NG ESO and WPD

IMPLEMENTATION PLAN: RESOLVING CONFLICTS BETWEEN ACTIVE NETWORK MANAGEMENT AND BALANCING SERVICES

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IMPLEMENTATION PLAN: RESOLVING CONFLICTS BETWEEN ACTIVE NETWORK MANAGEMENT AND BALANCING SERVICES

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GLOSSARY

Abbreviation	Meaning
ANM	Active Network Management
BaU	Business as Usual
BOAs	Bid/Offer Acceptances
BM	Balancing Mechanism
BS	Balancing Service
CBA	Cost Benefit Analysis
CEP	Clean Energy Package
CLASS	Customer Load Active System Services
ENW	Electricity North West
DC	Dynamic Containment
DG	Distributed Generation
DLH	Dynamic Low High
DNO	Distribution Network Operator
DPL	DIgSILENT Programming Language
EV	Electric Vehicle
FFR	Firm Frequency Response
GB	Great Britain
GEMS	Generation Export Management Systems
LIFO	Last In First Off
NG ESO	National Grid Electricity System Operator
NIA	Network Innovation Allowance
STOR	Short Term Operating Reserve
TRL	Technology Readiness Level

VDL	Voltage Dependent Load
WPD	Western Power Distribution

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EXECUTIVE SUMMARY

Active Network Management (ANM) schemes are becoming increasingly widespread on GB distribution networks. The schemes vary in complexity and scale but share a common objective - to enable Distributed Generation (DG) to be connected to distribution networks quicker and at lower cost. This is achieved by actively managing DG output to avoid breaching existing network limits, rather than undertaking expensive network reinforcement. ANM schemes benefit consumers by minimising the costs of connecting new (often low carbon) generation, which helps to decarbonise the network and reduce costs to consumers.

In recent years, National Grid Electricity System Operator (NG ESO) has increased the use of distributed assets for the provision of Balancing Services (BS). This has caused an increased risk of conflict between BS and ANM schemes. In some circumstances, ANM actions counteract the effect of BS procured by NG ESO. But in some cases, there are also unnecessary restrictions on the participation of ANM generators in BS, reducing market liquidity and increasing consumer costs.

This NG ESO and Western Power Distribution (WPD) Network Innovation Allowance (NIA) innovation project (undertaken by WSP, Cornwall Insight, and Complete Strategy) is investigation options to optimise coordination between ANM systems and NG ESO's operation of BS. The previous work of the project (as reported in the three earlier project reports) has identified several Test Cases to understand the potential conflicts between the provision of BS and ANM schemes, identified a shortlist of solutions to resolve those conflicts and estimated the potentially significant benefits that are associated with these solutions.

The solutions have been categorised into three main groups, covering:

- Reconfiguration of ANM schemes;
- Improved information exchanges; and
- Changes to market rules.

In this report, we focus on identifying the potential barriers that may impede the implementation of the final shortlisted solutions in this project to subsequently create a realistic implementation plan for each. These shortlisted solutions were assessed and described in the project workstream 4 (WS4) report. A range of different factors that may create barriers, including technological, regulatory, commercial, financial, organisational, and process related items have been considered in this report. Key findings include:

- For solution W1 which requires ANM systems to hold headroom when NG ESO instructs a decrementing BS from a generator connected downstream, the most significant barrier is anticipated to be the creation of appropriate communication links between NG ESO and DNO control rooms and the amendment of systems to send, receive and process new instructions between NG ESO and the DNO control systems.

- For solution X1 which requires DNOs to provide granular forecasts to generators on the likelihood of ANM curtailment, the most significant barrier is anticipated to be the development of granular forecasting capabilities on the behalf of DNOs.

- Finally, for solution Y1 which requires NG ESO to develop a risk-based framework for the dispatch of BS based on granular forecasts from the DNO on the risk of ANM curtailment, the most significant barrier is anticipated to be similar communication challenges as identified for solution W1. Alongside this, challenges are envisaged in reaching an industry agreed risk-based framework to account for non-delivery, alongside the development of granular forecasting capabilities on behalf of DNOs.

Subsequently, this report identifies a range of actions to be undertaken by Generators, DNOs, NG ESO, Ofgem and Third Party ANM providers to overcome these barriers, and to facilitate the implementation of our shortlisted solutions. It concludes that solutions W1 and Y1 may be considered as longer-term solutions, given the timelines associated with the underlying work require to enable appropriate communication links. Solution X1 may provide an earlier opportunity for benefits to be realised through more effective ANM coordination.

Further work is recommended to explore the implications of our findings for individual parties. This includes understanding the detailed steps that are required for different organisations to develop the capabilities required to support the implementation of the shortlisted solutions. This work should also identify opportunities for live trials, whereby technological solutions can be developed and stress tested, alongside regulatory and commercial considerations.

1 PROJECT OVERVIEW

WSP[1], Cornwall Insight[2] and Complete Strategy[3] are undertaking a Network Innovation Allowance (NIA) funded project on behalf of National Grid Electricity System Operator[4] (NG ESO) and Western Power Distribution[5] (WPD). The project investigates the optimal coordination of Active Network Management (ANM) schemes on both the distribution and transmission networks with Balancing Services (BS) markets.

1.1 BACKGROUND

NG ESO's Future Energy Scenarios[6] (FES) and System Operability Framework[7] (SOF) show that the installed capacity of Distributed Generation (DG) increased to 31GW in 2018 and is set to rise by a further 38GW to 69GW by 2030 across all FES scenarios. This significant growth of DG together with the development and adoption of smart grid technologies means that network operators, both transmission and distribution, have the need and the means to manage flows more actively on their networks.

DG often connects in clusters on the distribution network, in many cases due to natural resources and land availability (e.g., high concentrations of solar in the South West and high concentrations of wind in Scotland). As a result, it has the potential to breach operational limits on both the local distribution network, where it is connected, but also on the upstream transmission network in that area.

The volatility of renewable power generation makes the process of balancing the network more challenging and this is likely to be intensified as more sources are incorporated into the power network to meet net zero.

ANM is one of key technologies widely adopted on the GB electricity network to enable connection of DG and renewables to distribution networks quicker and at lower cost. ANM schemes are normally designed and operated to control the output of DG to avoid breaching existing network limits, while avoiding the need for expensive network reinforcement solutions.

However, as the number and scale of ANM schemes increases, so does the volume of existing distributed resources which are not controlled by ANM schemes (so called non-curtailable generators[8]) connected within the networks managed by ANM schemes. This gives rise to an increased risk of conflict between delivering BS and ANM schemes. ANM actions can counteract the effect of the BS procured by NG ESO from non-curtailable generators. This report presents several key shortlisted solutions which can potentially be used to address the conflicts between BS market operation and ANM schemes and assesses their relative merits.

1 https://www.wsp.com/en-GB
2 https://www.cornwall-insight.com/
3 https://complete-strategy.com/
4 https://www.nationalgrideso.com/
5 https://www.westernpower.co.uk/
6 http://fes.nationalgrid.com/
7 https://www.nationalgrideso.com/insights/system-operability-framework-sof
8 It refers to generation which is downstream of a constraint being managed by an ANM scheme but is not itself controlled by that ANM.

1.2 PURPOSE OF THIS REPORT

This report concludes the fifth phase of the project and covers the findings of WS5 as shown in Figure 1-1 below:

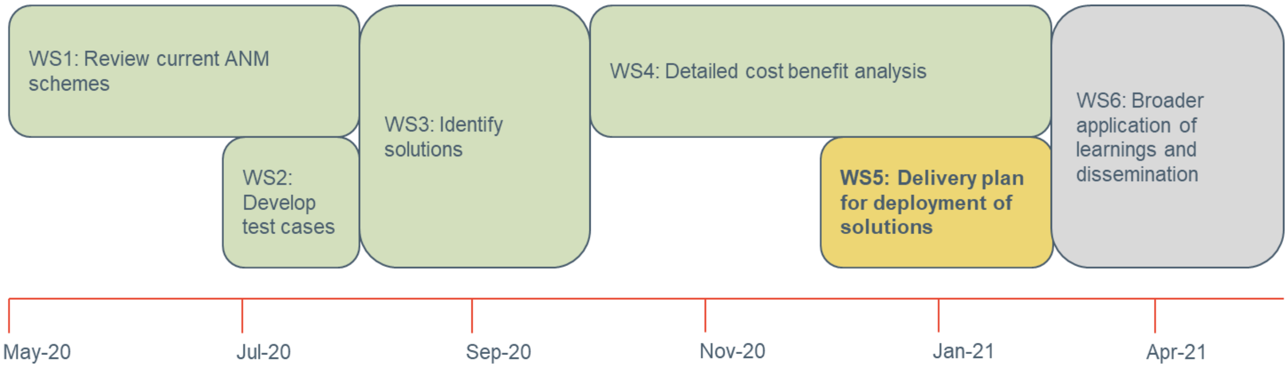

Figure 1-1: Focus of Report

This report focuses on:

- The barriers to implementing the solutions identified in the earlier work as part of WS4.
- The actions required to overcome these barriers, and how these may be allocated amongst different parties across the industry.

1.3 REPORT STRUCTURE

The remainder of this report is structured as follows:

- Section 2: A reminder of the Test Cases defined in WS1, and the respective solutions defined in WS3.
- Section 3: A description of the processes associated with the shortlisted solutions.
- Section 4: Assessment of the barriers to implementing the shortlisted solutions.
- Section 5: Assessment of actions for overcoming barriers to implementation, and proposed implementation plans for shortlisted solutions.
- Section 6: Recommendations and next steps.

2 OVERVIEW OF TEST CASES AND RESPECTIVE SOLUTIONS

2.1 TEST CASES

This section presents the network Test Cases that were established after reviewing and analysing relevant literature, internal discussions, and technical workshops with the project team, NG ESO and WPD teams, as well as other stakeholders through bilateral discussions and the Advisory Group. Test Cases were developed to allow an assessment of potential issues regarding ANM coordination with Balancing Services, and to understand the scope of potential benefits.

Table 2-1 summaries the Test Cases established in WS1 - full detail on Test Cases can be found in the WS1 and WS2 reports[9]:

Table 2-1 - Summary of Test Cases

Test Case	Type of Test Case	Description
1A	ANM system counteracts BS provided by DER or transmission connected resources	Incrementing service action from a non-curtailable generator in an ANM area is counteracted by an ANM generator
1B		Decrementing service action from a non-curtailable generator in an ANM area is counteracted by an ANM generator
1C		Service action from a non-curtailable generator in a GEMS area is counteracted by a GEMS generator
2A	ANM system counteracts BS provided by DNO using CLASS system	Demand reduction through a lowering of tap position (through CLASS) is counteracted by downstream ANM scheme
2B		Demand boost through a raising of tap position (through CLASS) is counteracted by downstream ANM scheme
2C		Reactive power absorption through tap stagger (through CLASS) is counteracted by downstream ANM scheme
2D		Demand reduction through disconnection of one transformer is counteracted by downstream ANM scheme
3A	Non-delivery or non-participation by DER in BS due to ANM risks	ANM generator curtailed and defaults on BS
3B		ANM generator unable to access BS markets

After deliberations with stakeholders, Test Cases 1B, 1C, 2A, 2D and 3B were identified as the most likely to generate benefits and thus focus was given to these during subsequent assessments.

9 Optimal coordination of active network management schemes with balancing services market available at https://www.westernpower.co.uk/downloads-view/164437

2.2 PROPOSED SOLUTIONS

This section provides an overview of the wide-ranging solutions that have been identified previously in the WS3 report. Table 2-2 groups together and summarises the solutions, including their high-level impacts on NG ESO, the DNOs, and generators (both non-curtailable generators in ANM areas and ANM generators). Table 2-2 also provides a high-level assessment of the pros and cons of each solution. It recommends whether the solutions should be investigated in greater detail through a full cost/benefit analysis (CBA). Full detail on all solutions can be found in the WS3 report[10].

Table 2-2 - Summary of WS3 solutions and recommendations

Solution Category	Solution	Effect on Parties and Operational Impacts	WS3 Recommendation
W – Reconfiguration of ANM schemes	W1 – Parallel decrementing instruction to DER and ANM	NG ESO – coordinator, medium-high impact DNOs – reconfiguration, medium impact Generators – better access to Balancing Services, low impact	Further consideration in WS4
	W2 – Preparatory incrementing instruction to ANM	NG ESO – coordinator, medium-high impact DNOs – reconfiguration, medium impact Generators – better access to Balancing Services but increased curtailment for some, medium impact	Further consideration in WS4, but anticipated that that high curtailment is likely to erode benefits
	W3 – Bring ANM curtailment ahead of Gate Closure	NG ESO – additional parameters in BM dispatch, medium impact DNOs – ANM redesign and forecasting, very high impact Generators – better BM access but increased curtailment for some, medium impact	Further consideration in WS4, but anticipated that this solution is unlikely to deliver benefits
X – Improved information exchange	X1 – Improved communication with generators	NG ESO – update terms of Balancing Services, low impact DNOs – improved communications and continual forecasting, high impact Generators – much greater operational information, high impact	Further consideration in WS4, specifically to understand pros and cons of this solution vs Y1
Y – Changes to market rules	Y1 – Risk-based Balancing Services valuation	NG ESO – coordinator of new framework, very high impact DNOs – forecasting and better ESO comms, high impact Generators – better access to Balancing Services, low impact	Further consideration in WS4, specifically to understand pros and cons of this solution vs X1
	Y2 – Framework for allocating network capacity	NG ESO – modify Balancing Services terms, low impact DNOs – design and implement framework, very high impact Generators – participation in market, high impact	No further consideration as overlaps with UKPN Energy Exchange project
Z – CLASS solutions	Z1 – CLASS to ANM coordination	NG ESO – status quo, low impact DNOs – coordinator (if using CLASS in load dominated areas), high impact Generators – status quo, low impact	Already deployed by ENW, so will be used as "reference case" for other solutions
	Z2 – CLASS visibility of ANM	NG ESO – status quo, low impact DNOs – coordinator (if using CLASS in load dominated areas), high impact Generators – status quo, low impact	Further consideration in WS4

10 Optimal coordination of active network management schemes with balancing services market – identification of solutions

3 SHORTLISTED SOLUTIONS

In the WS4 report[11], the solutions listed in Table 2-2 were reviewed against our assessment matrix and five were shortlisted for further consideration in cost benefit analysis. To develop implementation plans in WS5, we have refined this shortlist, removing two items from the scope of this analysis: Solution Z1 (CLASS and ANM separate operation) and Solution Z2 (CLASS visibility of ANM).

This report has not captured CLASS focused solutions for two reasons. First, in both cases, the relative size of the benefits associated with each solution in our WS4 assessment are significantly lower than the alternative shortlist solutions. Second, both Z1 and Z2 are of limited relevance for wider industry, given that CLASS is currently only implemented within ENWs network.

Consequently, the remainder of this report focuses on three solutions that have been shortlisted for further assessment from an implementation perspective: W1, X1 and Y1. In our WS4 report, the processes associated with each solution were summarised in a stylised flow chart. Below, we have expanded our analysis to identify how these processes will impact different parties across industry. As discussed in section 4, this approach allows us to identify the handoffs in each process, and the potential sources of any barriers to implementation.

[11] Technical and Cost Benefit Analysis of the Nominated Test Cases and Respective Solutions

Reconfiguration of ANM schemes (solution W1): This solution focuses on modifying the design, where necessary, of existing and new ANM schemes to allow for NG ESO instructions to the DNO's Distribution Management System (DMS), which would in turn be converted by the DNO into instructions to the ANM scheme. Those instructions would require the ANM to hold headroom in the specific instance when that headroom is created by NG ESO instructing a generator connected downstream of an ANM constraint to reduce output.

Figure 3-1 shows the flow chart of solution 'W1' sequences where a new communication path between NG ESO control room and the DNO control room will be required. This will subsequently require internal validation by DNOs, before requests are appropriately shared with the ANM controls. As highlighted by the dashed lines in Figure 3-1, this process may require the DNO to send multiple signals to both confirm and end hold headroom requests (and to consequently notify NG ESO), depending on the configuration of individual ANM schemes. In practice, the instruction sent from NG ESO to a DNO to hold headroom may need to take place before an instruction is sent to a generator, to ensure the headroom which will be created by NG ESO decrementing a generator is not filled by ANM before the NG ESO to DNO instruction is received and processed. This mitigates the risk of the reduction in output being counteracted.

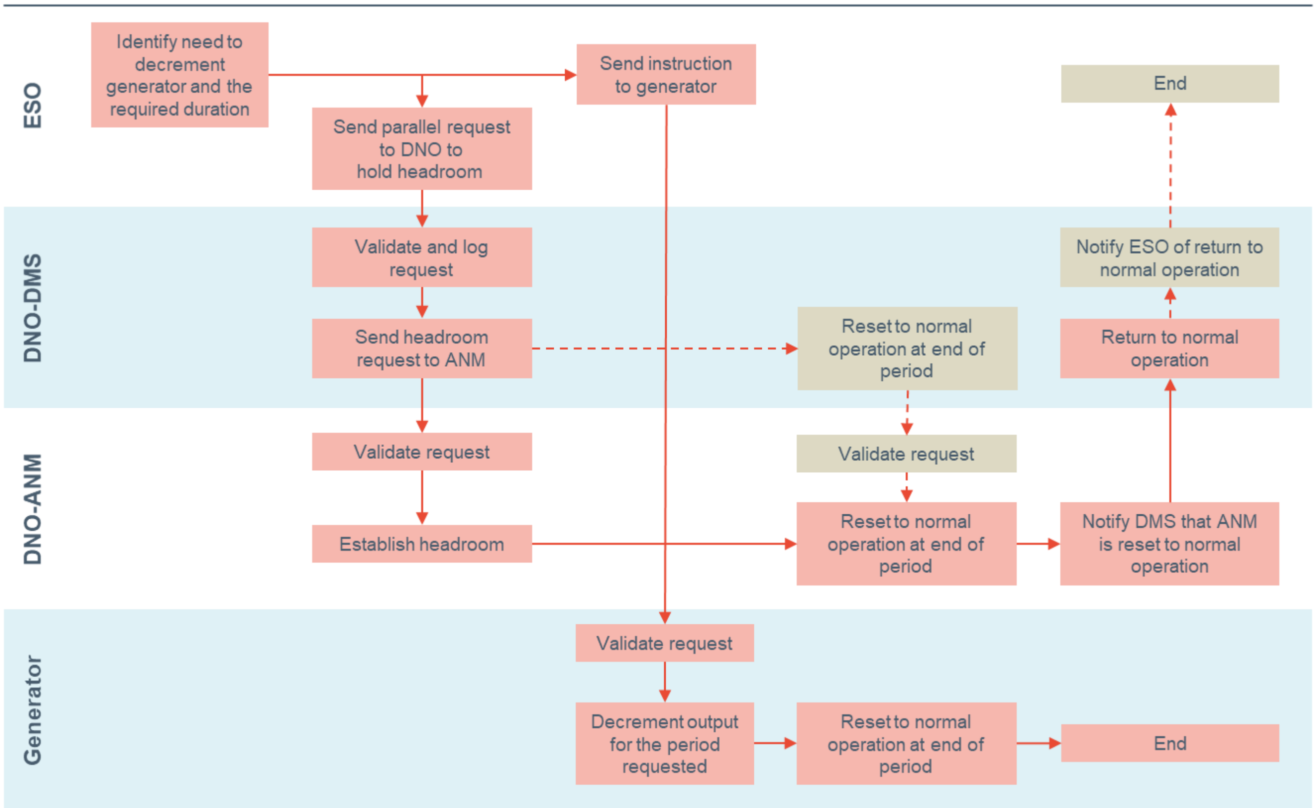

Figure 3-1: Overview of process associated with solution W1

Improved information exchanges and coordination (solution X1): This solution focuses on improving communication between ANM schemes and ANM generators, allowing generators to take more informed commercial decisions based on the likelihood of ANM curtailment. DNOs would likely issue forecasts to generators over a range of timeframes (from broad forecasts several years ahead as currently occurs through to month ahead, week ahead, day ahead and hour ahead timescales), enabling generators to commit assets to different services based on their varying procurement timeframes.

As shown in Figure 3-2, X1 is primarily focused on the DNO using prognostic modelling to approximate the likelihood of ANM curtailment. Dependant on the anticipated forecast, the ANM generator and non-curtailable generators in the area will or will not be able to participate in BS. Under this solution, DNOs are responsible for producing forecasts for individual generators, and providing these in specified timescales so that a generator can analyse them in advance of making commercial decisions. Following the provision of forecast information DNOs will also need to consider how this compares to actual curtailment and revise any future forecasts to account for learnings from this process.

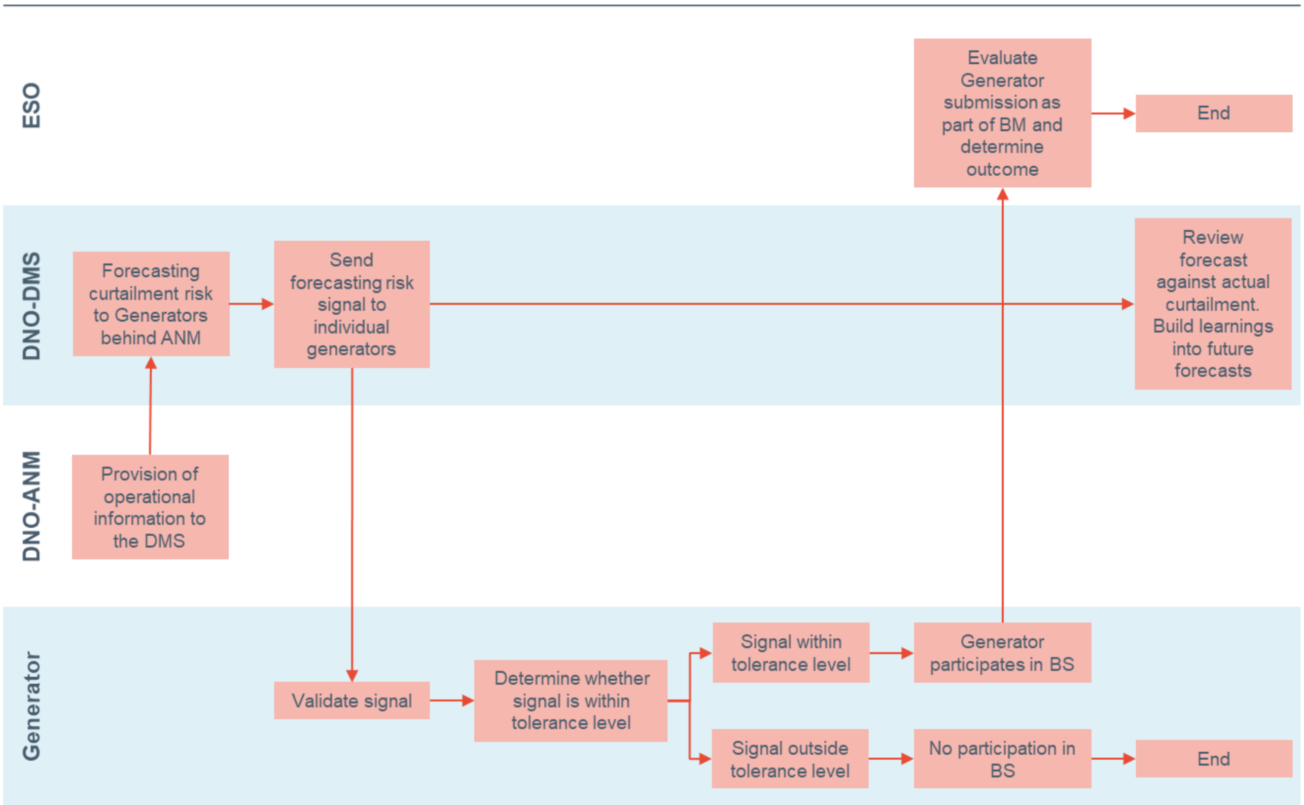

Figure 3-2: Overview of process associated with solution X1

Changes to market rules (solution Y1): This solution looks to market-based remedies by accounting for non-delivery risk due to ANM in the processes used for procurement of Balancing Services.

For NG ESO, a risk-based framework would be established to evaluate information provided by DNOs on curtailment risk for each ANM scheme. This framework would be used for selecting Balancing Service offers based on both price and curtailment risk where generators are connected downstream of ANM constraints. As shown in Figure 3-3 below, this view of risk would be used to evaluate generator submissions as part of Balancing Services. Solution Y1 looks at ways of 'splitting' risk between stakeholder's dependent on who is responsible for ANM not being able to provide required output i.e., if a generator is requested to provide increased output and there are no issues with the power network and no ANM curtailment, non-delivery penalties will apply. However, if non-delivery is because of a fault on the network or the generator is curtailed by the ANM scheme; a waiver on penalties will be imposed and the generator will be paid as if the service was delivered.

To determine whether penalties are required, DNOs would be required to undertake an ex-post assessment where non-delivery is identified, and to communicate their findings to NG ESO. This may require amendments to existing ANM systems to facilitate post event curtailment reports. As shown in Figure 3-3, this assessment would be used to ensure that appropriate payments are made as part of the settlement process. As identified in Solution X1, DNOs would also undertake a process to review the quality of their forecasts and make future refinements to the approach based on this information.

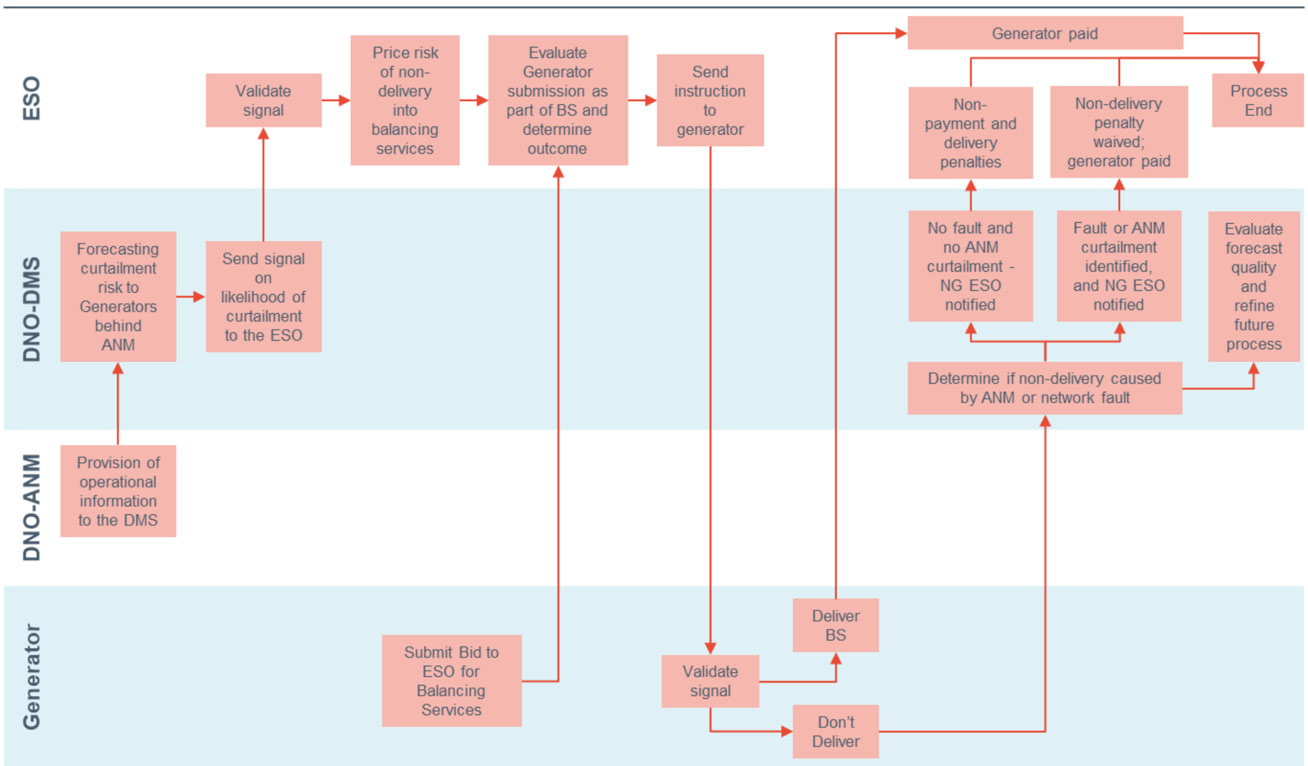

Figure 3-3: Overview of process associated with solution Y1

4 ASSESSMENT OF BARRIERS TO IMPLEMENTATION

4.1 OVERVIEW OF OUR APPROACH

We have used a systematic framework for assessing the potential barriers that may need to be overcome to support successful implementation. In designing this framework, we have focused on understanding both internal and external change that different parties may need to facilitate. Table 4-1 below summarises the focus of our assessment:

Table 4-1: Barriers to implementation assessment framework

Source of barrier	Key considerations
Technological	• How mature is the technology required for this solution? • Are there conflicts with existing technology that will need to be resolved? • What modifications or additions are required?
Regulatory	• How does the solution align to relevant regulation (e.g., Network licences, the Grid Code, Balancing and Settlement code)? • If regulatory change is required, what is the route for progressing this? Would it require a modification, or wider consultation?
Commercial	• How does the solution interact with existing commercial arrangements for the procurement of Balancing Services? • Does the solution require adjustments to connection agreements?
Financial	• What investment is required to deliver the solution? • Are there financial impacts for other parties?
Organisational	• What impact does the solution have on the existing roles of organisations involved in Balancing Services / ANM? • Will the solution create new responsibilities for any of these organisations? • If significant change is required, are the relevant organisations in a position to respond to this?
Process related	• How complex will the changes be to existing processes? • What groups of stakeholders will be impacted by these changes? • Are there interactions with processes outside of ANM / Balancing Services to consider?

Solutions W1, X1 and Y1 have been assessed against this framework, and further scrutinised through engagement with NG ESO and WPD, alongside the wider Advisory Group. In the sections below, we outline the barriers identified for each solution:

4.2 BARRIERS IDENTIFIED FOR SOLUTION W1

To facilitate the implementation of Solution W1, appropriate communication links must be established (if not already in place) to allow NG ESO to send instructions to DNOs to hold headroom in real time. This comes with its own challenges, as outlined in Table 4-2 below, alongside accompanying regulatory and commercial reforms required to allow the new instruction to be sent and acted upon.

Table 4-2: Barriers to implementation identified for Solution W1

Source of barrier	Key considerations
Technological	• Direct communication will be required between NG ESO and DNOs control rooms (or the ANM controller, depending on the architecture of individual ANM schemes) to ensure headroom is held when required. Inter-Control Centre Protocols links (ICCPs) are already implemented in the GB system to enable NG ESO to communicate with some DNOs but that these are not consistent across GB. • This communication link will need to be designed with appropriate consideration for security requirements, especially if direct links are to be established between NG ESO and ANM controls. • The technology is mature and therefore regarding maturity there are no barriers.
Regulatory	• New arrangements will be required to enable NG ESO to send instructions directly to ANM systems and to require DNOs to ensure their ANM systems respond appropriately. Such instructions could also be made visible to wider industry in the interest of market transparency. • The Balancing and Settlement Code (BSC) may also require alterations to accommodate the parallel NG ESO instructions to mitigate any counteraction between BS actions and ANM actions.
Commercial	• Existing connection agreements may not provide the flexibility required to accommodate the impact of the hold headroom instruction. Amendments may need to be considered to agreements involving ANM to include provisions for the DNO to hold headroom when instructed by NG ESO. • The information provided to connecting parties alongside such agreements may not adequately capture the impact of this new instruction. This may require amendments to DNO modelling of curtailment risk which informs such agreements, reflecting new interactions with NG ESO.
Financial	• Where communication links are not in place between NG ESO and DNOs, investment will be required to install a solution. To illustrate the potential scale of this investment, WPD previously established an ICCP link at a cost of approximately £80,000 through their “Interconnection of WPD and

Source of barrier	Key considerations
	National Grid SCADA systems[12]" project. However, by nature these costs will be specific to the characteristics of individual DNOs. • There are potential financial implications to the DNO from amending agreements it already has with resources under ANM control. This could be driven by having to absorb the cost of implementing new communications infrastructure to ANM controlled customers.
Organisational	• The organisation of teams operating within control rooms may need to be adapted to account for the new instruction associated with this solution. This may also see the allocation of new responsibilities specific to NG ESO / DNO communications.
Process related	• Existing ANM systems may not provide the capability to hold headroom in the format required under this solution. This could require amendments required to ANM logic/algorithms to ensure that NG ESO instructions can be acted upon. This process will also need to ensure NG ESO can issue communications to DNOs to instruct ANM schemes to hold headroom whilst requesting decrementing service action. The hold instruction from NG ESO will be required marginally ahead of the decrementing instruction to a generator to ensure the DNO is ready to hold headroom before a generator responds (unless instructions are issued directly to the ANM scheme).

4.3 BARRIERS IDENTIFIED FOR SOLUTION X1

Solution X1 requires the provision of detailed forecast information from DNOs to individual generators to enable them to make more informed commercial decisions regarding their participation in Balancing Services. From our engagement with stakeholders, we understand this represents a significant change in existing DNO forecasting capabilities and will require industry participation to understand the limits of such forecasts. As outlined in Table 4-3 below, the physical communication of this information is anticipated to be less complex than requirements identified for Solution X1.

Table 4-3: Barriers to implementation identified for Solution X1

Source of barrier	Key considerations
Technological	• Direct communication will be required between DNOs / ANM schemes and individual generators to provide forecast information on the likelihood of curtailment. This involves the sharing of commercial, rather than operational data, the latter of which is already communicated through existing infrastructure as part of the operation of ANM schemes.

12 https://www.westernpower.co.uk/downloads-view-reciteme/2347

Source of barrier	Key considerations
	• This communication link will need to be designed with appropriate consideration for security requirements. • Developing curtailment forecasts at the frequency and accuracy required may require investment in new forecasting tools. It will also require an ongoing commitment to ensure forecasting methods are reviewed and updated on a regular basis, learning from past forecast inaccuracies.
Regulatory	• There is a risk that in the absence of agreed standards, different DNOs will provide forecast information at different levels of granularity, or at different points in time. This creates a risk that generators connected to different networks can make more informed decisions regarding the Balancing Services, based on the information they receive. New regulatory requirements will need to govern this information and its provision. A level playing field will be required for BS providers, in terms of both geographic location and technology type. • There will be a need to stipulate risk tolerances around the forecast information given to generators, given it will inform Balancing Service decisions. NG ESO will continue with the application of relevant service assessment principles, ensuring all service providers are treated fairly and consistently. • There is also a risk that generators may treat the forecast information inconsistently. Regulatory requirements may be required to ensure the information is adequately evaluated or acted upon.
Commercial	• Limited commercial barriers are anticipated for this solution, given that its focus is on information provision to create new commercial opportunities for generators. This is anticipated to be the case if regulatory barriers identified above in relation to treating generators equitably are resolved. Connection agreements may need to be amended to reflect the additional forecast information that generators will receive from DNOs, alongside any obligation's generators may have in considering this information.
Financial	• Where appropriate communication links are not in place between DNOs and generators, investment will be required to install a solution. The financial implications of this would be anticipated to be lower than those for establishing the ICCP links required in solution W1.
Organisational	• DNOs will have to significantly develop their forecasting capabilities to potentially issue large volumes of granular communications to individual generators, on a regular basis. • ANM schemes are currently established to operate on very short time frames. To issue curtailment instructions to generators on a half hourly basis would require changes to existing processes.

Source of barrier	Key considerations
Process related	• Under this solution, generators would receive forecast information on a half hourly basis, at least at the day-ahead stage (and at shorter time intervals) and use this to inform their operational and trading decisions – this represents a significant change to their existing processes. DNOs would have to factor in providing this information alongside monitoring the network and taking ANM decisions.

4.4 BARRIERS IDENTIFIED FOR SOLUTION Y1

Solution Y1 requires the creation of a risk-based framework, under which NG ESO will evaluate submissions made by generators to account for the potential risk of curtailment. This represents a fundamental change to the existing procurement of Balancing Services, and alongside technological considerations to ensure communications can take place, there are significant regulatory and commercial barriers to overcome.

Table 4-4: Barriers to implementation identified for Solution Y1

Source of barrier	Key considerations
Technological	• Direct communication will be required between NG ESO and DNOs control rooms to provide information on ANM curtailment. As outlined previously, ICCPs are already implemented in the GB system to enable NG ESO to communicate with some DNOs. • This communication link will need to be designed with appropriate consideration for security requirements, with a common standard established across DNOs. • DNOs will be required to undertake detailed forecasting of curtailment risk for ANM schemes on a continuous basis. They must also identify and report to NG ESO ex-post which generators who failed to deliver were curtailed by ANM or impacted by network faults. • Developing curtailment forecasts at the frequency and accuracy required may require investment in new forecasting tools. It will also require an ongoing commitment to ensure forecasting methods are reviewed and updated on a regular basis, learning from past forecast inaccuracies.
Regulatory	• NG ESO will be required to develop and administer a risk-based framework – this is a fundamental change to the existing arrangements for the procurement of Balancing Services. NG ESO will subsequently be responsible for managing a risk on behalf of consumers that was previously borne by generators.

Source of barrier	Key considerations
	• NG ESO will require forecast information on curtailment risk from DNOs in a consistent format to apply the risk-based framework.
Commercial	• There is a risk that the process of NG ESO factoring in the risk of non-delivery is not sufficiently transparent for industry participants. This could have wider implications for confidence in procurement processes. • The risk-based framework that underpins solution Y1 will have commercial implications for generators and will require careful consideration to ensure fair treatment. • NG ESO may need to review and amend service terms to allow for the change in procurement of affected Balancing Services.
Financial	• As outlined in the case of solution W1, where communication links are not in place between NG ESO and DNOs, investment will be required to install a solution. There may also be costs to consider in relation to NG ESO's administration of the new risk-based framework, and the ultimate cost to end customers of managing this risk on their behalf.
Organisational	• This solution will create significant change for both NG ESO and DNOs to manage. NG ESO will need to apply the risk-based framework as part of BAU, whilst DNOs must undertake detailed forecasts and provide this information to NG ESO. DNOs will also need to undertake ex-post assessments to understand the causes of any non-delivery and share the results with NG ESO.
Process related	• Fundamental change is required to industry processes, including the provision of curtailment risk information to NG ESO prior to receipt of bids/offers from generators, application of the risk-based framework, and ex-post assessments where required. This requires significant co-ordination across multiple parties.

5 ASSESSMENT OF OVERCOMING BARRIERS, AND IMPLEMENTATING SOLUTIONS

Following our assessment of the potential barriers to implementing our shortlisted solutions, we have considered the steps required to overcome these. This includes a focus on the set of actions we have identified for individual organisations to enable their deployment. The remainder of this section outlines the actions in areas identified within our assessment framework (as outlined in section 4), focusing on the following parties:

- Generators
- DNOs
- NG ESO
- Ofgem
- Third party providers of ANM solutions

Where applicable, we have also identified where the actions identified in our review link to activities already captured within the ENA's DSO Roadmap, prepared under Workstream 3 of the ENA Open Networks Project[13].

Following these assessments, we subsequently present an indicative timeline for the sequencing of actions required to support the implementation of Solutions W1, X1 and Y1.

[13] https://public.tableau.com/profile/open.networks#!/vizhome/RM-97_16116703134880/Roadmap

5.1 OVERCOMING BARRIERS AND IMPLEMENTING SOLUTION W1

Most steps identified to support the implementation of solution W1 are envisaged to require action from NG ESO and DNOs. This reflects the direct communication between the two that sits at the heart of this solution. In Table 5-1 below, we summarise the range of actions identified, and links to activities already captured in the ENA's DSO roadmap.

Table 5-1: Actions identified to support the implementation of solution W1

Area	Activities required for implementation	Responsible parties				
		Generators	DNOs	NG ESO	Ofgem	Third Parties
Technological	**Instructions to DNOs –** NG ESO will need to embed the ability to send a "hold headroom" instruction within their existing operations.			X		
Technological	**Instructions from NG ESO –** DNOs will need to embed the ability to receive a "hold headroom" instruction within their existing operations. This will likely require changes to their DMS.		X			
Technological	**Communication links** – Where an appropriate link has yet to be established, action is required to create a secure method for sharing the required signals between NG ESO and DNOs. This link needs to be able to share instructions to "hold headroom" in a timely and reliable manner from the NG ESO control room to the DNO's control room. From WS4, we are aware that several DNOs already have established ICCP links, with appropriate security protocols, that could facilitate this solution. Common ICCP standards may also need to be agreed across DNOs as part of this action.		X	X		
Technological	**Instructions to ANM schemes** – DNOs will need to develop control room capability to rapidly pass instructions to their ANM schemes to hold headroom, and likely also work with their ANM providers to understand whether their current systems can comply with a 'hold headroom' instruction. If not, further work will be required to build in this functionality. DNOs will also need to identify whether they will need to provide different instructions to ANM schemes provided by different ANM providers, or if this process can be standardised. DNOs may also consider the option for hold signals to be shared directly from NG ESO to ANM schemes. This will help to address the risk of potential time delays if instructions need to be passed from the DMS to the ANM scheme.		X			X
Regulatory	**Grid Code amendments (1) –** A new procedure may need to be created to cover the interaction between ANM schemes at the distribution level and NG ESO. These procedures should align with ongoing work through the ENA Open Networks project in relation to the DSO transition.			X	X	

Area	Activities required for implementation	Responsible parties				
		Generators	DNOs	NG ESO	Ofgem	Third Parties
	Grid Code amendments (2) – Consideration of potential amendments to reflect the parallel instructions being issued by NG ESO. These changes would need to outline the appropriate processes and determine how DNOs are required to respond to signals.			X		
	Grid Code amendments (3) – This solution requires full information on generators behind ANM schemes to enable NG ESO to determine when a hold headroom instruction is required. DNOs already collect this information through embedded capacity registers, however further detail will be required to enable NG ESO to incorporate this into its process. NG ESO will also require information on the status of ANM schemes, and whether they are actively curtailing.			X		
Commercial	**Amendments to connection agreements –** DNOs need to assess the existing terms of their connection agreements to determine whether there is enough flexibility to account for the scenario whereby ANM schemes curtail in response to an instruction by NG ESO to hold headroom. Changes may be required if this is not possible, however this is not anticipated to be a significant amendment given that solution W1 focuses on the scenario whereby headroom has been created through a NG ESO intervention. Nonetheless, generators should be consulted in this process.	X	X			
	Amendment to curtailment information – DNOs will need to consider whether the scenario whereby an instruction for ANMs to hold headroom will have implications for the curtailment risk information provided to new generators considering an ANM connection. Amendments may be needed if existing information does not provide sufficient flexibility to accommodate the change. Generators should be consulted in this process.	X	X			

Area	Activities required for implementation	Responsible parties				
		Generators	DNOs	NG ESO	Ofgem	Third Parties
Financial	**Investment required –** As outlined above, the following investment will be required to enable this solution: - Establishment of appropriate communication links. Where an existing link is not in place, this will be more significant than expenditure required to modify existing links to accommodate new instructions. - Amendments to NG ESO systems and processes to send 'hold headroom' instructions; - Amendments to the DNO systems and processes to receive 'hold headroom' instructions; - Amendments to the ANM scheme to support the receipt of 'hold headroom' instructions; and - Testing of the above DNOs may consider Ofgem's innovation funding sources to support this investment. WPD previously received funding through the Low Carbon Network Fund the project titled "Interconnection of WPD and NGC SCADA systems[14]". UKPN also received funding through this fund for its Kent Active System Management[15] project, which had a broader scope that included establishing an ICCP link. Innovation funding does not impact the cost borne by consumers in the long run but may ease a barrier to implementation if costs fall on network companies which are not funded through price controls. Future proposals for innovation projects in this space would be required to go beyond the lessons already learnt from previous projects.		X	X		
Organisational	**Creation of additional instruction capability** – NG ESO's control room will need to develop the capability to issue hold headroom instructions, as outlined above in our technology assessment. From an organisational perspective this represents an additional task for control room staff to incorporate.			X		
	Responding to hold headroom instructions – DNOs will need to organise teams responsible for Distribution Network Management to validate instructions from NG ESO and determine the appropriate action. This will include identifying the relevant ANM system a hold headroom instruction needs to be communicated to and issuing this instruction.		X			
Process	**Warning of decrementing instruction –** To ensure DNOs can respond to an instruction to hold headroom in a timely manner, and to avoid possible counteraction from an ANM system, NG ESO may need to send notification of its intention to decrement a generator behind an ANM scheme to the DNO in advance of doing so and may also require acknowledgment from the DNO before instructing the generator to decrement. DNOs may consider the option for hold signals to be shared directly from NG ESO to ANM schemes to remove this timing issue.			X		

[14] https://www.westernpower.co.uk/downloads-view-reciteme/2347
[15] https://innovation.ukpowernetworks.co.uk/wp-content/uploads/2019/05/Final-Project-Report.pdf

Area	Activities required for implementation	Responsible parties				
		Generators	DNOs	NG ESO	Ofgem	Third Parties
	Standardisation of instruction process – DNOs will need to undertake work with their ANM providers to understand how a hold headroom instruction can be best accommodated. Once determined, DNOs and NG ESO should agree a standard format of the instruction, for example whether a time period will be provided by NG ESO or if two signals (for "start" and "stop") will be required, and whether/when the DNO is required to acknowledge receipt of instructions.		X	X		X

Table 5-2: Links between actions to implement Solution W1 and the ENA DSO roadmap

DSO Function	Activity	Link to implementation of solution W1
System Coordination	A9: Real time Data Exchange and Forecasting. Developing mature processes and IT infrastructure to facilitate operational data exchange in alignment with Open Networks WS1B P3 2020 Paper[16] on real time exchange and forecasting.	Whilst the data requirements referred to in this report are specific to Operational Tripping Scheme (OTS) arrangements being implemented on DNO networks to enable the tripping of DER for faults on the GB transmission network, there are overlaps with the potential instructions associated with this solution (for example, requesting DNOs to stop curtailing after a trip event).
	A21: Enable DNO-ESO control centre data exchange. Build and Implement appropriate communication link between DNO-ESO control centres e.g., ICCP link	This action is directly aligned to the technological solution we have identified to enable NG ESO to issue hold headroom instructions to DNOs. At the time of drafting, 3 DNOs are implementing, 2 have initiated whilst 1 has not currently planned this communication link.
Connections and Connection Rights	Various steps in relation to Activity A: Connection agreements, covering curtailment assessments, flexible connection agreements and the connections process. Many of these steps relate to actions identified in the Open Networks WS1 P7 2018 paper on curtailment process and ANM reliability[17]	These actions represent the existing progress that has been identified on the type of information DNOs provide in relation to curtailment. The additional impact of the hold headroom instruction will be an additional change compared to this ongoing work.

[16] https://www.energynetworks.org/industry-hub/resource-library/open-networks-2020-ws1b-p3-operational-tripping-scheme-arrangements.pdf
[17] https://www.energynetworks.org/industry-hub/resource-library/open-networks-2018-ws1-p7-good-practice-guide.pdf

Following our assessment of actions required to overcome barriers to implementation, we have considered the potential sequencing required to support successful deployment. Table 5-3 below summarises this for the range of actions associated with Solution W1. The timeline provided below indicates the potential period over which effort will be required to progress each action.

Table 5-3: Indicative implementation timelines for solution W1

Action identified	Complexity	Dependencies with other actions	Short Term (1-2yrs)	Medium Term (2-5yrs)	Long Term (5yrs+)
Technological					
Instructions to DNOs	Low	Links to form of comms link			
Instructions from NG ESO	Low	Links to form of comms link			
Communication links	Medium	2029 deadline in ENA DSO roadmap[18]			
Instructions to ANM schemes	Medium				
Regulatory					
Grid Code amendments (1)	Medium	Procedure dependent on comms link			
Grid Code amendments (2)	Medium				
Grid Code amendments (3)	Low				
Other regulatory amendments	Medium	Changed from ENA's Open Networks			
Commercial					
Connection agreement changes	Low				
Curtailment information changes	Medium				
Organisational					
Additional instruction capability	Low				
Hold head room instructions	Medium				
Process					
Warning of decrementing instruction	Medium	Dependency on the procedure agreed within Grid Code amendments			
Standardisation of instruction process	Medium	DNO work to understand instruction requirements for different ANM schemes			

[18] To date, both WPD and UKPN have established ICCP links in place, whilst SSEN is in the implementation phase. The timeline shown above aligns to the end date for this activity within ENA's DSO implementation plan (due for completion by 2029).

5.2 OVERCOMING BARRIERS AND IMPLEMENTING SOLUTION X1

The actions identified for Solution X1 require significant effort on the behalf of generators. DNOs also have a large role to play in the implementation of this solution, reflecting the fact that the provision of forecast information to generators underpins this solution. In Table 5-4 below, we summarise the range of actions identified, and links to activities already captured in the ENA's DSO roadmap.

Table 5-4: Actions identified to support the implementation of solution X1

Area	Activities required for implementation	Responsible parties				
		Generators	DNOs	NG ESO	Ofgem	Third Parties
Technological	**Communication links** – DNOs will need to establish appropriate methods of communicating information on forecast curtailment risk to individual generators. This information is commercial rather than operational, therefore does not require a hard infrastructure solution. It also does not require an operational link between generators and the DNO. If designed with appropriate security considerations, a web-based solution may be sufficient.	X	X			
	Curtailment forecasting – DNOs are required to provide granular forecast information on curtailment risk, to individual generators as part of this solution. These will need to be provided at various time frames, as concluded in the commercial actions described below. Depending on existing capabilities, DNOs will need to update existing modelling tools to produce this analysis. This should include engagement with generators to understand the type of information that would practically allow them to make more informed commercial decisions.	X	X			
Regulatory	**Distribution Code amendments –** DNOs will need to provide additional information on forecast curtailment risk in a consistent way to generators, given that this will inform their participation in Balancing Services. The Distribution Code should be amended to reflect both the timelines for the provision of forecast information, and the associated detail to be provided. This will require input from the ENA as the code administrator.		X		X	
	Generator licence/BSC amendments – Ofgem/NG ESO may wish to consider whether generator licences/the BSC respectively should be amended to provide a degree of direction on how generators should respond to the curtailment information provided by DNOs.	X		X	X	
Commercial	**Amendments to connection agreements –** DNOs need to assess the existing terms of their connection agreements to ensure they appropriately describe the limitations of curtailment forecasts and ensure DNOs are not held liable for the consequences of commercial decisions made by generators based on those forecasts. Amendments may be required to include appropriate disclaimers around new information	X	X			

Area	Activities required for implementation	Responsible parties: Generators	DNOs	NG ESO	Ofgem	Third Parties
	Amendment to curtailment information – As described in our assessment of technological solutions, DNOs will provide additional information to generators as part of X1. Industry will need to agree the appropriate time frames upon which this can be calculated and shared with generators.	X	X		X	
Financial	**Investment required –** As outlined above on the need to establish appropriate communication links, investment will be required to enable this solution. This would be anticipated to be less than the scale of investment identified in solution W1, given that operational technology does not need to be involved. More significant costs may be associated with the staff resource required to produce the forecasts underpinning this solution. DNOs may wish to consider funding opportunities available through the ongoing ED2 business planning process.		X			
Organisational	**Developing forecasting capability** – DNOs will need to further develop their forecasting capabilities to derive curtailment risk forecasts for individual generators. We understand through our engagement in this project that some DNOs are currently exploring these skills on individual project trials. For this solution to be effectively implemented, dedicated resource will be required to roll this capability out across all ANM schemes. It will also require an ongoing commitment to ensure forecasting methods are reviewed and updated on a regular basis, learning from past forecast inaccuracies.		X			
Process	**Developing forecasting capability** – DNOs will need to further develop their forecasting capabilities to derive curtailment risk forecasts for individual generators. We understand through our engagement in this project that some DNOs are currently exploring these skills on individual project trials. For this solution to be effectively implemented, dedicated resource will be required to roll this capability out across all ANM schemes.		X			
Organisational	**Standardisation of information sharing process –** DNOs should work with industry to agree the basis upon which information is provided to individual generators. This should include agreement on how far ahead of gate closure forecasts will be provided, and if individual forecasts will be refined over time as gate closure approaches. Without this, generators may have access to information informing their commercial decisions on an unequal basis.	X	X		X	

Table 5-5: Links between actions to implement Solution X1 and the ENA DSO roadmap

DSO Function	Activity	Link to implementation of solution X1
Connections and Connection Rights	Various steps in relation to Activity A: Connection agreements, covering curtailment assessments, flexible connection agreements and the connections process. Many of these steps relate to actions identified in the Open Networks WS1 P7 2018 paper on curtailment process and ANM reliability	These actions represent the existing progress that has been identified on the type of information DNOs provide in relation to curtailment. The additional impact of the hold headroom instruction will be an additional change compared to this ongoing work.

Following our assessment of actions required to overcome barriers to implementation, we have considered the potential sequencing required to support successful deployment. Table 5-6 below summarises this for the range of actions associated with Solution X1. The timeline provided below indicates the potential period over which effort will be required to progress each action.

Table 5-6: Indicative implementation timelines for solution X1

Action identified	Complexity	Dependencies with other actions	Short Term (1-2yrs)	Medium Term (2-5yrs)	Long Term (5yrs+)
Technological					
Communication links	Medium				
Curtailment forecasting	High	Technological developments are also dependent on actions required to develop resource capability			
Regulatory					
Distribution Code amendments	Medium	Scope of amendment should align to the forecasting capabilities developed by DNOs			
Generator Licence / BSC amendments	Medium				
Commercial					
Connection agreement changes	Low	Both changes must be consistent with the ultimate forecasting capabilities developed by DNOs			
Curtailment information changes	High				
Organisational					
Forecasting capability	High	Links to technological developments			
Process					
Forecasting process	Medium	Process will be informed by the format of forecast information			
Standardisation of information sharing process	Medium	Likely to be an enabling action to inform DNO work to develop capabilities			

5.3 OVERCOMING BARRIERS AND IMPLEMENTING SOLUTION Y1

Most steps identified to support the implementation of solution Y1 are envisaged to require action from NG ESO and DNOs. This reflects the direct communication between the two that sits at the heart of this solution. This finding is similar to that for solution W1, given the similarity in the communication link that needs to be established to support implementation. Table 5-1 Below, we summarise the range of actions identified, and links to activities already captured in the ENA's DSO roadmap.

Table 5-7: Actions identified to support the implementation of solution Y1

Area	Activities required for implementation	Responsible parties: Generators	Responsible parties: DNOs	Responsible parties: NG ESO	Responsible parties: Ofgem	Responsible parties: Third Parties
Technological	**Communication links** – Where an appropriate link has yet to be established, action is required to create a secure method for sharing the required signals between NG ESO and DNOs. This link needs to be able to regularly share information on curtailment risk across the network in a timely and reliable manner from DNOs to NG ESO. From WS4, we are aware that several DNOs already have established ICCP links, with appropriate security protocols, that could facilitate this solution. There may also be consideration of sharing such information more widely if requirement for market transparency		X	X		
Technological	**Curtailment forecasting –** DNOs are required to provide forecasts of curtailment risk associated with ANM schemes to NG ESO as part of this solution. Depending on existing capabilities, DNOs will need to update existing modelling tools to produce this analysis. This should include engagement with NG ESO to understand how this information will interact with the creation and application of a risk-based framework.		X	X		
Regulatory	**Creation of a risk-based framework –** This framework is fundamental to solution Y1 and will govern how curtailment risk is captured within Balancing Services. This will require significant engagement with industry and regulators to reach an agreed position, and appropriate scenario analysis to ensure no unintended consequences are created and to maximise transparency. It will also require an understanding of the potential costs associated with managing the risk.	X	X	X	X	
Regulatory	**BSC amendments –** The principles of the risk-based framework, and the rules under which it will be applied must be appropriately reflected within the Balancing and Settlement Code. Amendments will also be required to cover the application of non-delivery payments, now accounting for the risk of ANM curtailment preventing generators to respond in line with Balancing Services contracts. These could require to changes to Special Condition C16 of the transmission licence.			X	X	

Area	Activities required for implementation	Responsible parties: Generators	DNOs	NG ESO	Ofgem	Third Parties
	Distribution Code amendments – DNOs will need to provide information on ANM curtailment risk to NG ESO in a consistent manner to enable them to apply the risk-based framework. Code amendments will be required to govern how this information is provided. DNOs will also have an additional role to provide reasons for non-delivery, and to provide this information to NG ESO. This will require code amendments to capture the process DNOs should follow as part of this assessment, and the format in which this information is provided to NG ESO.		X	X		
Commercial	**Industry engagement on risk-based framework –** As described above, industry participation will be required in the creation and application of the risk-based framework. Generators will require sufficient transparency to understand how their Balancing Services bids are being treated and evaluated.	X	X	X		
Commercial	**Industry agreed approach on non-delivery assessment –** DNOs should work collaboratively to determine how reasons for non-delivery should be assessed and reported to NG ESO.		X	X		
Financial	**Investment required –** As outlined above on the need to establish appropriate communication links, investment will be required to enable this solution. Where an existing link is not in place, this will be more significant that expenditure required to modify existing links to accommodate new instructions. DNOs may consider Ofgem's innovation funding sources to support this investment. WPD previously received funding through the Low Carbon Network Fund the project titled "Interconnection of WPD and NGC SCADA systems[19]". UKPN also received funding through this fund for its Kent Active System Management[20] project, which had a broader scope that included establishing an ICCP link. Innovation funding does not impact the cost borne by consumers in the long run, but may ease a barrier to implementation if costs fall on network companies which are not are not funded through price controls. Future proposals for innovation projects in this space would be required to go beyond the lessons already learnt from previous projects.		X	X		
Organisational	**Deployment and application of risk-based framework –** NG ESO will need to embed the agreed risk-based framework within its procurement processes for Balancing Services.			X		
Organisational	**Developing forecasting capability –** DNOs will need to further develop their forecasting capabilities to provide the agreed upon curtailment risk forecasts of ANM schemes to NG ESO.		X			

[19] https://www.westernpower.co.uk/downloads-view-reciteme/2347
[20] https://innovation.ukpowernetworks.co.uk/wp-content/uploads/2019/05/Final-Project-Report.pdf

Area	Activities required for implementation	Responsible parties: Generators	DNOs	NG ESO	Ofgem	Third Parties
Process	**Forecasting process –** Internal DNO processes should be amended to accommodate the creation of the required forecast information as part of BAU. This will need to align to the timelines agreed in actions above.		X			
	Standardisation of information sharing process – DNOs should work with industry to agree the basis upon which information is provided to NG ESO. This information will need to be provided at agreed time frames to ensure that Balancing Services bids from individual generators connected on different DNOs are evaluated consistently under the risk-based framework.		X	X		
	Reasons for non-delivery assessment process – As described above, DNOs should agree a common process for determining the reasons for non-delivery, and how this is provided to NG ESO.		X			

Table 5-8: Links between actions to implement Solution Y1 and the ENA DSO roadmap

DSO Function	Activity	Link to implementation of solution Y1
System Coordination	A9: Real time Data Exchange and Forecasting. Developing mature processes and IT infrastructure to facilitate operational data exchange in alignment with Open Networks WS1B P3 2020 Paper on real time exchange and forecasting.	Whilst the data requirements referred to in this report are specific to Operational Tripping Scheme (OTS) arrangements being implemented on DNO networks to enable the tripping of DER for faults on the GB transmission network, there are overlaps with the potential instructions associated with this solution (for example, requesting DNOs to stop curtailing after a trip event).
	A21: Enable DNO-ESO control centre data exchange. Build and Implement appropriate communication link between DNO-ESO control centres e.g., ICCP link	This action is directly aligned to the technological solution we have identified to enable NG ESO to issue hold headroom instructions to DNOs. At the time of drafting, 3 DNOs are implementing, 2 have initiated whilst 1 DNO has not currently planned this communication link.
Connections and Connection Rights	Various steps in relation to Activity A: Connection agreements, covering curtailment assessments, flexible connection agreements and the connections process. Many of these steps relate to actions identified in the Open Networks WS1 P7 2018 paper on curtailment process and ANM reliability	These actions represent the existing progress that has been identified on the type of information DNOs provide in relation to curtailment. The additional impact of the hold headroom instruction will be an additional change compared to this ongoing work.

Following our assessment of actions required to overcome barriers to implementation, we have considered the potential sequencing required to support successful deployment. Table 5-9 below summarises this for the range of actions associated with Solution Y1. The timeline provided below indicates the potential period over which effort will be required to progress each action.

Table 5-9: Indicative implementation timelines for solution Y1

Action identified	Complexity	Dependencies with other actions	Short Term (1-2yrs)	Medium Term (2-5yrs)	Long Term (5yrs+)
Technological					
Communication links	Medium	Deadline of 2029 in ENA DSO roadmap[21]			
Curtailment forecasting	High				
Regulatory					
Risk-based framework	High				
BSC amendments	Medium	To align with the risk-based framework			
Distribution Code amendments	Low	To align with forecasting capabilities developed by DNOs			
Commercial					
Risk-based framework	High				
Non-delivery assessment	Medium				
Organisational					
Risk-based framework deployment	High	Requires conclusion of framework			
Developing forecasting capability	High				
Process					
Forecasting process	Medium	To align with forecasting capabilities developed by DNOs			
Standardisation of information sharing process	Medium	To align with relevant BSC amendments			
Non-delivery assessment process					

[21] To date, both WPD and UKPN have established ICCP links in place, whilst SSEN is in the implementation phase. The timeline shown above aligns to the end date for this activity within ENA's DSO implementation plan (due for completion by 2029).

6 RECOMMENDATIONS

This report has:

- Identified the barriers associated with implementing solutions W1, X1 and Y1.
- Considered actions required to overcome these barriers.
- Proposed a schedule of actions for each solution to support implementation.

The recommended implementation plans in this report aim to outline the key technological advancements that need to take place, capabilities that organisations need to develop, or supporting regulatory, commercial or process changes required to allow solutions to be deployed. To support continued progress towards implementation, future work should be undertaken to understand the specific requirements of different parties to make progress in the areas we have identified.

Future work should also identify opportunities to undertake live trails of the shortlisted solutions. This would provide a valuable opportunity to consider regulatory and commercial considerations alongside the design of technological solutions. A collaborative, sandbox-based approach working with a range of providers would allow progress to be made towards the ultimate outcomes, without imposing restrictions on thinking in the early stages of development. Trials should also be considered in areas where DNO forecasting on curtailment risk is required, to develop standardises approaches and to understand the potential limitations of any forecasts produced.