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Dear Steve

Northern Powergrid response to the Request for Information on LCNF Second Tier Projects seeking discretionary rewards

I am writing in response to your letter dated 6 July 2018 in which you requested information in order to understand the wider impact of the Low Carbon Networks Fund (LCNF) projects seeking a Second Tier Reward.

You asked two questions in your letter and these are answered in the annex to this letter.

We have outlined the principal impact that these projects have had on both deployment of new solutions on our networks (question 1) and changes to our operational practices (question 2). In order to aid clarity and understanding we have referenced in a table at the start of the annex how the various innovation projects relate to the changes we outline. We have also sought to reduce duplication by only describing the changes we have made in response to one of question 1 or question 2; dependent on whether it is predominantly a deployment of new assets or a change in operational practices including new commercial practices and customer solutions.

The information provided demonstrates where we have implemented change in Northern Powergrid as a result of the innovation taking place across the sector. We have also sought to evidence or quantify this benefit where we can. This demonstrates that the changes made in our business are influenced by a number of sources - it is unusual to ascribe a change to a single project and it is often a combination of influences that support the changes.

In summary, I trust the above categorisation and the content in the annex is of assistance in providing you with a clear view of the impact that the innovation projects have had for the customers of Northern Powergrid. If I may be of any further assistance then please make contact.

Yours sincerely

Jim Cardwell
Head of Trading and Innovation

Annex - Detailed responses to questions asked by Ofgem

	Low Carbon Hub	LV network templates	SoLa Bristol	Capacity to Customers	Falcon	Flexible Networks	Flexible Plug & Play	My Electric Avenue
Q1 – Deployments on our network								
Active network management	✓						✓	
Generator connection designs	✓							
Generator operation in reactive power mode	✓							
Active network ring	✓							
Selected overhead line uprating	✓							
Overhead line dynamic rating	✓						✓	
Dynamic voltage control	✓						✓	
LV monitoring		✓						
Real-time thermal ratings					✓	✓		
Alternative communication solutions							✓	
Frequent use switches							✓	
Q2 – Learning incorporated in operational practices								
Voltage reduction		✓				✓		
Reduction in statutory voltage limit		✓						
LV network templates		✓						
Domestic PV ratings		✓						
Flexibility services			✓	✓	✓			
Automated load transfer					✓			
Network monitoring						✓		
Regulators						✓		
Protection relays							✓	
Electric vehicle network impact								✓
Smart charging								✓

Question 1: Have the outputs and/or findings from any of these projects been deployed on your networks? Please provide evidence of the extent and impact of any such deployment.

Active Network Management (ANM)

We reviewed the ANM deployment outlined in the **Low Carbon Hub** and **Flexible Plug & Play** projects as part of the development for our specification for a standard ANM solution (NPg ref: NPS/007/020). That ANM system specification was used to procure a framework contract for ANM provision over the ED1 period.

The ANM deployment methods outlined in the **Low Carbon Hub** and **Flexible Plug & Play** projects also informed our approach to constraint analysis (NPg ref: IMP/001/016). We have three existing non-standard ANM zones controlling 408MW of constraint export from the 718MW of installed generation.

We are in the process of installing a new standard ANM system under the ED1 framework at Driffield in Yorkshire which will connect an additional 25.5MW of constrained generation across four participants.

With regard to opportunities for Network Enhancement, Northern Powergrid agrees with the approach taken in the **Low Carbon Hub** project that any asset replacement scheme ought to be considered in the context of good value enhancement opportunities for realistically predictable general growth in demand. We have also produced a connection agreement with new technical schedules for our first multi-customer replicable ANM scheme – this is being further developed in the ENA Open Networks programme.

Alternative Generation Connection Solutions

As a long-time supporter of 'non-firm' connections, Northern Powergrid have been implementing, relatively straightforward constrained/flexible connections for many years. The output from the **Low Carbon Hub** project aligns with our existing work on alternative generation connection solutions that is part of our design policy for all new connections (NPg ref: IMP/001/007). Generator constraint management solutions are considered if appropriate as part of the connections design process and discussions with the customer. This can range from a single constraint solution for a single generator through to an active network management (ANM) system for multiple generators.

Generator Operation in Reactive Power Mode

The **Low Carbon Hub** project output aligns with our existing work on alternative generation connection solutions that is part of our design policy for all new connections (NPg ref: IMP/001/007) and IMP/001/007/002). Changing the operating mode of generator from PF mode to PV mode in order to allow connection of generation has been used on a small number of cases. We envisage using variable PF control as being the alternative solution in future.

Active Network Ring

Conversion of radial networks to meshed ring networks is something that is possible in our design policy but we concur with the learning from the **Low Carbon Hub** project that it is often a costly exercise for the benefit derived. We have ring networks in NPg at 132kV, 66kV and 33kV in addition to radial networks (NPg ref: IMP/001/913 and IMP/001/914).

Selected Overhead Line Uprating

The learnings from the **Low Carbon Hub** project on replacement of overhead line designs using low loss conductors, higher rated conductors and ability to replace existing long span designs all aligns with work we have done on our overhead line specifications. Also we have the policy option of using fibre optics on overhead lines for connections (NPg ref: NSP/004/045 and optical fibre wrap used in the Blyth ANM scheme as a cost effective communications channel).

Overhead Line Dynamic Rating

As outlined in the **Low Carbon Hub** and the **Flexible Plug & Play** projects, the use of dynamic or real time thermal ratings for overhead lines is a policy option for our design engineers when considering new connections or network reinforcement (NPg ref: IMP/001/011). The only deployment to date on our network has been through our CLNR project. We have not yet identified a scheme that requires overhead line real time thermal ratings as used in the **Low Carbon Hub** project, but it remains our intent that we will deploy it on an operational basis.

Dynamic Voltage Control

The learning from both the **Low Carbon Hub** and **Flexible Plug & Play** projects on the use of a centralised system for voltage control and optimisation aligns with work demonstrated in our CLNR project; albeit our CLNR work was done in a more technically sophisticated way across multiple voltage levels using different types of voltage control device. This work impacted the specification for new AVC relays in terms of the controls and information required to interface with a central system.

We have also trialled modern AVC relays in CLNR and are now deploying them at all Northern Powergrid network supply point and primary substations as part of our smart grid enablers' programme. These will provide network monitoring information and more granular voltage control facilities via a digital communication using the DNP3 protocol (NPg ref: IMP/001/017 and NPS/005/003). Similar to the **Low Carbon Hub** project, and building on CLNR learning, we will implement a centralised system for voltage control using the voltage control devices we are deploying when we require it on constrained parts of the network (NPg ref: IMP/001/915).

As per both the **Low Carbon Hub** and **Flexible Plug & Play** projects, we have started to use the functionality of the new AVC relays to provide Load Drop Compensation at network substations. This allows us to operate the network at a lower voltage when there is high generation/low load and still be able to operate the network within statutory limits under outage or low generation/high load situations. This permits customers to connect more small scale generation at low voltage (NPg ref: IMP/001/915/002). Our control engineers are now able to see the operating tap position of a transformer and the direction of power flow through a transformer. This improved situational awareness will help control engineers make more effective and safer real time decisions in reconfiguring the network.

LV Monitoring

The **Low Voltage Network Templates** project was one of the first DNO projects to deploy monitoring at LV so the learning from it combined with the learning from other DNO projects and our own CLNR project have all helped in the development of our LV monitoring specification (NPg ref: NPS/007/021). As LV monitoring is a key project in our smart grid enablers' programme, we have deployed 60 LV monitoring units in 2018 and intend to install a further 200 by year end. We will then deploy at least a further 1,100

units by end of ED1. Further to this, the data obtained from the LV monitoring equipment is being used to identify thermal loading constraints and operating voltages outside of statutory limits. Approximately 10% of sites have so far required some form of intervention to ensure the continuity and quality of supply to customers.

Real Time Thermal Ratings

The use of dynamic or real time thermal ratings for overhead lines is a policy option for our design engineers as discussed above when considering new connections or network reinforcement (NPg ref: IMP/001/011).

As per the **FALCON** project (and our CLNR project) we have developed approaches for both transformers and cables. The NPg transformer ratings policy (NPg Ref: IMP/001/918) has been updated to explicitly allow the consideration of bespoke and dynamic ratings. Similarly, the cable ratings policy (NPg Ref: IMP/001/013) does allow the use of bespoke and dynamic ratings, however due to losses and the economics governing such dynamic ratings their use for cables will be limited with more opportunity for bespoke ratings. Although we have not yet identified a scheme that requires real time thermal ratings, it remains our intent that we will deploy it on an operational basis.

Alternative Communication Solutions

The **Flexible Plug & Play** projects use of a RF mesh communications platform for ANM communications was noted by us during the formation of our 2013 ED1 business plan annex on our smart grid development plan. We identified then that it may have the potential to be deployed for a different use case as a replacement for our secondary SCADA. We are presently in the process of developing our procurement specification for the replacement of our secondary SCADA system and the RF mesh remains a potential technology solution. The concept of IP based communications for controlling network assets using a modern protocol such as DNP3 has been adopted by us in our specification for the replacement of the primary SCADA communications network.

Frequent Use Switches

The **Flexible Plug & Play** project used 33kV RMUs as flexible switches. This is similar to our existing design philosophy of three circuit switches. The findings of the project have not caused us to update our policy (NPg ref: IMP/001/913).

Question 2: Have the learnings from any of these projects been incorporated into your operational practices? Please provide evidence of how such a change has provided valuable benefit for consumers?

Voltage Reduction

The findings from the **Low Voltage Network Templates** as well as the **Flexible Networks for a Low Carbon Future** projects reinforced our policy decision to reduce the 20kV and 11kV network operating voltages. This change in our operational practice was also informed by our work on the Customer-Led Network Revolution (CLNR) project and is more fully described in our own Second Tier Reward application. The benefits for customers of voltage reduction have also been described in our Losses Strategy and in our Environmental Report due to the increased voltage headroom this provides for generation. This change to our operational practices has the potential to release 10GW of headroom by 2050 in addition to financial for customers and carbon benefits.

We have completed a design review of all 584 of these networks for whether it is possible to reduce the operating voltage. We decided to reduce the target operating voltage on 551 networks and have completed 308 of them to date. Our voltage management policy (NPg ref: IMP/001/915) specifies the revised operating practice for target voltage.

Reduction in the Lower Statutory Voltage Limit

In line with the **Low Voltage Network Templates** project, we have participated in the ENA working group that assessed this and other DNO project outputs and then recommended via the report ETR140 a reduction in the lower limit. This has not been deployed as yet due to the need to change ESQCR.

LV Network Templates

We have found the technique used in the **Low Voltage Network Templates** project to be limited in its use and the work has been superseded by innovation projects that we have done with Element Energy on assessing existing load profiles and future load profiles due to various low carbon technology (LCT) take-up scenarios. We use this tool combined with other data to target LV monitoring installation.

We believe LV monitoring needs to be deployed at sites where they is uncertainty in loading e.g. commercial city centres, sites believed to be highly loaded, and on potential LCT clusters to better inform reinforcement decisions.

Domestic PV Ratings

We have noted the findings from the **Low Voltage Network Templates** project in the area of diversity between PV installations and level of output from individual PV installations. Some of these findings align with the output from our CLNR project. Together these findings informed changes to our LV design policy assumptions for PV which include a factor of diversity based upon number of customers and orientation of roof (NPg ref: IMP/001/911). Network studies undertaken by our design engineers incorporate the diversity assumptions from PV. The customer benefit of diversity is the use of less network infrastructure to supply demand and generation.

Flexibility Services

We expect that as NPg take on the wider role of operating the system through the DNO-DSO transition, we will be able to incorporate further lessons from the **FALCON** project as we look to procure services.

Further to this, we are looking to build on the outcomes from the **Capacity to Customers** pilot project and incorporate these learning points into our own Flexibility strategy later this year. Recognising ENWL's approach in procuring flexibility services 'post-fault', NPg will look to enhance the service it is able to deliver through providing a range of services outlined in the ENA DSO Service Requirements document[1] to deliver a fully comprehensive flexibility service for customers.

Northern Powergrid has taken key learning points and recommendations from the **SoLa Bristol** project and built upon these to deliver further learning in Barnsley on its Distributed Solar and Storage Study (DS3) project where over 40 council owned homes had PV and battery units installed. The key differences that NPg have implemented in the Barnsley project included; developing a more concentrated cluster of PV and behind the meter storage to observe better the impact on the distribution substation, connecting the storage at AC and therefore allowing the project participants to benefit from the Feed in Tariff; operating the storage via a third party aggregator as opposed to the DNO which allows additional future income streams for the battery owner.

The storage findings from the **FALCON** project are broadly similar to those of the CLNR project, although CLNR perhaps went deeper into voltage control, and as such we have implemented with more weight on our own findings.

Given the added restrictions that are expected on many forms of DNO ownership of storage, further implementation from the **FALCON** project is likely to be limited to innovation projects and resilience applications, for example the CLNR battery trading. Micro Resilience, Silent Night and Resilient Homes are new storage related innovation projects that build on the learning from projects like **FALCON** and CLNR.

The **FALCON** project proved the technical viability of flexibility services, which given firm/unfirm supplies have existed for some decades was to be expected. It went further to show that there was a commercial case other than simply at the time of connection.

Beyond our own testing of DSR in projects like CLNR, Activating Community Energy and Vehicle to Grid, the need for DSR deployment in BAU has not yet been reached. However, we expect market testing in 2018 to increase readiness and gain a better understanding of the resource availability.

Automated Load Transfer

The **FALCON** project also focussed on methods to reduce customer interruptions (CI) and customer minutes lost (CML). This learning has been adopted and taken forward in the Northern Powergrid deployment of automatic power restoration systems which are providing benefit to customers.

Network Monitoring

The existing practice at NPg has been to take ad hoc readings of load for design purposes. This operational approach has been supported by the conclusions reached in the **Flexible Networks for a Low Carbon Future** project.

[1] To be published shortly by the ENA Open Networks Project

The **Flexible Networks for a Low Carbon Future** project touched on similar issues to the network monitoring approach within CLNR. The project found that there was wide variance in the ratio of assumed headroom to actual headroom, but that with better monitoring there was an average increase of 8% additional capacity. Accessing this additional capacity without overloading the substations that do not have it available is a major driver behind our LV substation monitoring programme.

Regulators

The learning points brought out from the **Flexible Networks for a Low Carbon Future** project backed up our existing voltage control policy (NPg ref: IMP/001/915) and the application guide for HV regulators (NPg ref: IMP/001/915/001).

Protection Relay

The **Flexible Plug & Play** project trialled directional overcurrent protection with a load blinding feature to mitigate the protection problems arising from reverse power flow due to generation. The use of this type of relay is standard policy in NPg so the project confirmed our approach (NPg ref: IMP/001/014). Directional overcurrent protection with load blinding is in operational use within NPg at a small number of sites with reverse power flow due to generation. The benefit of this approach is a reduction in protection costs (of the order of £10k's) compared to the alternative protection solution or even replacement of the power transformer.

Electric vehicle network impact

The work on EV After Diversity Maximum Demand (ADMD) in the **My Electric Avenue** project, on which Northern Powergrid were a partner, echoed the CLNR work and provided additional data points for study, which given the number of EVs in use at the time was desirable. In conjunction with CLNR data, this work has been taken forward to facilitate our economic development of LV networks with both the **My Electric Avenue** and **Low Voltage Network Template** projects feeding into the review and update of engineering recommendation P5 (the national standard informing design policy for electrical networks feeding housing developments).

Smart Charging

The smart charging learning points gained from the **My Electric Avenue** project, proved the requirement for such functionality but unfortunately not the exact method trialled. It is not in a place to be taken forward at this time as neither the need nor the method have yet been realised. We are supportive of the further work SSE are doing via the Smart EV project and engaging in the 'network backstop' discussion on accommodating fast roll-outs of electric vehicles.

Project Governance

This **My Electric Avenue** project demonstrated delivery of a LCNF project by a non-DNO on behalf of a DNO. NPg routinely utilise project partners to help deliver NIA project but traditionally we have maintained the project management/coordination role within the projects. In future we could give consideration to outsourcing a whole project for delivery.