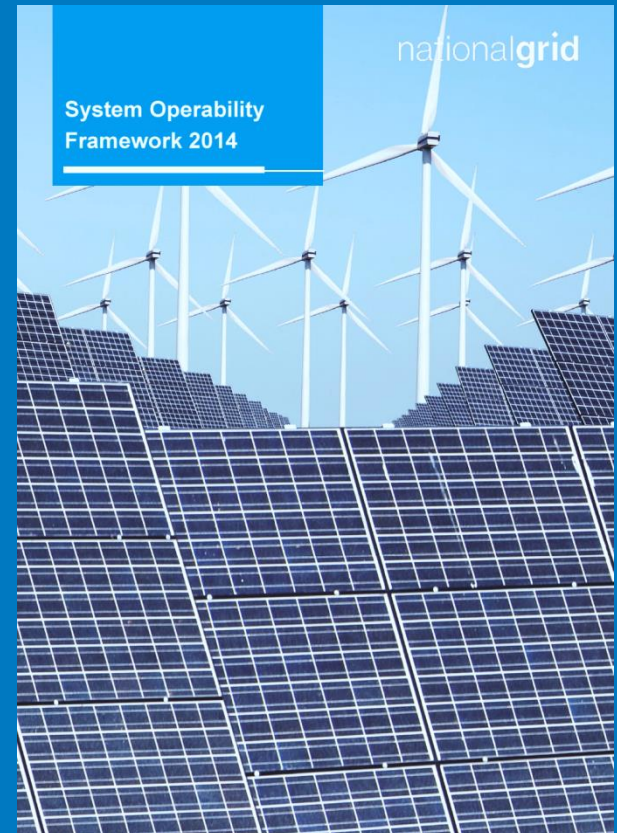


# System Operability Framework (SOF) 2014

Post consultation activities

**Ben Marshall**  
**Transmission Network Services**  
**GCRP- 21<sup>st</sup> January 2015**



# Agenda

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- Why do we need a SOF?
- How SOF works and example of results
  - Challenges and Opportunities
- Summary of Industry Consultation
- Current activities on SOF topics
- Next steps and how SOF 2015 will be developed

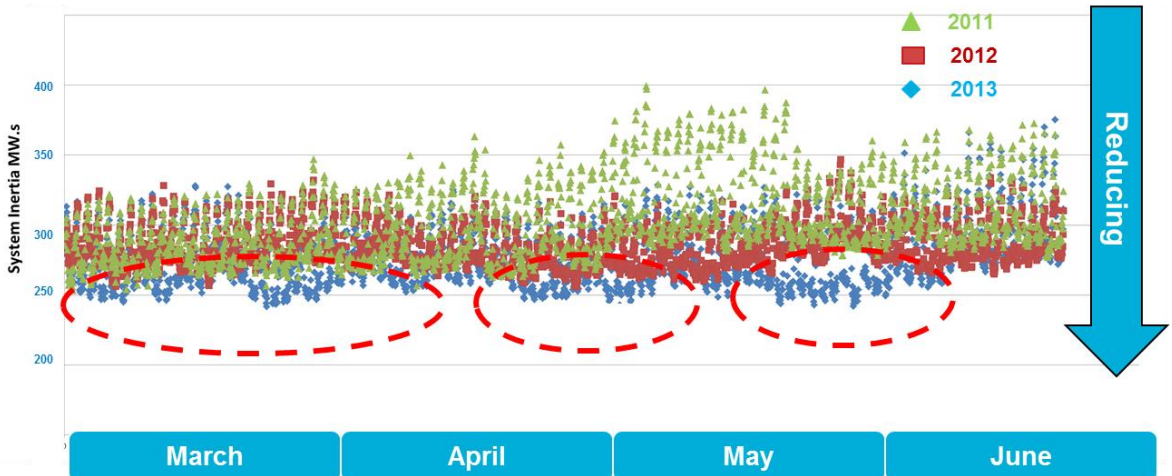
# Our System is Changing...

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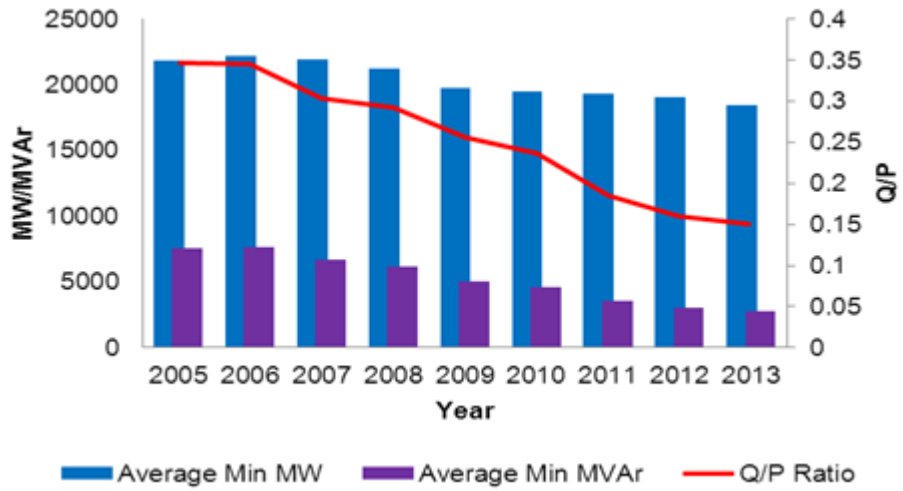


# And the Impact?

System Inertia



MVAr Demand



# What was SOF? Recap

**Low Carbon Life**

- Economic:** - Growing UK economy
- Political:** - Short term political stability that long term consensus around decarbonisation
- Technological:** - Renewable generation hit a low level. High innovation in the energy sector.
- Social:** - High uptake of electric vehicles but consumers still focused on energy efficiency. Going green is a by-product of purchasing decisions.
- Environmental:** - Carbon target hit. No new environmental targets introduced.

**Gone Green**

- Economic:** - Growing UK economy
- Political:** - Domestic and European policy harmonisation, with long term certainty provided.
- Technological:** - High levels of renewable generation with high innovation in the energy sector.
- Social:** - Engaged consumers focused on drive for energy efficiency. This results in high uptake of electric vehicles and heat pumps.
- Environmental:** - All targets hit, including new European targets post-2020.

**No Progression**

- Economic:** - Slow UK economic recovery
- Political:** - Incremental political decisions without Government, resulting in investor uncertainty.
- Technological:** - Gas is the preferred choice for generation over renewables. Little technological innovation occurs in the energy sector.
- Social:** - Consumers not engaged with energy efficiency. Low uptake of electric vehicles and heat pumps.
- Environmental:** - Targets are missed, no new environmental targets introduced.

**Slow Progression**

- Economic:** - Slow UK economic recovery
- Political:** - Policies still for sustainability but financial constraints prevent delivery of policies.
- Technological:** - Renewable generation chosen over low carbon generation. Low levels of innovation in the energy sector.
- Social:** - Engaged consumers focused on drive for energy efficiency but with low uptake of electric vehicles and heat pumps due to affordability.
- Environmental:** - Environmental targets missed but hit later. New European targets introduced.

**Future Energy Scenarios**

**Change in Energy Landscape**

- Generation mix
- Interconnection
- Demand side services

**Performance Requirements**

**Economic, Efficient and Operable System**

- Large infeeds (>1800MW)
- System stability
- Frequency
- Voltage
- Rotor angles
- Constraint minimisation
- Market facilitation

**Operational Challenges**

**Reduction in System Strength**

- System inertia
- RoCoF
- Primary response
- System stability
- Short circuit level
- Power quality
- Protection
- HVDC commutation
- System stability

**Operation Solutions & Opportunities**

**SMART Grid Development**

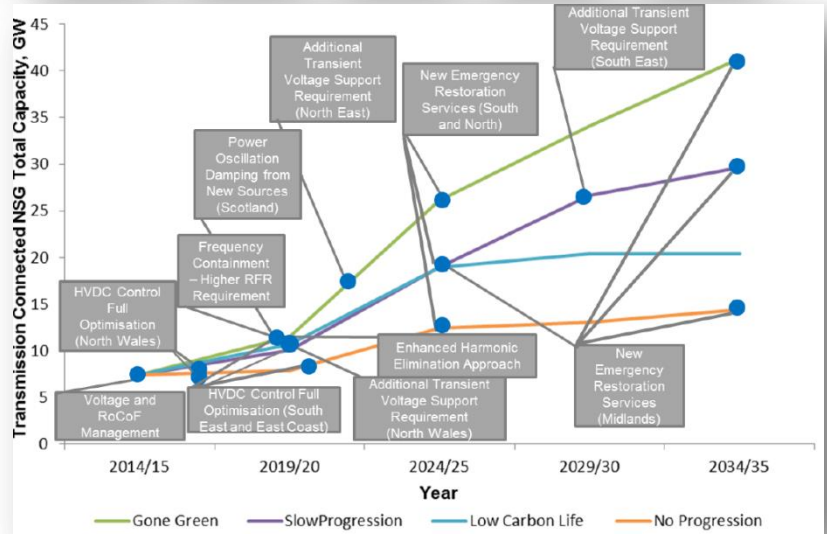
- Rapid response
- Demand side response
- Low load operation of thermal plants
- Dynamic thermal ratings
- System wide controller
- Parallel HVDC links

**Electricity Ten Year Statement**

**System Operation Chapter of ETYS**

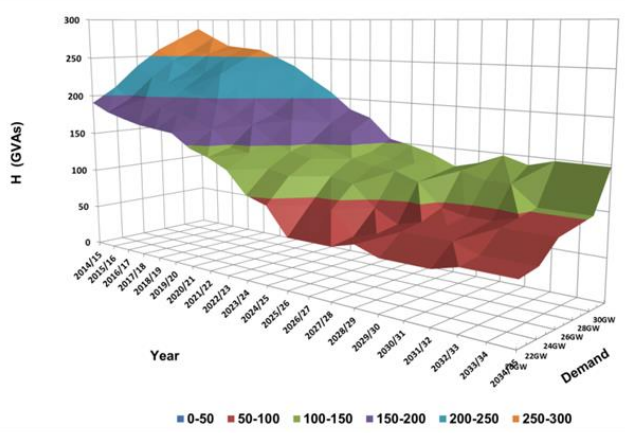
- Variations in each topic
- Opportunities for stakeholders to provide new services
- Stakeholder feedback

Change	Affected Subjects	Consequences
System Inertia	RoCoF	Trip of Embedded Generation
	Frequency Containment	Increase in Volume of Required Response
	Generation Withstand Capability	Trip of Larger Units (i.e. flameout)
Short Circuit Level	System Stability	Power Oscillations
	Protection	Faults not Detected by Protection Systems
	Voltage Dips	Trip of Embedded Generation without FRT Capability
Conventional Generator Closures and Increase in Distributed Generation	Voltage Management	Maintaining Voltage within Statutory Limits
	Resonance and Harmonics	Excessive Harmonic Voltage Distortions
	CSC HVDC Link Commutation	Inability to Import/Export Power Across CSC HVDC Links
Series Compensation	Emergency System Restoration	New restoration services and methodologies
	System Inertia and Short Circuit Level	New System Study Methodologies, services and asset investment
New SC HVDC Links	Sub-Synchronous Resonance	Interaction with the mechanical shafts of thermal units & shaft fatigue
New VSC HVDC Links	Control Systems	Adverse interaction with existing control systems (AVR/Governors/SVCs/STATCOMS)

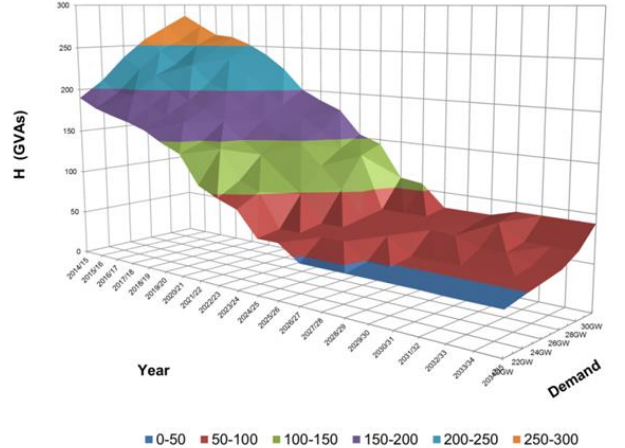


# Example - System Inertia

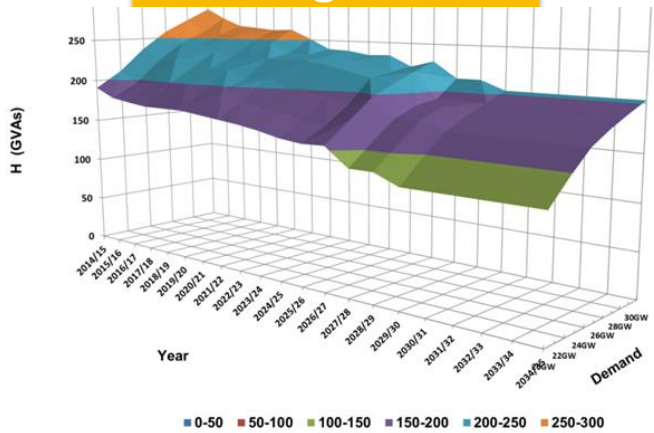
Low Carbon



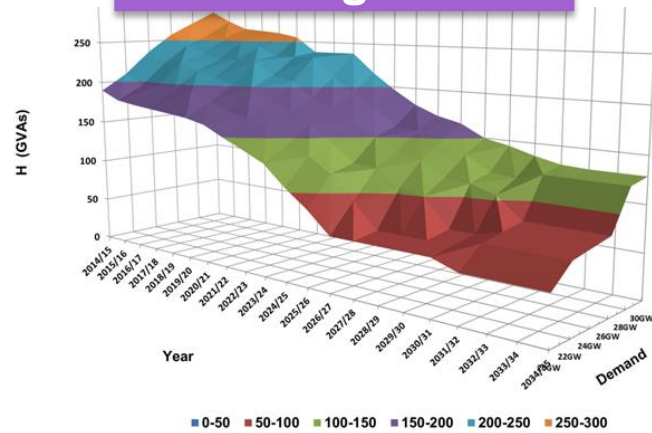
Gone Green



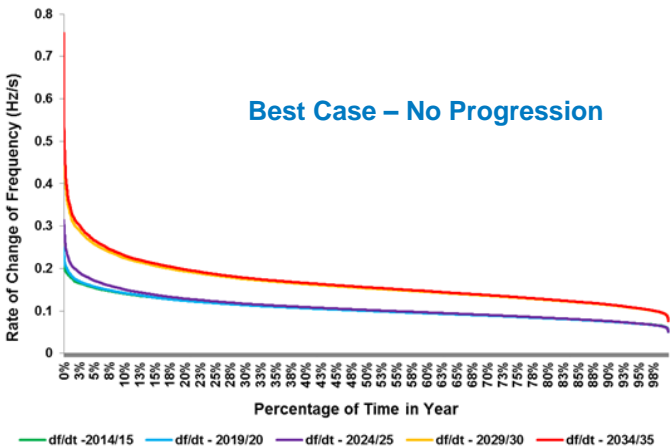
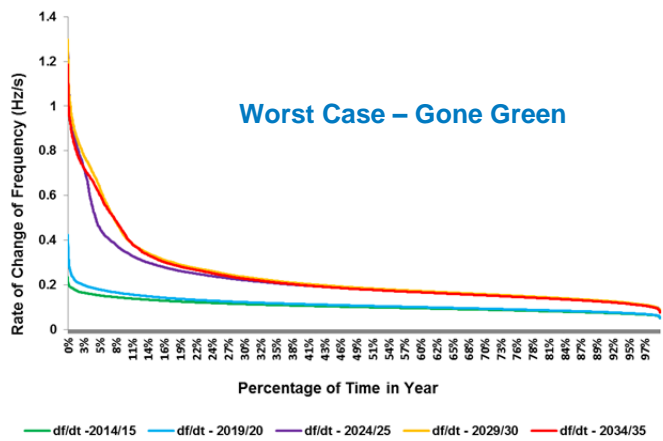
No Progression



Slow Progression



# System Inertia – RoCoF



### Key Messages

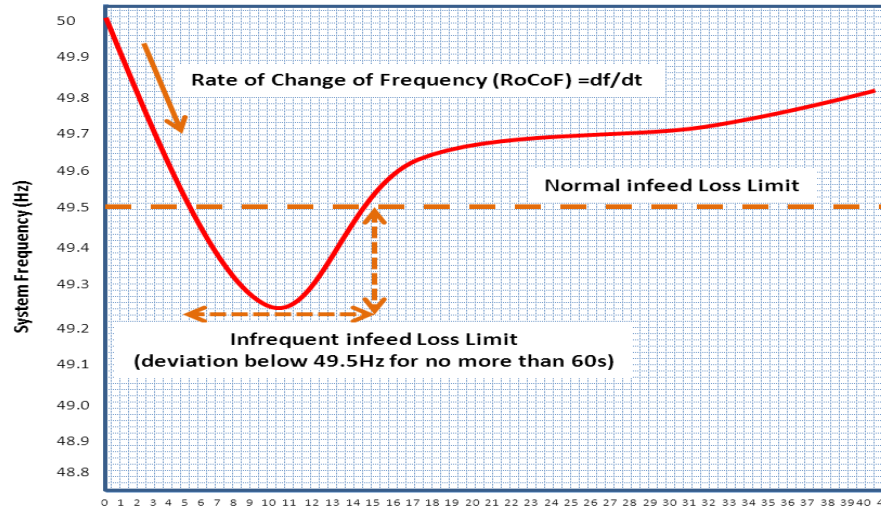
<b>df/dt &gt; 0.125Hz</b>	2014/15	2024/25	2034/35
Gone Green	19%	92%	90%
Slow Progression	19%	38%	96%
Low Carbon Life	19%	88%	93%
No Progression	19%	23%	82%

<b>df/dt &gt; 0.5Hz</b>	2014/15	2024/25	2034/35
Gone Green	0%	5%	8%
Slow Progression	0%	1%	8%
Low Carbon Life	0%	2%	3%
No Progression	0%	0%	1%

**df/dt > 1Hz/s less than 1% of time in all scenarios**

# Example - System Inertia & Frequency Containment (1)



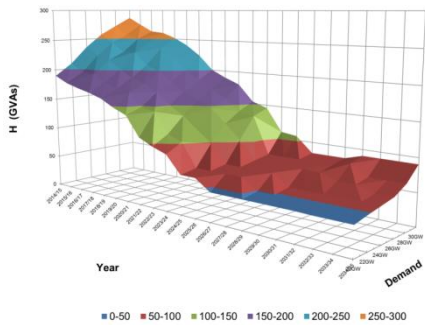
RoCoF (Hz/s)	Slow Progression	Gone Green	Inertia GW.s	Action Time (to reach 49.2 Hz)	Response Rate (MW/s)
0.125**	2013/14	2013/14	360	9	185
0.2	2019/20	2018/19	225	4	400
0.22	2022/23	2019/20	205	3.4	489
0.25	2023/24	2020/21	180	2.4	679
0.3	2024/25	2021/22	150	1.2	1148

Three times greater than current system capability

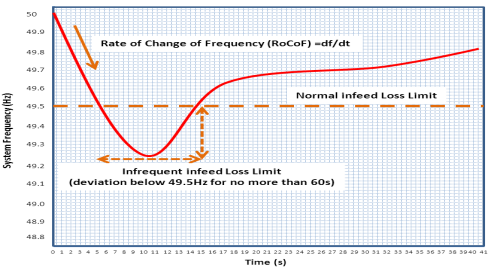
\*Figures assume a 2s delay between detection/response activation time



# Example - System Inertia & Frequency Containment (2)



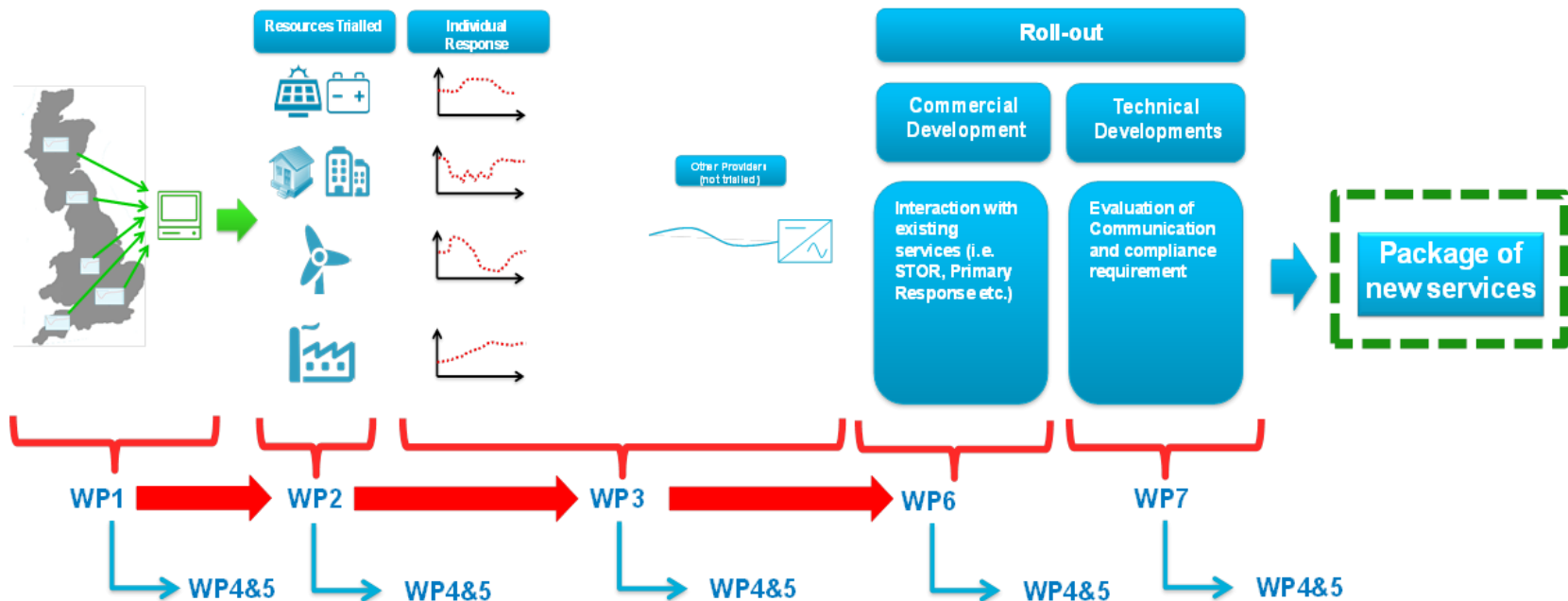
<b>Conventional Services</b>	Solution	Cost (2020 Gone Green)
	<b>Constrain generators</b>	<b>Extra £600m</b>
	<b>Constrain largest infeed/outfeed</b>	<b>Extra £130m-£270m</b> (depending on when the large infeeds are connected)
	<b>Carry larger volumes of response</b>	<b>Extra £210m</b>



<b>New Services</b>	Solution
	<b>Enhanced Frequency Control (Fast Response)</b>
	<b>Low Load Operation of Thermal Plants</b>
	<b>Synchronous Compensator</b>

# System Inertia – Frequency Containment (3) – Innovation

- Need for fast response was identified as part of SOF
- Enhanced Frequency Control Capability (EFCC) will demonstrate the effectiveness of such service

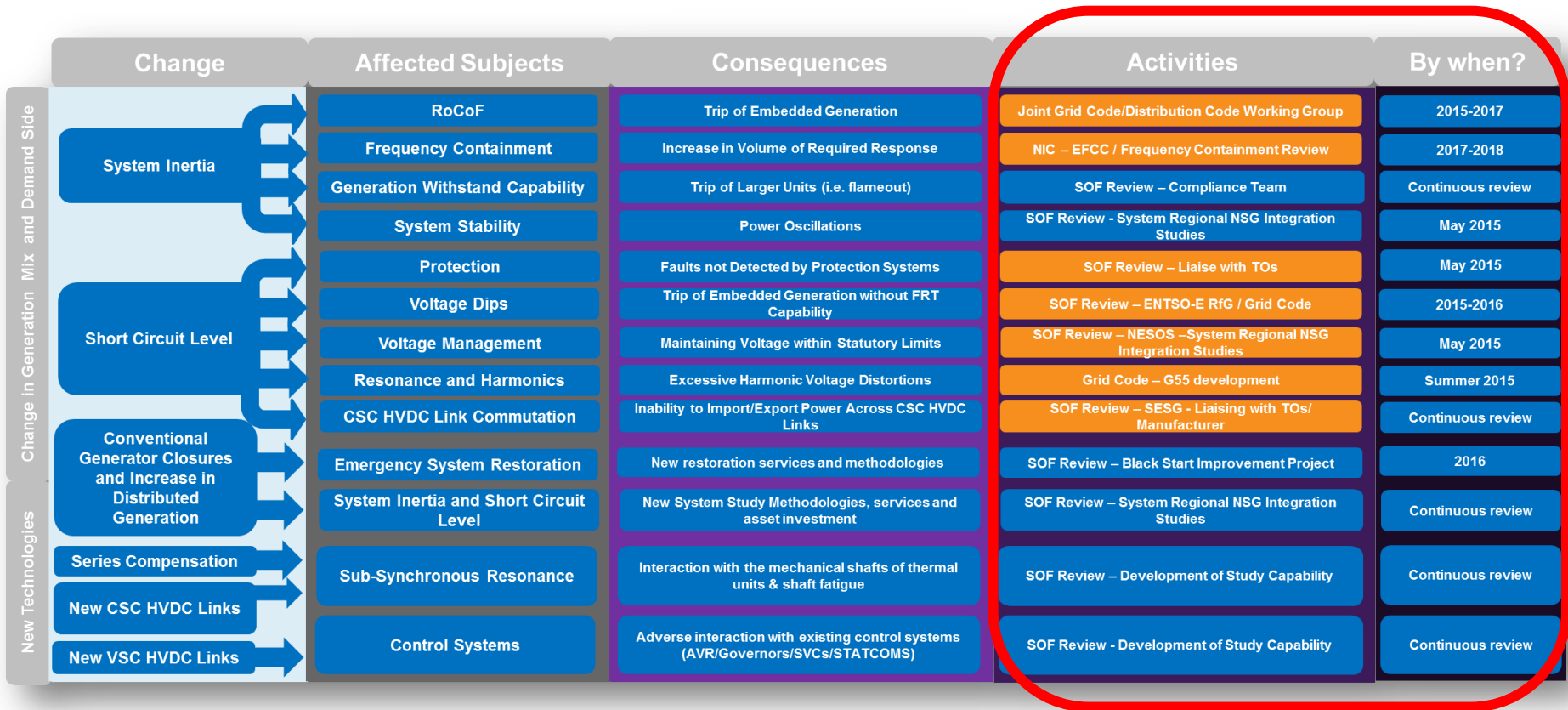


# Summary of Industry Consultation

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- **Generally positive (very good engagement)**
- **SOF Topics**
  - Number comments indicated the impact of change at the distribution level needs to be better articulated, i.e. DSR, EVs, etc.
- **SOF Solutions**
  - Better balance between market based products (i.e. wherever the technology is already capable), and new requirements
  - Solutions in long terms which require contract at early stages (i.e. synchronous compensator)
  - Solutions capable of providing number of services (i.e. Interconnectors, Storage)
- **SOF Engagement**
  - Strong desire to be involved at different stages of development of SOF, making it a GB Operability Framework

# Key areas and we are doing about it



Internal Activities

Joint activities / working groups

# Existing Engagement Forums

## SOF Engagement

### Generation

Operational Forum - Grid Code Review Panel - Compliance Meetings

- New services
- New generation technologies
- Generation withstand capability
- Modelling issues
- Installations worldwide
- Compliance issues
- Grid services to the generators
- Joint innovation projects

### Transmission

SQSS - STC – JPC- Grid Code Review Panel - Liaison Meetings

- Investment optimisation for design and operation
- New transmission technologies
- Operability and regional strategies
- SQSS and Code development
- Modelling issues and data exchange
- Joint innovation projects

### Distribution

ENA Grid Code & Distribution Code Review Panel – T&D Liaison

- Investment optimisation for design and operation
- New demand side technologies (i.e. heat pumps, DSR, storage)
- Operability and regional strategies
- SQSS, Grid Code and Distribution Code development
- Modelling issues and data exchange
- Joint innovation projects

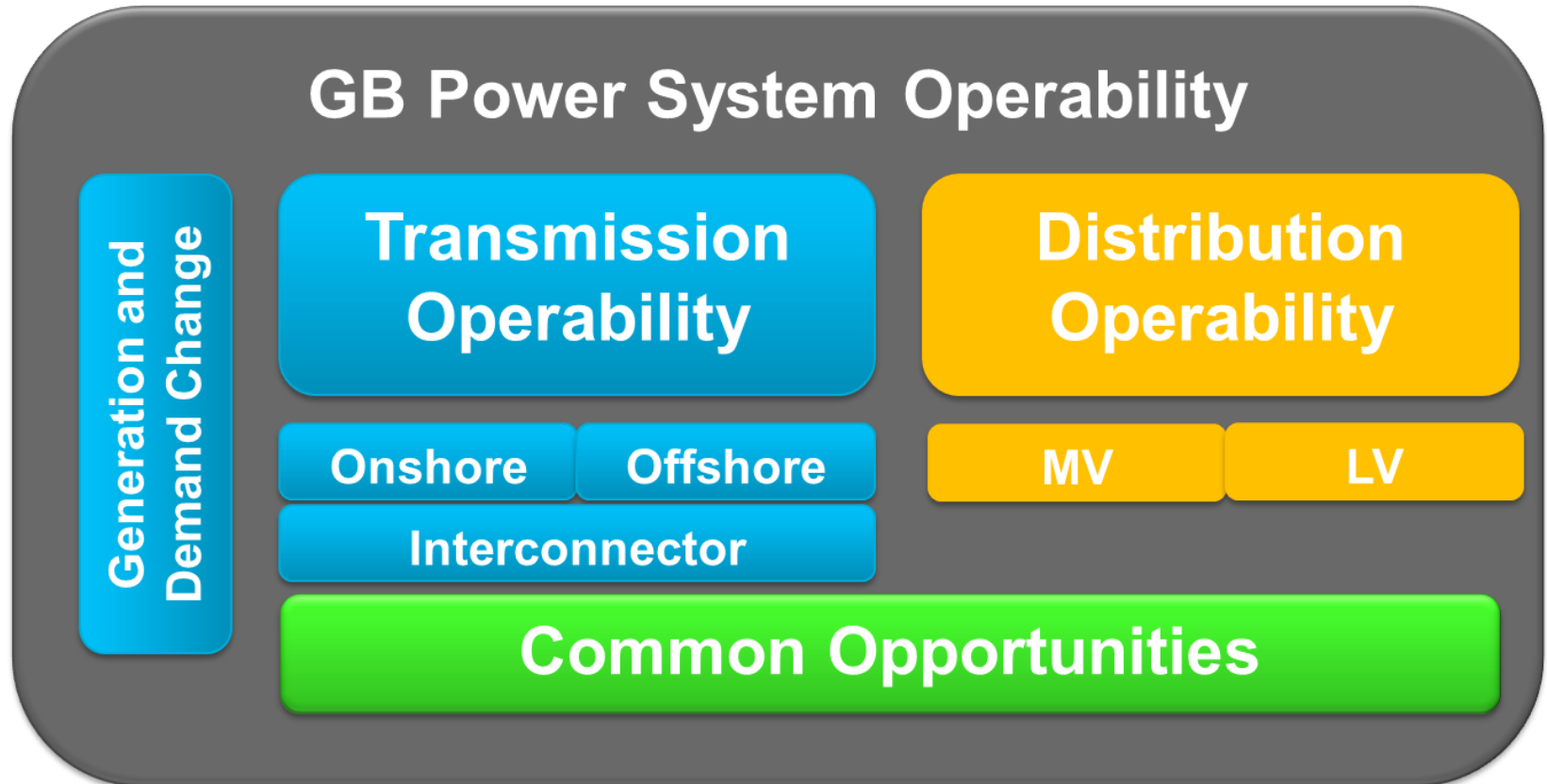
### Supply Side

Operational Forum - Liaison Meetings

- Demand Side Services
- Code development
- Operability of new technologies
- Modelling techniques (i.e. modelling DSR effects)
- Joint innovation projects

# SOF 2015 looking at whole system

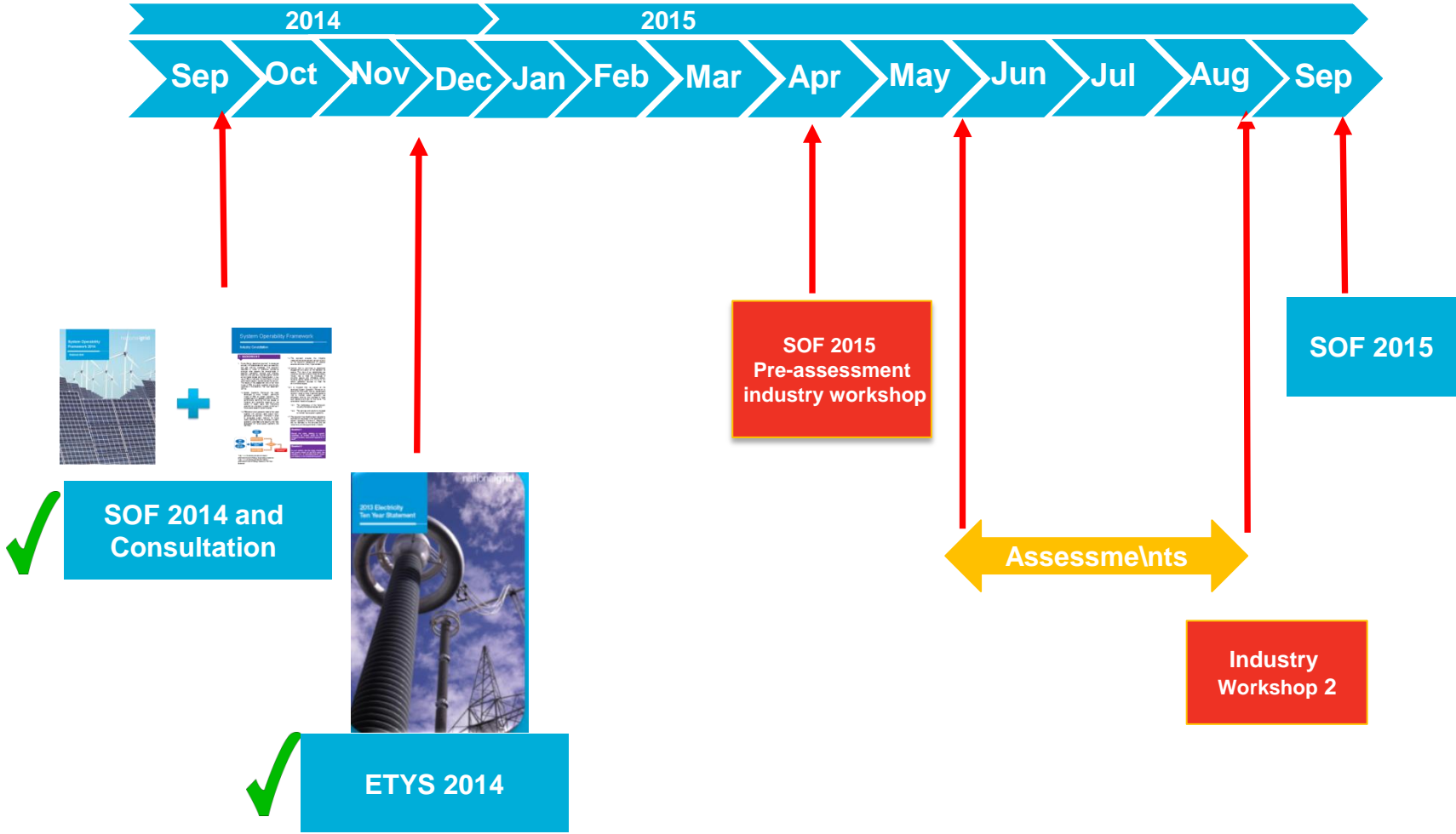
(bearing in mind many SOF 2014 topics are the whole system issue, i.e. Frequency )



a theme for future SOF?

DNO's Engagement

# Timeline for Development of SOF



## Key priorities for SOF 2015 - Summary

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- Stating how we responded to industry's comments on the consultation
- Better articulation of across Transmission and Distribution operability issues
  - Highlighting where the change is coming from, and what's the effect on
- Priority table (operability issues and opportunities)
- Update on innovation activities and what's needed
- Engagement strategy



# System Operability Framework

Thank you for your attention

For more information please email:

[box.transmission.SOF@nationalgrid.com](mailto:box.transmission.SOF@nationalgrid.com)

The screenshot shows the National Grid website interface. At the top left is the 'nationalgrid' logo. To the right are links for 'Corporate', 'UK', 'US', and 'Media'. Below the logo is a search bar with a magnifying glass icon. A navigation menu includes 'Home', 'Our services', 'Our company', 'In your area', 'Industry information' (which is highlighted in blue), and 'Careers'. Below the navigation is a red banner image. The main content area is titled 'System Operability Framework'. On the left is a sidebar with links: 'Industry information', 'Domestic gas customer satisfaction survey', 'Gas Commercial Frameworks', 'Gas Distribution Shipper information', 'Gas capacity methodologies', 'Gas Transmission operational data', and 'Gas transmission system'. The main text area contains the following content:

**System Operability Framework**

Our Future Energy Scenarios (FES) document is developed annually with stakeholders for use in our electricity and gas planning processes. This document describes a range of scenarios considering amongst other aspects the developments in electricity generation onshore and offshore, electricity and gas use, progress against national environmental targets and interconnection. A key use of FES has been the identification of extra transmission capacity required across the network. The results of this assessment and a high level impact of FES on system operation are annually published in the Electricity Ten Year Statement (ETYS).

The System Operability Framework (SOF) has been developed to study in-depth, year-round impact of FES on system operability. The process begins by assessing existing network performance, identifying the root causes of incidents and constraints observed on the system in recent years, and highlighting potential new changes in system dynamics in future years based on system studies. National Grid is committed to stakeholder engagement and action on the feedback we receive. The views of our stakeholders are crucial as we enter a period where the energy industry has to meet the challenges of providing secure and affordable energy, replacing ageing assets and moving to low carbon generation sources to meet the environmental targets.

It is important that we consult on the developed System Operability Framework to further develop this framework, and therefore we appreciate if you participate in our question based consultation.

The response to the SOF questionnaire should be sent to [box.transmission.sof@nationalgrid.com](mailto:box.transmission.sof@nationalgrid.com) by 10 October 2014.

Privacy notice

<http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/System-Operability-Framework/>