

Network Development Roadmap Progress Update

31st January 2020



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Executive Summary

The [Network Development Roadmap](#)¹, published in May 2018, set out our ambitious proposals to begin a transformation of our network development processes. The roadmap outlined our intention to identify the most efficient solutions to transmission needs by also considering solutions from distribution networks or from commercial providers alongside Transmission Owner (TO) solutions. We also set out our intentions to enhance our modelling capabilities to help us plan effectively for the increasingly complex range of network needs we now experience.



This update document is intended to set out our overall ambition, summarise progress so far, share learning and challenges, and to set out next steps beyond our pathfinding projects.

In November we launched our first ever tender for services to address longer term network reactive power needs. This followed another first earlier in the month, when we published our first tender for short term reactive power services from distribution connected providers. In December, we also launched a Request for Information (RFI) for residual constraint management services.

In addition to this, we built on our original roadmap proposals and introduced a new service for near term stability support, with a tender launched in November. This type of service is a new development and we are at the leading edge globally of buying a product of this type. The introduction of a service for longer term stability support during 2020 will complement this further.

This summer we also began a project, known as the Early Competition Plan, to explore how competition could be introduced to design, build, own and operate transmission assets. Subject to the necessary legislative changes, this competition will, in future, complement our roadmap transformations by allowing new parties to compete to build and own transmission assets.

To help us plan for increasingly complex network needs, we've developed the High Voltage Management Process and increased our understanding of stability challenges. We've also successfully trialled a probabilistic modelling technique for network analysis to help ensure we plan for the right amounts of network investment.

Our pathfinding projects currently focus on specific locations and needs to help begin this journey. Our ambition is that, during RIIO-2 (our next price control period, from April 2021 to April 2026) this approach will become the norm for transmission investment. Opening up these new markets will help us find the most efficient ways to support a zero-carbon network. We estimate that these changes have the potential to save hundreds of millions of pounds for consumers over the next ten years.

¹<https://www.nationalgrideso.com/publications/network-options-assessment-noa/network-development-roadmap>

Our Ambition

By 2025, the ESO will ensure the network is ready to handle 100 percent zero-carbon operation, whenever there is sufficient renewable generation. This will help to achieve the UK's commitment to net zero emissions by 2050. We intend to identify the most efficient ways to do this by comparing a range of different type of solutions, from different providers.

Historically, transmission network needs have been met through solutions provided by the incumbent TO. However, the rapid decentralisation of generation and a more integrated approach across the transmission and distribution systems means that there are new requirements and system needs, such as increasing stability and voltage challenges. There are also potentially new solutions to address those challenges.



The Network Development Roadmap set out our intentions, firstly, to enhance our analytical capabilities to ensure we plan effectively for those new system

requirements. This includes exploring a probabilistic modelling approach and improving our modelling of voltage and stability needs. Our [RIIO-2 Business Plan](#)² proposals (covering April 2021 to April 2026) builds on this and sets out proposals to embed the techniques we're developing into our suite of analytical tools. By 2024/25 we intend to have much more sophisticated analytical capabilities that allow us to undertake the volumes of analysis required and to look holistically across different types of network needs.

The roadmap also set out our proposals to identify the best solutions by comparing potential distribution network and non-network solutions alongside transmission network solutions. To do this, we've taken a 'learning by doing' approach, establishing pathfinding projects that aim to run competitive tenders for voltage needs, stability needs and residual constraints. We believe that this can drive significant value for consumers and, subject to ongoing learning from the pathfinding projects, we therefore intend to expand this approach during the RIIO-2 period.

These proposals represent a significant change of approach. This transformation has implications for industry frameworks, regulated funding deals, licence obligations and charging streams. These will take a number of years to be fully adapted to properly facilitate this new approach.

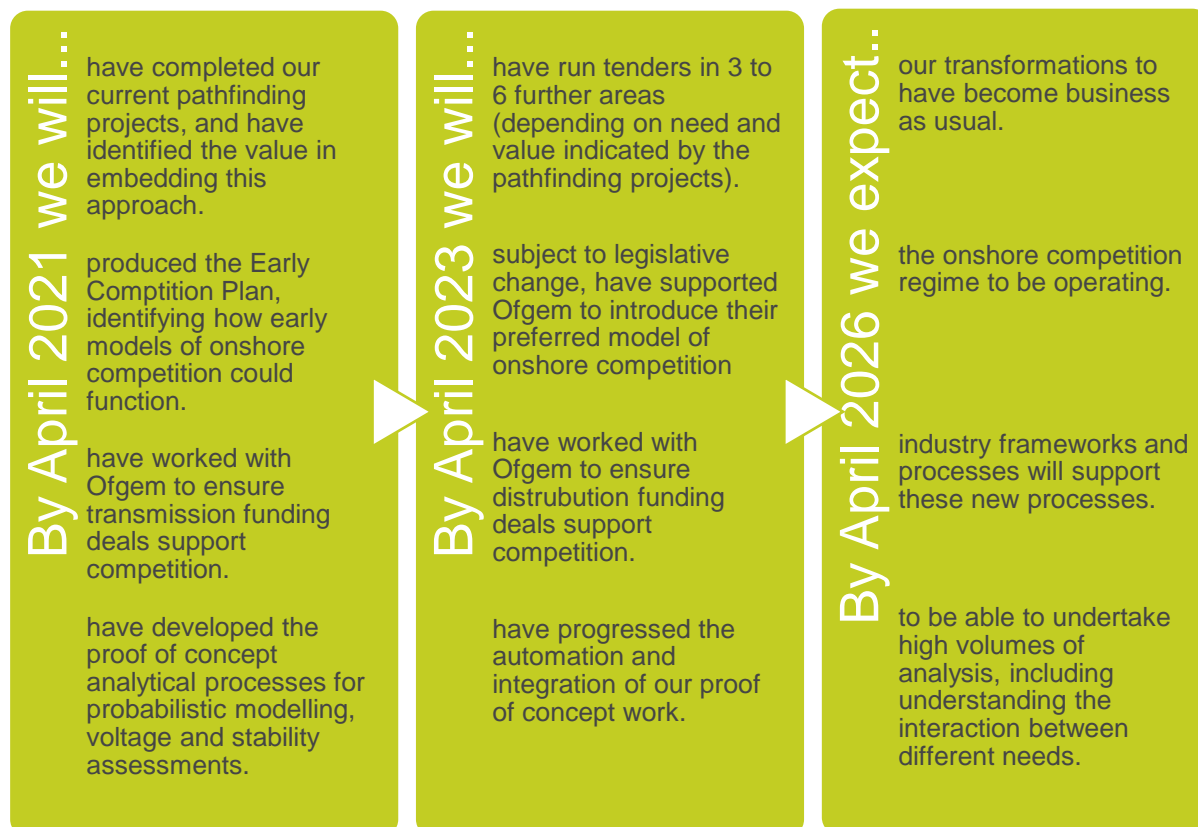
The ESO, and other industry participants, also need to adapt our ways of working to accommodate this change. For example, previously, our key network development stakeholders were network owners, with whom we engaged through our regular planning cycles and processes. Now however, we regularly engage with hundreds of commercial providers from a competitive perspective. Network owners meanwhile also have to adapt their ways of working to respond to greater uncertainty of where and when they themselves will need to invest in their networks.

We believe that, subject to ongoing learning, over the next 5 years we can adapt frameworks and processes so that this approach becomes business as usual. Once our pathfinding projects are completed, the next step towards achieving our ambitions will be to run a further three to six tenders during 2021-23, as set out in our RIIO-2 Business Plan proposals.

² <https://www.nationalgrideso.com/about-us/business-planning-riio/riio-2-final-business-plan>

During RII0-2, we also expect to see the introduction of legislation enabling companies to compete to design, build and own large transmission assets. This is sometimes referred to as ‘the CATO regime’ (Competitively Appointed Transmission Owners) or ‘onshore competition’. The ESO is currently exploring, through the Early Competition Plan, how such competitions could be run during the early stages of the project development lifecycle. Meanwhile Ofgem are exploring competitions that could be run later in the project lifecycle (after the project has received planning consents). The Early Competition Plan will set out proposals and implementation plans by February 2021. Ofgem will subsequently announce the next steps for the introduction of this regime. Further details on the Early Competition Plan are on our [website](#)³.

Summary of our ambition



Getting involved

We intend to continue to engage closely with stakeholder as our pathfinders and broader plans develop. Updates and how to get involved will be communicated via our [Roadmap distribution list](#)⁴ and also on our [webpage](#)⁵.

For the Early Competition Plan, our main distribution list will contain general updates. However, we also have a bespoke distribution list for more detailed engagement. If you'd like to be part of this sign up [here](#)⁶.

We welcome feedback on this roadmap update document which can be provided by emailing:

networkdevelopmentroadmap@nationalgrideso.com

³ <https://www.nationalgrideso.com/publications/network-options-assessment-noa/network-development-roadmap>

⁴ <https://subscribers.nationalgrid.co.uk/h/d/7E1C22C6A81C87FE>

⁵ <https://www.nationalgrideso.com/publications/network-options-assessment-noa/network-development-roadmap>

⁶ <https://subscribers.nationalgrid.co.uk/h/d/14D9350B9DB55CA2>

Progress of our roadmap proposals

This section sets out what we've done so far for each of the proposals from our original roadmap.

1) Expand the NOA to invite network and non-network solutions across the transmission and distribution networks to meet transmission needs

The NOA (Network Options Assessment) process considers which solutions to network needs provide the best value. We are broadening this out to consider a wider range of potential solutions.

To identify the best value option, we need to compare the value of different solutions through transparent and fair competitive processes. This ensures all participants have equal access to this business opportunity. Our pathfinders for voltage and stability (proposals 3 & 4) are developing these processes. In addition, we've also introduced a pathfinder for residual constraints. An RFI was published in December with a tender to follow later this year, dependent on learnings from the RFI.

We have further to go to understand the amount of value that can be achieved. However, we believe there is potential for significant value and so ultimately we hope to expand this process across network development.

2) Assess the year-round transmission network needs to a greater extent through taking a probabilistic approach

Our current planning approach is based on the boundary capabilities needed to manage peak events, based on analysis of one point in the year. A 'probabilistic approach', however, considers the likelihood of a particular event occurring by enabling us to generate and assess hourly snapshots across an entire year. This enables a more accurate assessment of the consumer value of investing in network assets.

We tested our probabilistic process on a region in the South East of the country where a single-snapshot approach is difficult because of the highly variable power flows on HVDC interconnectors to mainland Europe. Our initial findings were set out in [ETYS 2018](#)⁷ with a [further update](#)⁸ published separately in March. We found that the current single-snapshot boundary capability approach might over or under estimate boundary capability when compared to a more comprehensive probabilistic based analysis.

We have taken this further in [ETYS 2019](#)⁹ where we have published studies for additional boundaries. We present results of a data validation exercise for our tool and use maps to discuss the implications of differences between scaling-based deterministic and probabilistic analysis.

The next steps are to develop new tools that automate these techniques and allow us to undertake much higher volumes of analysis.



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<https://www.nationalgrideso.com/document/133836/download>

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<https://www.nationalgrideso.com/document/140781/download>

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<https://www.nationalgrideso.com/document/157451/download>

3) Apply a NOA-type approach to regional voltage challenges

Our high voltage pathfinder projects are establishing processes to identify the best value solutions to address regional voltage needs.

We have consulted on and published a screening process - [The High Voltage Management Process](#)¹⁰ – which will help us identify and prioritise regions with high voltage control related challenges. This includes a tool to help us more quickly review historical operational data relevant to high voltage issues. We are also working with the University of Strathclyde to develop a voltage optimisation tool to enable us to do voltage assessment with a large number of snapshots.

Our analysis identified the Mersey and the North England/Pennine regions as key focus areas for high voltage issues and so our pathfinder projects focused on these areas.

Through the use of RFIs, webinars and tenders we've engaged with stakeholders to understand what potential solutions might be available and to develop fair and transparent processes that support participation. We've also worked with Distribution Network Owners (DNOs) to allow distribution-connected providers to participate in reactive power services for the first time.

Our first long term tender – for Mersey – was published on 25 November 2019. This enables embedded assets and non-transmission options to compete with traditional Balancing Mechanism and TO options to solve a transmission voltage need for the first time.

Once we have considered the learnings from this first tender, we will announce our intentions for the Pennine region.

4) Consider expanding a NOA-type approach to the operability aspects of system stability

Similar to our high voltage pathfinder project, we are also looking to identify the best value solution to meet stability requirements.

'Stability' refers to the stability of frequency and voltage, and the ability of a user to remain connected to and to act to support the system during normal operation, during a secured fault or after a secured fault. Stability is a complex issue and is affected by the changing generation type and demand patterns.

In our [System Operability Framework \(SOF\)](#)¹¹ report on the impact of declining short circuit levels, we describe operability risks due to the decline in transmission system short circuit levels. We undertook additional analysis in Scotland to understand our stability needs, which we published in an RFI in July 2019.

We have tested new methods of analysing system stability and defined our regional stability needs by considering the impact of the decline in short circuit levels, fast fault current injection and inertia on secured network faults. This is the first time we have defined our technical performance specification that potential solutions will have to demonstrate.

Our RFI and other engagement activity has helped us understand what solutions the market could potential provide and what they need in order to be able to participate.

Following RFI feedback and additional analysis, we expanded our approach to also seek solutions to near term stability challenges nationally. A tender was launched on 5 November with results published on 29 January 2020. This will help inform our tender for long-term services, where we will be publishing an Expression of Interest (Eoi) for long-term services in Scotland shortly.

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<https://www.nationalgrideso.com/document/149636/download>

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<https://www.nationalgrideso.com/publications/system-operability-framework-sof>

5) Working in conjunction with ENA and wider stakeholder groups

We work closely with the Energy Networks Association (ENA), including conducting [analysis](#)¹² which confirmed that distribution network solutions have the potential to deliver cost effective solutions for voltage issues.

Previously, key stakeholders for our network development process were transmission network owners. Our stakeholder base now includes a wide variety of commercial providers and network owners, with over 100 people joining our stability webinar. Their views have, and continue to, inform our processes. We've engaged through a wide range of routes including:

- RFIs, webinars and tenders
- A network development event for commercial providers
- Webpage and monthly newsletters
- RIIO-2 engagement events and consultations
- Bilaterals and attending events and forums

6) Phase more detailed, regional information and processes throughout the year alongside the existing annual national assessment

Our aim is to improve how we communicate information about future network needs. One aspect of this is to publish more detailed regional information throughout the year.

Pages 10- 11 set out how we intend to communicate future needs, including identifying regions with voltage or stability challenges.

We're also continuing to consider how we can make our existing publications as user friendly as possible. We're aware some stakeholders appreciate visual information, such as heat maps, and also consistency of format. We have reviewed our NOA 2020 publication with the aim of making it more accessible. We welcome feedback on this.



¹²<http://www.energynetworks.org/assets/files/ON-WS1-P1%202018%20Investment%20Planning%20Processes%20-%20Approach%20vFinal.pdf>

Stakeholder feedback on our pathfinder projects

Our approach to network development stakeholder engagement has changed radically over the past 18 months. We've moved from engaging primarily with three TOs during regular planning cycles, to regular engagement with DNOs and hundreds of providers of commercial solutions.

We've introduced a webpage and monthly newsletter, and sought feedback and input through our network development event, RFIs, webinars and our NOA consultation.

Below are some key messages from our stakeholders:

Clarity on our future intentions

Our roadmap set out our plans to seek broader solutions to transmission system needs through pathfinder projects. However, both commercial providers and TOs are keen to know how these projects might develop in future. Commercial providers want to understand the potential scale of the business opportunity, while TOs need to know what they should or shouldn't plan for going forward.

Pages 10 -11 set out how we intend to communicate potential future network needs to provide an indication of what could be tendered in the future.

Sense of the potential business opportunity

Providers want to understand more about the markets in order to help them understand whether to participate. This is particularly true for new build projects that may have to risk investing capital. In addition to knowing what we might tender for in future, they want to know the likely prices of a service.

As our tenders progress this will help provide some information on potential price. However, it's important to bear in mind that this will vary for each tender as they are location specific and may involve building assets. Factors such as land challenges can impact on prices.

The ESO also publishes constraint costs associated with the B6 boundary and we have recently begun publishing more detailed constraint costs. We have begun publishing [regional voltage costs](#)¹³ and will shortly also be including 5 years of historic data.

We are continuing to work with TOs and Ofgem to explore what information can be made available on costs of regulated assets.

Easy to understand information

Our network development publications have previously been aimed primarily at TOs. This approach isn't necessarily helpful to commercial providers who are not familiar with the networks or equipped for detailed analysis. Less written information and more visuals (e.g. heatmaps) would be welcomed.

As our process for communicating future needs develops we will continue to work with commercial providers to produce this information in a meaningful way. We would welcome feedback as we progress.

Our RIIO-2 business plan proposals also contain plans to explore whether an external portal could be made available to help providers better understand the network and the impact their solution might have. A key challenge to this will be how we utilise the confidential commercial data we hold.

Appropriate timeframes for tenders

In order to build new facilities, if required, tenders need to be run sufficiently far in advance. Appropriate contracts also need to be in place for both providers and ESO (e.g. appropriate milestone and backups).

We're continuing to explore what timeframes and contractual arrangements are most appropriate through our pathfinder projects. We aim for consistency between services but there may be cases where this needs to vary due to the varying nature of different services.

¹³ <https://data.nationalgrideso.com/constraint-management/outturn-voltage-costs>

Challenges for our pathfinder projects

Part of our learning by doing approach is to identify and address any barriers within the current industry frameworks, funding arrangements and roles and responsibilities. Below are some of these challenges and our current thinking on them, which will continue to develop as we progress our pathfinding projects.

Funding regimes

Currently, network development undertaken by TOs is funded through their regulatory funding deals. There are no funding arrangements designed specifically to pay for solutions from other providers. For our pathfinding projects our approach will therefore be to pay for any non-TO solutions, including any solutions provided by DNOs, through the same process as balancing services. The solutions bought through pathfinding projects should reduce future balancing costs that would be incurred in the absence of the long-term solutions.

TOs and Ofgem are currently preparing for RIIO-2 (the TO's next funding deal period) and this will need to reflect our new approach. For example, there will need to be flexibility to deal with the uncertainty over whether TOs or other parties will provide particular network solutions.

DNO funding deals for RIIO-ED2 (2023 onwards) will also be developed over the coming years. Again, these need to reflect their role in the competitive process, both as a network owner and a potential solution provider. The approach taken may have a consequential impact on our processes.

Solution assessment methodology

Our pathfinding projects seek to compare regulated assets with market-based solutions. Regulated assets are typically costed on the basis of a 40 year asset life. However, we would not want to contract with market providers for this period. We therefore intend to assess all solutions, including regulated assets, over the period of the system need we have certainty of.

We are also requesting TO operation and maintenance costs for regulated solutions, along with capital expenditure and expectation of losses. This should help provide more parity between regulated solutions and market providers.

Connections process

Where a participant needs to connect a new asset to the network, the relevant TO or DNO will need to review the technical parameters to ensure it will be able to connect to the network. We are exploring a process to allow participants to submit technical and commercial information separately to maintain the commercial sensitivity.

Technical parameters would be anonymised and shared with the relevant network owner but commercial information will not be shared. A clear assessment methodology will also be produced by the ESO for network owners to follow. Network owners will need to ensure suitable business separation between the technical assessment and their own commercial submissions.

Distribution network limitations

Distribution networks are not historically designed to manage reactive power. Our pathfinding projects have revealed that embedded providers may be limited in their ability to provide reactive services, either through their connection agreement or by network restrictions. Investment may be required on the distribution network in order to enable the embedded provider to provide some services, which would need to be factored into any tender costs. We are working with DNOs to understand and explore solutions.

Connection of Zero MW solutions

Some of the solutions to voltage or stability challenges could be provided through non-generating assets, potentially using similar technology to that used by the TO (such as a reactor). Current industry codes had not envisaged this type of connection. Having considered the technical parameters of this type of connection, impact on the system and energy use, the ESO believes that it is most appropriate at this time to treat these types of connections as demand connections. We will continue to engage with TOs and connectees on whether any industry code changes are required.

Next steps beyond our pathfinders

In order to achieve our ambition, we need to move beyond our current pathfinders. This section sets out how we intend to move forward in order to continue this transformation.

Developing our tendering approach

As we progress further, we need to continue to work with the market to develop processes that unlock maximum value. For example, we are aware that for new build providers it can be challenging to put forward competitive bids based on securing a contract for one service at a time and therefore some providers want to be able to secure multiple contracts.

Our ability to align tenders depends firstly on where different network needs emerge or where there is significant interaction between specific products. Some network needs are location specific and can therefore only be addressed by solutions within certain locations. Currently, we need voltage support in the Mersey region, but stability support in Scotland.

Where locational network requirements do align, we will consider the most appropriate tendering approach, taking into account the learning we're gaining from our current pathfinder projects. In doing so however, we need to ensure that processes correctly value the contribution of providers across the different services in order to be fair and transparent. We also need to ensure that any processes do not inadvertently exclude providers who only provide one service.

Clear communication of potential future needs and therefore potential opportunities to secure contracts could also help providers develop competitive bids. The next section therefore sets out how we intend to communicate future network requirements and potential tenders.



Communicating future needs and tenders

We're aware there's been a lot of activity over the past year with lots of information published at different times. Our aim is to introduce a simple, ongoing, process so that stakeholders know what information they will receive and when.

Future network requirements are based on assumptions about future energy industry evolutions, as set out in our annual [Future Energy Scenarios \(FES\)](#)¹⁴ publication. Both FES and our network development analysis are updated annually. This means that our view on the future system requirements and on the best approach to address them also changes annually. Our analysis can also change within year in response to updates from the industry, such as the date of closure of a power station. The information we will provide is therefore designed to provide an indication of future needs, but it does not represent a commitment to buy particular services.

Our [Operability Strategy Report](#)¹⁵ is also a useful point of reference for a holistic view across the ESO's activities. The report explains the future challenges we face in maintaining an operable electricity system, what we are doing about them and how our work aligns with our 'operability milestones'. Opportunities for engagement are highlighted, as well as where to look for more information.

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<https://www.nationalgrideso.com/insights/future-energy-scenarios-fes>

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<https://www.nationalgrideso.com/document/159726/download>

Voltage and stability needs

Given the interaction between voltage and stability we aim to communicate future regional needs for both of these at the same time.

In Spring each year we intend to set out regional voltage and stability priority regions. This year we will set out voltage priority regions, with stability priority regions also included from 2021. The priority regions will indicate to providers where ESO might need to buy future services.

We then need to undertake further detailed analysis for each priority region, including exploring any existing available solutions. Once we have determined our voltage and stability requirements, tender processes will begin later each year.

Boundary reinforcements and residual constraints

Boundary reinforcement requirements are published in ETYS every November, with the recommended solutions published in NOA every January.

This year we also began publishing [System Requirement Forms](#)¹⁶ (SRFs). The SRFs provide a higher level of detail on system requirements for boundary reinforcements over the next 10 years than is available in ETYS. Previously they were only sent to TOs but will now be published each summer.

Our NOA publication also now sets out whether there might be potential value in seeking commercial solutions to support network development. Following this we will undertake further analysis on the residual constraints to determine the exact need and potential value of running tenders. We will announce by March whether we need to tender for commercial services that year and our approach to doing so.

Major Network Reinforcement

Our proposals for competition for major network reinforcements will be set out in our Early Competition Plan in February 2021, taking in to account progress of the require legislative change.

We expect the following sequence of activities for our tender processes:

	Communicating network requirements	Begin tender process
2019/20	Jan: NOA sets out potential value from commercial solutions for boundary constraints.	March: begin tender for boundary constraints, if required. Feb/March: publish Expression of Interest (EoI) for stability requirements in our current priority region (Scotland), followed by tender.
2020/21	Jan: NOA sets out potential value from commercial solutions for boundary constraints. May/June: publish voltage priority regions.	March: begin tender for boundary constraints, if required. Jan-March: <ul style="list-style-type: none"> publish EoI followed by tender for further stability services – we anticipate GB-wide stability requirements. tender for voltage services, as required.
2021/22	Jan: NOA sets out potential value from commercial solutions for boundary constraints. May/June: <ul style="list-style-type: none"> publish voltage priority regions. publish stability priority regions. 	March: begin tender for boundary constraints, if required. Jan-March: <ul style="list-style-type: none"> tender for further stability service, as required. tender for voltage services, as required.

¹⁶<https://www.nationalgrideso.com/publications/electricity-ten-year-statement-etys#tab-8>

Further developing our analytical capabilities

Subject to Ofgem's decision on our RII0-2 Business Plan proposals, we intend to continue to enhance our analytical capabilities. We will embed the proof of concept works we're developing within automated tools to allow us to undertake the high volume of analysis required. We will also integrate our analysis of different types of network needs to give a more holistic understanding of network requirements.

By 2024/25 we expect to have a suite of tools that enable us to quickly and accurately analyse all type of network needs, including the interactions between them. This will underpin decisions on what and when to invest to achieve maximum consumer value.

Below, we set out how our analytical capabilities will develop over the next two year.

ETYS 2020

In ETYS 2020 we intend to initiate developments to integrate pre and post fault actions (automated and manual) within the year-round analytical process. This will allow us to do a like-for-like comparison between the results produced using the current approach and our probabilistic tools.

We will also utilise techniques to calculate dynamic boundary capabilities, which are capabilities which represent year-round conditions as opposed to single values per season based on the current method that uses scaling techniques.

We will also provide an update on the development of our new voltage assessment tool.

ETYS 2021

For ETYS 2021, we will have completed our proof of concept for a bespoke joint network and market tool for probabilistic thermal analysis. This will demonstrate how it is possible to fully integrate our network and market analysis within a single platform, building in the processing power to solve ever more complicated network optimisations. These enhancements will allow us to further pinpoint the most economical time to invest in the networks – and the most efficient solution.

We will also have completed proof of concept for integration of probabilistic network analysis into the NOA process including ESO optimisation actions which will demonstrate how the tools and techniques we have been developing could bring benefit when integrated within NOA.

Innovation Projects

Study of Advanced Modelling for Network Planning Under Uncertainty:

This innovation project focuses on decision-making. It specifically explores questions around the 'least worst regrets' process, such as whether this is still fit for purpose against the uncertainty of planning timescales, and whether deterministic planning is still applicable. The project will review state-of-the-art planning techniques, which include probabilistic or risk-based approaches in decision-making. It will also explore the benefits of integrating technical and economic assessments into a single platform.

Application of Convex Optimisation to Enhance the NOA Process:

This Network Innovation Allowance (NIA) funded project, in collaboration with Strathclyde University, will develop an algorithm and code to include in our existing voltage assessment tools. This will enable us to analyse voltage requirements and develop solutions faster.

Faraday House
Warwick Technology Park
Gallows Hill
Warwick
CV346DA

Registered in England and Wales No. 11014226

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