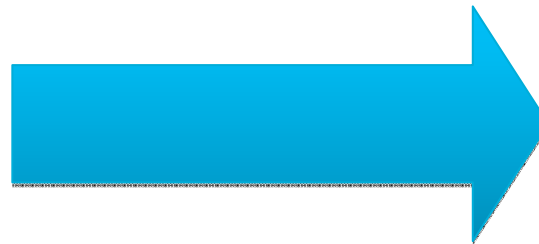


System Operability Framework (SOF)



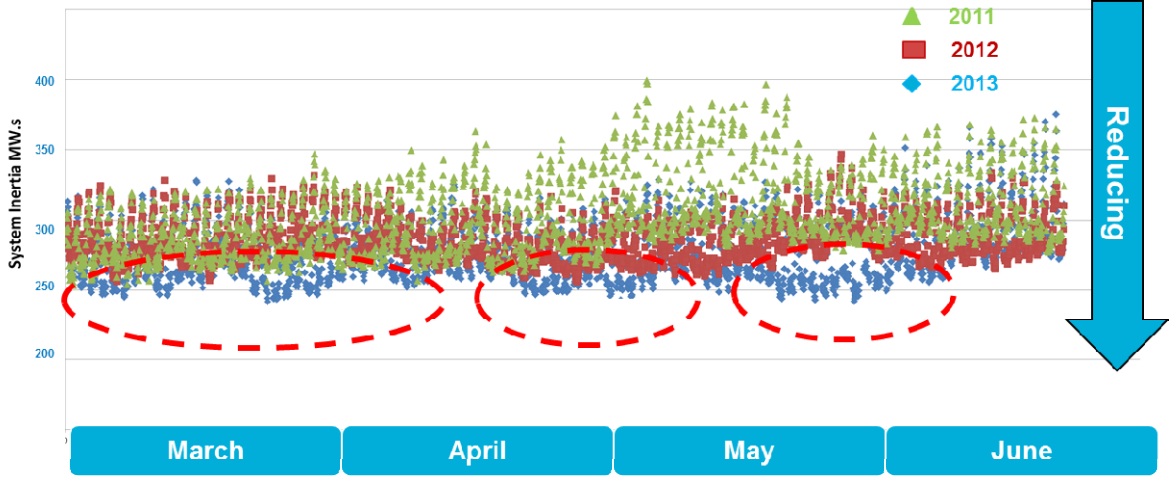
**Vandad Hamidi -SMARTer System Performance Manager
Transmission Network Services**

Changes so far...

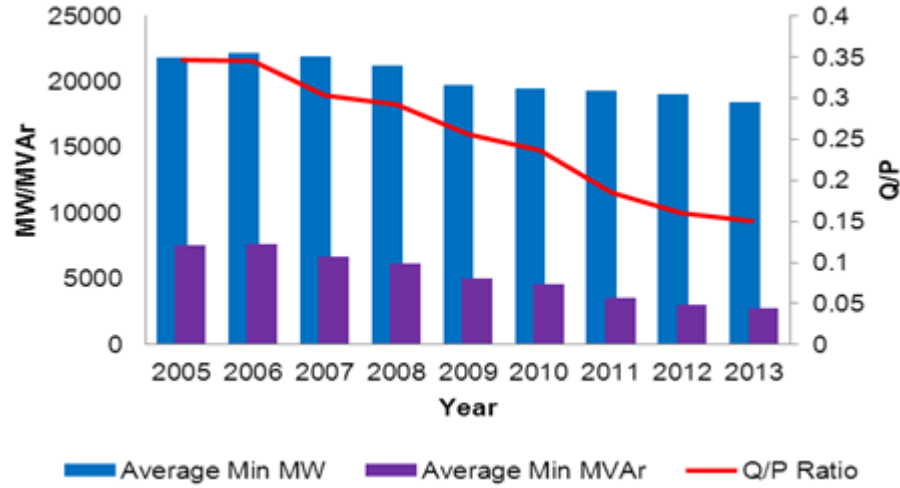


And the effect...

System Inertia



Reactive Power Demand



Future Energy Scenarios

a Affordability
More money available

a Affordability
Less money available

Low Carbon Life

Economic – Growing UK economy.

Political – Short term political volatility but long term consensus around decarbonisation.

Technological – Renewable generation at a local level. High innovation in the energy sector.

Social – High uptake of electric vehicles but consumers not focused on energy efficiency. 'Going green' is a by-product of purchasing desirable items.

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 – Inconsistent political statements within 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 – Political will 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.

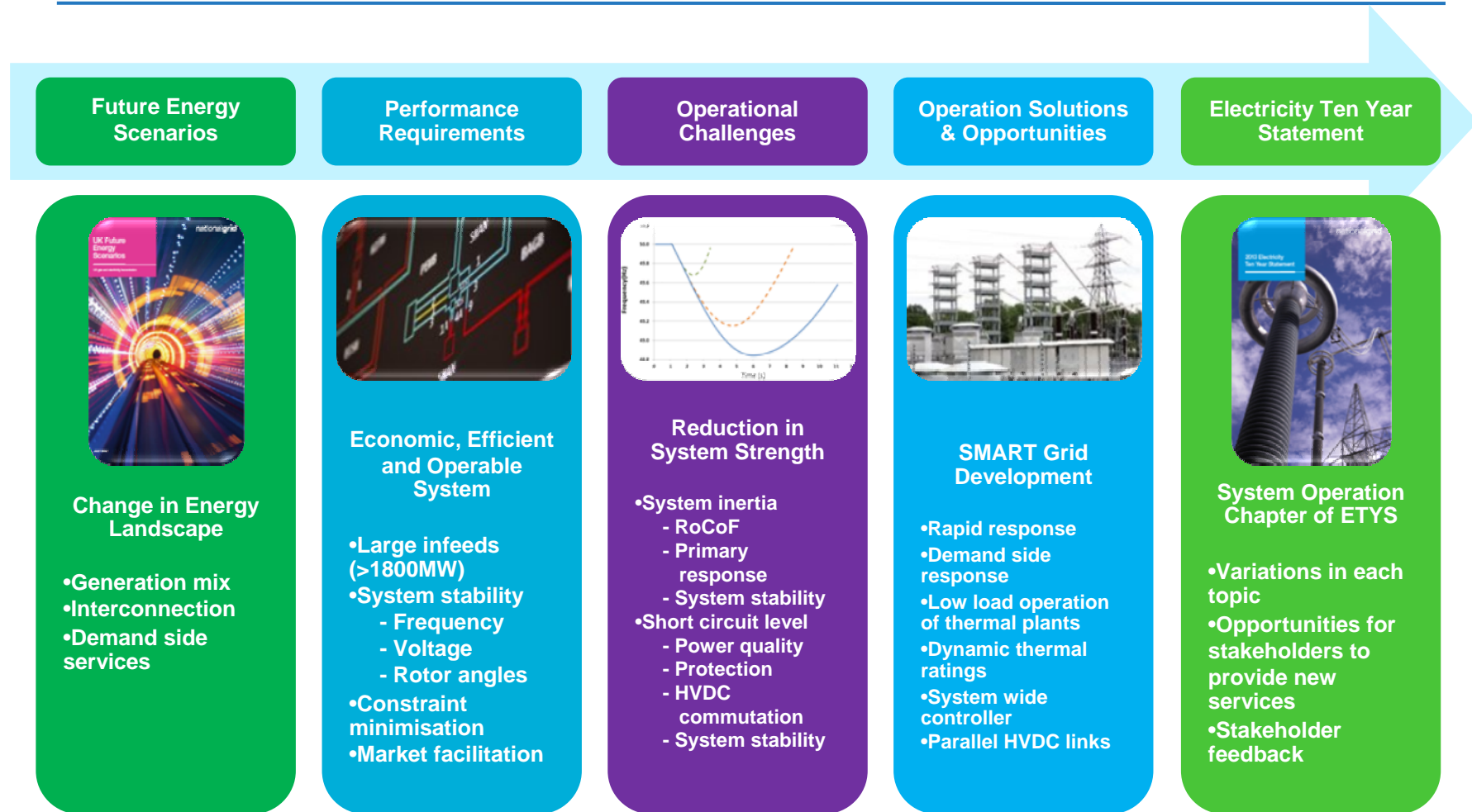
Social – Engaged consumers focused on drive for energy efficiency but with low uptake of electric vehicles and heat pumps due to affordability.

Environmental – Environmental targets missed but hit later. New European targets introduced.



a Sustainability
Less emphasis
 a Sustainability
More emphasis

System Operability Framework



International Experience

- Learnings used in SOF – Examples



DS3 Programme
Frequency and Voltage



Operating under Low Fault Level



Operating with high level of Wind and Solar



Generator withstand capability with high RoCoF

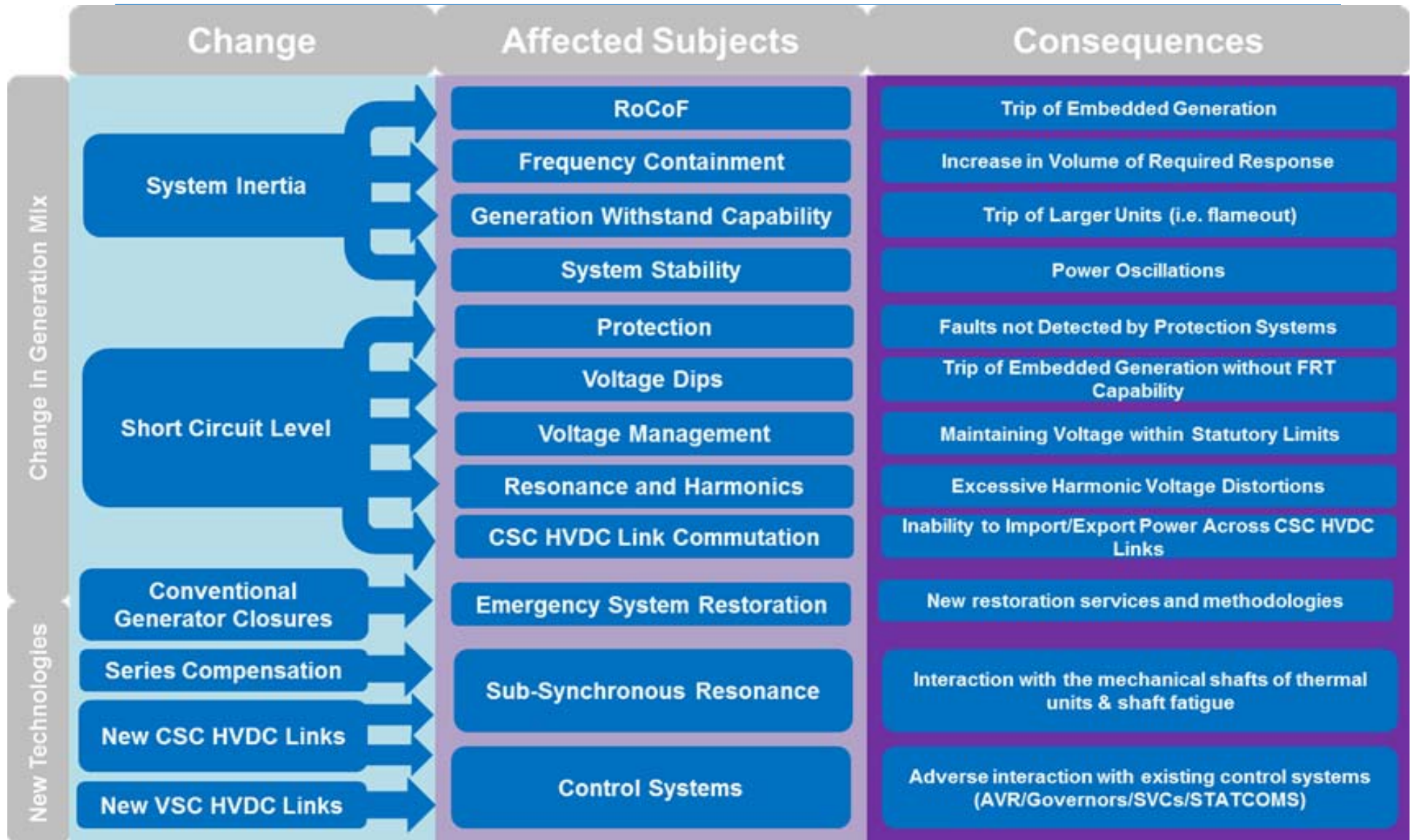


System Stability and Study Capability



Interaction between generator shaft and system resonance

SOF 2014 Topics



SOF Stakeholders



Interaction with Service Providers

	Change	Affected Subjects	Consequences
Change in Generation Mix	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)
		System Stability	Power Oscillations
		Protection	Faults not Detected by Protection Systems
Short Circuit Level	Short Circuit Level	Voltage Dips	Trip of Embedded Generation without FRT Capability
		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
New Technologies	Conventional Generator Closures	Emergency System Restoration	New restoration services and methodologies
	Series Compensation	Sub-Synchronous Resonance	Interaction with the mechanical shafts of thermal units & shaft fatigue
	New CSC HVDC Links		
	New VSC HVDC Links	Control Systems	Adverse interaction with existing control systems (AVR/Governors/SVCs/STATCOMS)



New Services

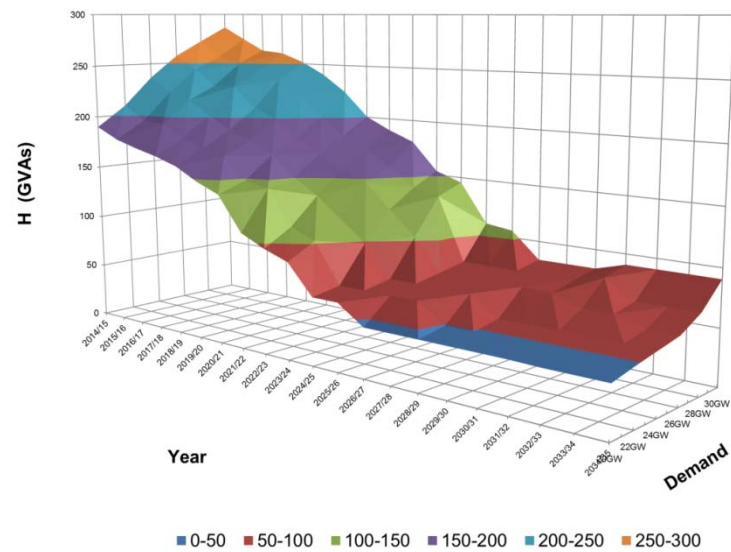
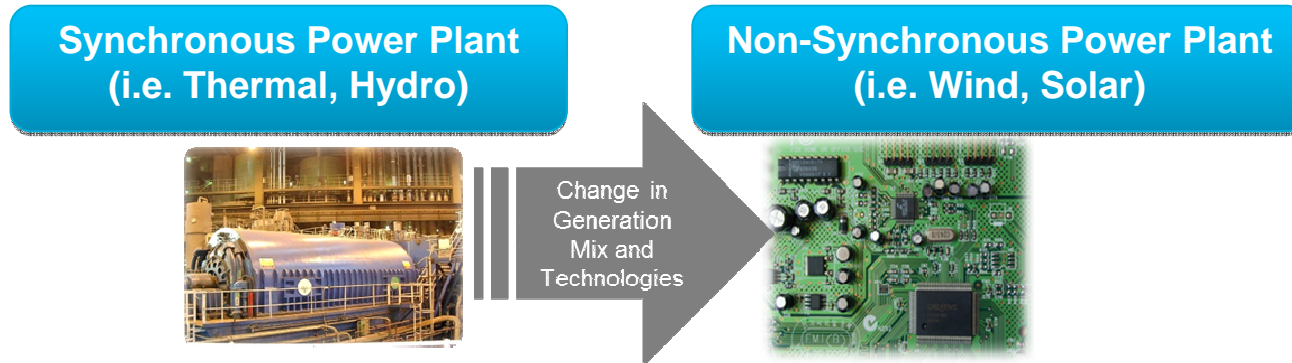
Balancing Services

- Fast Frequency Response
- Enhanced Reactive Power
- Black Start

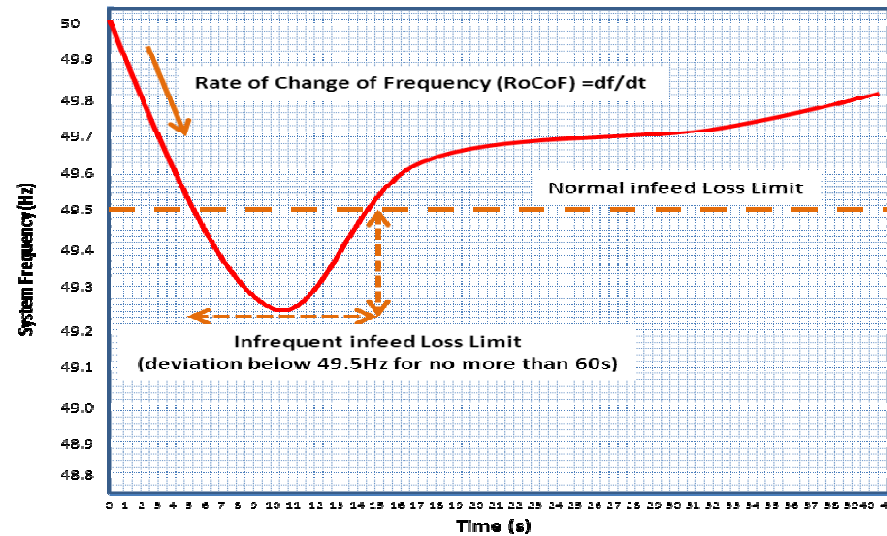
Network Services

- Demand Side Response
- Voltage Control & Enhanced Voltage Control

Example – Frequency Control (1)



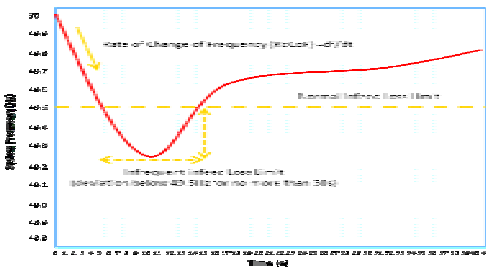
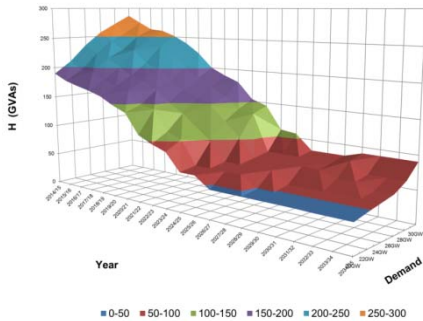
Example – Frequency Control (2)



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

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

Example – Frequency Control (3)

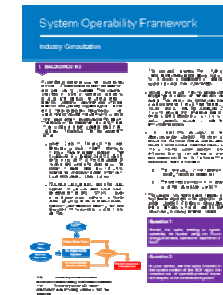


Conventional Services	Solution	Cost (2020 Gone Green)
	Constrain generators	Extra £600m
	Constrain largest infeed/outfeed	Extra £130m-£270m (depending on when the large infeeds are connected)
	Carry larger volumes of response	Extra £210m

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

System Operability Framework Consultation

- Over 30 Responses
- Mainly from Technology/Service Providers
- Feedbacks (relevant to Operational Forum)
 - Least cost solution (market/mandatory requirement)
 - Clear focus on need for new services
 - Solutions in future years requiring contracts at early stages of development
 - More collaboration on new services
 - More innovation on new technologies



System Operability Framework

Thank you for your attention

For more information please email:

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 these 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), 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 describes the Future Energy Scenarios (FES) document and the System Operability Framework (SOF). It states that the SOF is developed annually with stakeholders and is used for electricity and gas planning. The SOF is used to study the 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 by 10 October 2014. A 'Privacy' link is visible in the bottom right corner of the page.

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



Q&A

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