# ES Cornwall Memorial Scholarship

## Second Quarter Report

7 February 2024 to 6 May 2024

National Grid Electricity Transmission, Warwick, United Kingdom

by

Eugene Ma

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

# Acknowledgements

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# Executive Summary

Queensland's electricity system is undergoing a transformative shift towards cleaner, renewable energy sources. The ambitious Queensland Energy and Jobs Plan (QEJP) sets out a clear roadmap to drastically increase the share of renewable energy in the generation mix. This transition is underpinned by a new 500kV backbone and supported by significant investments towards new wind and solar projects, grid-scale batteries, and advanced pumped hydro storage facilities. The QEJP will reshape Queensland's energy landscape by phasing out coal-fired power generation, which has traditionally been a significant part of its electricity supply.

During this transition, I believe that Queensland can benefit from learning how other transmission system operators are developing their network, policies, performance requirements and control practices to facilitate the connection of inverter-based resources.

This report provides an overview of my experience during the second quarter of the ES Cornwall Memorial Scholarship. In November 2023, I began my placement at National Grid Electricity Transmission (NGET) in Warwick, United Kingdom in the Future Network Blueprints team. In my first quarter, I was tasked with developing Regional Strategies for the business. The development of the Regional Strategies continued during my second quarter, albeit with an increased focus on price control requirements.

The Regional Strategies are documents that enable staff to gain an understanding of the major challenges and proposed solutions within a geographic region. These documents bring together network and stakeholder requirements from across the business to provide a view of the power system that allows staff to design the network holistically. Following an internal review in March 2024, the structure of the documents was amended to better align it with the price control submission. The Regional Strategies structure was modified to better convey the network-level context for network reinforcements and site investment decisions made in National Grid’s price control submission.

The information captured in the Regional Strategies trickled down to the Site Strategies. Site Strategies at National Grid are designed to enhance the scope of information considered in site investment decisions to ensure a consistent ‘whole system’ approach is taken. Extensive consultation with NGET personnel across the business is required to ensure the needs of all parties are accounted for. Asset health, customer connection, network reinforcement and stakeholder needs are key considerations captured by the Site Strategies.

Driven by the need to accommodate the increasing demand for new connections, connections reform is currently taking place in the United Kingdom. The connections landscape is moving towards a first ready, first connected premise allowing ready or strategically significant projects to be accelerated, leading to faster connection times. While the change is expected to streamline the connections queue, more pressure will be put on system operators like NGET to have the flexibility to deliver accelerated projects quickly.

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# Glossary

| NAME | DESCRIPTION |
|---|---|
| **AC** | Alternating Current |
| **AO** | Asset Operations |
| **CC** | Customer Connections |
| **CFD** | Contract For Difference |
| **DFES** | Distributed Future Energy Scenarios |
| **DNO** | Distribution Network Operator |
| **DV** | Delivery Vehicle |
| **EISD** | Earliest In-Service Date |
| **ESO** | Electricity System Operator |
| **ETYS** | Electricity Ten Year Statement |
| **FES** | Future Energy Scenarios |
| **FNB** | Future Network Blueprints |
| **HND** | Holistic Network Design |
| **HNDFUE** | Holistic Network Design Follow Up Exercise |
| **HVDC** | High Voltage Direct Current |
| **IDD** | Infrastructure Development and Delivery |
| **ND** | Network Development |
| **NESO** | National Energy System Operator |
| **NGESO** | National Grid Electricity System Operator |
| **NGET** | National Grid Electricity Transmission |
| **NOA** | Network Options Assessment |
| **OFGEM** | Office of Gas and Electricity Markets |
| **PPA** | Power Purchasing Agreements |
| **QEJP** | Queensland Energy and Jobs Plan |
| **RCM** | Regional Connections Manager |
| **RIIO** | Revenue = Incentives + Innovation + Outputs |
| **SI** | National Grid Strategic Infrastructure |
| **T3** | Price Control Period 2026-2031 |
| **TCSNP** | Transitional Centralised Strategic Network Plan |
| **TO** | Transmission Owner |
| **TSO** | Transmission System Operator |
| **UK** | United Kingdom |

# 1 Background

My second quarter report builds on the information provided in my first quarter report, detailing my learnings between February and May 2024. During this period, I continued my stay at National Grid Electricity Transmission (NGET) as a Regional and Site Strategy Engineer. The role continued to revolve around developing and integrating the Regional Strategies into the RIIO-T3 price control submission.

During this quarter, the price control team worked towards hosting engagement sessions with the six Distribution Network Operators (DNOs) across the English network to receive feedback on the NGET price control plan. In parallel, the Site Strategies were formalised to ensure a consistent 'whole system' decision-making approach is followed for substations investments.

While abroad, I intend to develop a better understanding of how the UK is evolving their network, performance requirements and policy to facilitate the connection of new renewable generation. A connections reform is currently underway to streamline and alleviate bottlenecks in the connections process. In addition to reviewing the connections reform information available, I have spoken to Regional Connection Managers (RCMs) to hear their opinions on how the changes will affect how NGET operates. This information has been captured in Section 3.

# 2 Projects

The development of the Regional Strategies accelerated as the internal review of National Grid's RIIO-T3 submission in March 2023 neared. My responsibilities over this quarter have predominantly been dedicated to developing the Regional Strategies for internal review and carrying out changes across the documents following the outcome of the review.

This section describes the projects that I have worked on directly. Due to recruitment in middle management and as the RIIO-T3 price control submission approaches, my everyday tasks in the workplace have become more focused on the development of the Regional and Site Strategies. In Section 3, I have discussed the knowledge I have acquired that is not directly related to my workplace responsibilities.

The information in this report below expands on topics discussed in the first quarterly report. An understanding of National Grid's Asset Health scoring and Customer Confidence ratings, which have been discussed in the previous report is beneficial.

## 2.1 Price Control

Ongoing meetings with representatives of Ofgem, the energy regulator in the UK, have made it clear that a higher standard of reasoning will be required for the coming regulatory submission. They have stated that work proposed in the price control submission, especially for larger projects such as new substations or substation rebuilds, must consider the needs of the greater network now and into the future.

This presented many challenges for NGET. The submission required clear links running from strategic ideologies down to the site level. It became necessary to not only demonstrate the need for site investments that have been triggered as a result of declining asset health or new customers, but also to explore potential synergies with reinforcement projects in the area.

These factors which have varying time and technical requirements will affect the final decision to rebuild, maintain or replace the substation. The Regional Strategies were envisioned to be a gap-filler to bridge the disconnect between the strategic needs of the business and the site-specific needs in the price control narrative.

In March, the Regional Strategies were reviewed internally by key National Grid stakeholders which included the price control team and members of executive management. The feedback was largely positive, however, there was a need to better integrate the Regional Strategies into the price control submission. The Regional Strategies would be restructured to introduce the work required in the RIIO-T3 submission and outline the need cases for sites planned for development in the upcoming regulatory period. Detailed justification will be guided by Site Strategies and detailed in Engineering Justification Papers.

### 2.1.1 Integration of Regional Strategies into the Price Control Process

One of my key responsibilities when I first joined NGET was to bring the Regional Strategies up to date. The Regional Strategies were first created to start the process of *Whole System Planning* and to bridge gaps formed following the NGET restructure in 2021. The Regional Strategies divided the England and Wales transmission network into six regions, roughly aligning geographical, electrical and asset maintenance zones. Each Regional Strategy collated investment drivers and planned network investments to provide an accessible way for all staff members to gain an understanding of relevant projects in their region.

At the end of my first quarter, the Regional Strategies were developed to a stage where the following information for each region was captured:

- The strategic needs of a region which provided a summary of the long-term planning challenges in a region;
- The Key sites and transmission line infrastructure with deteriorating asset health out to a 15-year window;
- The customer connection volume paired with the Customer Confidence ratings, and;
- The upcoming network reinforcements triggered by the NOA (Network Options Assessment), HND (Holistic Network Design), and TCSNP (Transitional Centralised Strategic Network Plan) processes. Under these frameworks, ESO defines a range of boundary constraints to which NGET must offer solutions. The solutions proposed by NGET are assessed by the ESO and solutions that were considered economically sound are triggered.

A further month and a half of development remained before the internal review deadline. During this period sustainability, resilience and publicly available stakeholder information were added to the document. This information was beneficial for use as a reference to obtain a brief understanding of the key local projects when engaging with stakeholders but offered little value for internal business decisions as it lacked the specificity and detail required.

Following the internal review, the decision was made to restructure the Regional Strategies to make better suit it to the needs of the price control submission. The scope of the Regional Strategies would be expanded to introduce the strategic need of a site in the price control narrative. The structure of the document has been reshaped multiple times, however, the general arrangement follows the same four-step structure.

1. **Identification of long-term regional scenarios**
   The long-term generation and demand expectations are introduced to the reader. Forecasts and trends regarding connections, load and other factors help provide readers with a broad understanding of the region. Based on the macroscopic features of a region, the region could then be described as a generation-dominant or load-dominant area.

2. **Identification of strategic network needs within the region**
   The long-term power flow and voltage requirements are then introduced to the readers. The critical challenges that need to be overcome are described in this section. This is followed by a brief description of key strategic plans aimed at resolving these critical challenges.

3. **Identification of reinforcements required to meet strategic network needs**
   The planned network reinforcements are captured in the Regional Strategies. This section establishes network reinforcements required to meet the strategic network needs and identifies the sites that are potentially affected by these projects. For reinforcement schemes, multiple options considered and noted down.

4. **Introduction to Site trategies with asset health and customer connection information**
   Asset health and customer connection projects are usually site-specific and have been captured in the Site Strategies. National Grid has been developing Site Strategies as a method of consolidating and assessing all information to reach a site investment outcome.
   The Site Strategy for key sites are introduced to outline the strategic and regional objectives achieved through site investment outcomes. That is to say, the Regional Strategies aim to link the benefit (improved network capacity, connected capacity, etc) achieved with investment decisions made at a substation.

The purpose of the Regional Strategies is to provide the network-level context to network reinforcement and site investment decisions made in National Grid's price control submission.

#### *2.1.1.1 Supplementary Regional Strategy Documents*

In the Quarter 1 report, a geographical map of the Regional Strategies was briefly mentioned. Adobe PDF was used to mark up a diagram to depict changes in the network. Following the internal review, the decision was made to port the map over to a system diagram recognised across the business and by external stakeholders. This diagram, referred to as the *Network Picasso* is created in Microsoft Visio. The key benefits of moving to Visio is the ability to layer the diagram and its accessibility to staff across the business.

The *Network Picasso* is a useful visualisation resource that depicts the changes occurring on the network. An example diagram is shown on the next page.

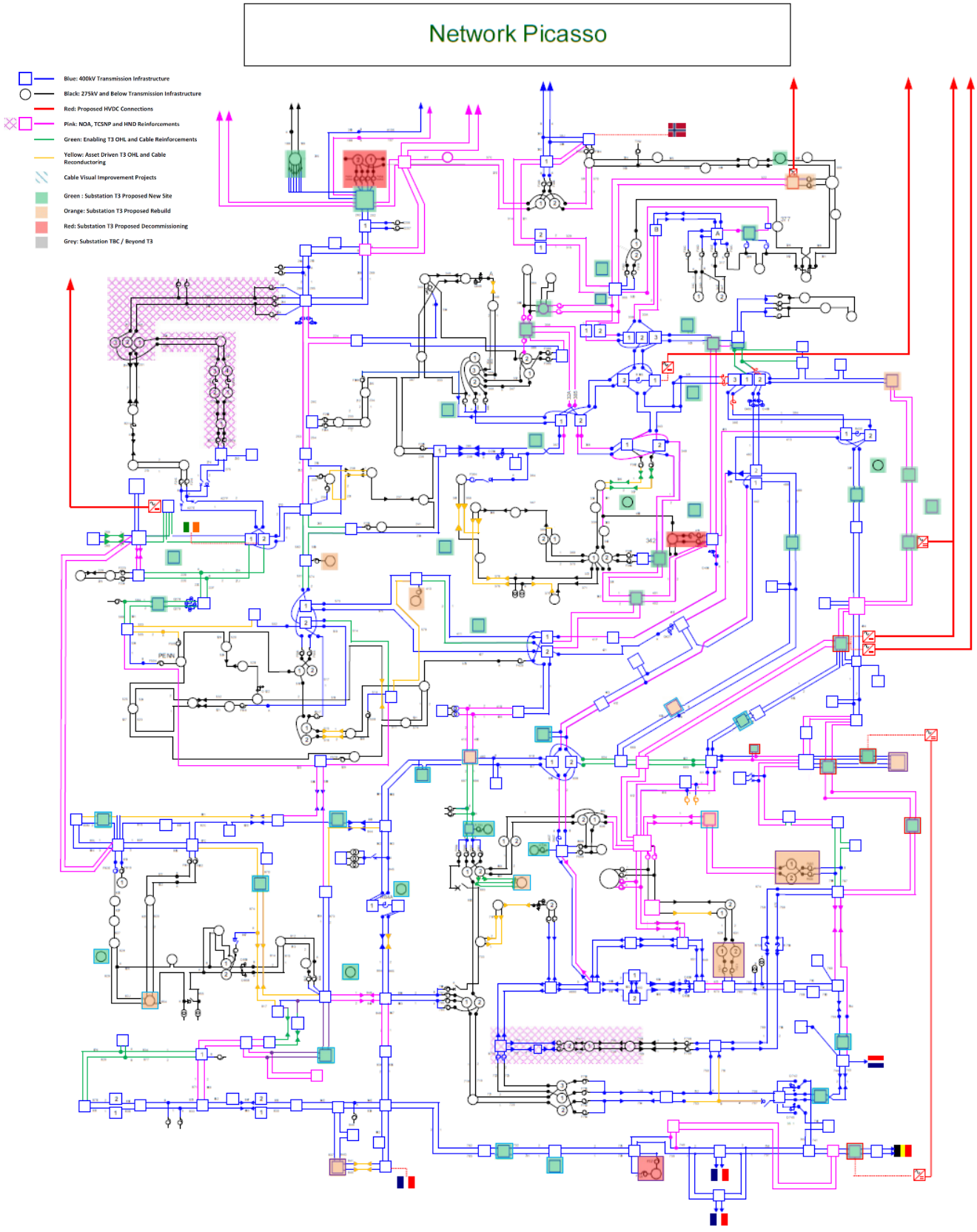


*Figure 1 - Network Picasso*

### 2.1.2 Price Control Engagement with Distribution Network Operators

In the upcoming price control period, the regulator Ofgem will hold NGET to a higher standard. An increasing focus has been placed on planning the network based not only on factual evidence but also on planning and developing around uncertainty. The regulator wants to understand the meaning and need behind the investment proposals and would like NGET to show that all considerations have been accounted for; from the asset level up to the system level and across the energy landscape.

National Grid undertakes periodic meetings with the six Distribution Network Operators (DNOs) which are used to address technical issues between the companies. These meetings are useful in addressing the mid to short-term needs of the businesses but lacks the flexibility and change possible in higher-level, strategic meetings.

To understand the strategic DNO requirements, meetings were set up with each DNO to share and discuss plans in the following price control period. These meetings are an opportunity to share larger plans early in development with the DNOs while the plans remain flexible. It is hoped that these meetings will give the opportunity for the distribution operators to shape the transmission network by influencing the network plans.

It is hoped that these engagement sessions will surface areas that require more consideration by NGET and allow NGET to better understand the strategic level ambitions of the distribution networks which will affect National Grid's price control submissions. The learnings from these industry engagement sessions are expected to provide NGET with a wider greater of the factors affecting not only substation investment. This work aims to:

- **Identify areas of the network where more supply points to the distribution network are required**
  NGET are developing a geographic forecasting tool that would identify distribution interface points that would require capacity uplift and also highlight areas that would require a new bulk supply point to be constructed to meet rising demand. However, under the current energy framework, the alignment between the transmission and distribution forecasts are limited. Consequently, the distribution needs forecasted by NGET may be inaccurate.

  Receiving information from the DNOs are necessary to creating an efficiently designed network. DNOs have a better understanding of their network needs and are known to model their networks down to individual streets. As a result, their forecasts are expected to be far more accurate than those of NGET. The information given to NGET in these sessions would not only useful when considering site strategy, the information can also be used to benchmark NGET studies.

  Ultimately these responsibilities would be taken over by the National Energy System (NESO), an independent entity replacing the ESO, which would overlook and coordinate strategy across the whole energy system. However, the NESO is still being established and is yet to be able to fulfil its duties.

- **Develop an early understanding of DNOs plans for new NGET sites**
  The joint planning meetings with the distribution network providers would be an opportunity for NGET to discuss new planned sites with the DNOs. In these meetings, much of the key details of the new site would have already been determined in isolation, leaving the parties to deliberate on the specifics of the technical design and delivery,

  There is an opportunity available in the strategic engagement sessions planned, for the DNOs to influence site designs to a greater capacity. A number the new sites have been triggered in the following price control period to host new connections and network infrastructure. The design of many of these new sites are yet to be finalised, providing the opportunity for DNOs to shape the design of the site. It is hoped that the feedback can lead to mutually beneficial design solutions.

- **Build a "whole system plan"**
  NGET has developed their price control plan to date using the information available to them with the best intentions. However, the business recognises that their plan is not perfect due to reasons that are not limited to data, resourcing and time constraints. Engagement with stakeholders like the DNOs is necessary to identify oversights in the price control submission. National Grid acknowledges that these meetings only mark the beginning and that continuing engagement with stakeholders would be required to create a plan fit for the whole energy system.

Further discussion will be required for complex topics raised in these sessions. Separate breakout meetings between the companies will need to be arranged with the required personnel to progress the issues in time for the price control submission.

To help facilitate the discussion, information from the Regional Strategies was extracted and used to create an information pack sent to the DNOs before the meeting for perusal. The information included overhead line, cable and substation work planned in the price control submission.

At the time of writing, one of six meetings has been conducted. The outcomes and learnings of all six DNO engagement sessions will be discussed in future reports.

## 2.2 Site Strategies

Investment decisions made for substations are shaped by a range of drivers stemming from immediate needs up to requirements years into the future. Building off the foundation set by Regional Strategies, Site Strategies at National Grid is designed to enhance the scope of information considered in site investment decisions to ensure more consistent 'whole system' decision-making. Extensive consultation with key NGET personnel across all Delivery Vehicles is required for each step of the process to ensure the needs of all parties are accounted for.

The Site Strategies follow a four-step process described below.

1. **Network Drivers are brought into a single place to enhance the level of information available to support decision-making.**
   Identifying and collating the company information was an initial exercise marking the start of the Site Strategies process. The information collected in the Regional Strategies outline the major infrastructure reinforcements occurring in the area. To ensure lesser-known drivers within the business are captured, a network design exercise was conducted with planning engineers from across the business. This exercise surfaced numerous parts of the network which required a deeper review to avoid sub-optimal decision making.

2. **Sites are assessed based on outputs from the Asset Health review**
   The Assets Operations Delivery Vehicle has implemented a methodology used to identify priority sites that require significant investment and coordination due to widespread asset health concerns. The assessment primarily uses top-down analysis to evaluate the health and remaining life of all primary equipment on the network based on the CIGRE TB858 standard. Substation health is then graded based on the condition of its constituent assets. The Quarter 1 report covers the specifics of the Asset Health review in greater detail.

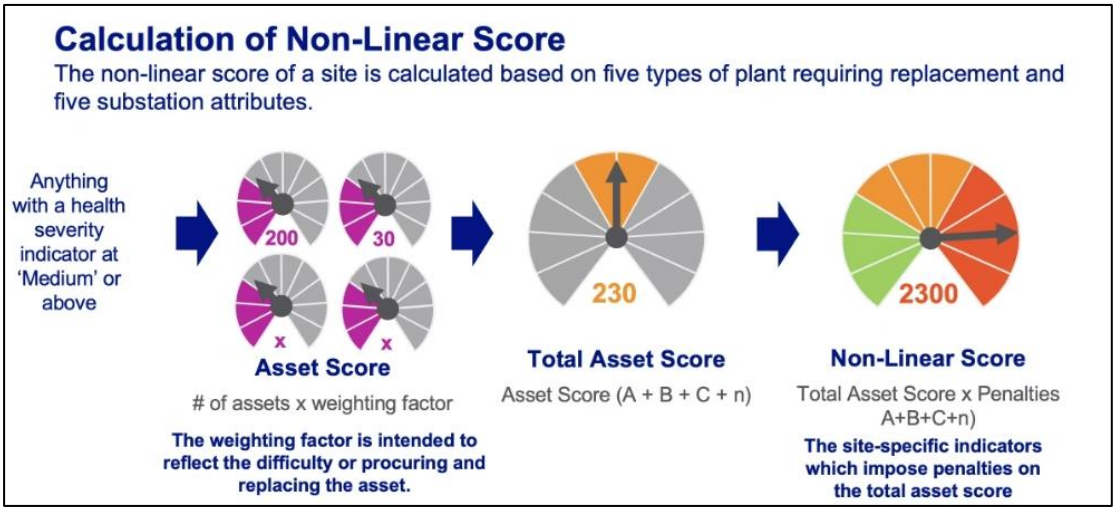


*Figure 2 - Asset Health Review Scoring*

Using the outcome of the Asset Health methodology, the minimum asset work required at substations in the following price control period can be determined. This would enable the categorisation of substations into health ratings using quantitative measurements based on the condition of the electrical assets within the substation.

Substation rebuilds are costly upfront investments that may ultimately save money for the business due to greater design flexibility, lower outage requirements and quicker delivery. Substations categorised as *high or above* are nominated for substation rebuilds to minimise the duration and outage required by the asset replacements. Additional verification of the asset condition on site would be carried out to

authenticate the information from the asset review and determine whether a site rebuild is the optimal path forward.

During this process, many rebuild candidates are reclassified as *maintain/upgrade* sites, where the site is maintained and the assets are incrementally upgraded when required. The downgraded classification from *New or Rebuild* following the Asset Health review in the Site Strategies process does not condemn the site to a *maintain/upgrade* future in the price control submission. Connection and network drivers are some of the considerations that as a collective, may trigger a substation rebuild.

3. **Customer confidence methodology is utilised and overlayed on the existing information**
   The Customer Connections Delivery Vehicle at NGET has historically applied a network planning philosophy that considered the connection of all contracted customers. Connection-specific substation designs and network reinforcements intended to release connection constraints were drawn out for each customer. These were called *Enabling Works*. Soley relying on this methodology is no longer practical due to the high connection volume and the significant level of contract attrition.

   The business is moving away from the *Enabling Works* network design philosophy towards customer agnostic network design principles. The new methodology aims to implement a wider range of substation and network upgrades designed to support a balance of connecting customers based on internal indicators and guidance from ESO forecasts. To help develop site plans, National Grid has established a customer confidence methodology to better estimate the number of connections at each site.

   The Customer Connections Delivery Vehicle has performed market analytics to categorise customers into a range of confidence levels based on a mix of quantitative and qualitative information to help guide network and resource planning decisions. The customer confidence methodology can provide enhanced guidance on the number of customers to account for in a substation design. The analysis is explained in detail in the Quarter 1 report.

   The results of the customer confidence methodology categorised each connection into a traffic light system which dictates its treatment in site and network plans.

   a. **Green**
      NGET is confident in connections in the green category. The necessary substation and network changes required are included in the site plan.

   b. **Amber**
      Connections categorised as amber are considered to be of moderate confidence. The price control framework allows for uncertainty whereby additional funds are released if certain network conditions eventuate, such as the connection of a customer. Connections in this category are likely to be

captured in the business plan through the uncertainty mechanisms and may be included in substation designs.

c. **Red**
These connections are unlikely to proceed based on review and are not included in the substation plan

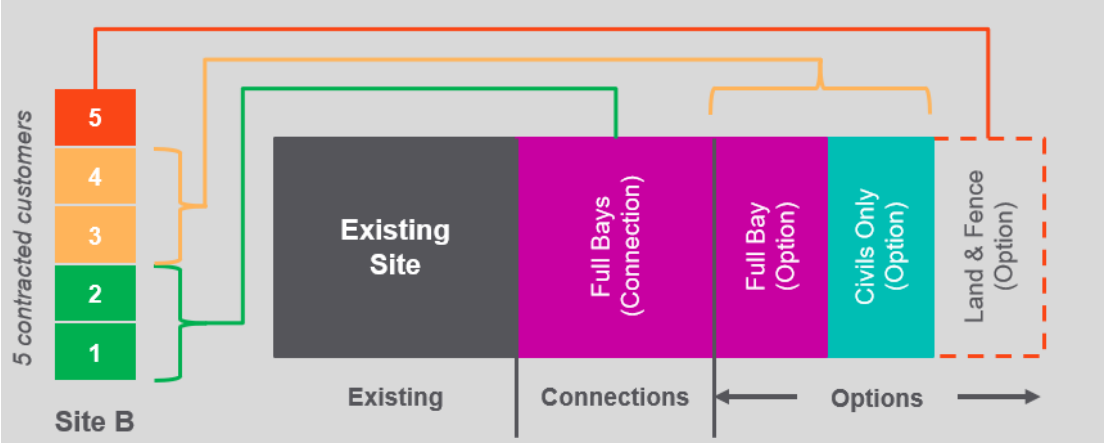


*Figure 3 - Allocation of Customers into Site Plans*

The total capacity of generation across England and Wales that are in the green and amber categories generally far exceeds the generation required as defined in the ESO's Future Energy Scenarios. Shown below, the total contracted generation capacity categorised into green, amber and red, is compared against the level of generation required by 2035. Under the assumption that the green customers will proceed to completion, it was deduced that between 15% to 30% of amber connections (dependent on their location) will be required to meet the 2035 level of generation required. These estimates are fed into the price control uncertainty mechanisms.

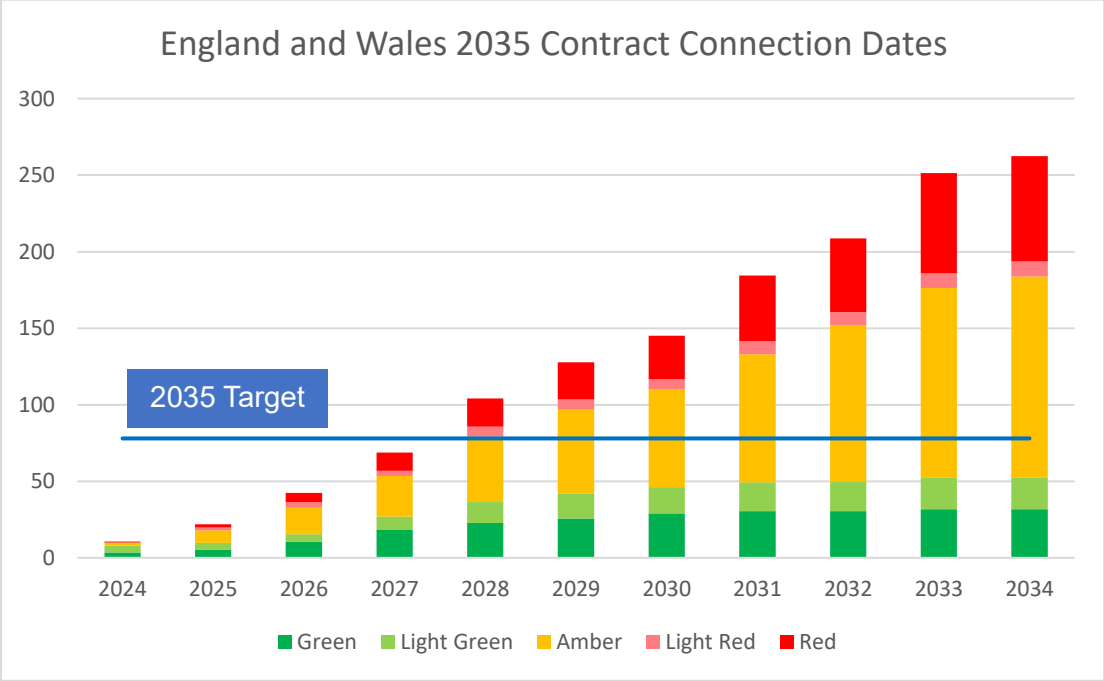


*Figure 4 - Total Connection Volume (Early 2024)*

4. **Substation investment decisions are tested through a robust option selection process**

   Based on the investment drivers collected, a range of substation investment options are created and examined. During the optioneering process, a wide range of considerations are taken that extend beyond the site-specific asset health and customer connection drivers. Network development and reinforcement plans affecting the UK transmission and distribution network captured in Step 1 are fed back into the optioneering process

   New offshore infrastructure and onshore network reinforcement projects are designed to meet general power flow requirements defined by the ESO. NGET has coined the term *Wider Works* for these reinforcements. *Wider Works*, specifically those which require new substation infrastructure weigh heavily in site decision-making due to their strategic importance. However, in many instances, the *Wider Works* projects do not yet have a final design and as a consequence, the sites impacted are not confirmed. As part of the option selection process, the *Wider Works* schemes must be progressed, at the very least, to provide certainty on the sites that will not be affected. This itself is a challenging process due to the interaction of these schemes with drivers both internal and external to National Grid.

Asset health, customer connection, network reinforcement and stakeholder needs are all important considerations in the design of the future network. These factors are heavily interlinked and require a significant level of study to be carried out to ensure the best decision is reached.

# 3 Other Learnings

## 3.1 Connections Reform

Ensuring customers can connect to the electricity network where and when they need to is crucial to achieving net zero, as well as to delivering affordability for consumers and maintaining security of supply.

Projects crucial to achieving net zero are facing serious connection delays. However, just as many projects with connection agreements will never connect. There is currently around 500GW of capacity across transmission and distribution holding connection agreements and this is increasing rapidly as an unprecedented number of renewable/low carbon generation and storage projects accept connection offers. The current pipeline of generation and storage projects seeking to connect goes substantially beyond what is required to meet decarbonisation targets, but are blocked by surmountable regulatory, technical, procedural and commercial barriers. Without action to remove these barriers, the connection queue will continue to increase with consequences on:

1. The ability to decarbonise the energy supply and meet net-zero targets;
2. Energy security;
3. Consumer bills, and;
4. Missed opportunities for jobs and economic growth.

In response, Ofgem has published a *Connection Action Plan* that sets out six key areas of action for all industry bodies including the system operators, network owners and the regulator itself. The key areas are as follows:

1. **Raise entry requirements to increase the quality of projects applying for transmission connections and deter speculative connection applications.**
   The ESO will start requiring a landowner Letter of Authority to evidence permission from a landowner for a transmission network connection application to be accepted.

2. **Remove stalled projects to release capacity for more viable projects.**
   The ESO will require milestones in transmission connection contracts which a connection customer must meet or face termination of their connection contract.

3. **Better utilise existing network capacity to reduce connection timelines.**
   The impact of connections is assessed by the ESO and network companies will change to enhance the use of flexibility, including non-firm/flexible connections.

4. **Better allocate available network capacity moving away from the first come, first served approach to one that connects projects that are readier to progress and are able to quickly make use of capacity.**
   A triage process will be implemented to ensure the most strategically important projects receive the strongest possible support to explore timely connection solutions, working together with Ofgem, the ESO and network companies.

5. **Improve data and processes and sharpen obligations and incentives.**

The ESO and network companies will give connection customers a better understanding of the condition of networks, to improve the quality of their connection applications and reduce speculative applications.

6. **Develop longer-term connections process models aligned with strategic planning and market reform.**
   To ensure the connections process is integrated to deliver strategic outcomes for a timely and efficient transition to a net zero energy system.

The ESO has recognised the challenges of the current connections framework as the connection queue continues to swell 20GW per month. In response to the Connection Action Plan, a *five-point plan* of tactical initiatives has been launched by the ESO to help improve the connections process in the short term. The points are as follows:

| | |
|---|---|
| **1** | **TEC Amnesty**<br>TEC Amnesty will allow customers to leave the connection queue or reduce their contracted capacity without incurring penalties for a limited period. This change is said to alleviate pressures within the pipeline of projects. 8.2GW of projects have terminated their projects under TEC Amnesty. |
| **2** | **Calculation of Connection Dates**<br>The ESO will change their background modelling assumptions which will update the project connection dates. |
| **3** | **Storage System Modelling Assumptions**<br>The impact of storage systems on the power system will be modelled differently. Engagement conducted by the ESO with storage developers indicates that the operating modes of BESSs will generally align with system needs |
| **4** | **Queue Management**<br>Customers holding live construction agreements must show continuing progression towards project completion. Projects that are not progressing against agreed milestones will be terminated. This ensures that capacity is fully utilised and that projects will have the best chance to connect when ready. |
| **5** | **Acceleration of Battery Connections**<br>Energy storage projects will be allowed to connect to the grid more quickly. The ESO understands that storage technologies can support the operability needs of the system during times of stress. Furthermore, accelerating the connection of storage will improve the understanding of their behaviours in multiple operating scenarios.<br><br>To mitigate potential operational risk, the outputs of these storage systems may be restricted under specific network conditions without compensation. |

The *five-point plan* is intended to stabilise the short-term connections ecosystem and came into effect in late 2023. Its effects are still to be fully appreciated; however, I have captured the opinions of a few NGET employees regarding the connections reform in Section 3.1.2.

### 3.1.1 Future Development

The *five-point plan* was designed to relieve the connection queue in the short term. There is a longer-term vision for change to the connections process. The ESO is moving towards a first ready, first connected framework, referred to as 'TMO4+' which is set to go live in January 2025.

*Figure 5 - Description of the TMO4+ Process*

Connections under the proposed *TMO4+* approach will need to pass through a two-gate process before a position in the queue is offered.

At Gate 1, applications will be assessed for competency, with competent applications being integrated into a coordinated network design to inform plans for building future network capacity. Offers will be issued at Gate 1 for the capacity and technology requested, with an indicative connection date and an indicative connection point. The indicative connection date under the *TMO4+* framework is subject to change and may move backward if other projects reach Gate 2 first and are offered a queue position. An earlier connection date is also possible in situations where the other projects have terminated and left the queue. This feature of *TMO4+* enables ready projects access to better connection dates.

To proceed past Gate 2, the connection must present several documents to show evidence of progression. Land rights must have been secured for the proposed location and application dates for submission for planning consent prepared. Projects may also be deemed by the ESO to have met Gate 2 where they meet specific strategic criteria, enabling strategic projects to be accelerated.

Following Gate 2, projects will be required to continue to demonstrate their progress via the Queue Management process. Projects not meeting their Queue Management Milestones may be removed from the queue, with capacity freed up by projects exiting the queue being used to provide more favourable dates to other projects that have met Gate 2.

The *TMO4+* framework is aimed at better meeting the reform objectives and those within the Connections Action Plan, as well as ensuring a smoother and more efficient process in future.

### 3.1.2 Discussion

The connections reform proposed by the ESO will change how NGET will perform its function. However, the general perception is that despite the coming connections changes, there is not enough being done given the amount of work impending. During this quarter, I have spoken with several Regional Connection Managers (RCMs) about their thoughts on the ESO's connections reform.

Regional Connection Managers handle a team that is responsible for a portfolio of connections. They are accountable for the delivery of a connections portfolio which includes work such as contact negotiation, performing power systems analysis, determining required network reinforcements and managing a connection delivery strategy. Two key points have emerged from my conversations with RCMs at NGET with regards to the changes being made to the connections process.

1. **Connections reform shifts the challenge to accelerating delivery speed**
   Traditionally, the connection process has followed a first come, first served basis. This framework has allowed NGET to develop an understanding of the order of upcoming works, enabling better outage planning and longer procurement margins. However, slow parties holding their place in the queue often delayed ready projects from progressing, leading to the development of a new connections policy by the ESO.

   The connections reform policy proposed focuses mainly on improving the management of the connections queue. Projects failing to meet milestones on time are moved back or removed, allowing ready projects to move forward. The premise of the first ready, first connected maximises the number of connections to the network, at least in theory.

   The new connections policy will change how National Grid Electricity Transmission approaches these projects. The variable connections queue will limit the planning NGET can undertake when a project is accelerated, forcing the business to move towards a delivery model catered towards speed and flexibility. Constraints in resourcing and supply chain will further bottleneck the company's ability to deliver projects quickly. In response, NGET is working to procure electrical assets in advance and in bulk to ensure that there is sufficient stock once the need arises.

   The connections reform will be an overall improvement to the historical framework. The reform will streamline the challenges faced in the connections queue but will surface constraints in resourcing and deliverability further downstream.

2. **Connections reform does not address challenges in the regulatory funding policy**
   Obtaining funding required to perform connection work from the regulator is a significant challenge for NGET that has not been addressed by the connections reform. Connection projects are partially funded through volume drivers that determine the revenue allowances that are adjusted based on the actual number of new connections or upgrades. This ensures that network companies are neither unfairly penalized nor unduly rewarded based on connection volumes. However, this mechanism does not sufficiently fund the *Enabling Works* that are required to connect a group of customers due to customer uncertainty. Consequently, the business heavily relies on the *Wider Works* defined in NOA and TCSNP processes to meet network constraints. The NOA and TCSNP processes are limited as they rely on ESO forecasts which can be detached from reality. The present regulatory frameworks may lead to a more constrained network if not resolved.

   The regulator Ofgem is reluctant to release funds to build new substations in advance for customers expected to connect. There is more risk inherent to constructing assets early for customers that are still uncertain. However, from the perspective of the RCMs there is already a significant shortage of connection nodes, and there is a belief that there will be sufficient customer interest anywhere on the network to justify a new site. Ofgem has challenged National Grid's approach. With no guarantee of funding from Ofgem, both NGET and the connecting customers are reluctant to be the

first to start construction without guarantees from all involved parties. As a result, plans for new substations will only be progressed for definite projects which is expected to result in significant resourcing bottlenecks in the future.

Although NGET has taken a cautious approach to new substation construction, the business is more willing to progress multi-driver substation projects. Many sites are expected to require significant changes in the following price control period which present themselves as opportunities to perform work in advance for expectant connections. Connection works for these sites require far less investment compared to new build substations and consequently are of significant value. The Site Strategies aim to capture these high-value projects into the site plans.

# 4 Future Plans

I have now spent six months at National Grid Electricity Transmission. My position at NGET has given me exposure to the strategic processes the business uses to navigate through the price control process. In May, I was part of a team that ran the distribution network engagement sessions across the UK. I intend to discuss learnings from this experience in the Quarter 3 report.

I have been negotiating with my managers to gain more direct exposure to topics related to my ES Cornwall Memorial Scholarship in the following quarter. We have reached an agreement that my responsibilities will shift to the Strategic Network Planning team as the price control work reaches a peak, before spending time with the Power Quality and Dynamic Modelling team, most likely in the fourth quarter.

The Strategic Network Planning team performs the optioneering and identifies the reinforcements required to meet the needs of the future network. The Power Quality and Dynamic Modelling team performs harmonic analysis and studies the control interactions in the network. Experience in both these teams will help develop my understanding of how NGET are adapting their network to meet a network with a growing penetration of inverters.

# 5 Bibliography

[1] National Grid ESO, “Connections Reform,” National Grid ESO, 2024. [Online]. Available: https://www.nationalgrideso.com/industry-information/connections/connections-reform.

[2] National Grid ESO, “Our Five-Point Plan,” National Grid ESO, 2024. [Online]. Available: https://www.nationalgrideso.com/industry-information/connections/our-five-point-plan.

[3] National Grid ESO, “GB Connections Reform,” National Grid ESO, 2024. [Online]. Available: https://www.nationalgrideso.com/document/316446/download.

[4] Queensland Government, “Energy and Jobs Plan,” Queensland Government, 2024. [Online]. Available: https://www.energyandclimate.qld.gov.au/energy/energy-jobs-plan.

[5] Ofgem, “RIIO-3 Strategic Stakeholder and Consumer Mission Consultation: Overview Document,” Ofgem, Dec. 2023. [Online]. Available: https://www.ofgem.gov.uk/sites/default/files/2023-12/RIIO-3%20SSMC%20Overview%20Document.pdf.