Date of Submission

July 2017

Network Innovation Allowance Project Close Down Report

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Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

Project Progress

Project Title

Alternative Cable Installation Methods (ACIM) – Phase 1 (Feasibility Study)

Project Reference

NIA_SSEPD_0016

Funding Licensee(s)

SHEPD, SEPD

Project Start Date

October 2015

Project Duration

15 Months after change request

Nominated Project Contact(s)

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Scope

The project aims to identify innovative cable installation methods that can reduce the cost of cable installation and increase the length of cables without having a joint. If the project identifies viable technologies, a second NIA project with the actual implementation will be considered.

Phase 1 (Feasibility study)

- Undertake a requirements gathering exercise internally within SSEN
- Work with the standard 'business as usual' cable suppliers to identify the maximum length of cable that can be supplied on the cable drum.
- Appoint an external company to undertake a 'horizon scanning' exercise and identify innovative solutions for cable installation. The company will also support SSEN in the supplier selection process.
- Undertake a procurement exercise in order to identify and select candidate innovative solutions for cable installation.
- Develop a report with recommendations in order to proceed to the design phase
- Undertake site selection and select appropriate installation method(s)
- Agree commercial terms with the parties of the supply chain that will need to be coordinated in order to provide the identified innovative solution(s).
- Arrange with the supply chain (cable installers, cable suppliers, product developers, etc.) the development of the deployment plan of the selected methods (implementation plan, H&S plan) which is expected to include surveys of the candidate site(s).

Objective(s)

- The project will determine whether there are innovative methods for cable installation that have the potential to reduce the cost of the cable installation/ laying exercise and/ or increase the length of cable that can be laid.
- The project will determine whether it is possible to increase the standard cable length and determine what the maximum cable length that can be manufactured and supplied within a drum is.
- The project will determine the construction/ implementation plan for the next phase.

Success Criteria

The project will be considered a success if it determines whether or not there are innovative methods for cable installation that have the potential to reduce costs and/ or install long sections of cable without joints.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

High level summary:

The Alternative Cable Installation Methods (ACIM) Phase 1 project undertook a series of actions in order to identify alternative cable installation methods. Through completion of these actions and upon review by subject matter experts it was determined that only one method warranted further detailed review. This consisted of floating cables in ducts using water.

The project submitted a change request on 26 September 2016 asking for time extension in order to consider the lessons learnt from the selected method and select an appropriate site to design a trial on. As declared within the submitted change request, only sites which are in the early stages of development could be considered for participation in the trial, as the selected method would influence the design of the overall cable installation scheme.

Following the submission of the change request (Sep 2016), a range of sites were investigated and the most suitable sites would only be entering the design stage after the intended innovation project close out date. The identified sites were in the concept stage and therefore they would not be able to facilitate the trial of the innovative cable installation within appropriate timescales.

Therefore, Scottish & Southern Electricity Networks (SSEN) decided to halt the project and focus the efforts on innovation programs that are able to deliver timely results. As a result a change request was submitted to Ofgem in Oct 2016 asking for premature closure.

Problem:

New connections to distributed generation, replacement or reinforcement of underground cable networks are part of the standard operations of network operators. Underground cables could be either directly buried or installed within ducts. Factors such as the characteristics of the asset, rating and the installation/ overlay environment influence the decision of which method is more beneficial to be used.

Commonly, cables are either designed as direct buried assets or as ducted systems, and involve open cut trenches in order to be laid. There are additional business-as-usual cable installation options, such as ploughing and horizontal directional drilling which are well established and are applied to particular environments only.

Open cut trenching, which is the most frequently used method for cable laying, although well understood, presents some drawbacks:

- It is a costly method and causes significant disturbance to the customers.
- In addition, the common limitations placed on DNOs in order to minimize the disturbance of the open-cut trenching and the characteristics of the methods itself (i.e. pulling through a winch) limit the amount of cable that can be installed without joints, which are considered as weak points of the network. Traditional maximum length between joints on 132kV is up to 1km and at lower voltages is commonly up to 500m, although quite frequently due to limitations placed on length of open cut trenches, the cable length without joints is much reduced.
- Finally, traditional open cut trenching requires operation from both ends of the route and such fact increases the cost in cases where it is not technically or economically feasible to construct a receiving pit at the end of

the route.

Performance against scope):

- **Task 1: Requirements Gathering (100% Completed):**
  Requirements were gathered with subject matter experts of SSEN and were used in order to influence the horizon scanning exercise undertaken.

- **Task 2: Maximum cable that can be manufactured within a cable drum (100% Completed):**
  SSEN engaged with three Business As Usual cable manufacturers regarding the maximum cable length that can be manufactured within a drum. Discussions with the cable manufacturers and internal subject matter experts revealed potential benefits and drawbacks of utilizing longer cable lengths.

- **Task 3: Horizon Scanning (100% Completed)**
  An external company was appointed and undertook a Horizon Scanning exercise which looked for innovative cable installation methods. The results of this exercise were combined with the outcomes of task 4 (SSEN procurement) and were reviewed by SSEN subject matter experts.

- **Task 4: SSEN Procurement Exercise (100% Completed)**
  SSEN undertook a procurement exercise aiming to complement task 3 by reaching to the supply chain already known to SSEN. The exercise took the form of a Request for Information (RFI) and concluded in a number of suppliers being considered by SSEN subject matter experts.

- **Task 5: Recommendations Report (100% Completed)**
  SSEN summarized the outcomes of tasks 3 and 4, consulted with SSEN subject matter experts and conclude to a recommendations report outlining which methods warrant further investigation. Only one method was recommended for progression to the design stage.

- **Task 6: Site Selection (50% Completed)**
  A number of sites were considered as part of the site selection. It was concluded that the appropriate sites would need to be in the design stage in order to be considered for utilization of the selected innovative method. Appreciating the timescales which would extend far beyond the project's timescale, it was considered appropriate to halt the project.

- **Task 7: Commercial Terms (0% Completed)**
  Considering the decision to halt the project ahead of selecting sites or designing the next stage, the discussions on commercial terms between the involved parties did not conclude.

- **Task 8: Construction Phase Plan for next stage (0% Completed):**
  Detailed surveys involving desktop reviews and on-site pressure testing (of an installed duct at a target site) took place in order to determine the feasibility of the method. Considering the decision to halt the project, the Construction Phase Plan for the next stage was not concluded.

Performance against the project plan:

The project was on target for being completed on time, after the change request submitted in Sep 2016. Considering the decision to halt the project, not the entire project plan was met.

Performance against the project budget:

The initial NIA allowed budget of the project was £225,000. At the change request submitted to Ofgem on 28/10/2016, the updated budget was £130,000 to account for the premature closure of the project. The actual cost incurred within the project was £111.530. The project has therefore been delivered within budget.

Performance against the project objective (100% Satisfied):

Objective 1: The project will determine whether there are innovative methods for cable installation that have the potential to reduce the cost of the cable installation/ laying exercise and/ or increase the length of cable that can be laid.

The project undertook a thorough market research and approached a number of suppliers offering promising cable laying solutions. Upon review it was concluded that only one method warranted further investigation. This method was based on the principle of floating cables with water into the ducts. Therefore this response to this objective is based on the particular method in reference:

- This method could indeed increase the length of cable that can be installed within a duct. Assuming that the manufacturers can manufacture longer cables and roll them in the drum (confirmed assumption depending on manufacture and cable type) and that the target site allows of operation of greater equipment, this target cable laying method could increase the length of cable that can be installed without joints.
- Analysis undertaken on a target site demonstrated that the financial viability of the method relies on the targeted site (which varies the transportation, storage, handling parameters) and the target cable or voltage level.
- It was concluded that for the 11kV cables, the floating method is not cost effective, while for 33kV is marginally cost effective. Considering the sensitivity of the method to site parameters, it was concluded that even application at 33kV would require a feasibility study on case per case basis.
- It was also concluded that the method can reduce the cable installation costs at 66kV and 132 kV installations where longer cable lengths are commonly installed and thus require a great number of joint bays and significant labor. The drawback is related to the cross bonding arrangements which can negate part or all of the financial benefits associated with the method. Certain cable systems require particular arrangement of connectivity of phases at certain distances for safety purposes. This requirement of cross bonding could negate the possibility of installing greater lengths of cable continuously (without a joint) and thus adversely affect the financial benefits of the innovative method.

The project was able to identify whether there are innovative methods able to reduce the cable laying cost and increase the length of cable that is installed and thus satisfied objective 1.

Objective 2: The project will determine whether it is possible to increase the standard cable length and determine what the maximum cable length that can be manufactured and supplied within a drum is.

As explained earlier, the project engaged with three BAU cable manufacturers and was able to establish what the max cable length that can be manufactured per drum per voltage type (for most commonly used cables) is. Significant variance is observed between different manufacturers, with a worth noting example showing that a manufacturer can provide 1,250m of a target cable type, while a second manufacturer can provide 4,850m of the same cable. The project was able to establish what the max cable length that can be manufactured in one drum is and thus satisfied the objective.

When selection and use is considered, a range of additional factors will need to be considered, including loading of the drum in relation to statutory obligations, capabilities of the target site for storage and handling, cost of equipment for handling of greater drums, route for transporting the cable drum to the site, etc. Despite the range of factors that need to be considered, analysis on per site basis would demonstrate what the most technically feasible and financially viable option is.

Objective 3: The project will determine the construction/ implementation plan for the next phase.

Considering the decision to halt the project, the Construction Phase Plan for the next stage was not concluded.

Performance against the success criteria (100% Satisfied):

Success Criterion: The project will be considered a success if it determines whether or not there are innovative methods for cable installation that have the potential to reduce costs and/ or install long sections of cable without joints.

As discussed earlier, the project identified one method able to install longer sections of cable without joints and has the potential to reduce the cable installation costs. The **success criterion is met**.

Required Modifications to the Planned Approach During the Course of the Project

No changes to the planned approach as declared in the NIA registration document were required. The change request submitted in Oct 2016 asked for premature closure of the project and such closure was implemented.

Lessons Learnt for Future Projects

Recommendations on how the learning from the project could be explored further:

The project made some key conclusions which are outlined in following sections. The outcome of the project will be useful both for network operators who undertake cable laying work and also for the prospective cable laying suppliers who would have visibility of the areas that network operators are looking for innovative solutions.

Recommendations of what form of trialling will be required to move the Method to the next TRL.

As the project was a feasibility study the starting TRL was 3 and the forecasted final one 4. The identified innovative method relying on water floating techniques is expected to have TRL of 5. Installations in other non-UK countries have taken place and a number of examples were provided by the supplier. In order to progress the target solution to TRL 9 the following steps would be required:

- Select site(s) which are in the design stage as this method would inform and dictate the appropriate site design. If the method is used retrospectively, it is not evident that financial savings will materialize.
- Trial the method across a range of scenarios (i.e. terrain under slope, routes with steep angles, long distances, sites involving cross bonding schemes, etc.) in order to determine the technical feasibility.
- Undertake a number of site-specific cost benefit analyses and extrapolate the results in order to make conclusive outcomes regarding the financial viability of the method.

Statement of whether the Project discovered significant problems with the trialed Methods

The method was not tested in the field as it was not part of the project scope. From the feasibility study the following were identified as potential challenges related to the method.

- Required modification to the duct arrangement to the target joint bay positions. Such arrangements reduce partially the financial benefits and increase H&S hazards to the operators. A thorough risk assessment and appropriate mitigation will need to be undertaken in order to ensure safe operations.
- From the pressure testing undertaken it was proven that the target ducts that would allow effective operation of the method would need to be either glued or fused in order to be able to sustain the required water pressure. Such additional cost was factored in the cost benefit analysis undertaken and was proven to result in positive outcomes.
- There are risks related to water leaking to roads or private property. Although such fact was not tested in the field, appropriate mitigation in the form of monitoring or patrolling will need to take place in order to control the consequences. The likelihood is reduced by investing in appropriate duct arrangements.
- The supply chain of such a solution is limited. Considering that such a method will need to influence the design of the scheme, such a method could potentially reduce the number of suppliers that could bid for the work and thus the network operators may not get the most cost effective price.

Comment on the likelihood that the Method will be deployed on a large scale in future.

In order for SSEN to consider network deployment, the method would have to be trialed and proven.

Discussion on the effectiveness of any Research, Development or Demonstration undertaken.

SSEN believes that the undertaken project resulted in a conclusive outcome. Considering that the work undertaken produced conclusive outcomes, the NIA project added value to the network operators and demonstrated effective use of customers' funds.

Key Lessons Learnt from NIA Project

Category 1: Horizon Scanning

No	Lesson Learnt Description	Recommendation
LL1.1	**Market Research & Supply Chain** The horizon scanning exercise undertaken as part of the project looked at the national and international domain	It is recommended that a horizon scanning exercise is undertaken at cases where a

	for innovative cable laying methods. Considering that only one solution was selected as innovative from the horizon scanning, it is concluded that the cable laying sector could attract more interest in order to develop cost effective and technically feasible techniques.	problem statement exists and solutions meeting the need are to be investigated. It is also proven that utilising different channels for reaching a wide ranging supplier base would increase the chances of identifying promising solutions. .
LL1.2	**International Best Practise** Part of the Horizon Scanning was to identify best practices followed in other countries. The majority of the responses revealed that on other countries the traditional cable laying techniques are followed. Engagement with the identified supplier also demonstrated that EU and Asian countries are looking at the floating of cables within ducts.	It is recommended that liaison with the international domain is utilised in order to share best practise and increase the likelihood of identifying promising solutions.

Category 2: Technical and Financial Performance of Cable Floating Method

No	Lesson Learnt Description	Recommendation
LL2.1	**Desktop Technical Evaluation** The project did not undertake field trials and as such they cannot comment on the technical feasibility using field data. However, upon review of background information provided by the supplier, the project was confident that the method could be trialled on the network in order to be proven.	It is recommended to review historic performance ahead of placing an innovative method to the network in order to allow progress on a controlled manner.
LL2.2	**Financial Evaluation** It was concluded that for the 11kV cables, the floating method is not cost effective, while for 33kV is marginally cost effective. Considering the sensitivity of the method to site parameters, it was concluded that even application at 33kV would require a feasibility study on case per case basis. It was also concluded that the method can reduce the cable installation costs at 66kV and 132 kV installations where longer cable lengths are commonly installed and thus require a great number of joint bays and significant labor.	The method would need to be looked at on project by project basis and determine at project level it is financially viable. As the particular method impacts the project design, it will have to be considered at an early stage in order to allow for financial savings to materialize.

Note: The following sections are only required for those Projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

Key Results and Outcomes:

- This method could indeed increase the length of cable that can be installed within a duct. Assuming that the manufacturers can manufacture longer cables and roll them onto the drum (confirmed assumption depending on manufacture and cable type) and that the target site allows for operation of greater equipment, this target cable laying method could increase the length of cable that can be installed without joints.
- Analysis undertaken on a target site demonstrated that the financial viability of the method relies on the

targeted site (which varies the transportation, storage, handling parameters) and the target cable or voltage level.

- It was concluded that for the 11kV cables, the floating method is not cost effective, while for 33kV it is marginally cost effective. Considering the sensitivity of the method to site parameters, it was concluded that even application at 33kV would require a feasibility study on case per case basis.
- It was also concluded that the method can reduce the cable installation costs at 66kV and 132 kV installations where longer cable lengths are commonly installed and thus require a great number of joint bays and significant labor. The drawback is related to the cross bonding arrangements which can negate part or all of the financial benefits associated with the method.

Technology Readiness Levels

As the project was a feasibility study the starting TRL was 3 and the forecasted final one 4. The identified innovative method relying on water floating techniques is expected to have TRL of 5. Installations in other non-UK countries have taken place and a number of examples were provided by the supplier. In order to progress the target solution to TRL 9 the following steps would be required:

- Select site(s) which are in the design stage as this method would inform and dictate the appropriate site design. If the method is used retrospectively, it is not evident that financial savings will materialize.
- Trial the method across a range of scenarios (i.e. terrain under slope, routes with steep angles, long distances, sites involving cross bonding schemes, etc.) in order to determine the technical feasibility.

Undertake a number of site specific cost benefit analyses and extrapolate the results in order to make conclusive outcomes regarding the financial viability of the method

Planned Implementation

SSEN would consider implementation to their network only after the method is trialed and proven in the field.

Other Comments

In the case the readers are interested in further information and lessons learnt, they can email fnp.pmo@sse.com.