

## Appendix 5 - System Defence and Restoration (March 2021)

### Structure of the Appendix

This Appendix provides an initial overview of the Function, including the snapshot of the roadmap of the Function and some key statistics.

We then go through each activity and the unique steps that sit under the activity. With the term “unique” we indicate all Common Steps aggregated at organisation level, where possible, as well as steps which aggregate Individual Steps (see section 2.7.2 of the main document for reference).<sup>1</sup>

We provide a summary table of each step which includes all the associated information as of the date of this publication. The fields of the table are explained below:

Step	Name of the step as included in the DSO Roadmap
<b>Step type:</b>	<i>Development / definition activity or network action or code change process or enabler/dependency.</i>
<b>Description:</b>	<i>Description of the step as included in the DSO Roadmap</i>
<b>ENA ONP Product:</b>	<i>Only relevant for steps which are associated to an ENA ONP Product.</i>
<b>Timeline:</b>	<i>Start date and completion date of the step. For aggregated steps, start date shows the earliest start date of the responses and completion date the latest completion date of the responses.</i>
<b>Organisation type:</b>	<i>Involved organisations who are responsible for delivering this step. If the step type is “Code change process”, then a delivery body which consists of a number of stakeholders (DNOs, Ofgem, TOs, ESO), is responsible for the code change process. In this case the step is allocated to the “Delivery body”.</i>
<b>Progress:</b>	<i>This field shows the number of organisations in each implementation level.</i>
<b>Additional information:</b>	<i>Additional information such as barriers, dependencies, good practices and links to public information is included in this field.</i>

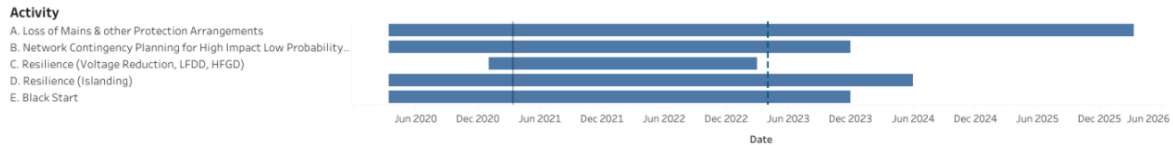
**Table 1 – Step table template, definition of the fields**

### Function 5

Function 5 – System Defence and Restoration consists of 20 unique steps, some of which are common across DNOs, T.E.F. projects and TOs or duplicated across different activities of this function. We received in total 81 contributions by the involved stakeholders (i.e. 81 steps by all organisations, which were aggregated to 21 unique steps, where possible).

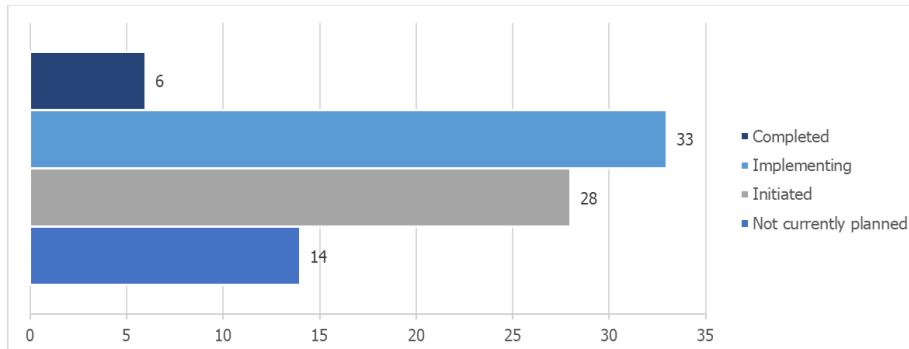
As of May 2020, Figure 1 shows that the roadmap of the “System Defence and Restoration” Function will be completed by 2026. Please note that timescales are only relevant to steps that have been planned or being implemented by the involved organisations. There are no dates for steps that are at conceptual level, meaning that the organisations plan to implement the step, but they do not know the timescale of the implementation (please refer to section 2.7.3 of the main document for reference).

<sup>1</sup> If a step is relevant to the wider industry, it is called Common Step. A step which is required for individual organisation to implement DSO functionality is called Individual Step. Individual steps are aggregated into a single generic step combining all individual network actions and described only at a high-level, anonymised basis.



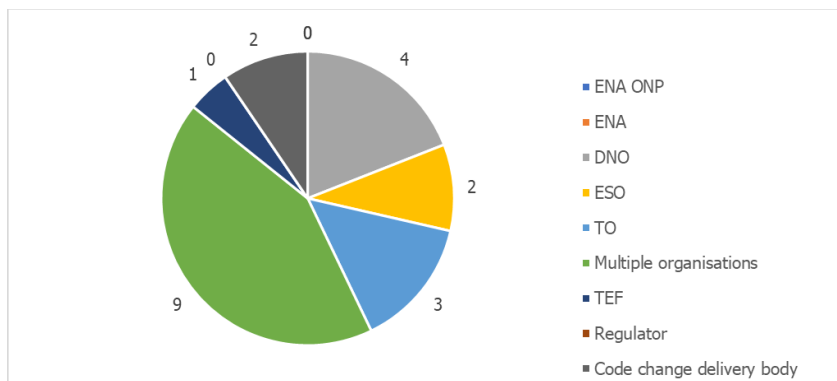
**Figure 1 System Defence and Restoration Roadmap**

Figure 2 shows the total number of organisations' contributions to the unique steps. Most contributions (~41%) of this function are currently being implemented. Only few of them have been completed and around one third of the steps have been initiated (i.e. acknowledged, but implementation has not yet commenced). 14 responses have indicated that the involved organisation is not currently planning to implement the step.



**Figure 2 Progress against implementation of "System Defence and Restoration" Function (No. of steps-contributions of each organisation)**

Figure 3 shows the number of unique steps that are led by each organisation type in the "System Defence and Restoration" Function. Around half of the steps in this activity involve multiple organisations, requiring contributions from DNOs, TOs and the ESO. Four steps are DNO-led only, while three steps are TO-led only. There are also two code change processes relevant to this activity.

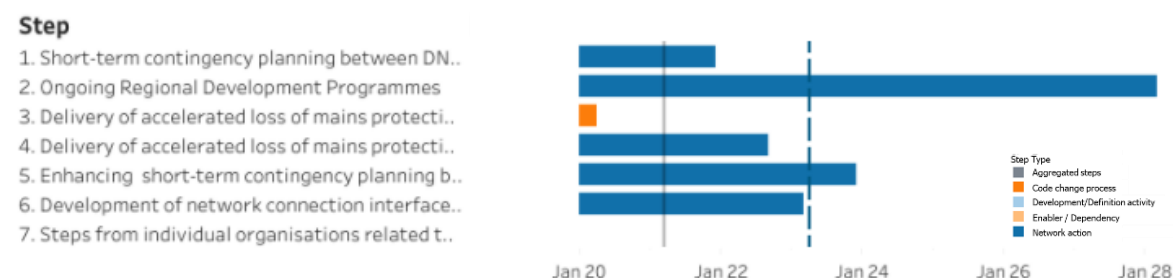


**Figure 3 Number of steps led by organisation type in Function 5**

## Activity A: Loss of Mains & other Protection Arrangements

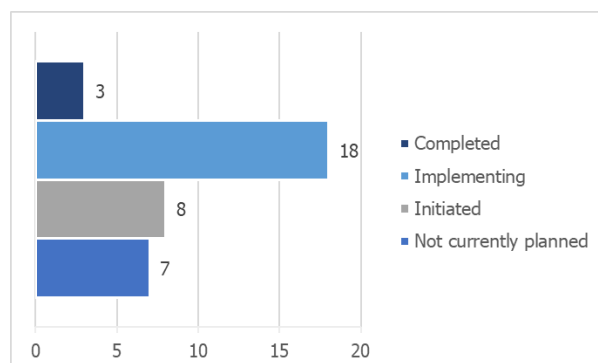
Description: Ensuring the design and implementation of DER connection arrangements that have adequate resilience to network disturbances. This includes the specification of connection interface protection arrangements (including Loss of Mains) and compliance testing.

Figure 4 displays the roadmap for activity A which consists of 7 unique steps:



**Figure 4 System Defence and Restoration – Activity A roadmap**

Figure 5 shows the total number of organisations' contributions to the unique steps. As of March 2021, 50% of steps in this activity are being implemented, and just over one fifth (22%) is in the organisations' pipeline to implement, but have not started yet ("Initiated"). 7 responses have indicated that the involved company is not currently planning to implement the step. You can find more details in the detailed step tables.



**Figure 5 Progress against implementation of "System Defence and Restoration" – Activity A (No. of steps-contributions of each organisation)**

The tables on the following pages provide detailed information for each step under Activity A.

## Step 1

Step:	Short-term contingency planning between DNOs and the ESO
Step type:	Network actions
Description:	DNOs and the ESO to develop protocols for short-term contingency planning utilising ancillary services. Work on this area has already been started through the South West Operational Tripping Scheme between the ESO and WPD.
ENA ONP Product:	2018 WS3 P3
Timeline:	January 2019 - December 2021
Organisation type:	DNO(6), ESO(1)
Progress:	Not currently planned(3), Implementing(4)
Additional information:	This is a step originally identified by the Least Regrets Analysis. Link can be found below: <a href="https://www.energynetworks.org/industry-hub/resource-library/open-networks-2019-ws3-p7-update-on-least-regrets-analysis.pdf">https://www.energynetworks.org/industry-hub/resource-library/open-networks-2019-ws3-p7-update-on-least-regrets-analysis.pdf</a>

## Step 2

Step:	Ongoing Regional Development Programmes
Step type:	Network actions
Description:	Development of Regional Development Programmes with industry partners as and when required. Objective is to inform protocols for short-term contingency planning between DSO & ESO utilising ancillary services. Implement new commercial contracts that optimise use of existing network assets by allowing DER to connect and provide transmission constraint management services to help manage their impact. ESO/ DNOs/ TOs collaboration to develop enhanced ways of working that facilitate active DER management for transmission system needs. DNOs and ESO to develop a process that facilitates proactive identification of future RDPs.
ENA ONP Product:	N/A
Timeline:	January 2019 - March 2028
Organisation type:	ESO(1), DNO(6), TO(3)
Progress:	Not currently planned(1), Initiated(3), Implementing(5), Completed(1)
Additional information:	Currently most companies are in discussion with the ESO or already implementing a regional development programme. One DNO is not currently planning an RDP, on the basis that current needs/requirements do not drive such an action. Most information can be found on the ESO's website: <a href="https://www.nationalgrideso.com/research-publications/regional-development-programmes">https://www.nationalgrideso.com/research-publications/regional-development-programmes</a>

### Step 3

<b>Step:</b>	<b>Delivery of accelerated loss of mains protection change programme</b>
<b>Step type:</b>	Code change process
<b>Description:</b>	As part of the Accelerated Loss of Mains Change Programme a modification to the existing G59 recommendation was raised. This modification has now been completed.
<b>ENA ONP Product:</b>	N/A
<b>Timeline:</b>	October 2018 - October 2019
<b>Organisation type:</b>	
<b>Progress:</b>	Completed(1)
<b>Additional information:</b>	This code modification has been completed and was an enabler for the initiation of step 5.

### Step 4

<b>Step:</b>	<b>Delivery of accelerated loss of mains protection change programme</b>
<b>Step type:</b>	Network actions
<b>Description:</b>	This is an industry led project delivered by National Grid ESO, Distribution Network Operators, and Independent Distribution Network Operators to accelerate compliance with new requirements in the Distribution Code. National Grid ESO and GB Distribution Network Operators (DNOs) / Independent Distribution Network Operators (IDNO) are undertaking this electricity transmission and distribution industry led initiative managed on behalf of the Distribution Code Review Panel.
<b>ENA ONP Product:</b>	N/A
<b>Timeline:</b>	April 2019 - September 2022
<b>Organisation type:</b>	ESO(1), DNO(6)
<b>Progress:</b>	Implementing(6), Completed(1)
<b>Additional information:</b>	More information on this step can be found at ENA's website: <a href="https://www.energynetworks.org/electricity/engineering/accelerated-loss-of-mains-change-programme.html">https://www.energynetworks.org/electricity/engineering/accelerated-loss-of-mains-change-programme.html</a>

#### Step 5

Step:	Enhancing short-term contingency planning between DNOs and the ESO.
Step type:	Network actions
Description:	Developing principles/methodology to apply to circumstances when DSOs can overrule market-based flex procurement with interventions to safeguard network
ENA ONP Product:	N/A
Timeline:	January 2019 - December 2023
Organisation type:	ESO(1), DNO(6)
Progress:	Not currently planned(1), Initiated(4), Implementing(2)
Additional information:	Network companies have flagged that it is currently unclear at what point an open market with competition, changes to emergency protocols (i.e. under normal conditions DNOs and ESO must operate a neutral an unbiased market). During an abnormal condition critical enough to whole system stability it is recognised that it is not always possible to operate the network in a neutral manner. The priority needs to switch to taking immediate actions for the greater good. A clear definition of when this switch becomes in operation would allow for network collaboration without breaching competition rules.

#### Step 6

Step:	Development of network connection interface arrangements
Step type:	Network actions
Description:	Liaison to identify the needs and terms of reference for the design of resilient network connection arrangements for D-network connected flexibility resources. Working group (to be set up) to define the principles, processes and systems for the design and implementation of these arrangements.
ENA ONP Product:	N/A
Timeline:	January 2020 - March 2023
Organisation type:	TO(3)
Progress:	Not currently planned(1), Initiated(1), Implementing(1)
Additional information:	This is a TO-led step and was identified as a common step for the 3 TOs during Function Surgeries.

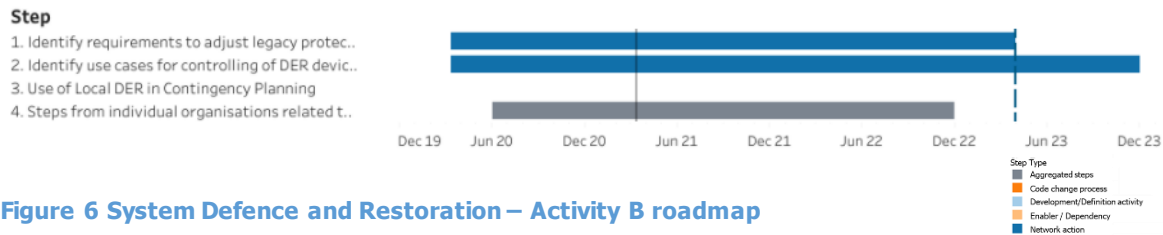
#### Step 7

Step:	Steps from individual organisations related to this activity
Step type:	Aggregated steps
Description:	This step aggregates steps required for individual DNOs or TOs to implement DSO functionality, but which have no wider industry relevance.
ENA ONP Product:	N/A
Timeline:	N/A
Organisation type:	DNO(1)
Progress:	Not currently planned(1)
Additional information:	One DNO has added a step that will further enhance this DSO activity. The step is linked to short-term contingency planning. Although this step is not currently planned, it is still considered relevant for the organisation for future implementation.

## Activity B: Network Contingency Planning for High Impact Low Probability (HILP) Events

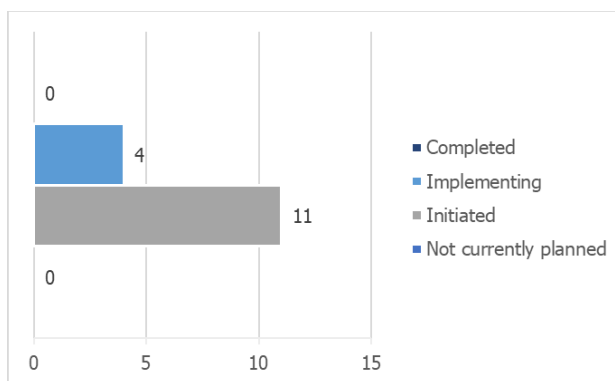
Description: Forward planning to ensure network has the capability to remain resilient against high consequence events such as extreme weather.

Figure 6 displays the roadmap for activity B which consists of 4 unique steps:



**Figure 6 System Defence and Restoration – Activity B roadmap**

Figure 7 shows the total number of organisations' contributions to the unique steps. As of March 2021, 11 steps (~73%) of this activity are in the organisations' pipeline to implement but have not started yet ("Initiated"), with the remaining 4 steps (~27%) being implemented.



**Figure 7 Progress against implementation of "System Defence and Restoration" – Activity B (No. of steps-contributions of each organisation)**

The tables on the following pages provide detailed information for each step under Activity B.

### Step 1

<b>Step:</b>	<b>Identify requirements to adjust legacy protection systems associated with HILP events</b>
<b>Step type:</b>	Network actions
<b>Description:</b>	Identify if there are any requirements to adjust legacy protection systems e.g. LFDD relay locations, LoM settings
<b>ENA ONP Product:</b>	N/A
<b>Timeline:</b>	August 2019 - April 2023
<b>Organisation type:</b>	DNO(6)
<b>Progress:</b>	Initiated(4), Implementing(2)
<b>Additional information:</b>	DNOs have flagged that new requirements on DNOs legacy protection changes events could be imposed by BEIS/Ofgem, which will have an impact on the implementation of the step. In addition Dcode to mandate changes in legacy protection settings could be raised and would be an enabler to this step.

## Step 2

Step:	Identify use cases for controlling of DER devices (e.g. EVs) during HILP events
Step type:	Network actions
Description:	DNOs to develop use cases for when small scale DER can be constrained or disconnected temporarily during emergency events. The EVTF recommended that DNOs should be given a capability to constrain or disconnect EV charge points temporarily for emergency situations. If given this power DNOs will need to determine which this facility can and can't be utilised.
ENA ONP Product:	N/A
Timeline:	January 2020 - December 2023
Organisation type:	DNO(6)
Progress:	Initiated(5), Implementing(1)
Additional information:	For this step to be implemented DNOs would need to be allowed to control EV charge points under emergency.

## Step 3

Step:	Use of Local DER in Contingency Planning
Step type:	Development / definition activity
Description:	Through a clearer understanding of the DSO Service and Emerging markets, a more informed approach to contingency planning can be developed. Aided through SPEN's involvement in both FUSION and Distributed Restart and SSEN involvement in TRANSITION, LEO and RaaS.
ENA ONP Product:	N/A
Timeline:	N/A
Organisation type:	TEF(1)
Progress:	Initiated(1)
Additional information:	This is step added by TRANSITION project. More information on projects TRANSITION and LEO below: <a href="https://ssen-transition.com/">https://ssen-transition.com/</a> <a href="https://ssen-transition.com/dso/leo/">https://ssen-transition.com/dso/leo/</a>

## Step 4

Step:	Steps from individual organisations related to this activity
Step type:	Aggregated steps
Description:	This step aggregates steps required for individual DNOs or TOs to implement DSO functionality, but which have no wider industry relevance.
ENA ONP Product:	N/A
Timeline:	June 2020 - December 2022
Organisation type:	DNO(2)
Progress:	Initiated(1), Implementing(1)
Additional information:	2 DNOs have added individual steps which sit under this activity. One step is related to new roles and responsibilities that may be required to delivery actions within this activity and the other step is about identifying required changes in protection systems.

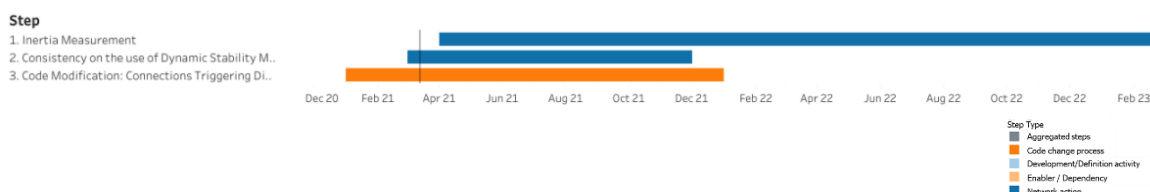


### Activity C: Resilience (Voltage Reduction, LFDD, HFGD)

Description: Providing whole system network resilience and defence through the design and implementation of mechanisms including Voltage Reduction, Low Frequency Demand Disconnection (LFDD) and High Frequency Generation Disconnection (HFGD).

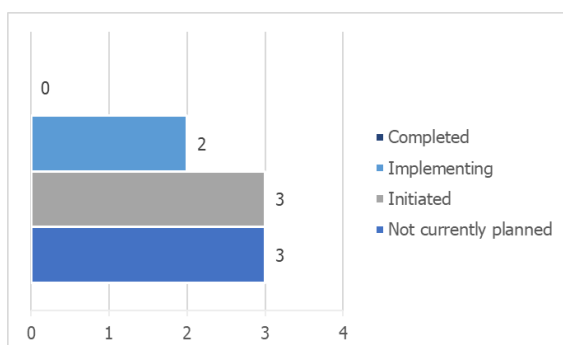
Figure 8 displays the roadmap for activity C which consists of 3 unique steps.

The tables on the following pages provide detailed information for each step under Activity C.



**Figure 8 System Defence and Restoration – Activity C roadmap**

Figure 9 shows the total number of organisations' contributions to the unique steps. As of March 2021, companies' contributions to these steps are split between implementing, initiated and not currently planned.



**Figure 9 Progress against implementation of "System Defence and Restoration" – Activity C (No. of steps-contributions of each organisation)**

#### Step 1

Step:	Inertia Measurement
<b>Step type:</b>	Implement a first of a kind tool to measure system inertia in real time and will use it to optimise real-time operation, service procurement and network development.
<b>Description:</b>	N/A
<b>ENA ONP Product:</b>	April 2021 - March 2023
<b>Timeline:</b>	ESO(1)
<b>Organisation type:</b>	Implementing(1)
<b>Progress:</b>	Implement a first of a kind tool to measure system inertia in real time and will use it to optimise real-time operation, service procurement and network development.
<b>Additional information:</b>	This is an ESO-led step, included in the ESO's forward plan: <a href="https://www.nationalgrideso.com/document/166441/download">https://www.nationalgrideso.com/document/166441/download</a>

## Step 2

<b>Step:</b>	<b>Consistency on the use of Dynamic Stability Mechanisms.</b>
<b>Step type:</b>	Network actions
<b>Description:</b>	Develop consistent approach on the use of Dynamic Stability Mechanisms (to manage power quality) utilising ancillary services.
<b>ENA ONP Product:</b>	N/A
<b>Timeline:</b>	March 2021 - December 2021
<b>Organisation type:</b>	DNO(6)
<b>Progress:</b>	Not currently planned(3), Initiated(3)
<b>Additional information:</b>	This is a step originally identified by the Least Regrets Analysis. Link can be found below: <a href="https://www.energynetworks.org/industry-hub/resource-library/open-networks-2019-ws3-p7-update-on-least-regrets-analysis.pdf">https://www.energynetworks.org/industry-hub/resource-library/open-networks-2019-ws3-p7-update-on-least-regrets-analysis.pdf</a>

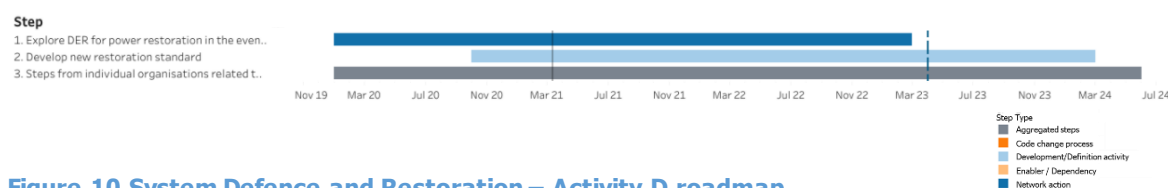
## Step 3

<b>Step:</b>	<b>Code Modification: Connections Triggering Distribution Impact Assessment</b>
<b>Step type:</b>	Code change process
<b>Description:</b>	This modification (CMP 328) proposes to put in place an appropriate process to be utilised when any connection triggers a Distribution impact assessment. Ensuring the process in place for such connections, best reflects the necessary contractual relationship of parties involved.
<b>ENA ONP Product:</b>	N/A
<b>Timeline:</b>	January 2021 - January 2022
<b>Organisation type:</b>	
<b>Progress:</b>	Implementing(1)
<b>Additional information:</b>	

## Activity D: Resilience (Islanding)

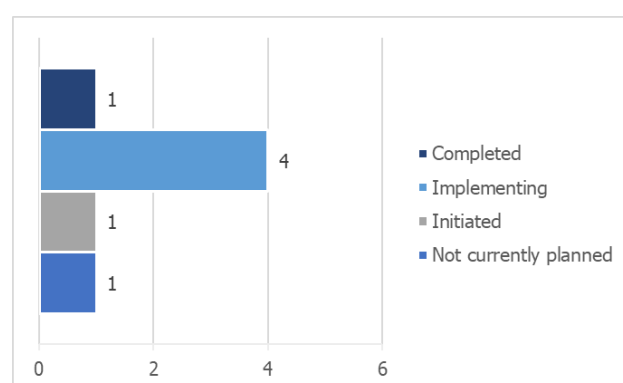
Description: Providing local and whole system network resilience and defence through the design and implementation of islanding mechanisms to enable local areas of network to remain in service in the event of a wider system incident.

Figure 10 displays the roadmap for activity D which consists of 3 unique steps:



**Figure 10 System Defence and Restoration – Activity D roadmap**

The figure below shows the total number of organisations' contributions to the unique steps. As of March 2021, these contributions mostly reflect steps are being implemented.



**Figure 11 Progress against implementation of "System Defence and Restoration" – Activity D (No. of steps-contributions of each organisation)**

The tables on the following pages provide detailed information for each step under Activity D.

### Step 1

Step:	Explore DER for power restoration in the event of black out
Step type:	Network actions
Description:	DNOs and the ESO to explore how DER can be used to restore power in the highly unlikely event of a total or partial blackout of the National Electricity Transmission System. The ESO and SP Energy Networks are working on the Distributed Restart project which explores this topic.
ENA ONP Product:	N/A
Timeline:	January 2019 - March 2023
Organisation type:	ESO(1), DNO(2)
Progress:	Not currently planned(1), Implementing(2)
Additional information:	This step will inform further actions for DNOs and the ESO and will be reliant upon outcomes of Distributed Restart project.

## Step 2

Step:	Develop new restoration standard
Step type:	Development / definition activity
Description:	Develop the new GB restoration standard, including the annual assurance framework, consistent with licence obligations
ENA ONP Product:	N/A
Timeline:	October 2020 - March 2024
Organisation type:	ESO(1)
Progress:	Implementing(1)
Additional information:	

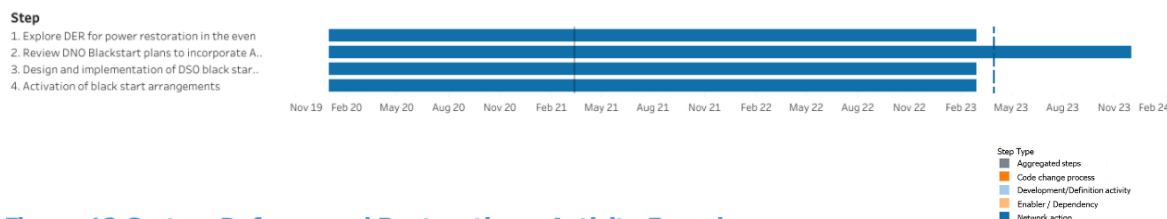
## Step 3

Step:	Steps from individual organisations related to this activity
Step type:	Aggregated steps
Description:	This step aggregates steps required for individual DNOs or TOs to implement DSO functionality, but which have no wider industry relevance.
ENA ONP Product:	N/A
Timeline:	April 2019 - June 2024
Organisation type:	DNO(2), TO(1)
Progress:	Initiated(1), Implementing(1), Completed(1)
Additional information:	DNOs are developing their own internal projects which will inform further steps to complete this DSO activity. One of the TOs has included a step about exploring the de-synchronised island management.

## Activity E: Black Start

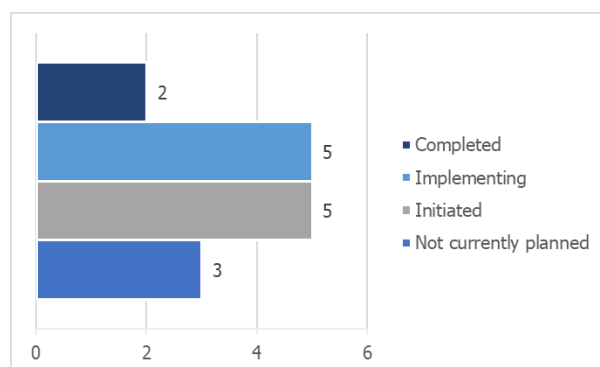
Description: Enabling whole system network re-establishment following a major system incident through the staged energisation of local networks. This could include the block loading of larger generators as part of wider Black Start plans.

Figure 12 displays the roadmap for activity E which consists of 4 unique steps:



**Figure 12 System Defence and Restoration – Activity E roadmap**

Figure 13 shows the total number of organisations' contributions to the unique steps. As of March 2021, one third of the steps is being implemented, another one third is in the organisations' pipeline to implement but have not started yet ("Initiated"). Two steps have been completed so far. Three responses have indicated that the involved company is not currently planning to implement the step. You can find more details in the detailed step tables.



**Figure 13 Progress against implementation of "System Defence and Restoration" – Activity E (No. of steps-contributions of each organisation)**

The tables on the following pages provide detailed information for each step under Activity E.

### Step 1

<b>Step:</b>	<b>Explore DER for power restoration in the event of black out</b>
<b>Step type:</b>	Network actions
<b>Description:</b>	DNOs and the ESO to explore how DER can be used to restore power in the highly unlikely event of a total or partial blackout of the National Electricity Transmission System. The ESO and SP Energy Networks are working on the Distributed Restart project which explores this topic.
<b>ENA ONP Product:</b>	N/A
<b>Timeline:</b>	January 2019 - March 2023
<b>Organisation type:</b>	ESO(1), DNO(2)
<b>Progress:</b>	Not currently planned(1), Implementing(2)
<b>Additional information:</b>	This step will inform further actions for DNOs and the ESO and will be reliant upon outcomes of Distributed Restart project.

## Step 2

Step:	Review DNO Blackstart plans to incorporate ANM, LCT, and flexible services
Step type:	Network actions
Description:	DNOs to review Blackstart plans to determine the usage of ANM, and Flexible services to help restoration as well as to update plans to incorporate the impact of LCT and DER on Blackstart restoration plans.
ENA ONP Product:	N/A
Timeline:	January 2019 - December 2023
Organisation type:	DNO(6)
Progress:	Initiated(5), Implementing(1)
Additional information:	This is a common step for all DNO, outside the ENA ONP workstreams. As per DNOs this step is reliant upon delivery of the ANM system and will inform whether ANM, LCT and flexibility services should be used for Blackstart conditions. DNOs have different plans as their network requirements are different (e.g. for some DNOs the use of LCT may not have a significant impact on Blackstart events).

## Step 3

Step:	Design and implementation of DSO black start arrangements
Step type:	Network actions
Description:	Development of Local Joint Restoration Plan (LJRP) as well as notification of Total Shutdown or Partial Shutdown and implementation of LJRP.
ENA ONP Product:	N/A
Timeline:	January 2020 - March 2023
Organisation type:	TO(3)
Progress:	Not currently planned(1), Implementing(1), Completed(1)
Additional information:	As per TOs, this step depends on DSO black start arrangements that require TO actions.

## Step 4

Step:	Activation of black start arrangements
Step type:	Network actions
Description:	Notify Black Start is completed; Notify normal operation is resumed to point of interconnection and transfer operational control.
ENA ONP Product:	N/A
Timeline:	January 2020 - March 2023
Organisation type:	TO(3)
Progress:	Not currently planned(1), Implementing(1), Completed(1)
Additional information:	As per TOs, this step depends on DSO black start arrangements that require TO actions. One TO has already put in place processes for black start arrangements which are subject to changes in legislation and standards as well as reliant on outcomes of industry projects (e.g. Distributed Restart, step 1).