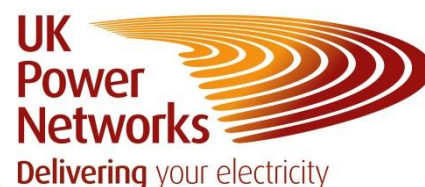


LCNF Second Tier Reward Submission

Flexible Plug and Play

May 2018



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Flexible Plug and Play

Executive Summary

UK Power Networks is proud to present this submission for Flexible Plug and Play (FPP) in the first assessment of the Second Tier Reward (STR) announced by Ofgem for projects which were funded as part of LCNF Tier 2 and have closed down before December 2016.

The project, which was the first example of Active Network Management (ANM) in mainland GB, performed exceptionally during its project lifecycle and has since been fully adopted into business as usual (BAU) processes within UK Power Networks connections teams under the branding Flexible Distributed Generation (FDG). The project unlocked £54.4m of low carbon generation during its lifetime and to date the connection methods developed have unlocked over 322MW of capacity, of which 117MW is operational and the remainder is accepted and offered connections to the electricity distribution network that would otherwise not be financially viable. UK Power Networks is proud to have delivered a project reducing network barriers to low carbon generation connection, supporting the UK's Carbon Plan¹.

FPP was a £9.7m, three year innovation project which closed down at the end of 2014, of which £6.78m was funded from the LCNF Tier 2 mechanism. The project trialed new technologies and commercial arrangements in order to connect more distributed generation (DG), such as wind and solar power, to constrained areas of the electricity distribution network. It has delivered greater flexibility in accommodating more affordable and faster DG connections, as well as enabling previously financially unviable DG schemes to become viable. The FPP project continues to deliver significant benefits for the customers who have contracted to connect using its methods, either during FPP or in the BAU FDG rollout. It also continues to benefit customers who connect using FDG offers, the BAU roll out of the FPP methods. To date, 117.35MW of new connections have been carried out with FPP and FDG methods and another 140MW capacity has accepted flexible connections using these methods and a further 65MW of offers have been issued, meaning a total of capacity has been released using the methods developed in FPP. That is, 322MW would connect over 13,000 homes, equivalent to a town the size of Bury St Edmunds².

With customer benefits at its heart, FPP paid back five times its project cost to customers within its project lifetime, through savings compared to traditional connection costs in constrained areas. We believe this exceptional performance is due to the excellent work of the project team. UK Power Networks has been delighted that FPP received external recognition for its performance in the recent independent Pöyry analysis of the portfolio of LCNF projects³ on behalf of Ofgem. Achieving a maximum score of 100 across the five categories is something to be proud of, and a mark of the exceptional performance of the project in its successful transition to BAU. This submission highlights the exceptional benefits provided by FPP and its subsequent BAU counterpart FDG.

¹ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47621/1358-the-carbon-plan.pdf

² Based on a standard domestic 100A single phase fuse connection and UK household average occupancy of 2.4 persons per house

³ https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

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Project Description and Submission Summary

Flexible Plug and Play (FPP) was a UK Power Networks project delivered between December 2011 and December 2014 by the UK Power Networks Innovation Team. It was partially funded through the LCNF Tier 2 mechanism; additional funding was provided through means noted in Table 1. UK Power Networks funded more than double the compulsory contribution – highlighting the level of support that was given to the project by the company's leaders and the commitment to its success.

Tier 2 Project Name	Flexible Plug and Play
Licensee Project Summary	A project to provide a cost effective and faster method for connecting DG customers onto constrained areas of the network. The project looked at technical and commercial issues to provide a new type of connection offer to customers
Tier 2 funding £k	6,780
Licensee compulsory contribution £k	989
Other contributions £k	External 1,000, UK Power Networks additional 1,002
Link to close down report	Flexible Plug and Play Close Down Report⁴

Table 1: Project Summary

Between 2011 and 2015, there was a 300% rise in enquiries for DG connection requests at UK Power Networks. The rapid increase in volume resulted in a major change to the way that UK Power Networks had traditionally operated. FPP enabled the growth of DG, the majority of it renewable energy, by reducing the cost of connection to the distribution network. The additional low carbon generation it enabled is playing a pivotal role in delivering the UK's Low Carbon Transition Plan targets. The project set out to provide a more cost-efficient and quicker way of connecting DG customers onto constrained areas of the distribution network by combining a technical and commercial solution to offer a new type of connection to customers. It was the first ever scale example of flexible connections using ANM in mainland GB and the project delivered the first practical implementation of allocating curtailment based on shared access via a capacity quota.

ANM connections allow customers to connect in a more cost effective and timely fashion to the distribution network by maximising the use of existing assets rather than reinforcing or upgrading the network. They work by allowing customers to connect to a point on the network, which is close to their generation site with the proviso that when the network is operating under certain constrained conditions, their export capacity could be reduced. This is done automatically by the ANM system developed in FPP.

The FPP project successfully delivered its project objectives and deliverables on time and to budget, along with all of its Successful Delivery Reward Criteria reports (SDRCs) and additional learning documents which are recognised as being best practice by a recent Pöyry report⁵. In doing so, it proved for the first time that flexible connections are a commercially viable alternative to conventional connection offers. As part of the project, 15 customers accepted flexible connection requests resulting in 54.4MW of DG connecting to the network that would otherwise not have been financially viable to do so due to prohibitively high connection

⁴ [http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Flexible-Plug-and-Play-\(FPP\)/Project-Documents/Close-Down-Report_Final.pdf](http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Flexible-Plug-and-Play-(FPP)/Project-Documents/Close-Down-Report_Final.pdf)

⁵ https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

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costs⁶. The project delivered exceptional benefits to customers and the FDG BAU solution continues to do so, delivering £73.5m benefits to customers to date⁷. The project success has seen it expand far beyond the original participants to a much wider audience of customers, who continue to benefit from flexible connection offers. UK Power Networks is hugely proud of the success of FPP and it is credit to the effort of the project team that the project received recognition from a number of external sources; being nominated for five awards and winning two within the project lifetime and since its closedown, as noted later in this submission. As a direct response to the findings and successes of the project, UK Power Networks made the following commitment in the RIIO-ED1 business plan:

“Integrate Flexible Plug and Play connection offers (as per our Low Carbon Network Fund Project) into business as usual by Q2 2015⁸.”

This commitment shows UK Power Networks’ investment into offering flexible connections as a BAU solution which is attributed to FPP’s success in transition to BAU. This commitment to long term use of flexible connection offers mean that the benefits that FPP can provide customers are continuing to be realised, several years after the project closedown, with E6 reporting showing savings of £73.5m by the end of the 2016/17 regulatory year unlocked by using the FDG methodology⁹. The commitment to the BAU rollout goes beyond providing FDG connection offers to new customers, it also includes investment to continually optimise the ANM systems. We continue to use learnings from the project and future rollout areas to develop more efficient methods to manage our networks to support the UK’s low carbon transition.

The solution developed in the FPP project is being deployed to additional areas under the FDG brand, which provides customers a flexible connection offer as designed in the FPP project. It provides a point of connection within the existing network without the need for/or ahead of reinforcement. The solution requires the customer to accept a temporary reduction to their export (curtailment) to ensure the network is kept within operational limits and to ensure the constraint is not breached. Where FDG is referred to in this submission, it refers to the BAU rollout of the flexible connection methods developed in FPP.

FPP is eligible for submission to the Second Tier Reward as its closedown report was published before the December 2016 deadline. This submission outlines the project performance against the set criteria outlined in the guidance for reward submissions. The submission focuses on the exceptional benefits to customers that the project and project learnings have realised, drawing on FPP publications such as SDRCs and progress reports as well as external recognition of the project including the Pöyry analysis of LCNF projects. Both FPP and FDG are considered in this submission, as the solution developed in the FPP project is realising customer benefits under the BAU branding, FDG.

Since the closedown report was published, a number of the quantitative measures used to evaluate the benefit of FPP can be updated and a comparison to elements of Table 8 in the close down report is shown below in Table 2.

⁶ Closedown Report Page 4 Paragraph 5

⁷ [https://www.ukpowernetworks.co.uk/internet/en/about-us/documents/UK POWER NETWORKS%20environment%20report%20v1.0%20PXM&GC%202017-10-27.pdf](https://www.ukpowernetworks.co.uk/internet/en/about-us/documents/UK%20POWER%20NETWORKS%20environment%20report%20v1.0%20PXM&GC%202017-10-27.pdf)

⁸ <https://www.ukpowernetworks.co.uk/internet/en/about-us/documents/6955%20ED1%20report%202017%2010%20INT%20final.pdf?track=ED-final>

⁹ [https://www.ukpowernetworks.co.uk/internet/en/about-us/documents/UK POWER NETWORKS%20environment%20report%20v1.0%20PXM&GC%202017-10-27.pdf](https://www.ukpowernetworks.co.uk/internet/en/about-us/documents/UK%20POWER%20NETWORKS%20environment%20report%20v1.0%20PXM&GC%202017-10-27.pdf)

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Benefit of Solution	Original bid	Closedown Report	End of April 2018	Comment
Capacity enabled by FPP to 2021	188MW	54.4MW	322MW	Conservative - assuming no further generation connects using FDG.
Assumed DG growth by 2021 in UKPN networks	5.4GW Wind	5.4GW Wind 7GW PV	5.4GW Wind 7GW PV 500MW Storage	Forecasts remain similar for wind and solar. Batteries are also now in the mix.
Expected number of FPP-type areas to roll out in the UKPN networks	11	20	42	Reflecting wider rollout across EPN and SPN areas, enabling 2.3GW of additional generation to connect (assuming connected capacity is equivalent to the original FPP area)

Table 2: FPP benefits compared to original submission

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Project Performance against reward criteria

Criterion A

A1 – Aspects of the Carbon Plan and/or Clean Growth Strategy that have been facilitated

During the project lifetime, FPP enabled £54m of low carbon generation projects

At its core, the driver for FPP was to reduce network barriers to connection of low carbon DG projects, in response to the high levels of demand for new DG connections, which saw DG enquiries rise to almost 9,000 in 2015. UK Power Networks is dedicated to supporting the UK's low carbon transition and ensuring that networks act as enablers to low carbon generation projects. To date we have connected 9.07GW of DG across our three license areas and continue to see high levels of interest in connecting new DG.

Network issues the project has proven to solve: As DG connection enquiries increased 300% between 2011 and 2015, network constraints such as thermal and reverse power flow constraints meant connecting new DG became challenging¹⁰. This resulted in less cost effective connection offers which relied on network upgrades or extensive cabling to a less constrained part of the network. For DG connecting customers it is not only a matter of cost but also a matter of time to connect; any delay in connecting to the network is a significant factor when considering the finances of projects and the achievement of the Renewable Obligation Contracts (ROC). Without commercial arrangements and the technical capability of ANM, traditional connection methods were the only available option. FPP enabled the development and demonstration of much needed ground-breaking commercial and technical arrangements. The project proved it was possible to offer a cost effective connection in otherwise constrained areas with an acceptable level of annual constraint of below 8%.

During the project lifetime, the connection offers and ANM methodology developed in FPP enabled £54m worth of low carbon generation, that would not have otherwise connected due to being financially unviable and has since saved customers £73.5m¹¹. In addition to the 54.4MW connected during the project lifecycle and 62.7MW connected to date under the BAU roll out, there is now an additional 140MW of generation which has accepted flexible connections and due to connect using FPP methodology, showing the sustained value and contribution of FPP and its BAU counterpart, FDG.

Facilitating the connection of low carbon generation projects to the distribution network has enabled carbon savings due to reduced carbon associated with electricity generation, which has contributed to the national reduction of 78MTCO₂ generated from power stations between 2011 and 2017¹². The generation connected by flexible connection is generating 187,600MWh per year¹³, saving 32kTCO₂ per year¹⁴, which would be enough electricity to drive an electric vehicle around the circumference of the earth over 30,000 times¹⁵. This major achievement is credit to the hard work from staff across UK Power Networks in

¹⁰ Closedown Report Page 3 Paragraph 8

¹¹ https://www.ukpowernetworks.co.uk/internet/en/about-us/documents/UK_POWER_NETWORKS%20environment%20report%20v1.0%20PXM&GC%202017-10-27.pdf

¹² <https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2017>

¹³ Using capacity generated, generation mix information and typical capacity factors for the generation types

¹⁴ Assuming a UK grid carbon intensity of 170gCO₂/kWh, derived from the data in Footnote 11

¹⁵ Assuming a 40kWh electric vehicle battery equating to a 168mile range and 24,901 mile circumference of the Earth

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connecting a number of new customers, and to the exceptional performance of the project, highlighting the benefits in a wider rollout than initially anticipated. In addition to the carbon savings made by enabling low carbon generation, the reduced need for network reinforcement or distance to traditional point of connection means that carbon associated with electricity network infrastructure – embodied carbon – will be saved through reduced construction of the electricity network. There is no defined methodology for calculating this embodied emissions saving and as such these considerations are not included in our quantitative evidence for this submission but should be considered as additional carbon benefit of the FPP project.

The project has been recognised externally in the areas of low carbon energy and sustainability for its outstanding performance. It won two Low Carbon Innovation Awards for the East of England Energy Group. And it was highlighted in the Pöyry analysis of LCNF projects, receiving the highest mark of any project in the category ‘Accelerated development of a low carbon energy sector’, receiving 5 out of 5. The report states that the project ‘clearly facilitates the connection of low carbon generation or demand. The carbon benefits are credible and quantified’¹⁶. External recognition of the projects success in providing carbon benefits and clean growth highlights the exceptional benefits that the project has delivered.

A2 – Releasing Network Capacity

The methods developed in the FPP project have released network capacity of 322.06MW for low carbon generation.

The network capacity released by flexible connections at UK Power Networks is detailed in Table 3. The project aims of FPP were to develop a method which would release capacity in constrained network areas in a cost effective manner for low carbon generation. The project’s original aim was to publish one connection offer to a customer for feedback, however at the end of the project, over 40 connection offers had been sent to customers. The project demonstrated the method worked in practice as well as theory, releasing capacity within the project lifetime, far sooner than originally anticipated. Success in this area has continued to provide benefit, connecting more DG onto the network more quickly and at lower cost. By the end of the project, 15 customers had accepted their flexible offers representing 54.4MW of DG that had been connected to the distribution network by flexible connections that would otherwise have been not financially viable. As such, the project had not set out to connect customers using FPP, only to provide feedback on the connection offer, the exceptional additional benefits to releasing network capacity is clear.

Capacity Type	Capacity Released (MW)
Connected during FPP Project	54.4MW
Connected as BAU through FDG	62.7MW
Accepted Offers	140MW
Offered Capacity awaiting response	65MW

Table 3: Capacity Released during FPP and FDG rollout

¹⁶ https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

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Since the FPP project close down, the technical solution has enabled a further 62.7MW to be connected, totalling 117.1MW low carbon generation that has connected to the distribution network that would have been financially unavailable without the methodologies developed in FPP¹⁷. In addition to this, there is currently 140MW of generation that has accepted FDG connection offers. In total, flexible connections have unlocked 251.1MW capacity for new DG to connect to the distribution network and an additional 65.5MW of connections offers have been issued and are awaiting customer response. 322MW would be the equivalent capacity of connecting 13,000 new homes to the electricity networks¹⁸. Considering the project objective was to seek feedback on a possible connection offer, we believe this performance to be exceptional. In addition to the successfully opened zones, there are four additional FDG areas planned in our published rollout plans¹⁹, which will continue to unlock capacity in constrained network areas.

A3 – Delivering Financial benefits

The methods developed in the FPP project have saved connecting DG customers £73.5m to date. The project saved these customers £54m during its lifetime – five times the project costs.

UK Power Networks is proud of our track record in delivering innovation projects that save customers money and make the network more efficient, less carbon intensive and safer. Saving customers money was an integral part of the design of flexible connections, instigated in the FPP project, targeting enough savings to progress projects which would have not been financially viable into connected projects. The FPP solution offers customer savings against traditional means of connection – particularly in areas where connection offers would include long cable routes, connecting at a higher voltage level or paying for network reinforcements.

During the project lifetime, the 15 customers who accepted flexible connections saved £54m compared to the alternative traditional BAU offers²⁰. This represents an exceptional return on investment – paying back five times the project costs within the project lifetime. This payback within the project lifetime demonstrates the great solution timing and market need, it also demonstrates strong financial benefits for an innovation project of its size and the fact that methods continue to deliver customer savings to date are a credit to the exceptional project value. The solution savings compared to traditional reinforcement is a benefit which will continue to increase, as the BAU rollout costs continue to reduce.

The FPP solution, under its BAU branding, FDG, continues to save customers money against the cost of traditional connections means. Savings for customers are calculated on a case by case basis. Savings to date using the methods developed during the FPP projects are £73.5m. In our E6 reporting submission, we have reported savings from FPP and FDG in the regulatory years 2014/15, 2015/16 and 2016/17 and will continue to do so as new FDG connections are delivered²¹.

The commitment to saving customers money was recognised externally, with FPP scoring top marks in the ‘potential to deliver net financial benefits to future and/or existing customers’ in the Pöyry analysis of the

¹⁷ <http://futuresmart.ukpowernetworks.co.uk/wp-content/themes/ukpnfuturesmart/assets/pdf/FutureSmart-Consultation-Report.pdf>

¹⁸ Based on a standard domestic 100A single phase fuse connection

¹⁹ <http://futuresmart.ukpowernetworks.co.uk/wp-content/themes/ukpnfuturesmart/assets/pdf/FutureSmart-Consultation-Report.pdf>

²⁰ Closedown Report Page 38 Paragraph 2

²¹ <https://www.ukpowernetworks.co.uk/internet/en/about-us/documents/UKPN%20environment%20report%20v1.0%20PXM&GC%202017-10-27.pdf>

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LCNF portfolio. The definition for this score is ‘*compelling evidence that the project is highly likely to deliver significant financial benefits in the long term (ED2 and beyond) to the majority of customers*’²².

FPP has not only delivered financial benefits to customers – in fact a major benefit of the FPP solution has been reduced time to connect for customers. This is discussed further in the ‘value for money’ section of this submission.

A4 – Rollout across the DNO’s system and across GB

Based on the success of FPP, UK Power Networks is delivering GB’s fastest rollout of flexible connections and services

It is in the rollout across the UK Power Networks distribution area and the successful implementation of flexible connections across the GB network that represents the real success of FPP. Figure 1 shows the areas of the UK Power Networks licence areas that have implemented an FDG connection zone. It can be seen that the adoption of FDGs has been widespread across UK Power Networks. **Ed Cowdery, Chief Executive of energy developer Encor Power, said:** “The permanent opening of flexible connections is a welcome opportunity to connect more generation and storage services, optimising network usage opportunities and resulting in beneficial cost reductions”.

Ahead of the project completing, UK Power Networks began to roll out the FPP connection offers to other zones within our DNO group’s networks, marking the success and benefit that the methodology had proven for both networks and customers. Since project closure, the methods developed in the FPP project have been fully integrated into our BAU connections process. Where areas are identified that ANM would help provide cost effective connection offers to low carbon generation, a scheme is opened and flexible offers are made. Following the success seen during the project, UK Power Networks made and delivered the following commitment in the RIIO-ED1 business plan:

“Integrate Flexible Plug and Play connection offers (as per our Low Carbon Network Fund Project) into business as usual by Q2 2015.”²³

The offering designed in the FPP project is known as Flexible Distributed Generation (FDG) offers in BAU rollout. FDG is an ongoing method of connecting DG across our networks²⁴. There are currently over 20 customers connected across Flexible Distributed Generation zones in total. At present, UK Power Networks is operating six FDG zones as shown in Figure 1. Despite concern in the recent Pöyry report that LCNF projects lack commitment to the uptake of innovation projects to BAU²⁵, FPP and FDG continue to be supported and applied at UK Power Networks. UK Power Networks is dedicated to enabling its networks for flexible connections and is working towards enabling the primary substations across its EPN and SPN networks as shown in Table 4. By the end of 2019 all of our substations in EPN and SPN will be FDG

²² https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

²³ <https://library.ukpowernetworks.co.uk/library/en/RIIO/RIIO-ED1-Commitment-Report/UK+Power+Networks+RIIO-ED1+Business+Plan+Commitment+Report+2015-16.pdf>

²⁴ <https://www.ukpowernetworks.co.uk/internet/en/our-services/list-of-services/electricity-generation/flexible-distributed-generation/>

²⁵ https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

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enabled. The commitment in providing greater coverage of this solution to the rest of our networks shows the benefits that it provides and the success of the FDG rollout.

Network	No. of Substations where FDG connections are available	
	FPP Closedown	April 2018
EPN	30	370
SPN	0	40

Table 4: Network Coverage of FDG

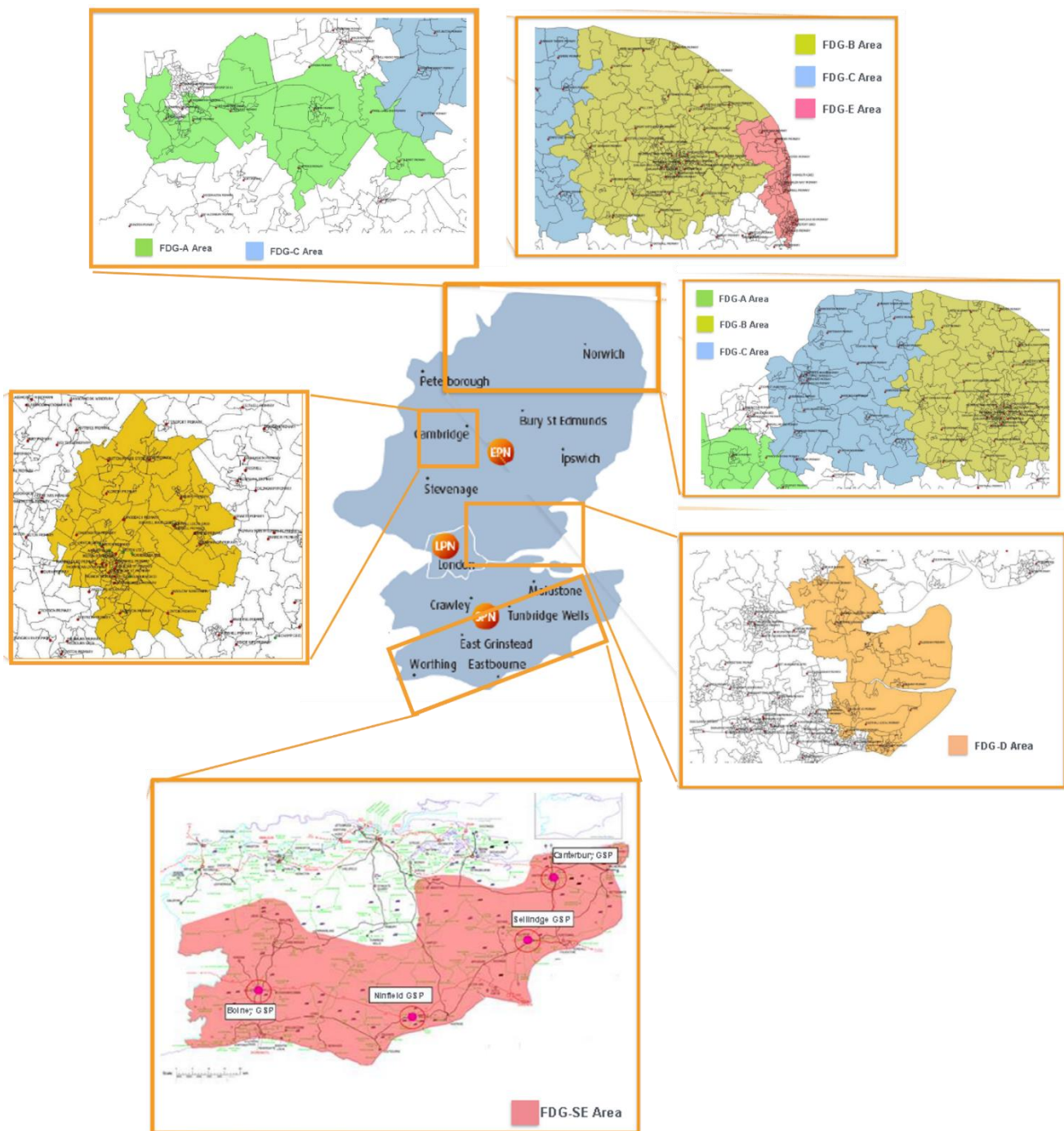


Figure 1: FDG rollout areas 2011-2017

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Not only are there continued connections using the FDG method, there is also commitment to improvement of the methodology and technical solutions. By continuing to invest BAU resources into not only the application but also the advancement of ANM across our networks. UK Power Networks is currently optimising the algorithms used within the ANM solution, which will move to real time assessment of our networks, allowing customers to benefit from reduced curtailment levels from their existing connection offers, which in turn will offer new additional financial benefits for Distributed Energy Resources (DER). As further evidence to the commitment in this FPP solution, we are tendering for a long term vendors, to allow us to continue to provide the technical solution to customers on flexible connections across our network, as ensuring DER curtailment reduction is a key DSO capability.

The benefits of a flexible connections methodology has been widely recognised across the GB network. As the first project to implement ANM using flexible connections in mainland GB, FPP proved the case for wider use across other DNO regions. There are currently six other projects being reported in RIGs E6 benefits tracking tables by other DNOs using flexible connections. FPP's learning and the subsequent learning from providing FDG connections as BAU at UK Power Networks has given confidence for the roll out of the technologies and commercial arrangements and has acted as an enabler for a number of other innovation projects and BAU projects supporting the DSO transition for UK Power Networks and other DNOs, including UK Power Networks' joint project with National Grid SO – Power Potential²⁶.

The learning generated in the project has allowed for a smooth transition to BAU at pace. The Pöyry report highlights that FPP learning reports are regarded as 'benchmark' standards and this is evidenced in the ENA best practice guide, which refers to the work of the FPP project in setting the standards for principles of access²⁷.

The flexible connection methods have now been widely adopted by all GB DNOs. In 2017, Ofgem reported that 3.7GW of connection offers have now been enabled nationally through a combination of flexible connection arrangements and more active management of existing and new capacity²⁸.

A5 – Value for money to customers

FPP delivered all of its milestones on time and under budget alongside exceeding its targets on many deliverables

FPP delivered exceptional benefits to customers under budget and delivered benefits above the project plan in a number of key areas which evidences the value for money from the customer funded innovation funding. Within the project lifetime, FPP delivered savings five times the project cost. In the Pöyry report – FPP scored a 5 out of 5 for 'effective project methodology and effectiveness of implementation' representing value for money for customers²⁹. In addition to complying with all of the objectives outlined in the Project Direction, FPP delivered more than planned, within budget in a number of areas and continues to deliver exceptional benefits to customers.

²⁶ <http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/power-potential/>

²⁷ http://www.energynetworks.org/assets/files/news/publications/1500205_ENA_ANM_report_AW_online.pdf

²⁸ <https://www.ofgem.gov.uk/ofgem-publications/111161>

²⁹ https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

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The project overachieved against its set objectives in a number of key areas while underspending, representing better value for the use of customer money³⁰.

- **Customer recruitment** – project aimed to provide one connection offer and receive feedback – instead 40 connection offers were issued and 15 were accepted.
- **Cost of installation** – reduced by more than 50% due to reducing the complexities of the technological solution³¹.
- **Cost of IT** came in 15% under budget due to website development costs being reduced by good procurement procedures – combining with an internal website rebranding.
- **Learning and Dissemination** costs were delivered under budget. Communication with key stakeholders through the DG owner community was delivered in conjunction with existing methods and events run by UK Power Networks.
- **Decommissioning costs** were 90% under budget due to there being no need to decommission FPP technical infrastructure because customers were satisfied with the connections they had been given.

In addition to the financial benefits for connecting customers through flexible connection offers, customers were able to connect to the distribution network quicker than they would have been able to under traditional connection offers. On average, FPP connected customers saved **29 weeks** in the delivery process of connection³², meaning the benefits associated with distributed generation being live on the electricity network are realised more quickly – benefitting both the customer and the wider UK economy.

A6 – Relevance and Timing of the project

The FPP project was set against a period of extremely high DG connection requests and the uptake of flexible connections shows its relevance

The FPP project was key to facilitating a networks response to the high levels of DG connection requests, driven by UK Government policies to drive low carbon generation. The project outcomes allowed UK Power Networks to support these policies in a cost effective, efficient manner and at pace, adapting to the relevant issues in the energy industry as they presented themselves. The project became the first scaled ANM scheme in mainland GB, dealing with issues of scale and commercial arrangements for ANM that were vital in order to connect DG within timing relating to incentives for low carbon generation, allowing generation to connect in a financially beneficial manner, in good time to meet UK Government ROC deadlines.

For FPP to deliver customer benefits worth five times the project value within its lifetime is a clear indicator of the timely introduction of the innovative solution for low cost low carbon DG connections. The ability to deliver at pace and scale, an project that combined technical and commercial innovations relied on exceptional efforts of the project team and a conducive market environment based on perfect timing, set against a backdrop of high DG connection requests. The project responded to the challenges caused by the

³⁰ [http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Flexible-Plug-and-Play-\(FPP\)/Project-Documents/Close-Down-Report_Final.pdf](http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Flexible-Plug-and-Play-(FPP)/Project-Documents/Close-Down-Report_Final.pdf)

³¹ Closedown report Page 5 - Table

³² Closedown report Page 38

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high connection requests – as such UK Power Networks identified that flexible connections were crucial to trial and implement at this timing.

As outlined in section A4, FPP has shown substantial success not just within the project lifespan but in its transition to BAU – both for UK Power Networks and other DNOs in the GB network. In its position as the first at scale ANM scheme used in mainland GB, it has acted as an enabler for a number of other innovation projects and BAU projects supporting the DSO transition for UK Power Networks and other DNOs, including UK Power Networks' joint project with National Grid – Power Potential, and the successful Kent Active System Management project³³. FPP's learning and the subsequent learning from providing FDG connections as BAU at has given UK Power Networks the confidence to roll out the technologies and commercial arrangements at scale.

Volumes of DG connection requests remain high, UK Power Networks received almost 5,000 DG customer enquiries in 2017, double the levels in 2011, meaning that the BAU rollout of FPP project, FDG, continues to play a vital role in our connections business product range. Customers continue to request information on FDG connections and are interested in new areas which may be planned in the future. The project itself was perfectly timed for DG connection requests, allowing projects to connect under beneficial Renewables Obligation incentive levels with timely and affordable connections. The speed and scale of the BAU transition has been unprecedented and this has been externally recognised in the Pöyry LCNF project analysis ' where FPP scored a 5 out of 5 in the section 'relevance and timing' showing that *'The project has been/is ready to roll out into BAU. Other DNOs have included the project in their business plans'*³⁴. This speed of BAU transition highlights the continued relevance of the project for UK Power Networks and other DNOs. The project was delivered before the development of the ENA ANM Best Practice Guidance and FPP learnings are shown in that report³⁵. The learnings from the first use of new Principles of Access arrangements allowed FPP to provide input to industry wide learning and specifications for roll out of ANM methods to other DNOs across GB.

Additionally to BAU activities, the project learnings continue to be relevant in new business activities, showing particular suitable timing and relevance in the transition from a DNO to a DSO, a change that all DNOs in the GB network are working through. ANM and higher real time visibility of smart networks is a big step in building capabilities which will enable DSO transition. FDG has been highlighted as the first of five key areas in the UK Power Networks DSO strategy³⁶. This commitment to continue the rollout of FDG shows the projects impact on our DSO transition activities. Using customer flexibility has been identified as one of our five key areas for 2017-2018 in our DSO Strategy³⁷.

³³ <http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/kent-active-system-management/>

³⁴ https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

³⁵ http://www.energynetworks.org/assets/files/news/publications/1500205_ENA_ANM_report_AW_online.pdf

³⁶ <http://futuresmart.ukpowernetworks.co.uk/wp-content/themes/ukpnfuturesmart/assets/pdf/FutureSmart-Consultation-Report.pdf>

³⁷ <http://futuresmart.ukpowernetworks.co.uk/wp-content/themes/ukpnfuturesmart/assets/pdf/FutureSmart-Our-DSO-Strategy.pdf>

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A7 – Methodology robustness and project readiness

FPP scored a 5/5 for 'effective project methodology and effectiveness of implementation'- *Pöyry report*

The project team were committed to customers and providing customer benefits throughout the project. The application process was designed to be simple and transparent for customers. The curtailment assessments conducted before offering a connection allowed customers confidence in their connection type. In the Pöyry report, FPP scored a 5 for 'effective project methodology and effectiveness of implementation', an external recognition of the methodology robustness used by the project team to deliver a ready and timely project.

The project team demonstrated flexibility to adapt to the changing scope of FPP outcomes. The team made the most of the opportunity to deliver exceptional benefits by engaging with customers above and beyond the project deliverables in the original bid and project direction. This commitment to achieving the best outcomes for customers enabled the project to deliver 15 accepted customer offers within the project lifetime, as opposed to its original goal of delivering one offer for customer feedback³⁸.

From the outset, UK Power Networks showed commitment to BAU integration of the FPP and this drove the flexibility in the project to deliver released network capacity during the project lifetime. The project successes were delivered through steady and deliberate planning throughout the project. The project used expert advice in stakeholder engagement (project partner Garrad Hassan) in order to engage early, and this philosophy has been taken through into our roll-out of subsequent areas of flexible connections and involved stakeholder consultation events with developers to gather their feedback before its launch.

It has been exemplified by customers acting as advocates for the project, culminating in one of our customers being willing to be part of our team presenting to the judging panel of the prestigious National Business Awards. Steve Reid, of Boaringhouse, was the first customer to accept a connection offer through FPP and he explained the benefit which the project had brought to their business, not only in financial terms but in terms of the way that the project team had engaged with customers. Customers have presented at two public events we have delivered, allowing other DNOs to hear first-hand from our customers and who in many cases are pursuing renewables projects in other DNO areas also.

A8 – Other benefits

There are a number of additional benefits that the FPP project and FDG rollout have provided:

- **Reduced network asset costs** – by enabling connections that did not require long cable lengths or network reinforcement – which saves costs for connections customers as well as all connection customers due to reduced reinforcement;
- **Support of the growth of the low carbon sector** in the UK, by supporting new and growing companies in the low carbon DG arena; and
- **Supporting the transmission network ancillary services** requirements – by enabling distributed generation on a wide scale in areas where it would otherwise be financially unfeasible.

³⁸ Closedown Report Page 30 Paragraph 3

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Criterion B

B1 – Details and significance of DNOs additional contribution

- The DNO compulsory contribution was 989k, the additional investment from UK Power Networks was £1,002k – this additional investment demonstrates the commitment of UK Power Networks in the solution.
- Over and above the additional financial contribution made throughout the project, investment was made in a number of areas while the project transitioned towards a BAU solution during the project lifetime. The investment was not only financial, but in effort through resource hours from BAU teams invested outside of the project budget. This additional contribution enabled the project to see more learning than expected when originally analysed. There has also been investment in recruitment through BAU roll-out.
- The success of the FPP project was instrumental in restructuring the Asset Management directorate at UK Power Networks, with the creation of the Smart Grid Development Team as a direct result of the performance of the project.
- In the Pöyry report, FPP score a 5 for the section ‘involvement of other parties and external funding’ under the criteria *‘The project involved a wide range of external partners covering the main technical /commercial / stakeholder aspects as applicable. External funding for > 10% of the project was obtained’*³⁹.

B2 – Issues that justified additional contribution

Seeing the necessity of finding a suitable methodology for offering flexible connections for customers wishing to connect in constrained areas, UK Power Networks invested a total of £1,991k in FPP. The investment above and beyond the compulsory contribution can be attributed to the commitment of UK Power Networks to find solutions that will benefit customers, and to the belief in the value of FPP.

- The relevance of the project to the challenges being seen on the electricity network at the time due to the increase in DG meant that UK Power Networks invested above and beyond in the project. The commitment to the project from the outset showed the intention to roll out to BAU as soon as possible.
- The success of the project meant that it achieved far more than its original deliverables. This meant that UK Power Networks invested above and beyond in terms of additional resource, both within the BAU teams and Innovation functions. This extra investment was made to commit to seeing the best results possible from the project and as a sign of the commitment to transitioning the methods to a BAU offering.

³⁹ https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

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B3 – Demonstrable Benefits to Customers

The additional investment and resource focussed on the project allowed for network capacity to be released during the project lifetime, which was over and above the original project goals. During the project, 56MW of capacity was released due to UK Power Networks contributions and FDG has contributed £73.5m of savings to DG customers.

- The additional effort allowed for a quicker transition to BAU – allowing customers to see the benefit of scale from the project at a pace far quicker than would otherwise have been possible. To date, 256MW of capacity has been released and we have a roll out plan to make 100% of the UK Power Networks EPN and SPN licence areas enabled for flexible connection.
- The exceptional achievements outlined in this submission were directly borne from the efforts of the project team as well as the additional resource time spend by BAU teams on the project, enabling its success in delivering financial benefits to customers.

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Criterion C

C1 – Demonstrate where the project has delivered more learning than was expected

FPP delivered learning above and beyond the project ambitions, Pöyry analysis of the LCNF portfolio, FPP scored 5 out of 5 in the section ‘Generates knowledge that can be shared amongst all DNOs’⁴⁰. There have been many examples of the learning generated during the FPP project being above expectations:

- The ANM system was optimised based on learning throughout the project. Aspects of the system were removed due to complexity and this reduced the cost of the systems, making it more accessible and more widely applied in BAU rollout;
- Commitment to continuous improvement of the project – increased optimisation, communications, real time algorithm calculations; and
- The number of stakeholders engaged was above and beyond project expectations. This allowed for greater learning in the project due to the enhanced feedback available on flexible connection offers. E.g. the acceptance of higher curtailment (up to 20%⁴¹) than was expected - meaning that wider rollout was possible.

C2 – Additional learning as a result of exceptional effort of the DNO

Exceptional effort in stakeholder engagement allowed for greater participation and therefore testing of the commercial viability of FPP connections. Without the extensive stakeholder engagement efforts, the benefits of the project would not have been realised to the extent they did, and continue to do so.

- Stakeholders were kept up to date and were given opportunities to feed into the BAU transition plan during the project, in order to gain learning from customers throughout the project.
- When FPP connection offers were seen to be as popular as they were, UK Power Networks showed exceptional commitment to accommodate the extra work required to deliver over 40 connection offers – undertaking extensive assessment work for each case. This additional work required commitment and resource from BAU teams.
- The Connections team at UK Power Networks were able to introduce FDG connection types during the FPP project lifetime – providing an additional connection product to DG customers during an exceptionally busy period of DG connection requests. Despite a period of high demand for connections, the team showed exceptional commitment to the project to maximise the success and therefore the learnings generated.
- The project team met with a number of other DNOs, both within GB and internationally during the project lifecycle to effectively understand the opportunities for wider rollout beyond the UK Power Networks license areas.

C3 – Exceptional capture and dissemination of learning that maximises value for all customers

FPP proved that ANM works in GB and as a result its learning has been shared with the rest of the GB DNO’s and allowed for a rollout of ANM systems across GB. It was therefore vital that the project shared its

⁴⁰ https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

⁴¹ Closedown Report

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wealth of learning in a number of ways. FPP delivered 12 learning reports, eight of which were SDRC's promised within the submission phase. The four additional learning reports were developed by the project team because there was significant learning from the different trials and the detailed documentation and publication of this learning allowed for greater knowledge sharing.

The project identified a number of technical and commercial learning points that have since been applied through the FDG rollout⁴²:

- Customers were willing to accept a higher level of curtailment than had originally been considered;
- The quadrature booster would not be needed at all sites, lowering the cost of rollout per site; and
- The project generated significant learning in designing, testing and operating a Radio Frequency mesh network in a distribution network environment.

The learning and dissemination roadmap for the project was finalised during the first quarter of the project and outlined the detailed plans for knowledge sharing. It ensured that the interested parties benefit from the FPP work and also raised awareness and understanding of the novel business model across the DG community. Specifically, the project produced the following learning events and material during the three years. The learning events were attended by an average audience of 80 which included Ofgem, DECC, DNOs, National Grid and the supply chain. In addition, there were bi-lateral meetings with other DNOs throughout the three years to share key findings that would aid replication. UK Power Networks has held meetings and provided information to Scottish Power, Western Power Distribution and Northern Powergrid⁴³. Since completion, FPP project learning is shared in the ENA ANM Best Practice Guide which has enabled learning to be shared to other DNOs. In addition to the SDRCs and mandatory progress reports submitted to Ofgem as part of the project, a number of other publications were made through FPP learnings, summarised in Table 5 below⁴⁴:

Publication/Dissemination Type	No.	Description
FPP Learning Reports	12	SDRC Learning Reports
University of Cambridge Papers	4	<ol style="list-style-type: none"> 1. Understanding best practice regarding interruptible connections for wind generation: lessons from national and international experience 2. Finding the Optimal Approach for Allocating and Realising Distribution System Capacity: Deciding between Interruptible Connections and Firm DG Connections 3. Distributed Generation: Opportunities for Distribution Network Operators, Society and Generators 4. The role of Distribution Network Operators in promoting cost-effective Distributed Generation: Lessons from the United States for Europe 5. Integrating Distributed Generation: Regulation and Trends in three leading countries

⁴² Closedown report Section 9

⁴³ https://www.ofgem.gov.uk/sites/default/files/docs/2015/05/fpp_sdrc_reward_application_v2.0_pxm_2015-05-01_final_0.pdf

⁴⁴ https://www.ofgem.gov.uk/sites/default/files/docs/2015/05/fpp_sdrc_reward_application_v2.0_pxm_2015-05-01_final_0.pdf

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FPP Learning Events	5	Events were held on commercial arrangements, telecommunications, the quadrature booster, smart connections and a final learning event was also held.
FPP Replication Event	1	Workshop with 12 DG customers to re-visit the commercial and technical solution in order to aid the roll out to BAU
Published Papers	12	Including papers at the CIRED conference, IET conference on power system protection and the Journal of Applied Energy
National and International Speaking Slots	Over 60	Further includes industry fora such as the DG Fora and other events. The FPP project also held regular slots at UK Power Networks' Quarterly DG Customer forums, keeping the wider DG community informed of the progress and developments on the project
Internal Training Activities	Over 50	Internal knowledge dissemination has played a significant role in transferring the knowledge into business-as-usual. The project worked alongside a number of internal departments and stakeholders to both deliver the FPP project activities, but also importantly to transfer and embed all knowledge generated by the project to support and ensure business readiness for delivery of the flexible connections

Table 5: Learning and Dissemination