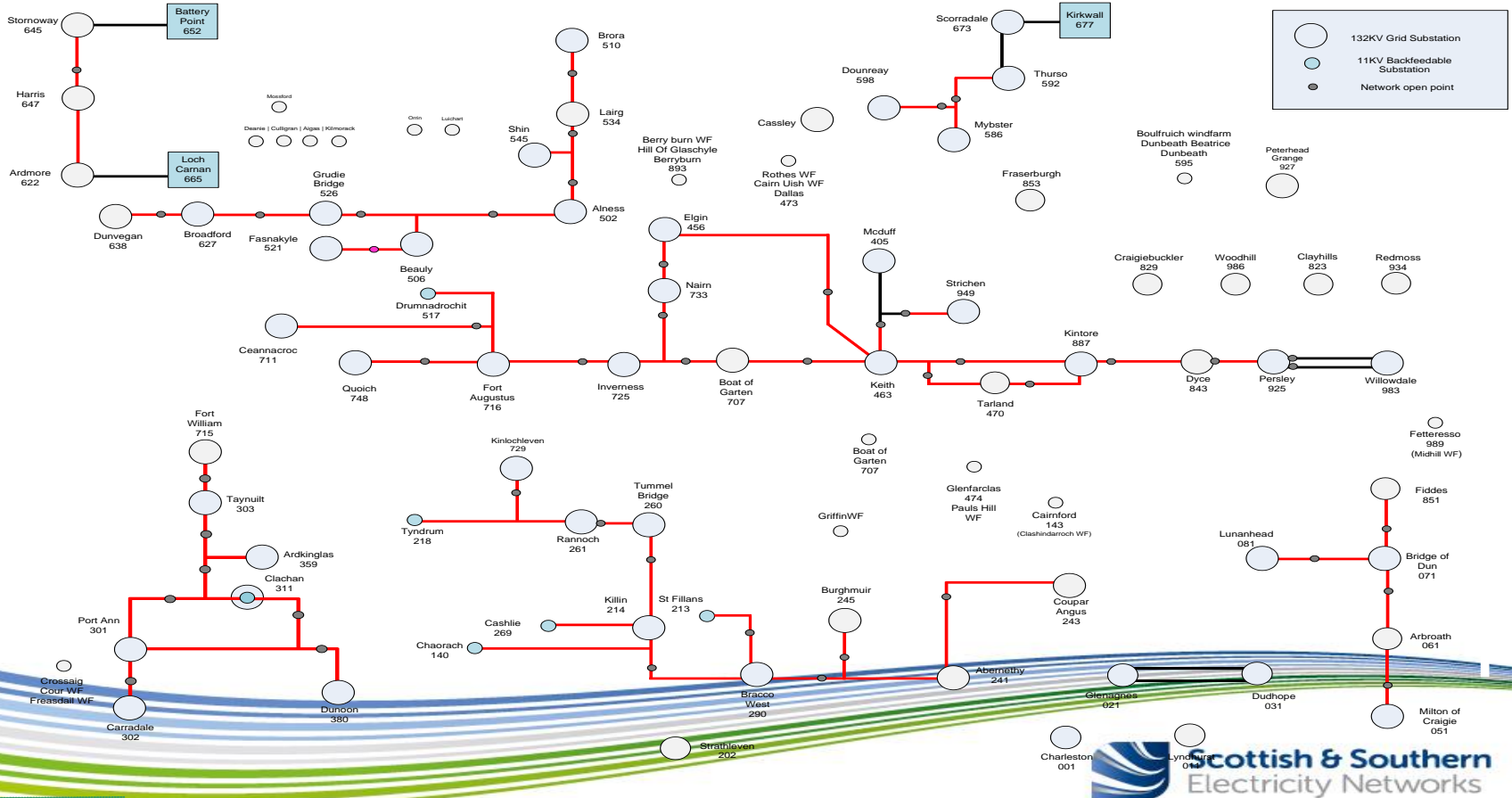
Plans for 2018/19

- Target to reduce customer interruptions by 33%
- Aim to be top performing DNO for Customer service
- Circa £70M to be spent for works on the SHEPD network
- Connecting 74 new exporters
- 523 Transmission Outages planned – current KPI of 41.7%
- 30 Live Line Harvesting jobs 375 working days to be carried out!
- 600 Items of automated plant installed creating 150 automated circuits

Export Security



Export Security cont.



Where to get more information?

- **Connections Charges Methodology Statement**

<https://www.ssen.co.uk/Library/ChargingStatements/SEPD/>

- **Generation heat maps**

<https://www.ssen.co.uk/generationavailability/>

- **Future engagement events**

<https://www.ssepd.co.uk/StakeholderEvent/BasicSearch/>

- **Other useful documents**

<https://www.ssen.co.uk/connections/usefuldocuments/>



Paul Jordan

Director of Business Development, Energy Systems Catapult

Ioanna Ketsopoulou

Researcher, The UK Energy Research Centre

Charles Moore

Energy and Policy Analyst, Sandbag

Thomas Edwards

Senior Modeller, Cornwall Insight

Charles Wood

Policy Manager, Energy UK

Chris McKaig

Outage & Emergency Planning Manager, Scottish & Southern Electricity
Networks



STORAGE & SYSTEMS CONFERENCE

13 JUNE 2018 GLASGOW

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OFFICIAL MEDIA PARTNER





Hannah Staab

Senior Due Diligence Project Manager
Natural Power



Paul Reynolds
Partner
Everoze Partners



Batteries: A Football Story

Paul Reynolds
13th June 2018

THE SET UP...



Also called WBA

FLEXIBILITY LEAGUE TABLE		ESR SPORT
No.	Team	
1	WEST BATTERY ALBION	
2	GAS UNITED	
3	OLD COAL ROVERS	
4	DSR LONDON	
5	PUMPED HYDRO	
6	SOLAR CITY	
7	WIND WANDERERS	
8	TIDAL TOWN	
9	DIESEL SET NORTH END	

GOALS SCORED BY WBA =
REVENUE AVAILABLE



GOALS CONCEDED = PROXY
FOR COSTS (and a function of transfer fees
(capex), wage bill (opex) and stadium costs (grid/land
costs))

SUPPORTING ANALYSIS

MODEL



Battery Storage Feasibility Modelling Tool



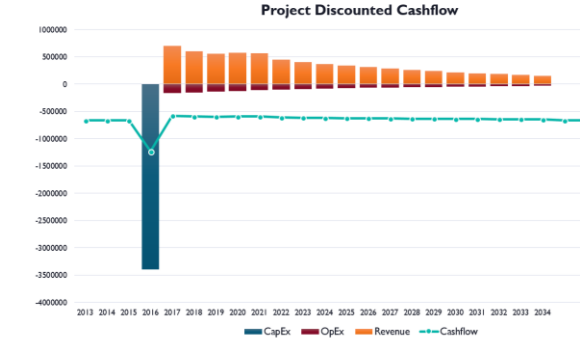
Experience:

- TA or IE on majority of EFR projects
- Due Diligence on EFR and FFR projects and portfolio (Port of Tyne, and others)
- Leading market reports (Cracking the Code; Digital Inertia)
- Market Entry Advice to developers, EPCs, investors and aggregators

INPUTS

- Battery Capacity
 - Power & Energy
 - Nameplate vs usable
 - Degradation for stack
 - Augmentation strategy
- Revenue streams and stacks
 - EFR / FFR
 - Capacity Market
 - Arbitrage (BM & Day ahead)
 - Demand charges
 - EV Charging
- Costs
 - Capex
 - Opex
 - WACC
- Profiles over time

DISCOUNTED CASH FLOW



SEASON SUMMARY

Year	Revenue streams	Revenue per MW per year	IRR



2012 SEASON

RESULT:

4 – GAS UNITED

0 – WEST BATTERY ALBION

No.	Team
1	GAS UNITED
2	PUMPED HYDRO
3	OLD COAL ROVERS
4	DSR LONDON
5	SOLAR CITY
6	WIND WANDERERS
7	TIDAL TOWN
8	DIESEL SET NORTH END
9	WEST BATTERY ALBION



2016 SEASON – BATTERY 1.0

GOAL! WBA

- EFR scores!

GOAL! WBA

- CM scores!

RESULT:

2 - WEST BATTERY ALBION

0 - OLD COAL ROVERS

No.	Team
1	WEST BATTERY ALBION
2	DIESEL SET NORTH END
3	GAS UNITED
4	PUMPED HYDRO
5	DSR LONDON
6	SOLAR CITY
7	WIND WANDERERS
8	TIDAL TOWN
9	OLD COAL ROVERS

SEASON SUMMARY

Year	Revenue streams	Revenue per MW per year	IRR
2016	EFR, CM,	~£80-130k	

2017 SEASON

The Champions have high hopes...

But

- EFR is out
- During season, FFR is 'saturated', only playing at night time and scoring less goals
- The ref Ofgem thinks WBA have an unfair advantage and:
 - De-rates CM (only allowed to play with one leg)
 - Reforms Triads
- WBA bring in Arbitrage of the bench

RESULT:

2 – DSR LONDON

1 – WEST BATTERY ALBION

No.	Team
1	DSR LONDON
2	GAS UNITED
3	DIESEL SET NORTH END
4	PUMPED HYDRO
5	SOLAR CITY
6	WIND WANDERERS
7	WEST BATTERY ALBION
8	TIDAL TOWN
9	OLD COAL ROVERS

SEASON SUMMARY			
Year	Revenue streams	Revenue per MW per year	IRR
2017	FFR*, CM, TRIADS**, ARB	~£50-75k	

* Nighttime only FFR. **Post reform TRIAD

BATTERY MODEL 1.0 is over...



THIS SEASON (2018)

CONFIDENTIAL – BATTERY 2.0

NEW TACTICS FOR WBA

	Benefits	Challenges	Revenue stack	Revenue per MW per year
Co-locate (sharing a stadium with Solar City or Wind Wanderers)	Lowers costs	Doesn't help WBA score more goals. Metering needs care	FFR (nighttime only), CM, arbitrage	£45-75k

THIS SEASON (2018)

CONFIDENTIAL – BATTERY 2.0

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Go behind-the-meter (bring Peak Charge Reduction into the team)	New revenue stream & potentially lower grid/land costs	COMPLEX! Targeted Charging Review	Peak Charge Reduction (DUoS, Demand TNUoS, CM Levy) FFR (nighttime only), CM	£75-150k

THIS SEASON (2018)

CONFIDENTIAL – BATTERY 2.0

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Go merchant (bring in Balancing Mechanism to the team)	New revenue stream. Avoids FFR	Challenging to access. High risk market, both on price and volume.	BM, CM, arbitrage	£35-100k

THIS SEASON (2018)

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Support EV charging (in grid constrained sites)	New revenue stream	2-4 peak in charging expected -> longer duration battery. Timing of EV roll out	EV charging, FFR (nighttime only), CM	£60-100k (subject to EV charging commercial model)

THIS SEASON (2018)

CONFIDENTIAL – BATTERY 2.0

NEW TACTICS FOR WBA

	Benefits	Challenges	Revenue stack	Revenue per MW per year
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Play in Europe (Ireland, Germany and France)	New revenue streams.	Understanding new market, players and regulations	IE: FFR, POR, SOR, TOR FR/DE: PCR	IE: €100-300k* FR/DE: €75-125k

THIS SEASON (2018)

CONFIDENTIAL – BATTERY 2.0

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Exciting, youthful team... full of innovation and flare... but they struggle to consistently score enough goals to cover the costs



THE FUTURE

- Old teams are struggling
- New players are coming in
 - Faster Acting Frequency Response
 - DSO Services
- Costs are coming down

TOTAL BATTERY-BALL



No.	Team
1	WEST BATTERY ALBION
2	DSR LONDON
3	EV VALE
4	PUMPED HYDRO
5	GAS UNITED
6	INTERCONNECTOR TOWN
7	SOLAR CITY
7	WIND WANDERERS
8	TIDAL TOWN

MORALS

- Battery 1.0 is over
- Battery 2.0 is now
- The future is bright

“
NECESSITY
IS THE MOTHER
OF INVENTION
”

EVEROZE CAN HELP YOU GET MATCH FIT



Thanks for listening

Talk to us

contact@everoze.com

everoze.com

 [@everozepartners](https://twitter.com/everozepartners)



experts | evolving | energy



Andy Lowe

Head of Business Development
Flexitricity

Ancillary Services and the Balancing Mechanism

Storage, Renewables and Flexible Assets

**Demand Response.
Delivered.**



Flexitricity

Flexitricity in a nutshell

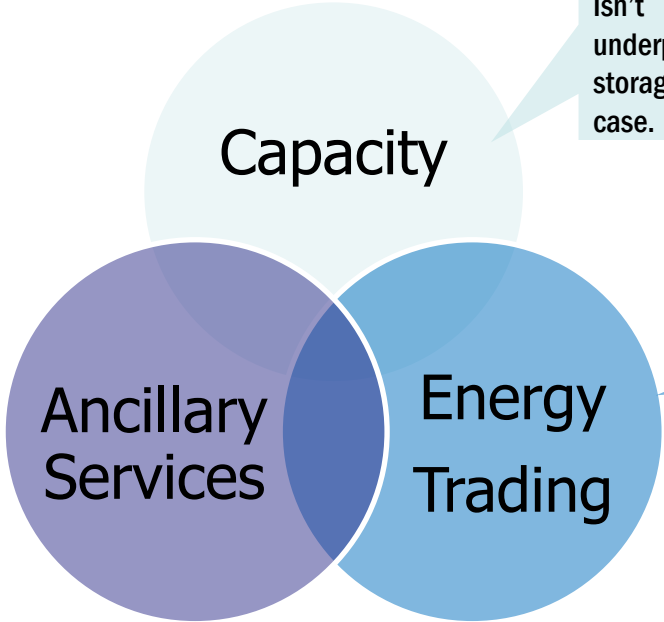
- First, largest and most diverse demand response aggregator
- Energy supplier
- First aggregator to enter Balancing Mechanism
- 9,700 demand response events
- 24-hour operations
- Fully automated, <1s to 30m response
- DRUPS, CHP, flexible load, standby diesel, hydro, storage, gas peaking
- Positive and negative reserve
- Industrial, commercial, public sector
- Leader in innovation



Flexitricity

Market drivers – what’s happening and why become a supplier?

Growing flexibility in this market, but also seeing saturation. SNaPS!



All qualifying CHP should be in here already. Isn't underpinning the storage business case.

The big opportunity for flexible users.

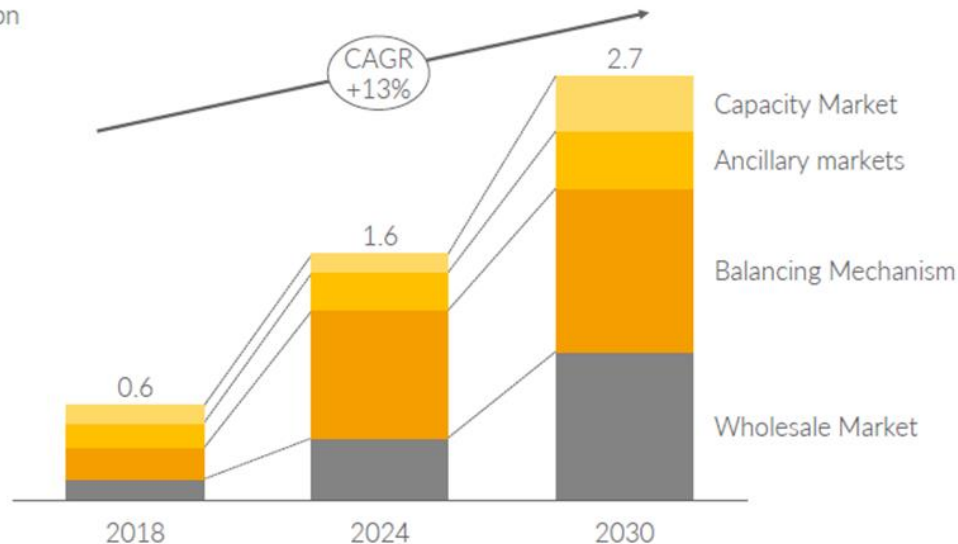


Changing Value in Flexibility

Aurora estimate revenue of flexible technologies will be driven primarily by wholesale and balancing

AURORA
ENERGY RESEARCH

Revenue for flexible technologies
£bn

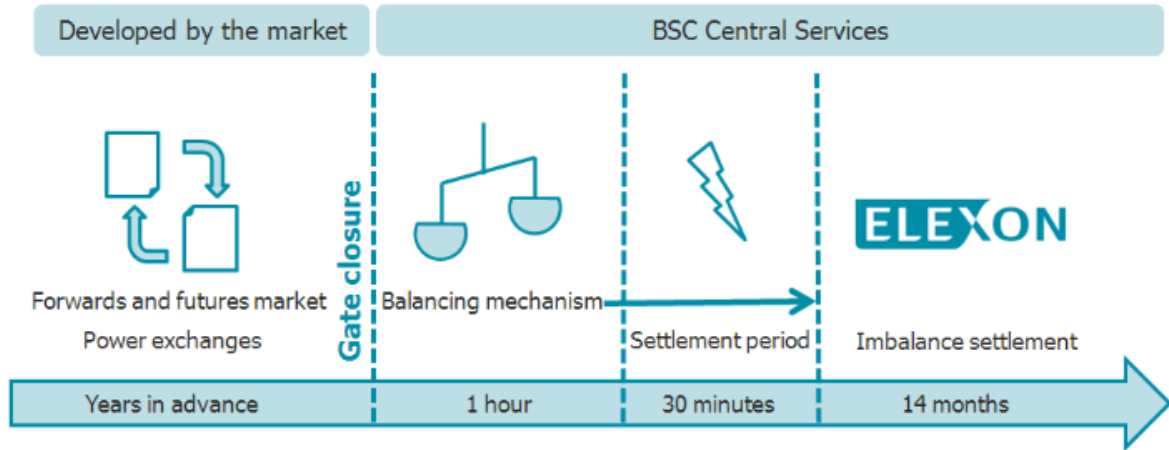


Source: Aurora Energy Research

Flexitricity

Balancing Mechanism

- 48 Settlement Periods per day
- 1 hour before SP = Gate Closure
 - Who can make trades:
 - Before gate, everyone
 - After gate in the BM, NG only
- Pay as bid
- Both energy and system actions
- Both increasing and decreasing generation



Flexitricity



FAN-TASTIC Wind farms could be paid to STOP producing energy

Rise in number of solar panels popping up on Brits' homes means the power grid is being swamped with extra energy

By Margi Murphy
10th April 2017, 3:58 pm

2017



4 COMMENTS

WIND farms could be paid to STOP working in case the energy they produce swamps the power grid.

National Grid forecast yesterday that demand would fall to a record low this summer thanks to the popularity of solar panels and farms.



Wind farms paid £1m a week to switch off

New figures show £53m was given to the wind industry last year to keep turbines switched off to regulate electricity supplied to National Grid

f 4K | t | p 0 | in 57 | 4K | Email

2015

Markets | Tech | Pursuits | Politics | Opinion | Businessw

ane-Force Gusts ot Record Pay to U.K. -farms

2016



go, more than £100 million

Updated on August 23, 2016 – 10:46 AM BST

almost £5
ind tens of thousands of homes were left without power
7:15AM GMT 04 Jan 2015
Follow 802 followers

Print this article

Wind Power News » UK News »

Balancing Mechanism

National Grid:

“As we continually work to balance the system, we can ask generators of all kinds, not just wind farms, to come on or off the grid to help us balance supply and demand, or to manage ‘constraints’ in the network.”

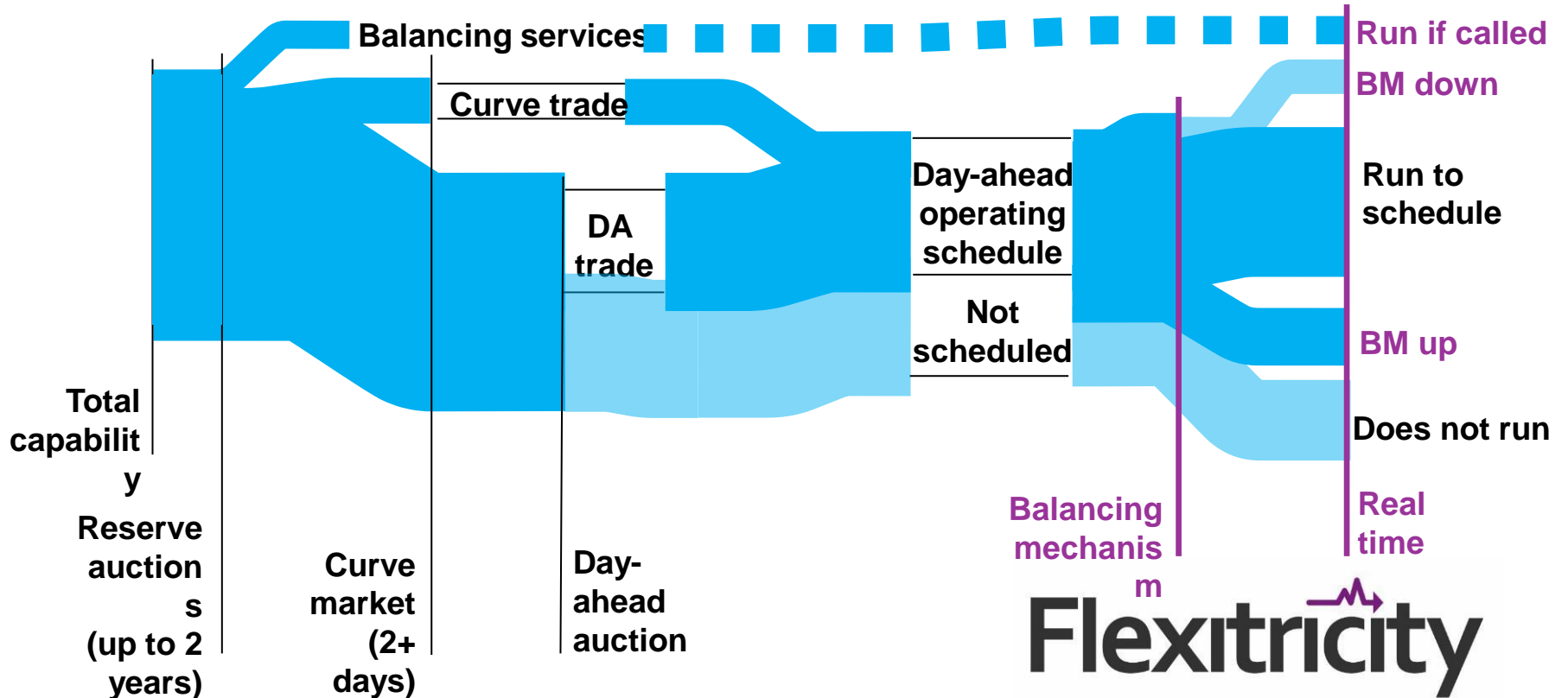
“This is something we do many times every day and have done for many years. It is a normal part of our job, and we have a number of well-proven tools to help us do it, including buying generation onto or off the network one or two days ahead of real time, and bids on the balancing mechanism within one or two hours of when the energy is needed.”

So, who is it for?

- Storage
- Hydro
- AD
- Gas peakers
- BtM flexible generation
- Flexible load
- Wind



Flexibility in the Balancing Mechanism



26/1/18 Period 17: Imbalance Price £100/MWh

Buy Stack

Sell Stack

Index	Id	Acc ID	BOP ID	CADL Flag	SO-Flag	STOR-Flag	Re-Priced	RSP	Offer Price	Offer Volume	DMAT Adjusted Volume	Arbitrage Adjusted Volume	NIV Adjusted Volume	PAR Adjusted Volume	Final Price	TLM	QAPO * TLM	QAPO * PO * TLM
42	T_DEEP-1	94403	1	F	F	F	F	0.00000	128.00000	0.042	0.042	0.042	0.000	0.000	0.00000	0.00000000	0.000	0.00
43	T_DEEP-1	94401	1	F	F	F	F	0.00000	128.00000	1.500	1.500	1.500	0.000	0.000	0.00000	0.00000000	0.000	0.00
44	T_DEEP-1	94402	1	F	F	F	F	0.00000	128.00000	2.667	2.667	2.667	0.000	0.000	0.00000	0.00000000	0.000	0.00
38	T_FFES-2	114163	1	F	F	F	F	0.00000	115.00000	6.000	6.000	6.000	0.000	0.000	0.00000	0.00000000	0.000	0.00
39	T_FFES-2	114162	1	F	F	F	F	0.00000	115.00000	6.000	6.000	6.000	0.000	0.000	0.00000	0.00000000	0.000	0.00
40	T_FFES-2	114161	1	F	F	F	F	0.00000	115.00000	3.000	3.000	3.000	0.000	0.000	0.00000	0.00000000	0.000	0.00
41	T_FFES-2	114160	1	F	F	F	F	0.00000	115.00000	2.250	2.250	2.250	0.000	0.000	0.00000	0.00000000	0.000	0.00
34	T_CARR-2	15300	1	F	F	F	F	0.00000	109.00000	1.200	1.200	1.200	0.000	0.000	0.00000	0.00000000	0.000	0.00
35	T_CARR-1	16473	1	F	F	F	F	0.00000	109.00000	2.667	2.667	2.667	0.000	0.000	0.00000	0.00000000	0.000	0.00

Buy Stack

Sell Stack

Index	Id	Acc ID	BOP ID	CADL Flag	SO-Flag	STOR-Flag	Re-Priced	RSP	Bid Price	Bid Volume	DMAT Adjusted Volume	Arbitrage Adjusted Volume	NIV Adjusted Volume	PAR Adjusted Volume	Final Price	TLM	QAPB * TLM	QAPB * PB * TLM
1	T_STAY-1	54134	-1	F	F	F	F	NULL	37.61000	-19.800	-19.800	-19.800	0.000	0.000	0.00000	0.00000000	0.000	0.00
2	T_STAY-4	56400	-1	F	F	F	F	NULL	37.51000	-26.350	-26.350	-26.350	0.000	0.000	0.00000	0.00000000	0.000	0.00

26/1/18 Period 26: Imbalance Price £0/MWh

Buy Stack

Sell Stack

No Records Found

Buy Stack

Sell Stack

Index	Id	Acc ID	BOP ID	CADL Flag	SO-Flag	STOR-Flag	Re-Priced	RSP	Bid Price	Bid Volume	DMAT Adjusted Volume	Arbitrage Adjusted Volume	NIV Adjusted Volume	PAR Adjusted Volume	Final Price	TLM	QAPB * TLM	QAPB * PB * TLM
70	T_DINO-5	77430	-1	F	F	F	F	NULL	0.00000	-3.750	-3.750	-3.750	-3.750	-2.885	0.00000	0.9910100	-2.859	0.00
71	T_DINO-5	77429	-1	F	F	F	F	NULL	0.00000	-5.000	-5.000	-5.000	-5.000	-3.846	0.00000	0.9910100	-3.812	0.00
72	T_DINO-5	77427	-1	F	F	F	F	NULL	0.00000	-5.000	-5.000	-5.000	-5.000	-3.846	0.00000	0.9910100	-3.812	0.00
73	T_DINO-5	77426	-1	F	F	F	F	NULL	0.00000	-5.000	-5.000	-5.000	-5.000	-3.846	0.00000	0.9910100	-3.812	0.00
74	T_DINO-5	77428	-1	F	F	F	F	NULL	0.00000	-5.000	-5.000	-5.000	-5.000	-3.846	0.00000	0.9910100	-3.812	0.00
75	T_DINO-5	77424	-1	F	F	F	F	NULL	0.00000	-5.000	-5.000	-5.000	-5.000	-3.846	0.00000	0.9910100	-3.812	0.00
76	T_DINO-5	77423	-1	F	F	F	F	NULL	0.00000	-5.000	-5.000	-5.000	-5.000	-3.846	0.00000	0.9910100	-3.812	0.00
77	T_DINO-5	77422	-1	F	F	F	F	NULL	0.00000	-12.500	-12.500	-12.500	-12.500	-9.615	0.00000	0.9910100	-9.529	0.00
78	T_DINO-5	77425	-1	F	F	F	F	NULL	0.00000	-5.000	-5.000	-5.000	-5.000	-3.846	0.00000	0.9910100	-3.812	0.00
79	T_DINO-5	77421	-1	T	F	F	F	NULL	0.00000	-5.000	-5.000	-5.000	-5.000	-3.846	0.00000	0.9910100	-3.812	0.00
80	T_DINO-5	77420	-1	T	F	F	F	NULL	0.00000	-8.750	-8.750	-8.750	-8.750	-6.731	0.00000	0.9910100	-6.670	0.00
68	T_SCCL-1	58445	-1	F	F	F	F	NULL	35.15000	-7.000	-7.000	-7.000	-7.000	0.000	0.00000	0.0000000	0.000	0.00

So how much is it worth?

Batteries

- £45-55k/MW (1C) to £65-75k/MW (0.5C)

Hydro (peaking with storage)

- ~£200k/MW

Gas peakers

- £70-80k/MW

Lessons

- The change has already happened
- Storage means many things
- Diversity is good
- The energy market is tough
- From project finance to merchant
- Flexibility is key



New times, new language

~~Baseload~~

Flexibility





Flexitricity operates the first, largest and most advanced demand-response portfolio in Britain. Join us today. Call **0131 221 8100**.

Andy Lowe, Head of Business Development, andy.lowe@flexitricity.com.





Louise Dalton

Senior Associate

CMS Cameron McKenna Nabarro

Olswang LLP

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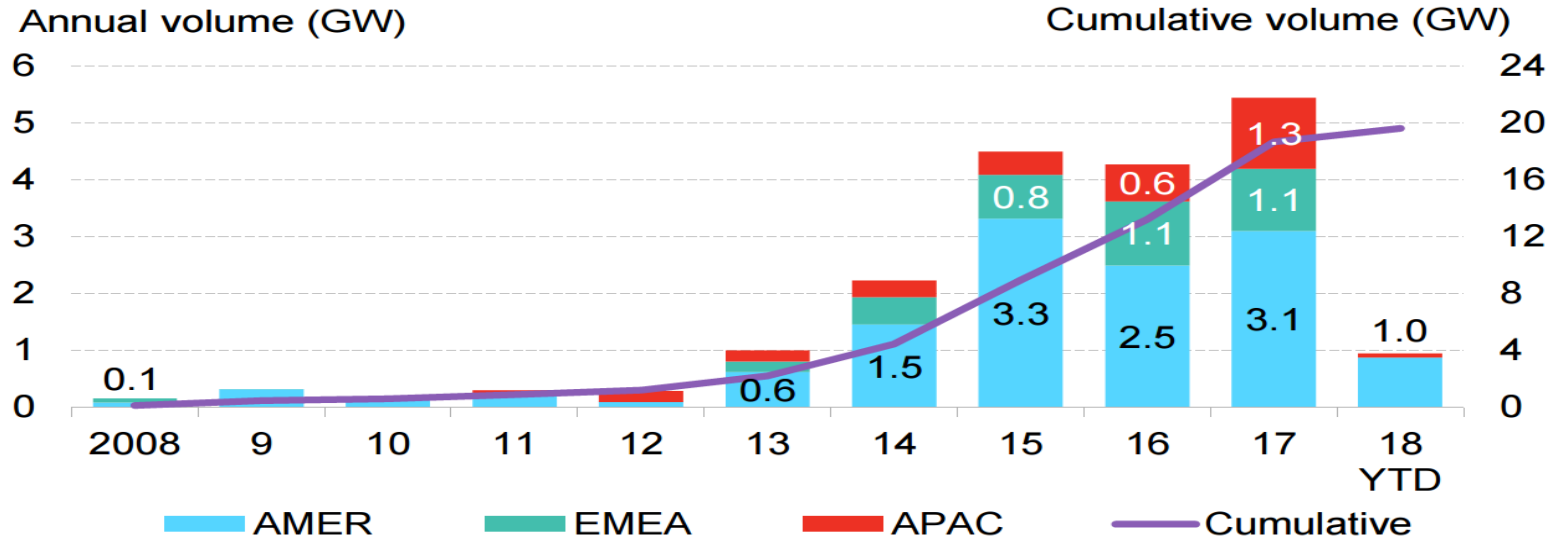
Law . Tax

Corporate PPAs

Louise Dalton, Senior Associate, CMS

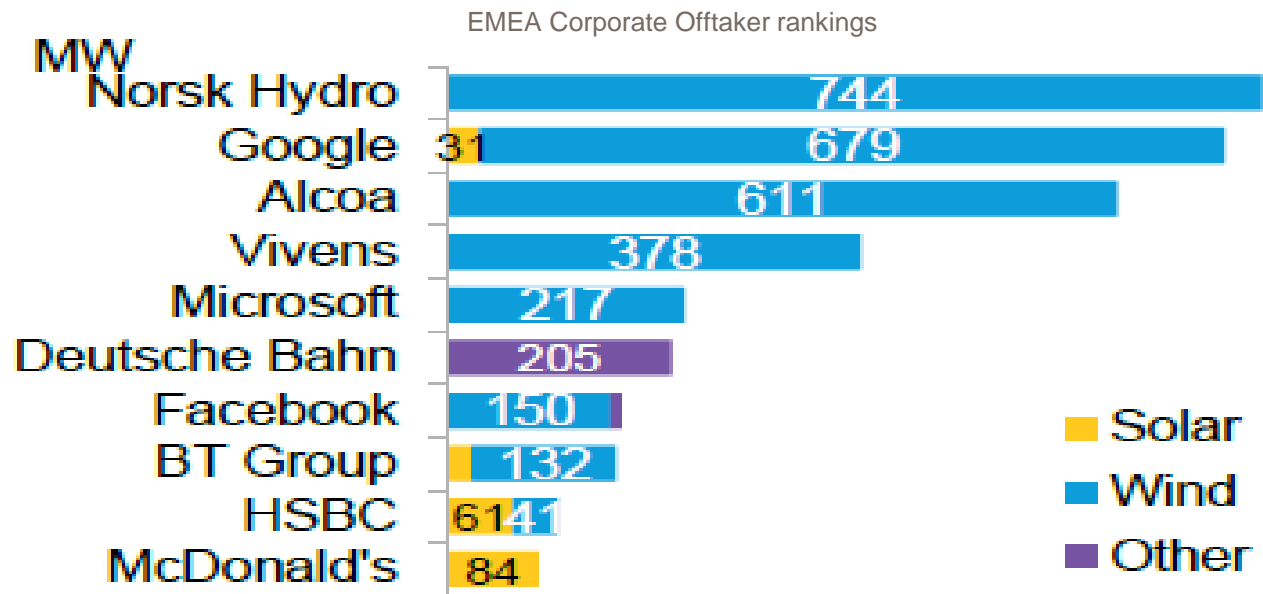


Global volume of Corporate PPAs



Source: Bloomberg New Energy Finance Note: Onsite PPAs not included. APAC number is an estimate. Pre-market reform Mexico PPAs are not included. These figures are subject to change and may be updated as more information is made available.

European Corporate PPA market



Source: Bloomberg New Energy Finance

Corporate PPAs: Key issues

Parties

Structure

Pricing

Development
risk

Volume

Performance

Credit support

Change in law

Force majeure

Termination

Information
obligations

Boilerplate

Hannah Staab

Senior Due Diligence Project Manager, Natural Power

Paul Reynolds

Partner, Everoze Partners

Andy Lowe

Head of Business Development, Flexitricity

Louise Dalton

Senior Associate, CMS Cameron McKenna Nabarro
Olswang LLP



Joe Mitchell
Policy Officer
Scottish Renewables



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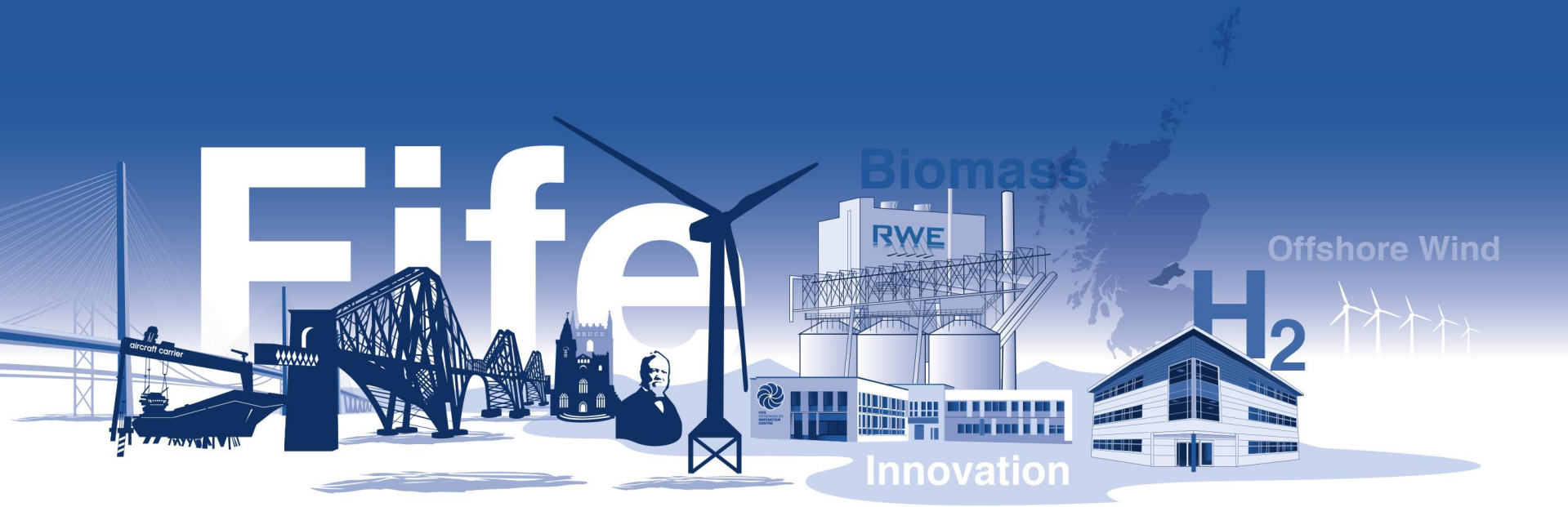
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Scottish Renewables Storage & Systems Conference

Glasgow, 13 June 2018

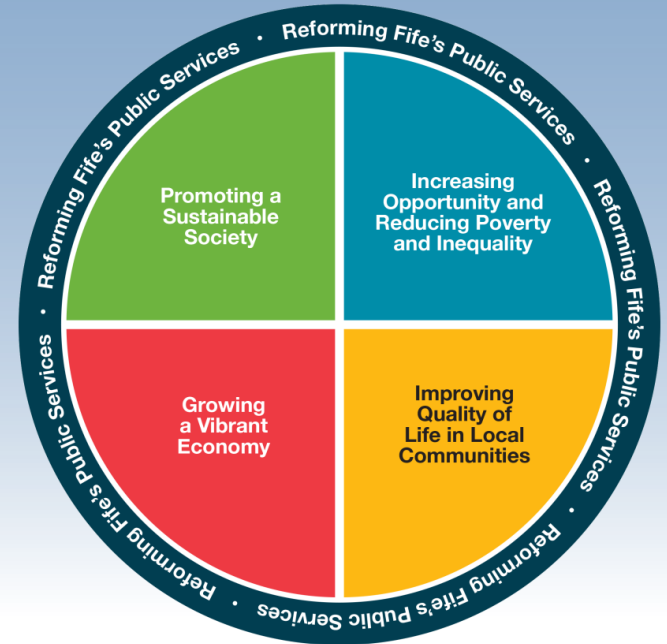
Fife means business.



INVEST IN FIFE

Introduction to Fife

- Third largest council in Scotland out of 32 councils, after Glasgow and Edinburgh
- 5th region in terms of growth and 11th local authority in the whole of UK
- 360,000 residents, 160,950 households
- Fife Council employs 17,935 persons
- c. £800M budget



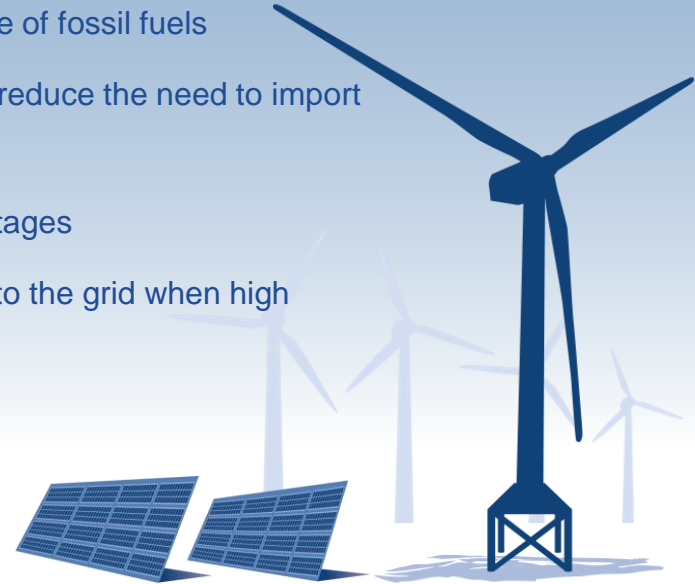
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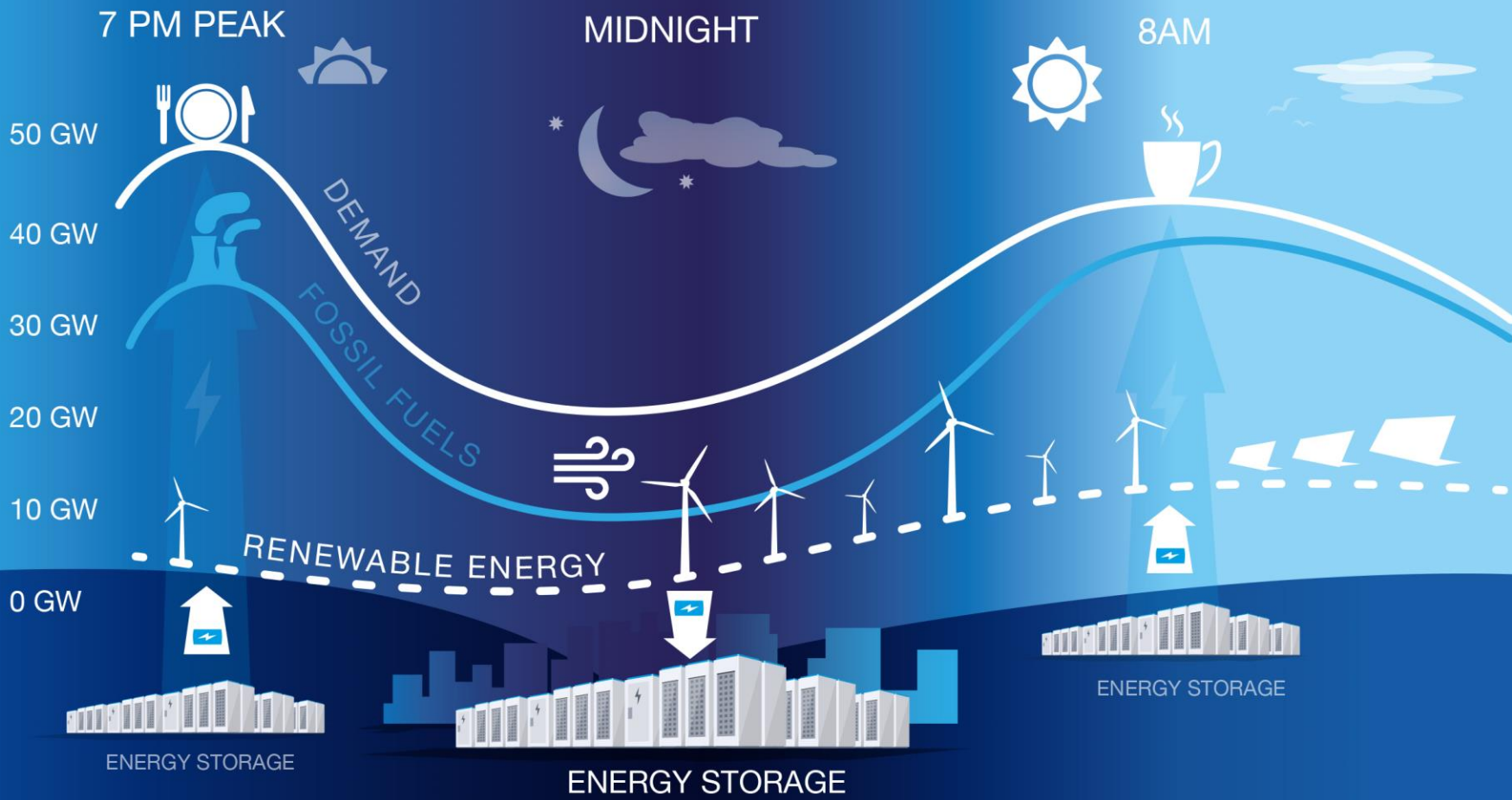
Leading in Renewables and Low Carbon Advancing Energy Storage Systems

Energy Storage is increasing important as we move to the Game of Grids

- It enables integration of more renewables in the energy mix to reduce usage of fossil fuels
- Decreases the need to invest in new conventional generation capacity and reduce the need to import electricity
- Reduces grid systems upgrades and improves stability during electricity outages
- Reduces costs by storing energy when prices are low and using, or selling to the grid when high
- Significantly reduces energy loss during transmission and distribution

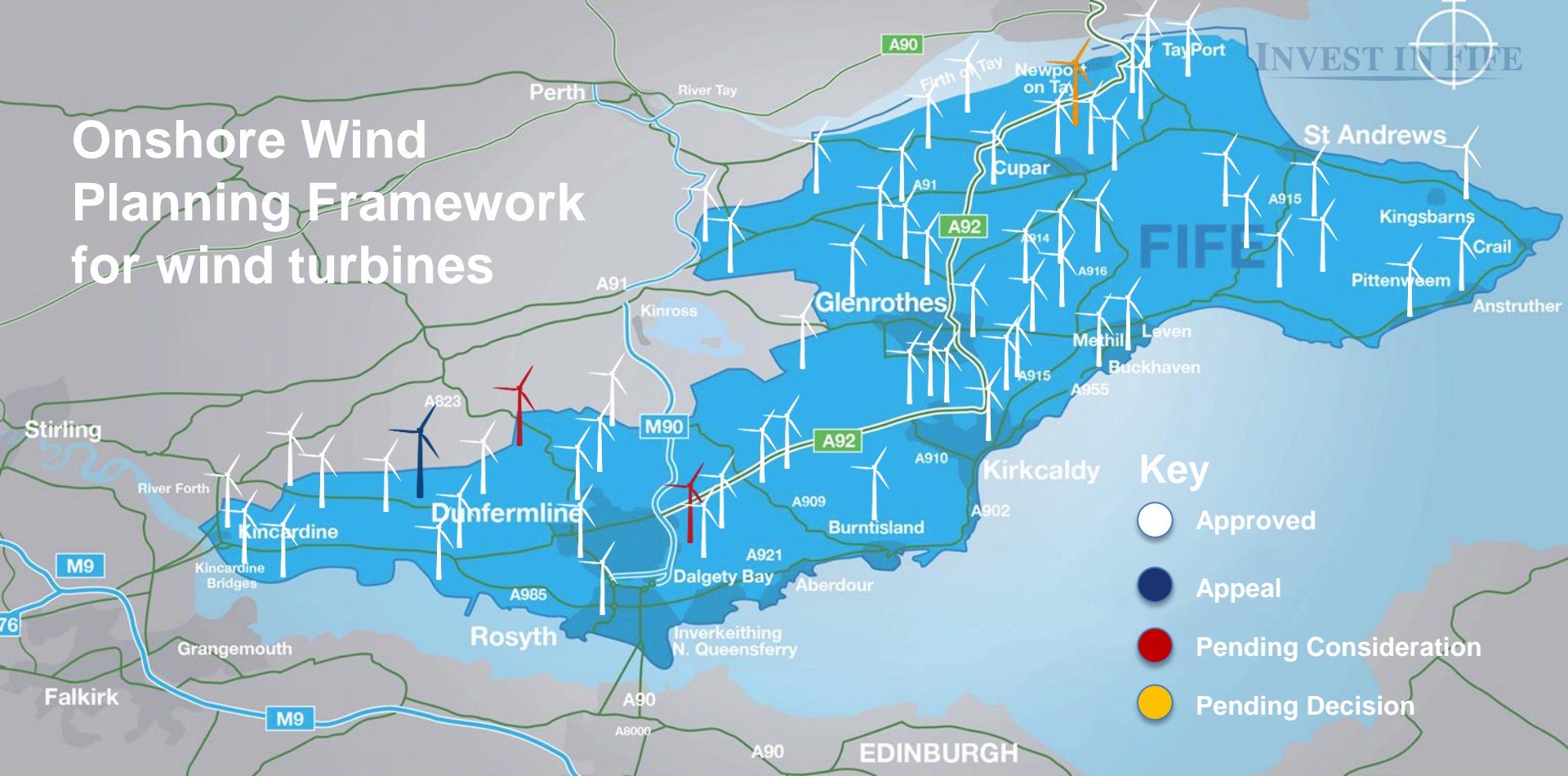
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Fife means business.

Onshore Wind Planning Framework for wind turbines



Fife means business.

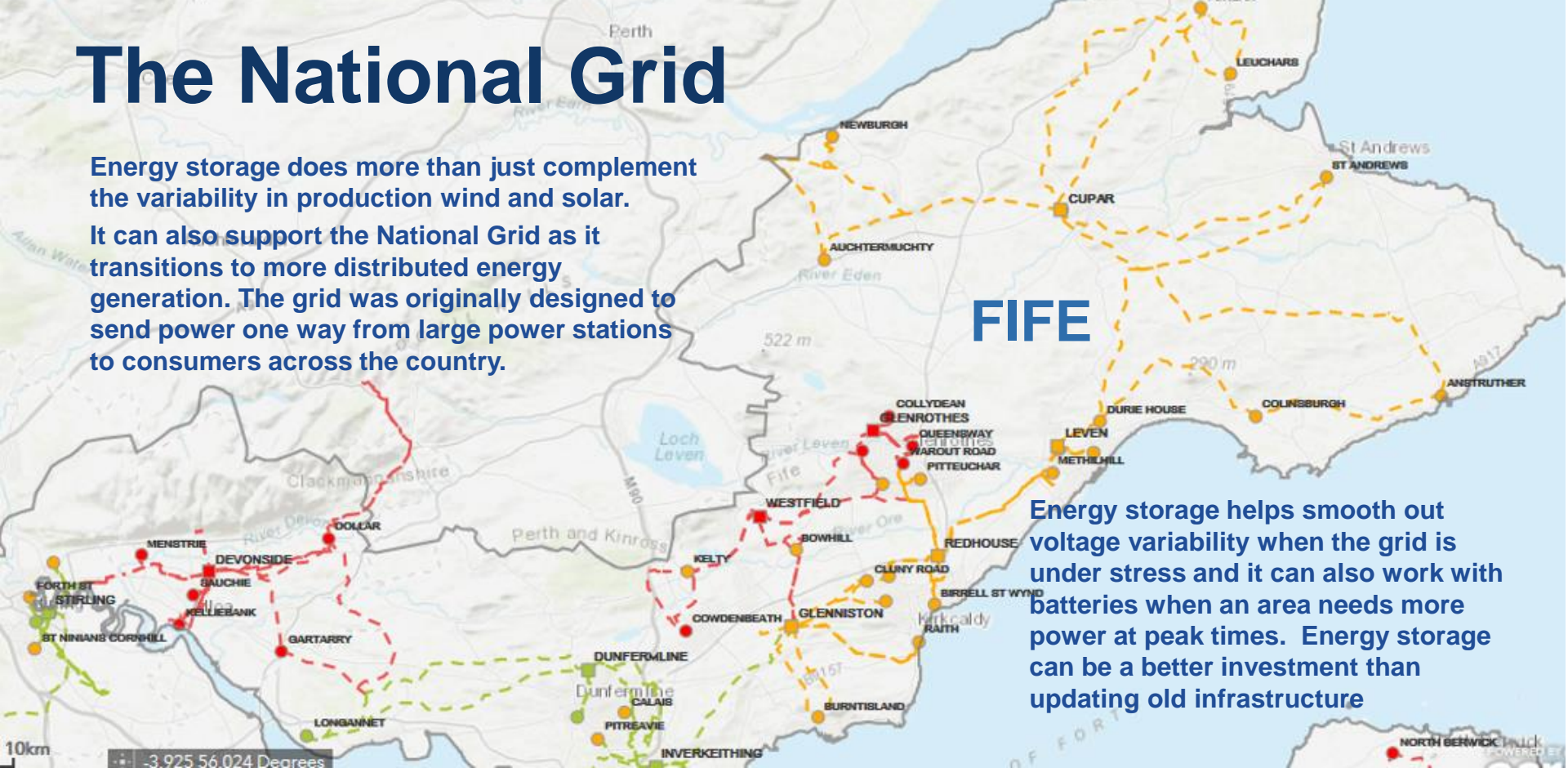
Solar Radiation Map with planning applications



Fife means business.

The National Grid

Energy storage does more than just complement the variability in production wind and solar. It can also support the National Grid as it transitions to more distributed energy generation. The grid was originally designed to send power one way from large power stations to consumers across the country.



Energy storage helps smooth out voltage variability when the grid is under stress and it can also work with batteries when an area needs more power at peak times. Energy storage can be a better investment than updating old infrastructure

Fife means business.

Types of Storage

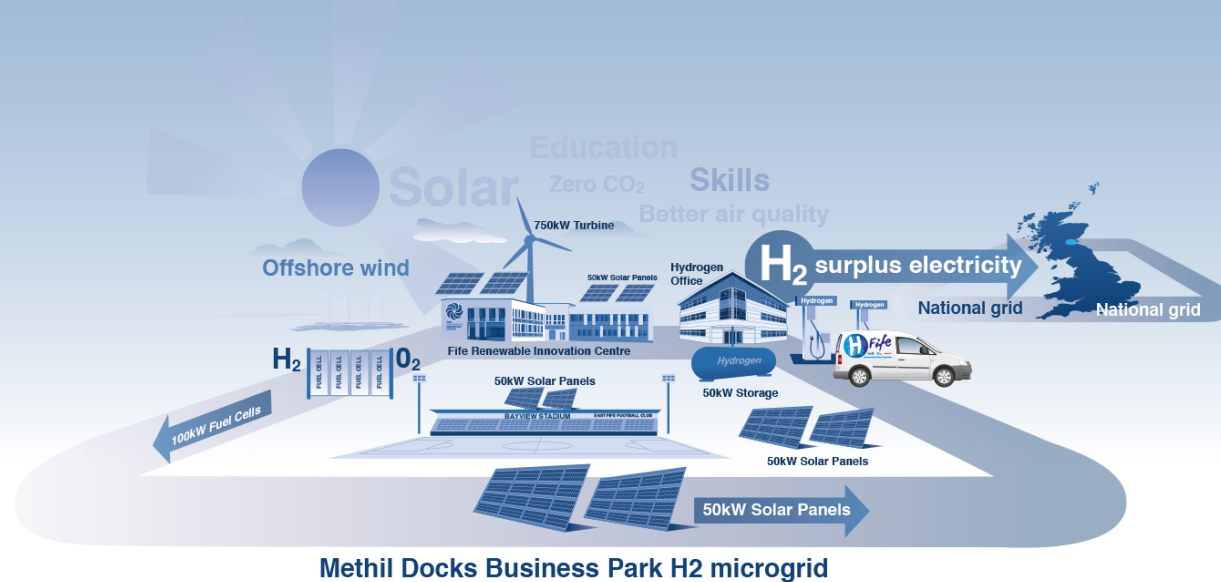
The main types of storage widely used are Batteries and Hydrogen

The University of St Andrews is leading the way in research into solid oxide electrolysis and fuel cells as well as developments in future battery technologies.

There are approved planning application in Fife for over 200 MW of battery power.



Fife is home to the Levenmouth community energy project, on the world's first fully Hydrogen powered mini grids.



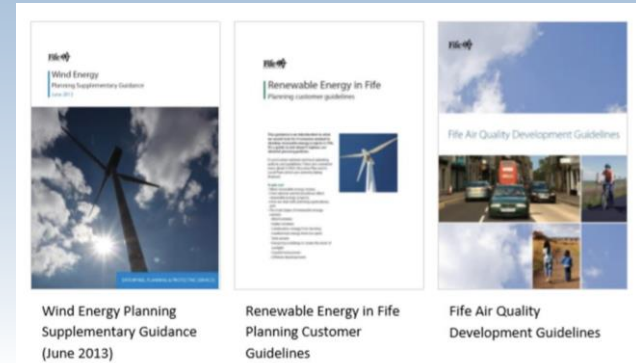
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A supportive Planning environment

In line with the Scottish Government drive to lower carbon, Fife Council's planning service encourages energy storage as part of low carbon energy proposals and has just announced draft Supplementary Guidance on Low Carbon Planning.

Key points referring to storage include

- Energy storage facilities must be designed to be appropriate to their location, and screened if required.
- Fife Council will consult with the Health and safety Executive and the Scottish Environment Protection Agency on the location of hydrogen energy storage facilities.
- In some locations it may be appropriate to include a decommissioning condition for end of use of the facility.



Fife means business.

Contacts

Invest in Fife offers a single door approach to working with inward and mobile investment projects and has a proven track record in securing new business, jobs and investment for the region.

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