Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Jan 2014

Project Reference Number

NIA_NGET0132

Project Registration

Project Title

UltraWire

Project Reference Number

NIA_NGET0132

Project Licensee(s)

National Grid Electricity Transmission

Project Start

August 2013

Project Duration

3 years and 11 months

Nominated Project Contact(s)

Fan Li

Project Budget

£2,750,000.00

Summary

The UltraWire project consists of two parts:

The Nano Carbon Enhance Materials (NCEM) consortium, comprising a number of industrial and academic partners is a collaboration forum where knowledge is shared between interested parties in enhanced Nano Carbon materials.

The second part is the Euro FP7 project Ultrawire. This project is aimed at developing a copper nanocarbon composite with significantly improved overall properties, including electrical, thermal and mechanical performances compared with bulk copper. The proposal also aims to develop production process that will be scalable to large volume manufacture.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

This projects describes the scientific development and pilot-fabrication of electrical wire made from ultra conductive copper (Ultrawire), an advanced copper-carbon nano composite material. Wire is the most common form in which copper carries electrical energy today, and this is the most useful form for immediate take-up by the energy industry. The project brings factory processes and science together using leading European copper, cable and manufacturing equipment industries.

Copper nanocarbon composites could form the next generation of conductors, where copper contributes the benefits of electrical conductivity, whereas nanocarbon brings to this composite its low weight, flexibility, mechanical reinforcement and thermal management. Recent breakthrough in the chirality control of carbon nanotubes could contribute significantly to the electrical conductivity of these composite materials beyond the performance achieved by bulk copper conductors. The material and process costs required to achieve improvement of the overall performance of copper based electrical conductors, need to be compatible with large scale conductor manufacturing and overcome the issues such as the cost of the nanocarbons and the difficulty of scaling up the

production processes.

Method(s)

Research

- WP1 - Synthesis & Characterisation of nano-structures Carbon
- WP2 - Electrolytic Plating of Copper on to nano-carbon fibre yarn
- WP3 - Synthesis & Characterisation of nano-structured Cu-C composites using continuous casting method.
- WP4 - Production & Characterisation of nano-structured carbon-copper composite wire.
- WP5 - Joining of Nano-structured carbon-copper composite wire.
- WP6 - Applications of Nano structured copper composite conductors.
- WP7 - Recycling of Nanocarbon containing copper.
- WP8 - Pilot plant planning and industrial implementation.
- WP9 - Safety & Risk
- WP10 - Exploitation & Dissemination
- WP11 - Project Coordination and Management

Scope

The UltraWire project consists of two parts.

The Nano Carbon Enhance Materials (NCEM) consortium, comprising a number of industrial and academic partners is a collaboration forum where knowledge is shared between interested parties in enhanced Nano Carbon materials.

The second part is the Euro FP7 project Ultrawire. This project is aimed at developing a copper nanocarbon composite with significantly improved overall properties, including electrical, thermal and mechanical performances compared with bulk copper. The proposal also aims to develop production process that will be scalable to large volume manufacture.

Objective(s)

The ultimate objective of this proposal is to define a pilot process route capable of high volume production of a copper-based conductor wire (UltraWire) with at least 40% improved electrical conductivity and significantly enhanced physical properties for use in the electrical distribution and automotive industries.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The primary success criteria for this project are:

• to test demonstrator UltraWire under conditions required by electrical transmission and automotive specifications

• to identify those joining methods for UltraWire that maintain, as far as possible, the electrical properties across the join and minimises reductions in other physical properties

•to define suitable methods for recycling UltraWire and returning it into the copper processing chain. A further option is to recycle material from either route back into the continuous casting experiments at AGH and determine any loss in electrical conductivity.

• to ensure that all the above methods and processes pose minimal Health & Safety risk from the use of nano-materials.

Project Partners and External Funding

The project partners are: University of Cambridge, Outotec, National Grid, Aurubis, Aalto University, CNT ltd, Nexans, AGH, KME, IOM, PSA Peugeot Citroen, Wieland. External funding amounts to approximately £2.8m.

Potential for New Learning

Electrical conductors are central to all aspects of the electricity system, yet the nature of the conductors used in generators, transmission and distribution lines, transformers and motors has changed little in the last 100 years. The world relies on copper and aluminium for nearly all bulk electrical applications. A conducting material that has higher conductivity, improved mechanical properties

and lighter weight than these conventional conductors would be a game changing development for nearly all aspects of electricity systems. Copper and aluminium have very poor mechanical properties (particularly aluminium), high overall weight, creep/fatigue, resistive losses and significant limitations in current carrying capacity. Copper is much better electrical conductor, however, modern applications show an increasing demand for better heat and electric current carrying capacity at the level beyond copper base materials.

Scale of Project

This project is European wide, encompassing the leading European research organisations in order to achieve optimal progress and application. The UK involvement enables National Grid to steer the research to applications that are of most relevance and potential benefit to electricity transmission network customers.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

This project is being delivered across Europe in parts, but is being co-ordinated in Cambridge.

Revenue Allowed for the RIIO Settlement

Zero

Indicative Total NIA Project Expenditure

£110,000

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

n/a

How the Project has potential to benefit consumer in vulnerable situations:

n/a

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

This materials being developed by the Ultrawire project, if successful, could be implemented into underground cable designs in order to decrease the cost per megawatt of power transmitted. The target conductivity improvement for Ultrawire is 40% higher conductivity than IACS (the International Annealed Copper Standed). This would have a material effect on the cost experienced by the consumer where underground circuits are required.

Please provide a calculation of the expected benefits the Solution

Research project - not required.

Please provide an estimate of how replicable the Method is across GB

This technique could be applied to the new infrastructure projects that utilise underground cables.

Please provide an outline of the costs of rolling out the Method across GB.

This is not applicable to this project. The project will need further development into commercialised products that could be used in new infrastructure projects.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☑ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

- ☐ A specific piece of new equipment (including monitoring, control and communications systems and software)
- ☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven
- ☐ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)
- ☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology
- ☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution
- ☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

n/a

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

The project addresses the following themes, detailed in the National Grid Electricity Transmission Innovation Strategy:

Strategic : New Material and Technologies
Strategic : Long Term Research

- ☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Is the default IPR position being applied?

- ☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

Following a review of the ENA smart portal and National Grid's main innovaiton partners (including Universities and EPRI) National Grid confirm that this work has not been done before.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

n/a

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

n/a

Relevant Foreground IPR

n/a

Data Access Details

n/a

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

n/a

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

n/a

This project has been approved by a senior member of staff

☑ Yes