SUSTAINABLE ENERGY WEEK

An initiative of the European Commission

17-21 JUNE 2019

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Delivering clean energy on EU islands

Grid Scale Energy Storage: The Key to a Cost Effective Transition to Zero Carbon Electricity Systems by 2025

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Agenda

- Operational challenges in isolated 100% zero carbon electricity systems
- Planning the Grid to Cope with Minimum Demand
- How can synchronous energy storage enable zero carbon operation, addressing the energy trilemma
- The business case of grid scale energy storage
- EASE paper on Regulated Island
- Conclusions

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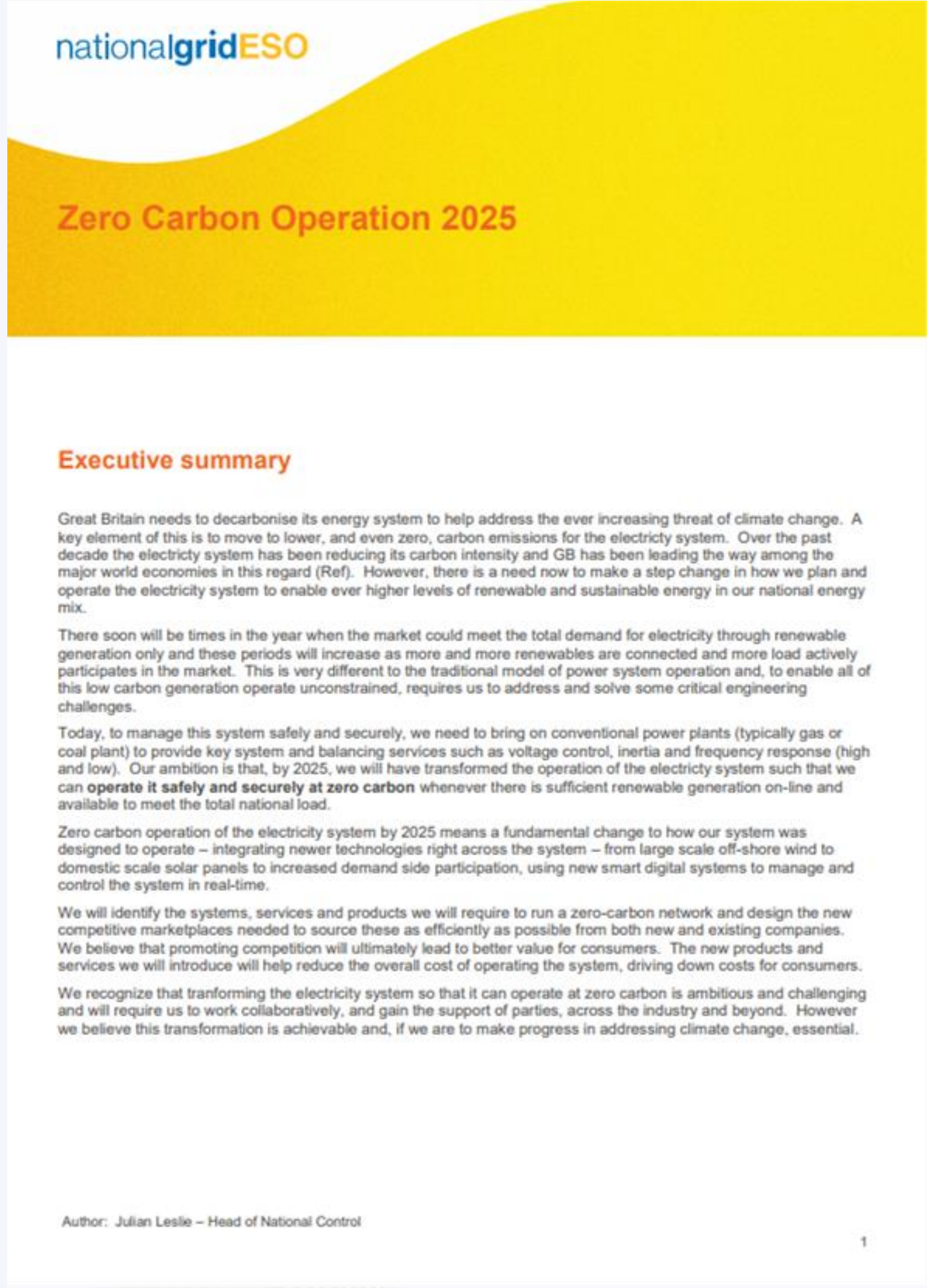
Operational challenges in isolated zero carbon electricity systems


nationalgridESO

Zero Carbon Operation 2025

Executive summary

Great Britain needs to decarbonise its energy system to help address the ever increasing threat of climate change. A key element of this is to move to lower, and even zero, carbon emissions for the electricty system. Over the past decade the electricty system has been reducing its carbon intensity and GB has been leading the way among the major world economies in this regard (Ref). However, there is a need now to make a step change in how we plan and operate the electricity system to enable ever higher levels of renewable and sustainable energy in our national energy mix.

There soon will be times in the year when the market could meet the total demand for electricity through renewable generation only and these periods will increase as more and more renewables are connected and more load actively participates in the market. This is very different to the traditional model of power system operation and, to enable all of this low carbon generation operate unconstrained, requires us to address and solve some critical engineering challenges.

Today, to manage this system safely and securely, we need to bring on conventional power plants (typically gas or coal plant) to provide key system and balancing services such as voltage control, inertia and frequency response (high and low). Our ambition is that, by 2025, we will have transformed the operation of the electricty system such that we can **operate it safely and securely at zero carbon** whenever there is sufficient renewable generation on-line and available to meet the total national load.

Zero carbon operation of the electricity system by 2025 means a fundamental change to how our system was designed to operate – integrating newer technologies right across the system – from large scale off-shore wind to domestic scale solar panels to increased demand side participation, using new smart digital systems to manage and control the system in real-time.

We will identify the systems, services and products we will require to run a zero-carbon network and design the new competitive marketplaces needed to source these as efficiently as possible from both new and existing companies. We believe that promoting competition will ultimately lead to better value for consumers. The new products and services we will introduce will help reduce the overall cost of operating the system, driving down costs for consumers.

We recognize that tranforming the electricity system so that it can operate at zero carbon is ambitious and challenging and will require us to work collaboratively, and gain the support of parties, across the industry and beyond. However we believe this transformation is achievable and, if we are to make progress in addressing climate change, essential.

Author: Julian Leslie – Head of National Control

1

Source: National Grid ESO 2019

1) Synchronous Inertia, Short Circuit Infeed and Frequency control

- To ensure a stable and secure network there needs to be sufficient synchronous inertia, short circuit infeed and frequency control.
- ***Action***: Develop the full technical definition of the services and products needed to provide inertia, short circuit infeed and stability.
- ***Action***: Enabling renewables for the provision of reserve and synthetic inertia through utilisation of *Power Available.*

2) Voltage Control

- Static and dynamic voltage support will be required to ensure that voltage limits stay within the operational limits.
- **Action**: Complete a market tender process for both short- and long-term voltage solutions in selected GB regions.

Operational challenges in isolated zero carbon electricity systems

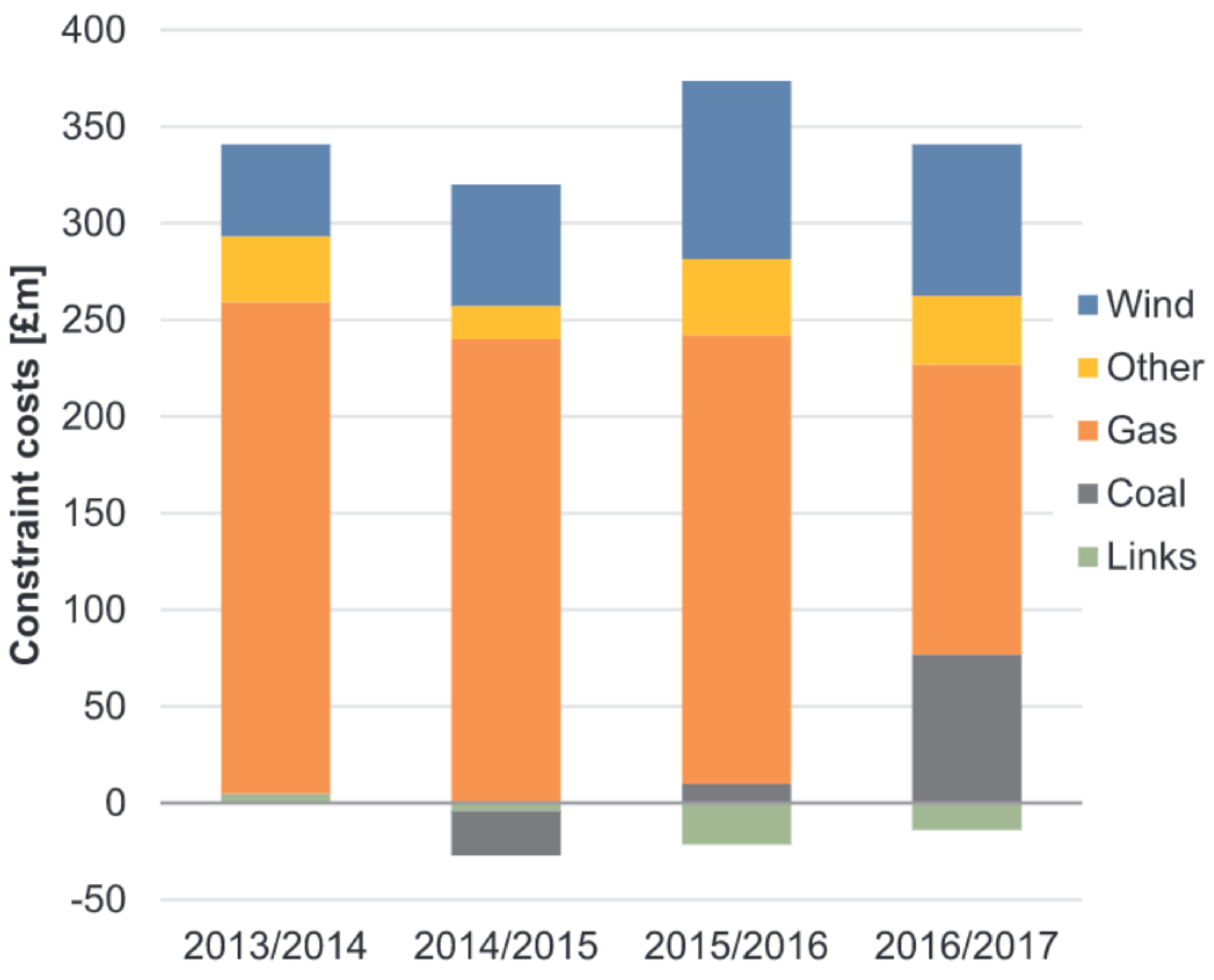


Fig. 8. Yearly constraint costs in Britain by fuel; data: [50].

Source: Joos, Staffell, 2018. " Short Short-term integration costs of variable renewable energy: Wind curtailment and balancing in Britain and Germany

3) Wind Curtailment

Causes:

- Insufficient boundary Capability;
- Low levels of Synchronous Inertia or Fast Fault Current;
- Low demand.

- **Current action**: When the power transfer across a transmission system boundary is above that boundary's capability or when the penetration of Non-Synchronous generation is above a certain level, grid operator reduces power output from renewables to avoid overloading or system instability (high RoCoF) on the exporting side. To maintain an energy balance, this energy is replaced with generation on the importing side.

- **Future Action**: Implementation of a Constraint Management Pathfinder to procure market-based solutions to create competition with traditional network solutions.

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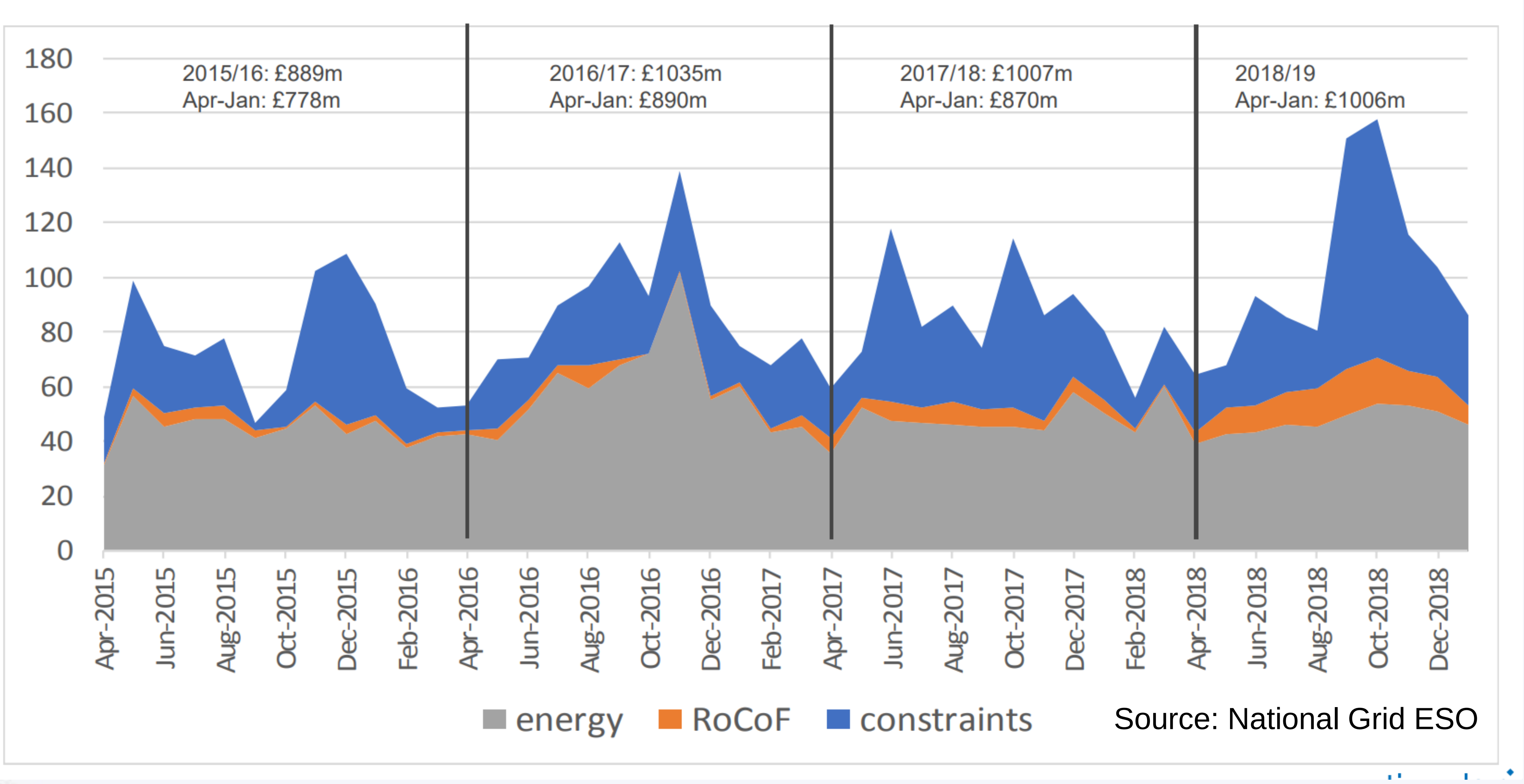
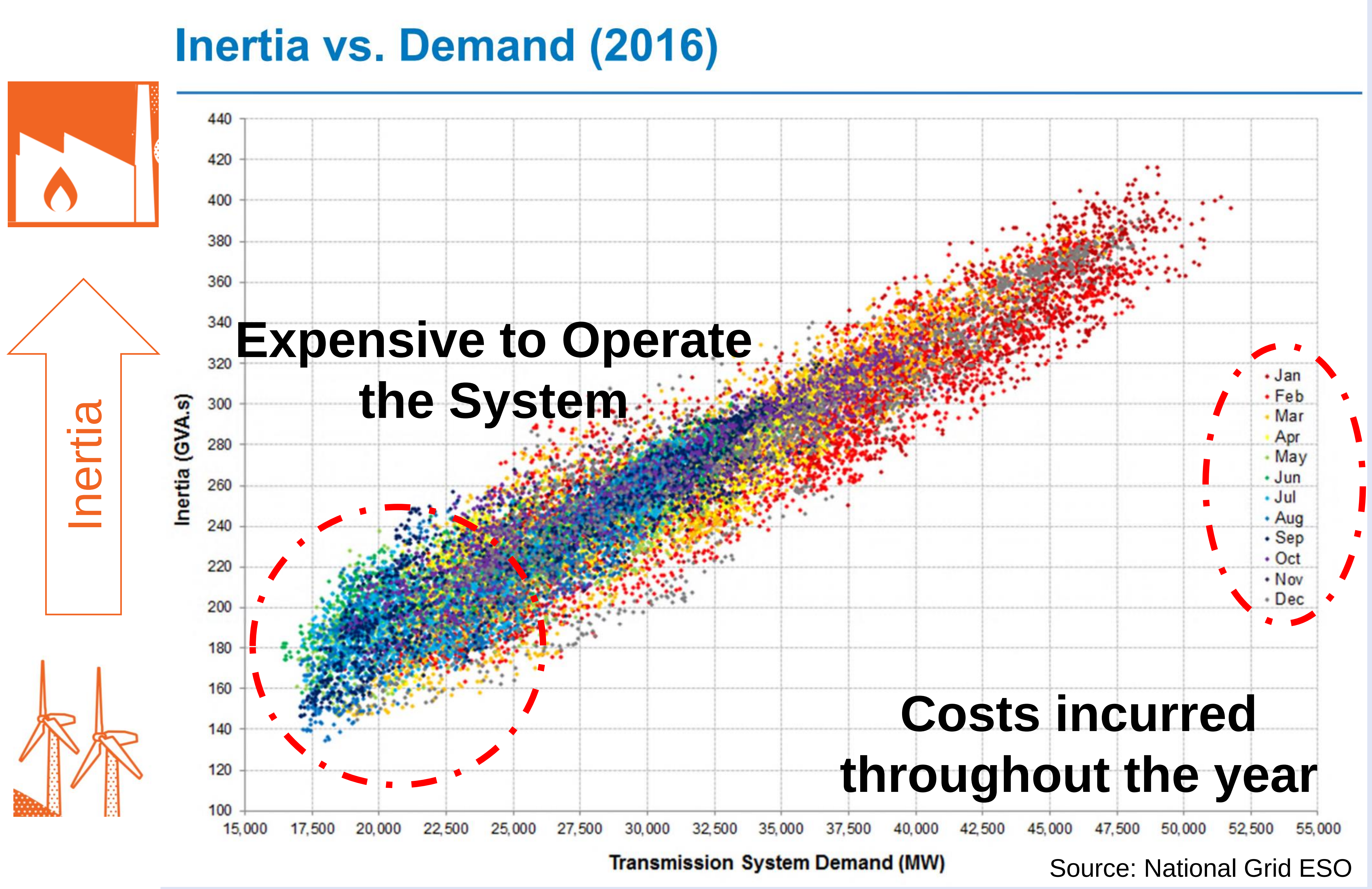
Planning the Grid to Cope with Minimum Demand

Cost to operate the system is growing consistently YoY



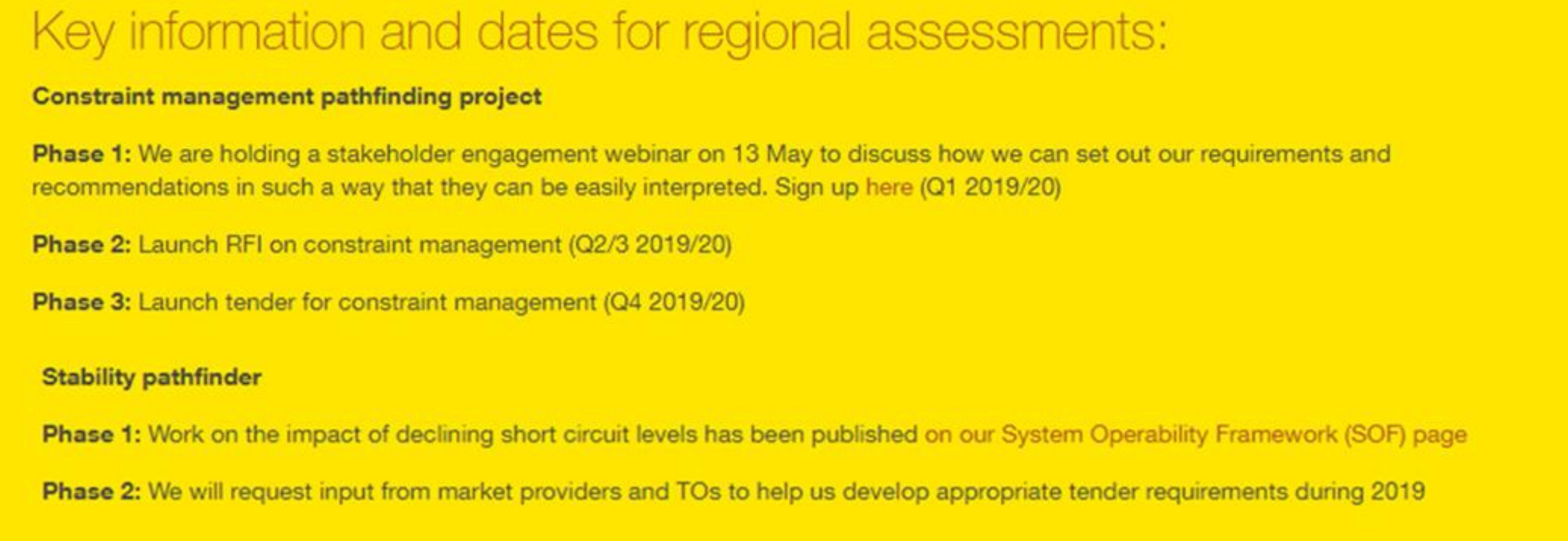


- Additionally, **£330 million** spent on managing **voltage** over the past three years;
- **Neither** flexible conventional generation **nor** Demand Side Response are **effective** in reducing system operation cost when demand is at it's minimum.

How can synchronous energy storage enable zero carbon operation and route to market

Stability Services

Source: Adapted from National Grid ESO, "System Operability Framework. Whole System Short Cirtuit Levels", December 2018.



Key information and dates for regional assessments:

Constraint management pathfinding project

Phase 1: We are holding a stakeholder engagement webinar on 13 May to discuss how we can set out our requirements and recommendations in such a way that they can be easily interpreted. Sign up here (Q1 2019/20)

Phase 2: Launch RFI on constraint management (Q2/3 2019/20)

Phase 3: Launch tender for constraint management (Q4 2019/20)

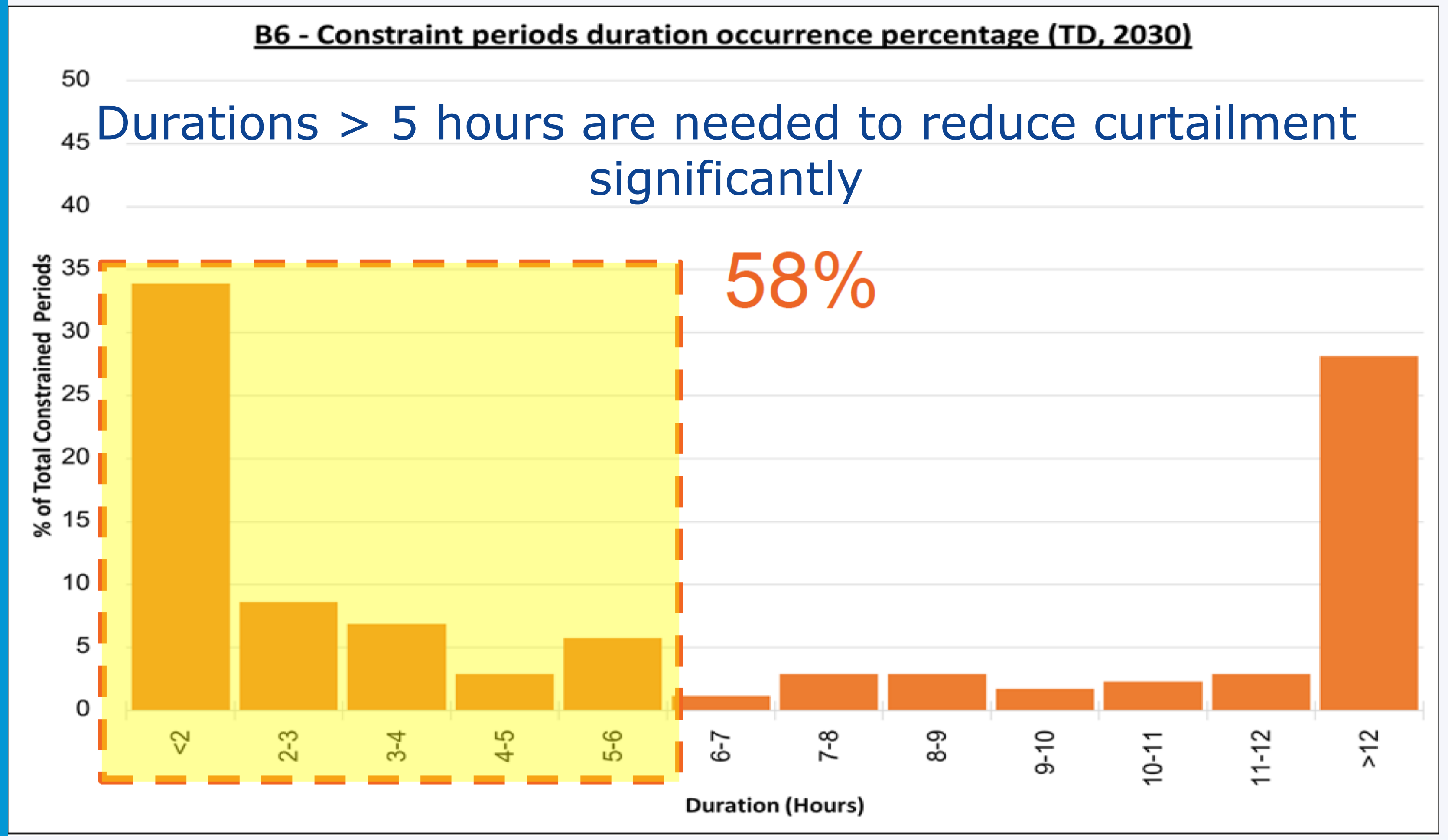
Stability pathfinder

Phase 1: Work on the impact of declining short circuit levels has been published on our System Operability Framework (SOF) page

Phase 2: We will request input from market providers and TOs to help us develop appropriate tender requirements during 2019

Source: National Grid ESO

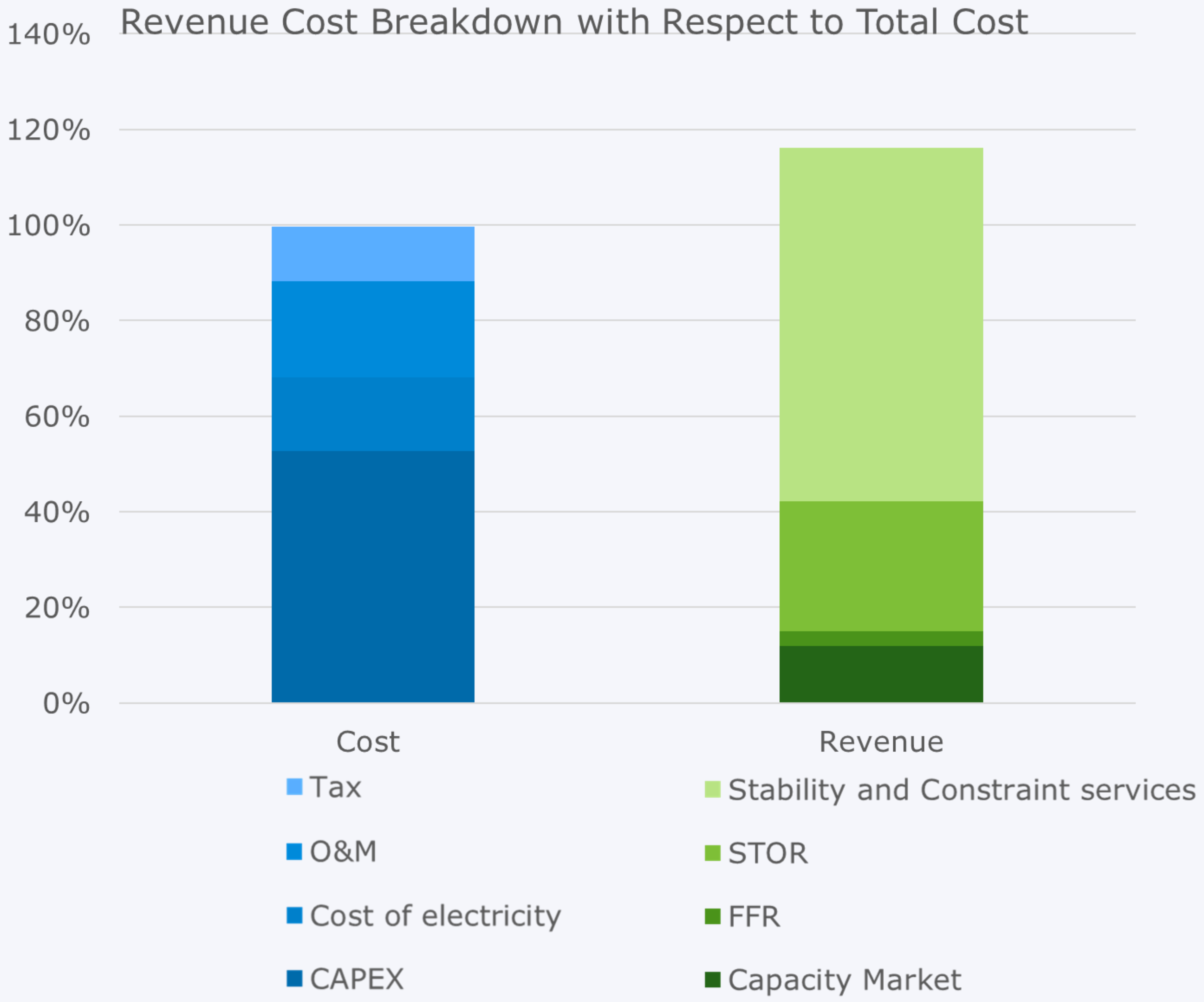
Constraint management



- Currently, System Operators pay conventional plant to operate at their Stable Export Limit when stability services are needed. This creates **additional balancing** and results in **higher CO2 emissions**;
- **Synchronous Energy Storage** can provide stability services and avoid curtailment by increasing demand.

Illustrative Business Case of a 100 MW / 500 MWh CRYOBattery

Source: Highview Power.



Highview Power

EASE Study on Power System Challenges of Island Systems with High Shares of Variable Renewables

European Association for Storage of Energy

http://ease-storage.eu/

Further details on challenges encountered in islands across the world can be found at an EASE paper to be released in Summer 2019.

Conclusions

- The grid used to be planned to cope with peak demand, however minimum demand is driving operating costs now
- Cost are dominated by Voltage Control, Inertia and Constraint management, additional costs to manage Short Circuit Level coming in the future
- The role of Systems Operators is crucial, ensuring cost effective system operability requires identifying constrained parts of the grid
- Pathfinder projects are needed to identify viable solutions and business models to help bring new technologies to the market
- Transparency and competition are key for a cost-effective transition towards zero carbon electricity systems in islands

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Questions?

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