

CNT2002 Addendum

| <b>Proforma box number/<br/>Spreadsheet</b>   | <b>Where the latest information can be found</b>  |
|---|---|
| Appendix A – Project Costs                    | Response to CN004 provides the underlying calculations supporting the figures presented in the Second Tier Funding Request tab of Appendix A. |
| Appendix A – Direct Benefits                  | Response to CN005 provides the underlying calculations of direct benefits presented in the Direct Benefits tab of Appendix A.                 |
| Appendix A – Net Benefits                     | Response to CN006 provides any underlying calculations supporting the figures presented in the Net Benefits tab of Appendix A.                |
| Box 13 (Successful Delivery Reward criterion) | Response to CN042 provides more evidence on the successful delivery reward criterion.   |
| Appendix A – Direct Benefits                  | Response to CN046 provides the final assessment of the direct benefits associated with the project.   |

# Low Carbon Networks Fund Full Submission Pro-forma

**In completing this proforma DNOs should consider the regulation, governance and administrative processes set out in the LCN Fund Governance Document**

## Section A: Project details

### Project Summary

**Box 1: Please provide details of the Project, the Method and Solution**

#### **Central Networks Low Carbon Hub - Optimising renewable energy resources in Lincolnshire**

##### **THE PROBLEM**

Traditionally the distribution networks have been designed to operate passively. This means that the network is designed with a tapering capacity on the assumption that electricity generation is large scale and centralised, and power flow will be unidirectional from the higher voltage transmission system to the lower voltages of the distribution network. The capacity of network circuits and components is dictated by the maximum demand, the fault level rating and the need to maintain voltages within defined ranges.

When a generator is connected to the distribution network power flow often becomes bidirectional, fault level is increased and voltage control becomes more complex. Conventional design solutions to the resulting changes in fault level, voltage control and capacity are often substantial cost. This can mean that in areas which have abundant renewable energy resources the connection of distributed generation is uneconomical.

Lincolnshire is one such area. It has a rich wind resource which may be under utilised for distributed generation due in part to electricity distribution network connection costs.

##### **THE SOLUTION**

Creating an active smarter design and operation of the network will allow generation to be connected to the distribution network more economically. This will allow the most suitable generation sites to connect to the network.

The Low Carbon Hub solution will develop a distribution network optimised for demand and generation whilst demonstrating solutions to some of the network limitations.

## THE METHODS

The Low Carbon Hub has six project components and these will be trialled together as outlined below:

**1. Network enhancements** – Sections of existing overhead lines will be upgraded within the demonstration area with higher rated conductors to increase the network's capacity to connect DG. This work is in addition to investment already funded through the DPCR5 settlement.

**2. New commercial agreements** – Innovative agreements will be negotiated with DG customers to optimise their output and mitigate network issues (e.g. To deliver reactive power service) using real time network measurements. Potential limitations of the current regulatory framework will be identified.

**3. Dynamic voltage control** – Building on the principles of an existing Innovation Funding Incentive (IFI) project, the 33kV target voltage will be actively varied. This will be done dynamically based on real time measurements of demand and generation. Dynamic voltage control should increase network utilisation whilst maintaining the system voltage within the statutory limits.

**4. 33kV active network ring** – The active ring allows increased control of the 33kV system and network reconfiguration based on real time power flows. Construction of the ring will involve the installation of an additional circuit breaker, a new interconnector and smart grid protection and control.

**5. Flexible AC Transmission System (FACT) Device** – A Flexible AC Transmission system device will enable us to control both network voltage and system harmonics of the active ring. This equipment is not normally deployed on Distribution networks for this purpose. Shunt compensation will be used to generate or absorb reactive power. These highly technical solutions will be designed to increase the amount of distributed generation that can be connected.

**6. Dynamic system ratings** – The Skegness Registered Power Zone delivered innovative connections to offshore wind farms based on dynamic rating of overhead lines. This component will further develop the solution and test new techniques to calculate the network capacity and operating limits based on real time asset data.

## THE PROJECT

The demonstration project will be undertaken on an area of primary network where there has been a history of connection enquiries that our customers tell us haven't proceeded due to high network reinforcement costs. East Lincolnshire has attracted a large number of connection requests but due to a relatively weak network there have only been two connections.

The innovative techniques detailed above will be used together to demonstrate how the network can connect significantly more generation with greatly reduced network reinforcement costs.

## **Box 2: Please provide a description of the Project**

### **Low Carbon Hub description**

The Low Carbon Hub is based around the existing 33kV wood pole overhead lines in East Lincolnshire. This network supplies electricity to homes and business in the areas surrounding Skegness, Alford, Mablethorpe, Ingoldmells and Chapel St Leonards.

Appendix B shows that the grid substation at Skegness supplies nine different primary substations through seven circuits. The Low Carbon Hub will involve four of the primary substations and alter the design or operation of five circuits. The alterations can be viewed through the direct comparison between the Single Line Diagram before and after the network changes. These network alterations along with the operational and commercial aspects of the project will create the opportunity for distributed generators connecting to the network.

The project will directly engage with a number of distributed generators. Project partners will come forward following a workshop explaining the Low Carbon Hub to be hosted by Central Networks. The workshop will invite all distributed generator developers to participate in the Low Carbon Hub with developments of between 3 MW and 30 MW.

Nine of the existing distributed generators who have already applied for network connections have been contacted as part of the project development. All nine are interested in attending the workshop to learn about the opportunities created by the Low Carbon Hub. The Low Carbon Hub could connect upto 110 MW of additional distributed generation.

To ensure the process is fair we will not form any contractual relationships with customers until after the generator workshop. One of the main project aspects is to create a new set of commercial agreements that will provide benefits to generators and network operators. The commercial arrangements will be created in conjunction with all interested customers.

### **What we have already done... (Planning, design and studies)**

Central Networks has recognised that some areas of our network receive more connection enquiries for distributed generation than others, based on the availability of natural resources. The East Lincolnshire region of our distribution network has received a high number of enquiries, mainly from onshore wind developers due to the high average wind speed. Many of the connections create network issues, as the infrastructure was designed for passive electricity flows. Using conventional network reinforcement techniques to reduce the generator effects is inherently costly and our customers inform us this is a factor for not connecting a generator.

Central Networks believes that connecting distributed generation will play a key part in the UK reaching its 2020 targets for generating electricity from renewable sources, and started to look for a new method to connect generation to the network that is more economical by departing from conventional design. The design is a combination of new technologies, new operating procedures and commercial contracts.

The network studies have showed that the amount of generation that can connect to a network is increased if a systematic plan was formed taking into account all the activities in the area.

The design brings together technologies from different areas of the electricity sector and builds on operational principles already demonstrated. Combining all aspects together it has been possible to create an opportunity to connect upto 110MW of distributed generation for much lower cost than the convention alternatives. Power system analysis of the network and protection designs give us confidence the network can be operated in this way, and can be implemented with the funds requested.

#### **What we will do after the award**

After the bid award, Central Networks will appoint a Project Manager (PM) for the Low Carbon Hub. This PM will form the project team and before network construction is started, the following preliminary activities will be carried out:

1. Host a workshop inviting all interested parties to attend, to attract external project collaborators. From the group of interested parties the commercial arrangements will be discussed to determine mutual benefits.
2. Create a number of technical specifications for installing optical fibres and microwave links on network assets.
3. Design the network based on actual generator locations, the current design has been based on previous enquiry locations. The design will be re addressed to determine if it can be optimised for the external collaborators' actual points of connection.
4. Select the FACTs device, based on the output of European Procurement Assessment. The procurement exercise will be used to ensure right supplier is selected.
5. Plan for long lead time items and secure wayleaves and planning permissions for new items.
6. Create the knowledge dissemination tool that will demonstrate to interested parties the activities we are carrying out.

#### **The order in which we will build and test things**

The hub will be delivered in a logical process to allow the project to proceed:

1. Install the microwave links to create communication channels between the substations ready for the network ring and to test the dynamic control voltage algorithm.
2. Delivery 20.1 km of Overhead Lines nominated for rebuild in DPCR5 with the optical fibres.
3. Develop the voltage control algorithm within PowerOn<sup>FUSION</sup> control system.
4. Construct the active ring by installing two ring main units and a new interconnector.
5. Install unit protection scheme to allow the network to be operated as a ring.
6. Install Facts device and commission to support the voltage control.
7. Implement the Dynamic system ratings algorithm within PowerOn<sup>FUSION</sup> control system.

Please see appendix 1 for further details and overall summary of the project

**Box 3: Please outline the changes which you have made to the Project since the Initial Screening Process**

**Does the high level Solution being demonstrated and the high level Method being trialled in the Project remain the same as that contained in your Screening Submission? Yes**

The fundamental aspects of the Low Carbon Hub are the same as detailed in the screening submission. However there have been a number of changes since the Initial Screening Process:

1. Following a more detailed planning exercise, the total project costs have increased from £3m to £3.5m.
2. In the main, the increased project costs are due to greater knowledge management and dissemination aspects within the project.
3. Consequently the LCNF funding request has also increased slightly from £2.7m to £2.8m, the level of cost increases have been offset by the increasing benefits.
4. An external collaborator will be selected for the FACTs device. The collaborator will be determined after a European procurement process.

**Project Costs**

**These should be the same amounts as detailed in the Full Submission Spreadsheet tab entitled 'Second Tier Funding Request' included as Appendix A**

|                                    |  |
|------------------------------------|--|
| <b>Total Project Cost</b>          | £ 3,527,503                                    |
| <b>External Funding</b>            | £30,000 from external an external collaborator |
| <b>DNO Extra Contribution</b>      | £0   |
| <b>DNO Compulsory Contribution</b> | £349,829                                       |
| <b>Second Tier Funding Request</b> | £2,837,629                                     |
| <b>Project Completion date</b>     | 02/2015  |

## Derogations or exemptions

**If awarded funding, will you require a derogation, licence consent or exemption, or any change to the regulatory arrangements in order to undertake the Project or cater for contingencies? No**

**Box 4: If Yes, DNOs must provide a summary of the details of the derogation, licence consent or exemption, or change to the regulatory arrangements required**

Central Networks will not seek any derogations or exceptions for the Low Carbon Hub as we are able to carry out all activities within the existing frameworks.

## Section B: Project Management

**DNOs must provide an organogram outlining roles and responsibilities in the Project and the organisational structure. This must be included as Appendix C.**

**Contact details of DNO Principle Project Manager:**

|                        |  |
|------------------------|--|
| <b>Name and Title:</b> | Philip Bale – Energy Projects Engineer   |
| <b>Telephone:</b>      | 02476184442  |
| <b>Email:</b>          | <a href="mailto:CNUKEnergyProjects@central-networks.co.uk">CNUKEnergyProjects@central-networks.co.uk</a>         |
| <b>Address:</b>        | Central Networks<br>Herald Way<br>Pegasus Business Park<br>East Midlands Airport<br>Castle Donington<br>DE74 2TU |

**Box 5: Please provide details of your Project plan**

DNOs should outline up to ten key milestones associated with their Project.

| Date    | Milestone   |
|---------|---|
| 02/2011 | Host a workshop with distributed generators interested in connecting to the Low Carbon Hub  |
| 06/2011 | Dissemination to other GB DNOs and IDNOs of design recommendations for connecting optical fibres and wireless links to new and existing wood pole overhead power lines              |
| 07/2011 | Dissemination of a new set of commercial arrangements jointly create between generators and the DNO.  |
| 03/2012 | Completion and demonstration of the dynamic voltage control capability implemented within GE PowerOn <sup>Fusion</sup> (Network control system widely used by UK DNOs)              |
| 02/2013 | Completion and demonstration of the dynamic system ratings capability implemented within GE PowerOn <sup>Fusion</sup> (Network control system widely used by UK DNOs)               |
| 07/2013 | Completion of the nominated 20.1km of Overhead Lines that have already been included in the DPCR5 submission to the new Low Carbon Hub standard. (See diagram in Appendix B)        |
| 01/2014 | Installation and commissioning of the Flexible Alternating Current Transmission system (FACTS) device.  |
| 08/2014 | Operation of the 33kV active network ring connecting Alford, Trusthorpe, Chapel St Leonards and Skegness. Creating a network suitable for demonstrating the high penetration of DG. |
| 12/2014 | Completion of the Low Carbon Hub, demonstrating the knowledge from the six project areas  |
| 02/2015 | Dissemination of knowledge to other DNOs, IDNOs and distributed generators.   |

**A full Project plan, presented as a Gantt chart, must be provided as Appendix D:** DNOs must include a month by month breakdown of the activities associated with a Project; milestones, delivery of outputs and deliverables, dependencies, critical path, responsibilities, phases and key decision points.

## Project Budget

**DNOs must complete the Full Submission Spreadsheet tab entitled 'Second Tier Funding Request' and include it within Appendix A**

**Box 6: Please provide a breakdown of your total employment costs for the total Project which you are project managing and highlight where these are funded by, or provided by others**

Total employment costs should include all the costs used for labour, including pensions but excluding Contractors (whose costs are detailed separately). Personnel with the same role can be grouped together

| Staff type  | Total Costs | Person days | Funding   |
|---|-------------|-------------|---|
| Dedicated Project Manager for the Low Carbon Hub activities | £240,640    | 1080        | Funded as part of the DNO Compulsory contribution |
| Trade Staff including Linesperson, Fitters, Jointers        | £79,545     | 357         | LCNF  |
| Construction Project Management                             | £65,730     | 295         | LCNF  |

| Staff type                   | Total Costs | Person days | Funding |
|------------------------------|-------------|-------------|---------|
| Protection and Commissioning | £30,080     | 135         | LCNF    |
| System Design & Commercials  | £27,406     | 123         | LCNF    |
| Communications Engineers     | £2,897      | 13          | LCNF    |

**Box 7: Please outline the main Equipment costs required for the total Project which you are project managing**

| <b>Item description &amp; No. of units</b>              | <b>Function in Project</b>  | <b>Cost per unit</b> | <b>Total Cost</b> | <b>Funding</b> | <b>Direct Benefit</b>   |
|---|---|----------------------|-------------------|----------------|---|
| FACTS Units   | The FACTS device will control voltage variations caused by intermittent generation and varying demand. The reactive power generation will aid the reduction in losses   | £500,000             | £500,000          | LCNF           | By demonstrating enhanced voltage control, significantly more distributed generation can be connected to the distribution network.          |
| 2x 33kv Ring Main Unit                                  | The plant is required to allow increased control of the network during fault conditions.  | £140,000             | £280,000          | LCNF           | Installation to facilitate the FACTS device and the new interconnector. Both reduce losses and increase connection of generation            |
| 4.5 km circuit Overhead line & 0.5 km Underground cable | The network interconnector is required to split the Skegness Alford Chapel St Leonards teed circuit.  | £164,425             | £164,425          | LCNF           | Creates greater thermal capacity allowing greater generation connection, improved network availability for generators.                      |
| 5 x Unit protection schemes                             | The network will have five current differential protected zones. Operating the network as a ring will require the protection to have an increased level of discrimination to ensure a high level of network reliability and safe operation. | £30,000              | £150,000          | LCNF           | Ability to operate the network as a ring, more connected DG with increase network availability, whilst maintaining safe network operations. |

| <b>Item description &amp; No. of units</b> | <b>Function in Project</b>  | <b>Cost per unit</b> | <b>Total Cost</b> | <b>Funding</b> | <b>Direct Benefit</b>   |
|--|---|----------------------|-------------------|----------------|---|
| Filters                                    | Filters will be used to reduce the harmonics created by generators. Network models show the network around the Low Carbon Hub including generators would breach the statutory limits for network harmonics. | £75,600              | £75,600           | LCNF           | Harmonic filtering will allow the connection of generators to the network whilst still complying with mandated engineering standards.                   |
| Overhead Line rebuilds                     | Required to increase the voltage stability on the network, reducing the voltage rise issue created by connecting distributed generation.  | £75,375              | £75,375           | LCNF           | Reduce the network losses through lower network impedance. Increase the thermal rating of the network allowing greater levels of generation to connect. |
| Optical Fibres                             | Installed to provide a reliable communications path for the unit protection schemes.  | £75,600              | £75,600           | LCNF           | Facilitates the network ring, increases the connection generation and provides a greater network availability for generators                            |
| 1x Circuit Breaker                         | Plant required creating an increased level of discrimination, ensuring a high level of network reliability and safe operation.  | £47,000              | £47,000           | LCNF           | Facilitates the network ring, reduces network losses, increases the level of connected generation and the network availability for generators           |

**Box 8: Please outline the Contractor costs required for the total Project which you are project managing**

| <b>Contractor</b>                            | <b>Role in Project</b>  | <b>Funding</b>             | <b>Expected length of contract</b> | <b>Total Cost</b> |
|--|---|----------------------------|------------------------------------|-------------------|
| FACTs provider                               | Combine the FACTs device with the On Load Tap Changer to deliver the best voltage control for the Low Carbon Hub. | Provided by FACTs provider | 2 Months                           | £30,000           |
| Communications network (Fibre and Microwave) | Create a communications network design to allow protection and SCADA data.  | LCNF                       | 3 Months                           | £60,000           |
| Communications network (Fibre and Microwave) | Install the necessary fibre and microwave networks.   | LCNF                       | 8 Months                           | £150,000          |
| Legal  | Assist in creating a new commercial contract between generators and land owners for communication permissions.    | LCNF                       | 3 Months                           | £80,000           |

**Box 9: Payments to users or Customers**

**Please outline the details of any payments you wish to make to users or Customers as part of the Project.**

| <b>Type of user or Customer</b>                            | <b>Payment per User</b> | <b>Total Payment</b> | <b>Funding</b> |
|--|-------------------------|----------------------|----------------|
| Customer payments are not a feature of the Low Carbon Hub. |                         |                      |                |
|  |                         |                      |                |
|  |                         |                      |                |
|  |                         |                      |                |



## Cost over-runs & Unrealised benefit

**Box 11: Please detail any cost over-run you anticipate requiring for the Project and express this as a percentage of the funding you are requesting**

The Low Carbon Hub includes significant network alterations, the majority of these are to the primary network. The Low Carbon Hub detailed budget includes contingency averaging 6.3% across the project aspects; this is to allow for sensible cost variations from the initial desktop design to full project implementation.

Central Networks are therefore comfortable with the default level of cost over run protection.

5 %

**Box 12: Please detail the level of protection required against Direct Benefits in excess of the DNO Compulsory Contribution**

Central Networks seeks the default level of protection against direct benefits.

50%

## Successful Delivery Reward Criteria

### Box 13: Please set out your proposed Successful Delivery Reward Criteria

| Successful Delivery Reward criterion   | Evidence  |
|--|---|
| <p>Dissemination of the knowledge generated by the Low Carbon Hub to other Distribution Network Operators.</p>   | <p>The final project report will detail the systematically captured data, including the project expenditure, operation and future financing model through papers, workshops and conference presentations</p>  |
| <p>Development of a UK technical recommendations for:</p> <ol style="list-style-type: none"> <li>1. Installing optical fibre on existing wood pole OHL</li> <li>2. Installing optical fibre on new wood pole OHL</li> <li>3. Installing microwave or radio links for networks</li> </ol>                           | <p>A set of three comprehensive documents sent to all UK DNOs and IDNOs within the first year of the project. The technical recommendations will provide cost and design for generic OHL designs.</p>   |
| <p>Development and dissemination of a future financial model detailing how future Low Carbon Hub could be created in other suitable network locations without LCN Funding.</p>   | <p>Based on the development cost and lessons learnt from the Low Carbon Hub, evaluate the potential for a future ahead of need development in different network locations.</p>  |
| <p>Development of the FACTS device to control voltage changes, determining if the voltage can be controlled by installing and operating the FACTS device.<br/>Record evidence to ascertain if this improves the quality of supply to demand customers and enables greater network availability for generators.</p> | <p>The demonstration of the FACTS device connected to the network through a site visit and the working control algorithm within PowerOn<sup>FUSION</sup>. The knowledge learnt from this section of the project will be disseminated through a paper.</p> |

| Successful Delivery Reward criterion                               | Evidence  |
|--|---|
| Development of a stronger relationship with distributed generators | Demonstration of an improved relationship with generators involved throughout the Low Carbon Hub trial to ascertain if the trial is delivering an enhanced service. This will be conducted through a telephone survey by an external agency before and after the project commences. |
|  |   |
|  |   |
|  |   |

## Section C – Evaluation Criteria

### Accelerates the development of a low carbon energy sector

#### Box 14: Outline how the Solution accelerates the development of a low carbon energy sector

The Low Carbon Hub will demonstrate how substantial levels of renewable generation can be connected to a primary distribution network. This contributes to the UK Low Carbon Transition Plan target of 30% of electricity being generated from renewable sources by 2020. The Lincolnshire area is rich in renewable resources and has had a high volume of connection enquiries with limited network infrastructure. This makes it an ideal location for an LCNF demonstration, as we understand from customers that network connection is sometimes a preventative factor to distributed generation being installed. As the UK approaches 2020 and other distributed generation technology matures, conventional electricity networks will increasingly prevent suitable sites being developed.

The solution we are trialling delivers the following carbon benefits:

- Accelerates the connection of renewable DG – Novel approaches will enable renewable DG to connect more quickly and at a lower cost than with conventional solutions. This zero carbon generation will reduce the carbon content of the local grid. Generation and demand will be balanced at a local level in real time, minimising the need for imports from the national grid, and occasionally allowing low carbon exports.
- Reduces emitted carbon from technical network losses - By installing the smart grid components visibility of the network will be greatly improved, leading to an increased capability to manage voltage and power factor to reduce losses.
- Reduces the carbon footprint associated with construction activities – A single strategic investment as proposed will eliminate the need for multiple infrastructure projects.

Our prediction for the NPV of deploying the Low Carbon Hub solution across the UK is £2.2bn. This is based on two sites being developed within each distribution licence area; it will be possible to connect upto 1,400 MW of installed distributed generation before 2020 using techniques demonstrated by the Low Carbon Hub. These sites, like the East Lincolnshire area, are otherwise unlikely to be developed due to the cost of conventional network reinforcement.

## **Has the potential to deliver net benefits to existing and/or future customers**

**DNOs must complete the spreadsheet tab 'Net benefits' within the Full Submission Spreadsheet and include as Appendix A.**

**Box 15: Please provide a qualitative account of the net benefits which the Solution has the potential to deliver if rolled out across GB.**

The Low Carbon Hub could be repeated regardless of geographic locations, voltage levels or project scale. This will allow DG customers to cost effectively connect to distribution networks in any part of the UK that would have otherwise required extensive conventional network reinforcement.

### ***Cost***

It has been assumed the future nationwide solution could be delivered for an average cost of £2.4 million per project and that two future projects would be installed per licence area, each connecting an additional 50 MW of generation that couldn't have been previously connected before 2020. The duration and proportionate cost profile applied for each replica is the same as for the trial. The East Lincolnshire Low Carbon Hub will develop the key principles, and include one off expenses not needed to be replicated for future projects.

### ***Carbon Benefits***

The principal carbon benefit is the displacement of centralised fossil fuelled generation by local renewable DG. The carbon benefit calculation assumes a 33% load factor and a lifetime of 25 years for onshore wind generators. Each hub is assumed to have 50MW generation capacity and an output of 147587 MWh. The carbon saved takes the Defra conversion factor for rolling average grid electricity in 2008, converted to currency by the DECC non traded carbon price.

### ***Other Benefits***

The other benefits section assumes that each low carbon hub reduces losses (as described in the 'Direct Benefits' tab) and receives the DPCR5 losses mechanism treatment (£60/MWh). The DPCR5 DG incentive is assumed to continue at the assumed 50MW of generation per hub. Further it is assumed that the generators and FACTS device have a life of 25 years.

The scale of the first low carbon hub is defined by the existing network in the East Lincolnshire area, the level of generation that has requested connection and the network constraints. Creating a network ring at 33kV will combine two existing network circuits. The knowledge generated from the low carbon hub will help to determine the scale of future projects. Connecting a large amount of generation onto the low carbon hub will fully test the principles the low carbon hub.

There are financial benefits that will accrue to Distributed Generators but have not been included in Appendix A, for example the reduced sole use connection costs.

## **Direct Impact on the operation of the Distribution System**

### **Box 16: Explain the way in which the Project/Solution has a Direct Impact on the Distribution System**

This project is focused exclusively around the operation of the distribution network. New operating procedures will be developed and refined. The network will dynamically distribute locally generated power providing key learning on how to operate smart grids with high DG penetrations in real time.

The solutions we are trialling will directly impact the operation of the network through a range of technical, commercial and operational approaches including:

- Increased visibility and control of the 33kV system (e.g. power factor, voltage management and power flows)
- Demonstration of previously unproven high voltage network assets
- Real time management of connected DG and relationship with DG customers
- Operational interface with GBSO

**Generates new knowledge that can be shared amongst all DNOs**  
**Answers to this section should be detailed in boxes 17 to 19**

**Box 17: Explain the new learning which will result from a successful Project**

The Low Carbon Hub will be constructed within a typical rural distribution network. Consequently the hub could be replicated at a large number of locations across the UK. In addition some aspects of the hub, such as the technical standard for installation of communication links on wood pole overhead lines, could be widely used as stand alone applications. The project will bring incremental learning in four key areas.

The hub network design is intended to offer more flexible operation that will allow more generator capacity to connect to a section of network at a lower cost of reinforcement. The project will test the network design in terms of dynamic voltage control, network availability and level of losses. The results will influence network design into the future.

The use of a FACTS device in a distribution network will provide important learning in terms of both operational procedures and effectiveness. Network monitoring will demonstrate the extent to which a FACTS device can moderate the step changes in voltage associated with intermittent generation, improve voltage regulation in coordination with on line tap changers and influence network losses.

Central Networks in conjunction with the generators that connect to the hub will develop commercial agreements that will be different to those traditionally held between DNOs and generators. The agreements will seek to optimise generator export in a way that will minimise network issues, for example by delivering reactive power services. The resultant forms of agreement will provide useful templates for generator connections UK wide.

The project will deploy dynamic voltage control schemes and communications links to support network control and protection. The design of the voltage control schemes and the deployment of optic fibre and wireless communication links on wood pole overhead power lines will both require the development of technical specifications. It is likely that these specifications will form the basis of technical standards which can be adopted across the industry.

The project will incorporate several methods of learning capture. The overall performance of the hub will be assessed by analysis of network data gathered by network transducers. An enhanced level of transducer coverage will give greater visibility of network performance, allowing comparison with modelled forecasts of network behaviour. This will allow robust conclusions on the effectiveness of control schemes and network devices. Learning about the installation of equipment will be captured in method statements, specifications and technical standards. Commercial arrangements will be trialled and best practice will be proposed in agreement templates.

### **Box 18: Outline the arrangements for disseminating learning from the Project**

The learning from this project will be disseminated through a combination of transparency during implementation and formal records such as papers and technical standards.

The project's progress will be captured and displayed on our external web site both through a project gantt chart and photographs displaying physical progress. At regular intervals invitations will be extended to DG customers, Ofgem, other DNOs and other relevant stakeholders to visit and observe the project. It is widely recognised that first hand experience often provides the most powerful learning, and this high level of transparency offers the opportunity to an industry audience to follow the project closely.

Learning from all aspects of the project will be captured systematically. This will include the design, installation and operational stages of the project. This learning will be shared with DNOs and IDNOs through papers, workshops and conference presentations.

A number of technical specifications will be developed to implement the project, in particular relating to the installation of optic fibre and wireless communication links on wood pole overhead power lines and the design of voltage control systems. These specifications will be shared, and are likely to form the basis of technical standards.

The data from enhanced network monitoring will populate a data base with wind speed, generator output and corresponding network conditions. The new software tool will use this data to evaluate network performance against original planning standards. The results of the analysis will be shared with all DNOs, and the software tool will be made available to DNOs to enable them to repeat the analysis for their own networks.

The new features of the contracts with generators taking part in the trial, and their performance in practice, will be shared with other generators, subject to commercial confidentiality.

An assessment will be made of how the hub principle could be implemented without support from the Low Carbon Network Fund. This will be shared with all DNOs. Central Networks expect the results of this assessment to influence our DPCR6 business plan.

**Box 19: Outline the arrangements for Intellectual Property Rights (IPR)**

**Does the Project conform to the default arrangements for IPR?** Yes

No agreements on IPR have been signed at this stage of the project development. Central Networks will seek to enter into agreements which are in keeping with the IP principles set out by Ofgem on 15 April 2010. Early discussions with our bid partners have highlighted some areas which they would wish to discuss in more detail including the definitions of foreground and background IPR, the scope of license grants and warranties.

## **Involvement of External Collaborators and external funding**

**Does the Project involve External Collaborators and/or external funding?** Yes

**Box 20: If you have been unsuccessful in attracting External Collaborators and/or external funding to the Project, please detail your endeavours to do so**

Central Networks has approached two market leaders with the capability of providing a FACTs solution. Significant interest has been shown as they also believe the principles being demonstrated could help stimulate market opportunities. An open market tender is required for the FACTs device procurement to comply with European procurement laws.

The connection of generation to the Low Carbon Hub must be a fair process between new and existing market players. We will hold the generation workshop within 60 days of winning the LCNF funding; this will ensure we capture all interested participants as well as the nine existing market players that have already shown an interest. Holding the generator workshop within the first ten weeks of winning the LCNF funding will ensure generation can be involved in the project at the earliest opportunity.

**Box 21: Where funding is provided by a third party that is not an External Collaborator, DNOs should provide details of the funder. If there is more than one External Funder, details of others can be included as an appendix:**

|   |   |
|---|---|
| <b>Organisation name</b>                | No funding is being provided by a third party |
| <b>Type of organisation</b>             |   |
| <b>Amount of funding</b>                |   |
| <b>Funding arrangements</b>             |   |
| <b>When funds will be provided</b>      |   |
| <b>Conditions of funding</b>            |   |
| <b>Risks/uncertainties</b>              |   |
| <b>Details of contract or agreement</b> |   |

**Box 22: Details of External Collaborators**

DNOs should provide details of the 6 main parties who are collaborating with them on a Project. Details of any further External Collaborators should be included as an appendix.

|  |  |
|--|--|
| <b>Organisation Name</b>                               | <b>FACTs Provider</b>  |
| <b>Relationship to DNO (if any)</b>                    | There is no relationship between the external collaborator and Central Networks  |
| <b>Type of Organisation</b>                            | The external collaborator is an experienced FACTs provider already supplying solutions on UK distribution or transmission networks to allow asynchronous generators to comply with the grid code.  |
| <b>Role in Project</b>                                 | The company will: <ol style="list-style-type: none"> <li>1. Supply the FACTs device and network filters</li> <li>2. Implement the device into the distribution network as part of the dynamic voltage control, allowing the FACTs target voltage to be varied dependent on the network conditions.</li> <li>3. Provide commissioning, operation and maintenance guidance of the device.</li> </ol>                                 |
| <b>Prior experience brought to Project</b>             | Facts devices are unusual for the distribution network and still at the trialling stage. The supplier will have operated in the UK market to allow asynchronous generators to comply with the grid code. This will allow them to adapt the device to control the network voltage to allow an increased level of generation connected to the network and increase the strength of the distribution network.                         |
| <b>Funding</b>   | The Facts provider will develop the operational capabilities for the FACTs dynamic voltage control and then implement into the GE PowerOn network control software, calculated at £30,000.   |
| <b>Contractual relationship</b>                        | Due to European procurement laws, we will conduct a full market evaluation post award.   |
| <b>External Collaborator benefits from the Project</b> | The FACTs provider will develop the capability to strengthen the distribution network to facilitate distributed generation. The FACTs provider can develop and demonstrate their control capabilities to be suitable for distribution network control.<br><br>Facts providers feel this will help stimulate a new market for them, demonstrating this capability of combining a FACTs unit and the existing OLTC through the LCNF. |

|   |  |
|---|--|
| <b>Organisation Name</b>                                    |  |
| <b>Relationship to DNO<br/>(if any)</b>                     |  |
| <b>Type of<br/>Organisation</b>                             |  |
| <b>Role in Project</b>                                      |  |
| <b>Prior experience<br/>brought to Project</b>              |  |
| <b>Funding</b>  |  |
| <b>Contractual<br/>relationship</b>                         |  |
| <b>How funding relates<br/>to benefits from<br/>Project</b> |  |

|   |  |
|---|--|
| <b>Organisation Name</b>                                    |  |
| <b>Relationship to DNO<br/>(if any)</b>                     |  |
| <b>Type of<br/>Organisation</b>                             |  |
| <b>Role in Project</b>                                      |  |
| <b>Prior experience<br/>brought to Project</b>              |  |
| <b>Funding</b>  |  |
| <b>Contractual<br/>relationship</b>                         |  |
| <b>How funding relates<br/>to benefits from<br/>Project</b> |  |

|   |  |
|---|--|
| <b>Organisation Name</b>                                    |  |
| <b>Relationship to DNO<br/>(if any)</b>                     |  |
| <b>Type of<br/>Organisation</b>                             |  |
| <b>Role in Project</b>                                      |  |
| <b>Prior experience<br/>brought to Project</b>              |  |
| <b>Funding</b>  |  |
| <b>Contractual<br/>relationship</b>                         |  |
| <b>How funding relates<br/>to benefits from<br/>Project</b> |  |

|   |  |
|---|--|
| <b>Organisation Name</b>                                    |  |
| <b>Relationship to DNO<br/>(if any)</b>                     |  |
| <b>Type of<br/>Organisation</b>                             |  |
| <b>Role in Project</b>                                      |  |
| <b>Prior experience<br/>brought to Project</b>              |  |
| <b>Funding</b>  |  |
| <b>Contractual<br/>relationship</b>                         |  |
| <b>How funding relates<br/>to benefits from<br/>Project</b> |  |

|   |  |
|---|--|
| <b>Organisation Name</b>                                    |  |
| <b>Relationship to DNO<br/>(if any)</b>                     |  |
| <b>Type of<br/>Organisation</b>                             |  |
| <b>Role in Project</b>                                      |  |
| <b>Prior experience<br/>brought to Project</b>              |  |
| <b>Funding</b>  |  |
| <b>Contractual<br/>relationship</b>                         |  |
| <b>How funding relates<br/>to benefits from<br/>Project</b> |  |

## **Box 23: Other partners**

### ***Distributed Generators***

Nine renewable energy developers who have already applied for generation points of connection in the Lincolnshire area have been approached to determine the extent of their interest in the principles being demonstrated by the Low Carbon Hub and they are all interested in knowing more. These generators will be invited to the generator workshop along with all other interested parties.

### ***Local Authority***

Central Networks has worked with East Lindsey District Council to ensure the project helps facilitate the delivery of their renewable generation targets.

Central Networks has also worked with East Midlands Development Agency (EMDA) to coordinate their regional targets for generating more energy from renewable sources with the Low Carbon Hub. We will continue to work with EMDA and its successor organisation during the delivery phase.

### ***Technical Partners***

We have worked with Fundamentals Ltd to develop the Automatic Voltage Control at Skegness under an OFGEM Innovative Funding Incentive project. Fundamentals share our view that an ability to vary the network voltage based on real network conditions is the next transition for smarter networks with increased levels of distributed generation. Please see appendix 2 for a letter of support from Fundamentals Ltd.

## Relevance & Timing of Project

### Box 24: Please outline why the learning from the Project is relevant to Network Operators

2020 targets for renewable energy imply that the level of generation connected to networks before the end of DPCR6 will have to increase significantly. Any constraints on distribution networks which might restrict generator connections could prevent the UK from reaching its targets. The cost of generator connections is based on the point of connection and the amount of upstream reinforcement required. If successful, the techniques used in the demonstration project could be applied to any DNO's network. They will be used to provide a point of connection closer to the generator and require less upstream reinforcement. Reducing the cost of generator connections will reduce barriers to achieving renewable energy targets and aid the move to a low carbon economy.

If the methods used in the trial are successful then, in general terms, a higher level of generation will be able to connect to a given piece of network at lower cost than if conventional network designs were used.

The knowledge gained by operating the network will include better understanding of generator availability and load factor. This knowledge can be used to review security of supply standards and in particular the contribution that can be made by intermittent generation, in terms of voltage control and load growth.

The successful trial would open the possibility to future collaboration between generators and network operators, helping to develop suitable network locations to provide value for money and facilitate more generation connections, of mutual benefit.

Both of these factors would be reflected in business plans for future price controls. Plans for network reinforcement are in part driven by the security of supply standard, and recognition of an increased contribution by generation may reduce the need for network reinforcement. Collaboration with generators to develop suitable locations may give rise to some investment ahead of need, or at any rate projects with a different business case to those put forward in DPCR5, and these would be reflected in DPCR6 business plans.

## **Demonstration of a robust methodology and that the Project is ready to implement (answers should be detailed in boxes 25 to 27)**

### **Box 25: Please demonstrate that the Project has a robust methodology and can start in a timely manner**

Central Networks has received a number of enquiries from generator developers for connections in the East Lincolnshire area in recent years. The Low Carbon Hub concept has been developed over a similar timespan. The project was first scoped in 2009 and has evolved further over the last twelve months. A significant amount of design work has been carried out based on generator locations as per the previous enquiries. Consequently the network design and protection requirements are well developed and ready for the trial.

Rebuilding the 20.1km of overhead lines to a conventional design is already included in the Central Networks DPCR5 business plan and work programme. The implementation of the modified overhead line design for the trial can be readily accommodated without disrupting the work programme.

The project plan takes into account the aspects of the trial with long lead times to which we cannot formally commit until the project has been awarded. We are ready to commence immediately other aspects with shorter lead times.

Stakeholders including generator developers and the local authority have been consulted and are aware of the scope of the trial. They are ready for further engagement as the trial progresses to implementation.

The costs for the trial have been estimated using two approaches. For those elements of the project that relate to conventional network activities the same unit costs have been used as those allowed by Ofgem in DPCR5 Final Proposals. For products and services that are not standard to Central Networks' normal operations budget quotes have been obtained from contractors and suppliers. In combination the two approaches represent a robust cost estimate. The submitted costs cover the network alterations shown on the single line diagram and protection document. Post award, the network alterations will be reviewed to identify any further efficiencies.

The benefits that Central Networks derives from the project are in the form of reduced losses and revenue from the DG Incentive.

The reduction in losses has been calculated by modelling actual hourly load data from May 2009 to May 2010 against the existing network and proposed network and taking the difference between the two. The losses reduction from the installation of a 20.1km of lower impedance conductor and a new 5.1km interconnector can be modelled with a high level of confidence. The losses reduction as a result of using the FACTS device and the generator output can be modelled with a lower degree of confidence as a number of assumptions are required. The FACTS device will reduce losses by exporting the reactive power requirements of the hub; it has been assumed the device will operate on average exporting 1MVAR over the lifetime of the unit, but will vary between  $\pm 4$ MVAR. The generator load factor is based on experience of offshore wind generators but applies a 3% reduction to reflect onshore performance.

## **Box 26: Please provide details of the risks associated with the Project**

Central Networks has identified a several risks during the project development stage. Consideration has been given to how these risks could be reduced or mitigated. The project costs have contingency applied averaging 6.3% across all activities to take into account these project risks. The key risks identified are listed below, along with the steps proposed to manage them.

### ***1) The project can not be delivered for the amount of funding requested***

The design of the project has been sufficiently detailed to ensure that the amount requested is sufficient to deliver the Low Carbon Hub; contingency built in where appropriate has created the confidence to request the default arrangements for cost overrun protection.

### ***2) Significant additional network expenditure is required due to unforeseen network scenarios***

The processes for obtaining wayleaves and gaining planning consent are naturally uncertain in terms of duration and outcome. Both could result in increased expenditure if the proposed design, routes or locations are not permitted. The overall project design of the Low Carbon Hub is such that it could still demonstrate the majority of the project aims if the required planning consents or wayleaves were not granted in the way anticipated. This would however change the scale of the project; we are working closely with ELDC to mitigate this risk.

### ***3) There are extensive planning delays involved for either Low Carbon Hub activities or Generators construction***

We are working with DG customers and ELDC to coordinate planning requests.

### ***4) Experimental aspects of the trial do not fully realise the planned benefits***

The experimental sections of the Low Carbon Hub have been demonstrated at a lower Technology Readiness Level (TRL) and through the IFI mechanism. This has given Central Networks the confidence to develop the functions implementing them together in the Low Carbon Hub. Central Networks will be partnering with experts in these sections to reduce the risk. The safe operation of the distribution network will not depend on any of the experimental features.

### ***5) Generators choose not to connect to the network as they are targeting other locations***

One of the reasons the location of the Low Carbon Hub will be in Lincolnshire is due to the high number of connection enquiries and the high cost of connection preventing generators connecting. Nine of the distributed generators that have made connection enquiries have been contacted; all are interested in the project and would like to know more about costs, areas and network constraint. The workshop for generator developers will publicise the potential of the hub to a wider audience to increase the likelihood of connection applications.

### ***6) Generators choose to generate in new locations within East Lincolnshire and request different points of connections.***

The design has been carried out with likely generator locations based on previous enquiries. However the design concept is flexible and some degree of generator location shifting can be readily accommodated.

**Box 27: Please provide details of the risk monitoring procedures you will put in place for the Project**

Central Networks will proactively manage the risks associated with the Low Carbon Hub using existing procedures within the business. The risk management processes, based on project management industry standards, consists of six sequenced stages.

1. Risk Management Planning
2. Risk Identification
3. Qualitative Risk Analysis
4. Risk Response Planning
5. Risk Monitoring and Control
6. Project Closure

The risk process will be continually reviewed by a project board consisting of senior managers, to ensure risks are correctly categorised and the adequate mitigations have been put in place to reduce the risks where possible. This continual improvement should ensure any risks can be reacted to before they become an issue.

The risk will be recorded using the standard documentation.

- Risk Register
- Outage Risk Calculations
- Risk Management Plan
- Risk Management File
- Issues Log
- Project Health Check
- Risk Management Close out Report
- Risk watch reports
- Buddy Reports

These risk management techniques will ensure the Low Carbon Hub can be delivered to time, quality and cost whilst maintaining our high standard of Safety, Health and Environmental management.

## Section D: Appendices

Please list all the appendices you have attached to this pro-forma and outline the information which they provide. Where these appendices support any information provided in the pro-forma, that information should be adequately referenced

|                   |   |
|-------------------|---|
| <b>Appendix A</b> | <b>Full Submission Spreadsheet</b>  |
| <b>Appendix B</b> | <b>Maps and network diagrams</b>  |
| <b>Appendix C</b> | <b>Organogram</b>   |
| <b>Appendix D</b> | <b>Project plan</b>   |
| <b>Appendix E</b> | <b>Information sources referenced in Box 14</b>   |
| <b>Summary</b>    | The Central Networks Low Carbon Hub submission includes two numbered appendices. Appendix 1 is our document to describe our vision for the Low Carbon Hub, and will be distributed to customers and other interested parties who wish to know more about the project. It describes the work that will be carried out by the project. Appendix 2 is a letter of support from Fundamentals Ltd, a technical partner in our bid. |
| <b>Appendix 1</b> | Low Carbon Hub vision   |
| <b>Appendix 2</b> | Letter of support   |
| <b>Appendix 3</b> |   |
| <b>Appendix 4</b> |   |
| <b>Appendix 5</b> |   |
| <b>Appendix 6</b> |   |
| <b>Appendix 7</b> |   |