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## NIA Project Registration and PEA Document

### Date of Submission

Feb 2018

### Project Reference Number

NIA\_SPEN\_1801

## Project Registration

### Project Title

Distributed Ledger Technology-enabled Distribution System Operation (Phase 1)

### Project Reference Number

NIA\_SPEN\_1801

### Project Licensee(s)

SP Energy Networks Distribution

### Project Start

March 2018

### Project Duration

2 years and 1 month

### Nominated Project Contact(s)

James Yu (SPEN), Kate Jones (SSEN,  
kate.l.jones@sse.com), Boris-Emanuel Yazadzhiyan  
(UKPN, Boris.Yazadzhiyan@ukpowernetworks.co.uk)

### Project Budget

£400,000.00

## Summary

This project will investigate the use of Distributed Ledger Technology for smart contracts in Distribution Network Operation.

### Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

## Problem Being Solved

The DSO transition requires the implementation of efficient, neutral market platforms on the electricity networks, enabling a high penetration of distributed generation, flexible loads and energy storage. Co-ordinating these and balancing the network, will require new solutions. Distributed Ledger Technology (DLT), including blockchain, is recognised as a revolutionary approach which is particularly suited to co-ordinating multiple entities in a network, allowing automated contract formation and settlement, and providing security and resilience. In a major report on DLT published in January 2016, the Government Chief Scientist, Sir Mark Walport, sets out how this technology could transform the delivery of public services and boost productivity.

DLT based smart contracts include rules for information exchange, contract formation and value transfer among multiple entities, based on a shared ledger which is easily validated. They could reduce the cost of establishing mutual trust between multiple DER owners and network operators who have agreed to behave in certain ways. DLT could also provide a means to manage electric vehicle charging and the integration of energy storage.

This project, recognising the potential of DLT to enable the DSO transition, addresses the major technical and commercial challenges, including:

- Where DLT applications could be deployed; how they are designed; and how they interact with market participants
- How to define the commercial relationships between all participants, including the need for new channels for the flow of information and market signals
- How the DSOs should make optimal decisions on network operation using smart contracts between DER owners and DSOs, to maintain network balance and resolve contention issues
- What cyber-security attack vectors there are for DLT and how they compare to existing systems architecture
- How DSOs and DERs can have sufficient trust in metering information from each other, while allowing each to retain commercially sensitive and legally protected information
- The IT infrastructure requirements and specifications for each participant
- How to integrate DLT solutions with existing metering systems, network control systems, and power electronic converters

The optimal adoption path to enable co-ordinated, progressive implementation without large, risky step changes

## Method(s)

The proposed project will build upon the success of the pilot research activities funded by EPSRC HubNet ("Blockchain based smart contracts for peer to peer energy trading using the GB smart metering system") and ENCORE ("Feasibility of applying Blockchain and smart contracts technology to distribution grid management in the GB power system") from Cardiff University.

The project aims to create, test and quantify the performance of example agreement mechanisms encoded as DLT based smart contracts for distribution system operation. The project will define rules for interactions between neighbouring system operators (DNO or DSO). Then it will co-ordinate the actions of DERs on a distribution network within the same ownership. Alongside this, a use-case using actual network data, will be developed to allow a DNO/DSO to best employ the defined smart contracts. Finally, the whole system will be implemented and demonstrated in software simulation environment, engaging with stakeholders in the supporting networks to raise the common level of understanding.

## Scope

The project begins with a detailed review of existing distributed ledger technology (such as blockchain) and smart contracts, with particular focus on the energy sector; and a study of their design, deployment and interfaces.

It then proceeds to demonstration software and hardware implementation, in a simulation environment, enabling DNO engineering and commercial staff to gain experience and understanding of DLT applications. This stage will also clarify and demonstrate the IT requirements for each kind of DLT network node, and the security implications of DLT architecture.

## Objective(s)

The over-arching objective is to investigate the viability of using DLT based smart contracts for distribution network operation, including the potential transition to a system operator role. To do this, the project aims to encode rules for agreement in to DLT based smart contracts. In doing this, the objective is to create knowledge and transfer know-how to the participating networks, and the wider industry, in the arrangement and safe deployment of, and interaction with, DLT based smart contracts. The project also aims to inform network licensees of the commercial and technical potential for DLT enabled smart contracts to be integrated into business as usual practices; and to provide a basis for evaluating commercial offerings. Finally, the project will also inform industry steering groups and governing bodies as to the potential for, as well as any practical limitations of, such technologies to lower the system-wide cost of operation through governance changes.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

- A review is delivered covering DLT platforms, smart contract development and activity in the energy sector, providing clear description of current research landscape in the sector
- Developed, tested and verified the performance of smart contracts encoding rules for DSO-DSO and DSO-DER interactions
- Participating networks gain experience and understanding of DLT applications, and this knowledge is disseminated especially to inform the DSO transition process, through multiple dissemination events
- A study is delivered of the optimal adoption path for DLT solutions within the networks industry

## Project Partners and External Funding

N/A

## Potential for New Learning

- The project has significant potential to create new learning, in particular:
  - Background information relating to the technical feasibility, benefits and drawbacks in usage of DLT based smart contracts for distribution system operation
  - Know-how relating to the architecture and detailed implementation of smart contract systems
  - Understanding of a broad range of potential applications including wayleave, document and asset management, market platforms for peer to peer trading, and balancing services
  - Consideration of information flows required to produce effective decision support algorithms
  - Feasibility for future real application to the UK network including DC links
  - Scalability of DLT technology and mapping out the pathway for Network

## Scale of Project

The project is a small scale evaluation of the potential uses of DLT applications in a controlled environment, as well as an initial implementation of rules and decision algorithms. The initial study and first trials in a controlled environment are a necessary precursor to a further project which may include network trials.

implementation

Increased understanding of DLT systems, enabling well informed assessment of third party vendor products and solutions which are DLT based

### **Technology Readiness at Start**

TRL3 Proof of Concept

### **Technology Readiness at End**

TRL6 Large Scale

### **Geographical Area**

The Licensed area in SPD, SPM, SSEN and UKPN

### **Revenue Allowed for the RIIO Settlement**

N/A

### **Indicative Total NIA Project Expenditure**

£350,000 (Phase 1, review, design and simulation)

## 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 is a knowledge-gathering research project. It is intended to enable subsequent developments that may lead to specific applications which offer financial benefits to customers. SPEN will carry out the detailed design to realise the NET benefits.

#### Please provide a calculation of the expected benefits the Solution

N/A

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

N/A

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

One outcome of the project is a route map for the GB DNOs to adopt DLT applications.

### 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

RIIO-2 Projects

- 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

The demonstration of a viable application to enable a neutral market platform for energy trading, the analysis of rules for smart contract formation, and the experience of testing DLT applications which may have other uses within the DSOs, will enable networks to evaluate those use cases which offer possible business benefits.

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

n/a

- 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.

Currently, there is no blockchain-enabled Distribution system operation available in the UK and Globally.

### 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

The DLT is one of the key innovative technologies identified by the UK government as the key enabler for the society. We have no such a project looking at the operational scenario in the network sector in the UK

### 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

TRL level and the uncertainty of the innovation projects

**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**

while the significant technical advantages can be cited from various academic publications, there is no evidence to prove it. SPEN, SSEN and UKPN are jointly, after consulting with the fellow DNOs to carry out this project and share the learning under ENA

**This project has been approved by a senior member of staff**

Yes