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System Operability Framework Summary

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SOF Development Process

The System Operability Framework (SOF) 2015 outlines how the future operability of the electricity transmission system is expected to change in response to the impact of developments outlined in the Future Energy Scenarios (FES) 2015.It also highlights the new opportunities for developing more innovative solutions and services to enhance the operability of the power networks in Great Britain.

Future Energy Scenarios

Changes in the Energy Landscape

- Changes in the generation mix
- Embedded generation growth
- Demand side developments
- Increased interconnection

Performance Requirements

A Secure and Operable System

- Maintain an operable system within frequency and voltage limits
- Minimise system constraints
- Facilitate the energy market

Operational Challenges

System Inertia and Strength

- Significant inertia and strength reductions
- Requirements for primary response
- Managing RoCoF
- Protection
- Power quality

Solutions and Opportunities

Development of a Smarter Grid

- Operation of plant and network under low load condition
- Rapid response
- Demand side management
- System wide control capability

SOF 2015 Topics

Topic	Assessment	Impact
System Inertia	Whole System Minimum Inertia	Decreasing whole system minimum inertia in future years
	Rate of Change of Frequency (RoCoF)	Trip of embedded generation protected by RoCoF relays
	Frequency Containment	Increase in volume of response required
System Strength and Resilience	Protection	Difficulty detecting and clearing faults on weaker networks
	Voltage Dips	Widespread voltage dips and disconnection of embedded generation
	Voltage Management	Voltage containment and need for additional reactive compensation
	Power Quality	Power quality issues and need for additional filtering
	LCC HVDC Commutation Failure	Inability to operate LCC HVDC links in weak network conditions
	Demand Control	Reduction in effectiveness of demand reduction by voltage control
	System Emergency Restoration	Reduction in black start plant and system restoration challenges
Embedded Generation	Regional System Stability	Stability issues associated with increase in embedded generation
	Low Frequency Demand Disconnection	Risk of cascade loss of generation should LFDD relays operate
	Active Network Management (ANM)	Uncoordinated TSO/DSO actions in constraint management
	Demand Forecasting	Increased demand forecasting error and increase in balancing actions
New Technology	Sub-Synchronous Resonance	Resonance issues and torsional shaft interaction
	Control System Interaction	Oscillations arising from uncoordinated control systems
	New Nuclear Capability	System flexibility and the impact of frequency response derogation
	Demand Side Technologies	Changes in demand profile and impact of demand side technologies

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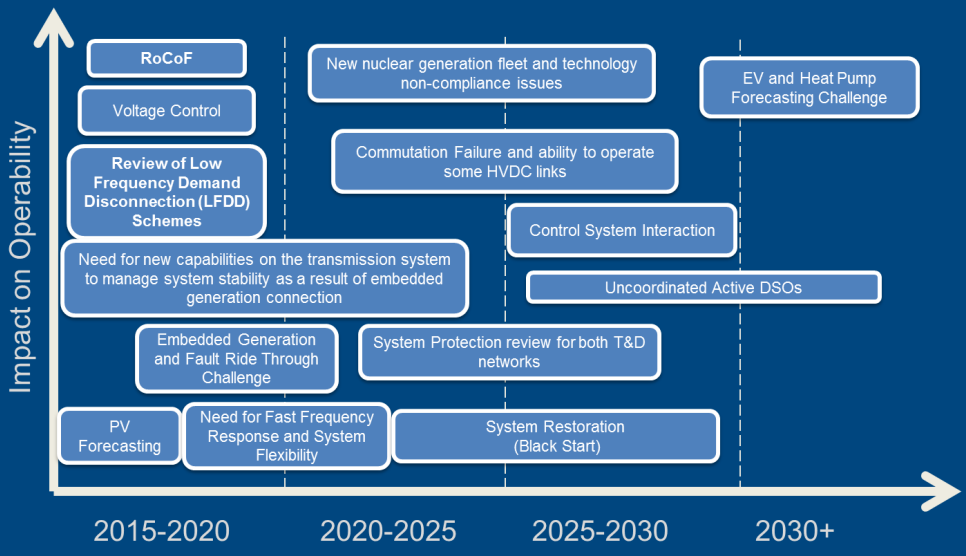
Future Operability Strategy

In SOF 2015, we have gathered the recommendations and potential solutions that were identified in individual topic assessments. Based on the timeline of operability challenges, a holistic strategy for the development of new services and capabilities is proposed. In doing so, we have attempted to consider the technology readiness, the necessary coordination required, and the potential capabilities which can be provided by a given technology or service.

Timeline of SOF Challenges



Operability Area		RoCoF Management	Frequency Management	Voltage Management	Protection System Effectiveness	System Restoration Capability	Low Frequency Demand Disconnection	Commutation of HVDC links
Non-Service Based Actions	Changes to various industry codes and standards	●	●	●			●	
New Operability Service	New service from Non-Synchronous Generation	●	●	●		●		
	Distribution System Operator (DSO) Services		●	●		●		
	Support from Embedded Generation		●	●				
	Synchronous Compensator	●	●	●	●			●
	Interconnector Services	●	●	●		●	●	
	Flexible Non-Synchronous Generation	●	●					
	Flexible Synchronous Generation	●	●	●	●			●
	Energy Storage	●	●	●		●	●	
	Demand Side Services	●	●				●	

Key Messages of SOF 2015

System Inertia

- System inertia continues to decline across all Future Energy Scenarios.
- Primary frequency response requirement will increase by 30 – 40% in the next 5 years.
- By 2030, the response requirement will be between 3 and 4 times today's level.
- In the absence of alternatives, providers available today cannot meet requirements by 2025 under 2 scenarios, 2030 under 3 scenarios and 2035 under all scenarios.

Embedded Generation

- Increase in embedded generation is contributing to a number of operability challenges, but also represents significant potential for the provision of system services.
- To maintain the stability of the transmission system new cross- system capabilities are required.
- SO, TOs and DNOs must work more closely to coordinate provision of services between networks.
- There is an immediate need to review Low Frequency Demand Disconnection (LFDD) schemes which are affected by exporting distribution networks with large amounts of embedded generation.

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System Strength and Resilience

- Natural support to the grid is significantly reduced and greater access to demand side resources is required for the provision of grid support services.
- System strength declines are significantly more pronounced and extensive than 2014 assessments and the suitability of existing protection systems for low fault level operation must be reviewed.
- Voltage management continues to be a growing challenge. Without access to whole-system resources, transmission solutions alone cannot economically address future system requirements.
- System emergency restoration strategy is under review due to the unavailability of existing black start plant in the future.

New Technologies

- New nuclear generation will have a significant impact on system operability in the future and the system requirement for flexibility is particularly important.
- Demand side technologies such as battery storage present a significant opportunity for new system services and further network impact assessment must be carried out to access these capabilities without risks to operability.

Future Operability Services and Key Actions

Service	Key Actions
New Services From Non-Synchronous Generation	• Develop new ancillary services to utilise non-synchronous generation. • Value the services to indicate revenue opportunities for non-energy production activities. • Demonstrate the capability of wind and solar PV (standalone & hybrid PV-Storage) to support frequency.
Demand Side Services	• Engage with demand side service providers on LFDD alternatives. • Engage widely through the SMART Frequency Control project on the new Enhanced Frequency Control Capability service specifications.
Energy Storage	• Valuation of new services. • Continue to trial hybrid renewable generation and storage model. • Address regulatory barriers for ownership and provision of system services from energy storage.
Flexible Synchronous Generation	• Engage with plant owners to better understand any additional flexibility through plant modification in terms of: ❖ Minimum output level and services at that level; ❖ Ramp up and down capability at different output levels. • Work with manufacturers and developers to factor flexibility and new services into new plant design. • Value the services that flexible generation can provide.
Interconnector Services	• Engage with developers, owners and other TSOs to develop a shared understanding of the system services required in GB and other countries. This will facilitate trade-offs between countries.
Synchronous Compensator	• Explore the conversion of existing generators to synchronous compensators with plant owners. • Value services that synchronous compensators could provide as a basis for new system services.
Support From Embedded Generation	• Work with DNOs on frameworks to access services. • Demonstrate capability as part of the SMART Frequency Control project to support grid frequency. • Develop new services to enable participation in frequency control. • Model the system impacts of embedded generation in providing voltage support and the effectiveness for TOs and DNOs.
DSO Services	• Work with DNOs on frameworks to access services from a range of distributed resources including generation, storage and demand. • Develop common customer propositions for DSO services. • Identify the best value options for consumers (considering DSO's in conjunction with other options). • Develop approaches to enable new entrants to offer various system services. Explore the wider system considerations of providing these as DSO type services (i.e. voltage reduction for demand control). • Develop techniques to model the whole-system behaviour of DSOs. Framework and code changes to underpin new roles and enable the provision of DSO services.

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