FLEXIBLE PLUG AND PLAY PROJECT: KEY CONSIDERATIONS FOR NETWORK WIDE ROLL OUT OF ACTIVE NETWORK MANAGEMENT FOR DISTRIBUTED GENERATION CONNECTIONS

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ABSTRACT

The Flexible Plug and Play (FPP) project is a UK demonstration project focused on developing smart solutions for enabling cheaper and faster Distributed Generation (DG) connections in constrained distribution networks. The project started in January 2012 and will run until December 2014.

Flexible or Interruptible connections is the core method developed (and currently being tested) by the FPP project to offer renewable generators new connection agreements using latent capacity in the network, providing acceptable but not guaranteed availability of that capacity.

In order to achieve that, it relies on communication/control technologies and a new commercial framework for allocating, managing and contracting the interruptible capacity. It also requires new skills/tools and process for planning the network and developing the flexible connection offers.

The Flexible Plug and Play project has successfully designed a methodology for offering Flexible connections to distributed generation customers within a 700km^2 trial area in the Eastern Power Networks (EPN) distribution network license area and has contracted eight customers to connect using the technical platform and contracts developed by the project. The actual connections will take place in 2014.

Furthermore, building on the evidence obtained throughout this three year project (both in terms of pull by the DG community/UKPN internal stakeholders and readiness of the solution), **UK Power Networks has committed to incorporate these Flexible (defined as "interruptible" by the FPP project) DG connections as part of its RIIO ED1 Business Plan submission [1]** as an alternative offering to customers.

The purpose of this paper is to provide a brief update on the FPP project and provide an overview of the key activities currently being **undertaken to prepare UK Power Networks for the roll out of the Flexible connections as a standard business solution.**

INTRODUCTION

The UK government is maintaining a strong commitment to renewable energy as part of diverse, low-carbon and secure energy mix as stated in the UK Renewable Energy Roadmap Update 2013 [1]. This is supported by UK's ambitious target for 30% electricity generation from renewable energy by the year 2020.

The Flexible Plug and Play (FPP) project is an innovation initiative looking to address this requirement in the electricity distribution network which was awarded funding by the UK energy regulator OFGEM as part of the Low Carbon Network Fund (LCNF) scheme. It is a nearly £10 million project running from January 2012 to December 2014.

The aim of the FPP project is to facilitate cheaper and faster connection of distributed generation (DG) to the constrained area of the distribution network. This approach involves offering interruptible connections which allow generators to connect to the distribution network without extensive reinforcement that otherwise may be required. Instead, the participating DG customers enter into a commercial agreement with the distribution network operator (DNO) where the DNO can control their output to keep the network within operating limits.

The FPP project is being trialled in a 700km² area across two grid (132kV/33kV) and ten primary (33kV/11kV) in Cambridgeshire in England, UK and has issued interruptible connection offers since March 2013.

This paper briefly discusses the technical and commercial solutions trialled by the project, findings from the trial and outline the key areas DNOs must consider when defining a strategy to deploy interruptible connections for DG as a conventional practice.

THE PROBLEM

Renewable energy projects seeking connections in a constrained part of the network have received expensive

connection offers which make their projects unviable. The high connection costs of these projects are due to the extensive reinforcement works required to mitigate the specific thermal and voltage network constraints regarding each connection. Although these expensive connections represent an unrestricted network access (i.e. firm) solution, generation developers are not in a position to assume these costs.

THE SOLUTION

The technical platform

In order to mitigate these network constraints the project has deployed a technical solution involving a number of smart devices in the network that are centrally and actively managed by a deployed Active Network Management (ANM) system.

The FPP connection is based on a technical platform comprising of a wireless radio frequency mesh communications infrastructure, a real-time deterministic ANM control system for managing multiple generator outputs against multiple constraints and solutions, such as dynamic overhead line rating, which addresses specific network constraints. The technical solution was commissioned in September 2013 [2].

The smart commercial arrangements

While the technical solution delivers the technical capability required to control the generators, suitable commercial and contractual arrangements need to be in place in order to achieve that.

In order to give some certainty to generators as to the level of curtailment they will experience under the actively managed connection, a central component in any commercial proposal will be to provide a clear and predictable set of rules by which generators will be curtailed in the event that a constraint occurs (i.e. principles of access). By modelling the technical characteristics of the grid, using a robust set of assumptions and simulating curtailment under these specified principles of access, generators can then forecast the likely levels of curtailment through time with a reasonable degree of certainty.

The FPP project has offered connections under two different types of principles of access:

1. Last In First Out (LIFO) curtailment is based on a first come first serve principle. Any binding network constraint is resolved by curtailing first the generator who connected last. Although this alternative may not be technically efficient, as it may not connect as many MW as the network could sustain, it does provide certainty to the first developers because they are insulated against greater curtailment caused by the connection of later generation.

2. Pro-Rata curtailment resolves constraints based on each generator's proportional contribution to the restriction. As such, when the limits of the network are reached, curtailment is shared equally amongst all generators that are exporting onto the network in the moment of the constraint.

The FPP project has implemented the pro-rata approach by developing a novel methodology "Capacity Quota" [3] where the network operator guarantees the maximum amount of MW that will connect in a specific network on a shared curtailment basis.

As of March 2014, eight FPP offers had been accepted (total 31.75MW) while 20 offers had been issued (total 71.6MW. The first connection is planned for April 2014 with the rest following through 2014.

Furthermore, building on the evidence obtained throughout this three year project (both in terms of demand by the DG community and readiness of the solution), **UK Power Networks has committed to incorporate these Flexible (defined as "interruptible" by the FPP project) connections as part of its RIIO ED1 Business Plan submission** as an alternative offering to customers.

KEY ROLL-OUT CONSIDERATIONS

In preparation for the business-wide roll out of active network management for DG connections, UK Power Networks is considering all key aspects to ensure that the project, through careful planning, will deliver the necessary benefits to customers and mitigate any risks for the network operator and the customers.

The aim of a roll-out project is to develop a consistent business-wide approach to offering flexible/interruptible connections based on the work that is being undertaken by the pilot project (in this instance the FPP project).

Three key workstream areas need to be considered:

1. **Technical Solutions** – focused on defining robust technical solutions accepted and adopted by the network operators' business
2. **Commercial and Regulatory considerations** Clear and practical commercial framework for offering flexible connections consistently that meets the regulatory requirements.
3. **Organisational Requirements** - Clear business sponsorship and ownership of the new systems and processes, development of new

processes, skills development and training needs.

The roll-out project will introduce new ways of working for UKPN and its customers and will engage a wide number of internal and external stakeholders in the process.

Strong **stakeholder internal and external engagement** will be one of the key success factors to enable a transition that suits both the businesses requirements as well as meets the customers' needs.

The project will built on the key findings and lessons learnt from the FPP work and as such there will be a continuous cycle of input from the existing FPP documentation and team members.

The following section considers the three workstream areas in greater detail.

TECHNICAL SOLUTIONS

The main objective of this workstream is to define the technical scope of the wider roll-out by evaluating the characteristics of different network areas, the technical solution alternatives and proposing the overall technical architecture for implementation at a wider scale.

Defining the network scope for the roll out

This first phase of the project will involve a combination of qualitative and quantitative analysis over the full UK Power Network licence areas to provide clear understanding of the current constraints that limit the distributed generation connection capacity and the costs and benefits of implementing a flexible connections approach to each area.

A set of criteria and a methodology will be developed to determine the rollout zones. The criteria and methodology will include both technical (e.g. capacity headroom on existing substations) and commercial (e.g. connection application activity) parameters and inputs. The first step of the analysis will be a qualitative screening analysis of all possible network sections to be considered for enabling for Flexible DG Connections based on the agreed set of criteria. The outcome of this analysis will be the set of network sections deemed most promising for Flexible Connection 'enabling'.

Quantifying the impact of Flexible Connections

The second step in the analysis will be a quantitative scoping analysis where the screened network sections will be analysed to identify the technical and commercial implications of Flexible Connection enabling (e.g. typical generation curtailment volumes and Flexible Connections infrastructure cost). This will be the critical step that will shape the remainder of the project and will rely heavily on inputs from the UK Power Networks Infrastructure Planning (primarily) and Connections teams.

The main outcome of this task is the evaluation of network areas and the technical and commercial parameters of the relevant Flexible Connection solutions.

Control solution specification

Once the key criteria for identifying Flexible Zones have been determined and roll-out areas selected, the UK Power Networks Flexible Connections Team will assess the control system options to realize Flexible Connections.
A set of approved, standardised control solutions appropriate to the network constraint problems identified. This stage of analysis must outline pros and cons for each control solution, as well as explain the hosting network criteria applicable for each level of control (e.g. required measurements, communications infrastructure)..

Telecommunications strategy and ICT architecture

The output of the analysis of telecommunication and ICT architecture requirements should include the basic communication media and protocol requirements for any of the different control systems proposed by the Technical Solution analysis. This should also include a list of alternative but approved, standard communication solutions to support the selected control solutions. The requirements identified should be met by each communication alternative. The list of alternatives will include potential providers, estimated costs and key differentiating characteristics (including the performance of the control solution that incorporates each communication option).

The main outcome of this task is the specification of the preferred telecoms solutions to support Flexible Connections.

COMMERCIAL AND REGULATORY CONSIDERATIONS

This workstream will determine the commercial and contractual framework to be utilised for the wider business roll-out of Flexible (interruptible) connections.

The following areas need to be considered:

Principles of Access

The main output of this analysis will include a proposed criteria or methodology for implementing the Capacity Quota or LIFO (or any other method) and the agreed process for calculating it.
The trial experience to date has shown that pro-rata allows more generation to be connected at reasonable levels of curtailment. However, the mechanics for applying could be complex depending the nature of the network constraint (and in some instances impractical to apply altogether). Both Last-in-First-Out and Quota approach can be complex to manage at increased volumes and careful planning is required in selecting the preferred approach.

Templates
The purpose of this work will be to identify all necessary legal and commercial documents that are impacted and produce standard templates for their use.
Examples of these are connection offer letters and supporting documentation and Connection Agreement which is the enduring contract between the network operator and the customer.

Ongoing Capacity Management

When offering connections, it is very important to maintain a transparent chronological order of when the customers have requested their connections. This chronological connection application order sets out the priority in which capacity is allocated and also determines the generator's position in the curtailment stack. It is important that a process is in place to enable visibility and tracking of the applied for and contracted capacity and relevant curtailment estimates and agreed rules, tools and management process for maintaining and managing the capacity/curtailment on an ongoing basis both for connected and in application DG customers.

Cost Recovery & Charging Methodology

The definition of a clear and transparent methodology for charging ANM connection costs, that is consistently implementable and within our regulatory obligations. One of the key considerations here is that in many instances the ANM connections included significant elements of computer software and hardware rather than traditional network assets.

ORGANISATIONAL TRANSITION

Finally, a key area of work will be to identify where the key changes to the current processes will be required and determine the key roles, responsibilities and owners of each element of all new processes and systems for offering Flexible DG connections.

The following element should be considered under the organisational transition scope:

- An End-to-End process for offering interruptible connections that will formalise the interactions across all relevant business departments.
- Customer service approach and support – this type of offers involve significant customer interaction post energisation of the connection and as such it is essential to have a customer support structure in place.
- Knowledge transfer and training – ensuring that all key staff and users have been trained to the new methods, systems and processes.
- Stakeholder engagement - Innovation embedment projects fall under the business change project category where all stakeholders play a major role in their success. Having a clear and effective communications and stakeholder engagement strategy will be critical in achieving the project's objectives.

CONCLUSION

This paper has described the Flexible DG Connection solutions trialled in the UK Power Networks FPP project. The FPP project is entering a crucial stage in connecting several generators under new non-firm, flexible arrangements. As this innovative trial deployment of Active Network Management is full realised with the imminent connection of managed generation units, UK Power Networks is committing to and planning the wider roll-out of ANM supported Flexible Connections. The paper has set out the key considerations and processes required to create a 'business as usual' solution from the FPP trial results and this acts as a valuable reference point for other network operators considering ANM roll-out.

REFERENCES

[1] UK Power Networks website, RIIO ED1 Business Plan Executive summary, http://www.ukpowernetworks.co.uk/internet/en/about-us/business-plan/

[2] UK Power Networks, Flexible Plug and Play website, "Technical solution learning report", www.flexibleplugandplay.co.uk, September 2013

[3] UK Power Networks, Flexible Plug and Play website, "Principles of Access learning report", www.flexibleplugandplay.co.uk, December 2012