SIF Project Registration

Date of Submission

Apr 2022

Project Reference Number

10027585

Project Registration

Project Title

Eye in the Sky - Application of satellite data to improve grid resilience

Project Reference Number

10027585

Project Licensee(s)

National Grid Electricity Transmission

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

box.NG.ETInnovation@nationalgrid.com

Project Budget

£119,105.00

Project Summary

Aim. This project is aimed to investigate new satellite data analytics solutions via remote sensing that can help GB networks to improve understanding of the asset conditions, better allocate resources, prepare, and respond to extreme weather events. The final solution should significantly reduce the requirements for manual ground and aerial based monitoring. This would allow the GB transmission network to be better informed about the network conditions and more reliable while lowering emissions and costs associated with Operation & Maintenance activities. This is closely aligned with the Data and Digitalisation challenge's aim to improve data monitoring, increase efficiency, reliability, security, and resiliency of networks.

The project meets the scope of the competition in following key areas:

1. "How to improve the visibility of infrastructure and assets, for instance new digital infrastructure or novel uses of senor and communications technologies" The proposed solution will improve the visibility of the infrastructure and assets during normal operation as using satellite data that will increase the frequency of the assets surveys compared to current ground based methods.
2. "How novel uses of data and digital platforms can significantly improve network planning, modelling and forecasting capabilities." The satellite data can be improve the response to climate change effects like flooding, heavy rain, snow storm or wildfire and provide warning to the network companies for better planning and resource allocation.

Partners. The energy networks project partners NGET, NGGT and other GB networks will benefit from better visibility of the asset conditions, informed resource allocation in response to extreme weather event and fast event recovery, all it will improve the overall resilience and reliability of the networks. Cranfield University is a research expert in aerospace technologies will provide scientific support about future satellite technology development. Spottitt is a private sector organisation with expertise in satellite data analytics and digital technologies will evaluate available and future technologies that can benefit networks while European Space Agency (ESA) as a data owner will provide access to the satellite data.

Method. The project team will evaluate several potential applications of satellite data analytics for improving grid resilience. The deliverable of the project will include technical feasibility of the application as well as a cost benefit analysis against existing methods. In the future phases of the project the short-listed applications will be developed and tested to reach a sufficient readiness level to be implemented in the business as usual network operations.

Third Party Collaborators

Spotitt Ltd

ESA

Cranfield University

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Context. Energy infrastructure is vulnerable to natural hazards and extreme weather events that are becoming more frequent due to the impacts of climate change. In recent years Great Britain's (GB) electrical network companies reported the declining resiliency margins available to maintain the grid stability, hence the chances of prolonged power outages are continuously increasing. When extreme events like flash flooding, heavy rain, snow storm, wildfire etc. occurs it is difficult to quickly assess the severity of damage using the existing manual inspection/surveying methods. Deploying specialised teams across large affected areas, sometimes in remote locations, incurs significant costs and safety risks for the technical personnel and equipment. Due to these reasons electrical power networks are less resilient to disruptions, faults or damage caused by climate change events, that have not existed when most of the network infrastructure was designed and built.

Problem. To maintain continues grid operation the electrical networks are required to inspect their network regularly for the purpose of power network's condition monitoring, vegetation detection, heat loss, land subsidence, etc. Traditional methods used for inspection include field surveys and airborne surveys conducted by teams travelling "on foot" or by helicopters. The ground-based method is labour-intensive and the helicopter method has a limited detection rate due high costs for frequent surveys across entire network lowering the overall visibility of network assets' conditions.

These existing manual inspection methods of electrical networks can be assisted and partly replaced by the use of remote sensing data available from earth observation satellites. Rapidly developing satellite data technology has a significant potential to enable new monitoring systems and tools. These can be used for direct detection of network damage, and for hazard risk response to enable more efficient deployment of resources.

Solution. The advantages of using remote sensing satellite data for transmission networks can be significant. Firstly, during normal operational time satellite data can be used to aid regular maintenance such as detection of vegetation or bird nests on/around the transmission towers, unauthorised construction, damaged power assets etc. Secondly, during a natural disaster, access to data about the location and effects can allow better and quick resource allocation to increase the resiliency of the power network. Thirdly, satellite data can be used to make predictive models for events that are not considered in the existing models that are based on historic data from pre-climate change era.

Project Approaches And Desired Outcomes

The Big Idea

The proposed project will investigate the potential of using remote sensing data available via satellites to identify cost effective applications that can benefit the networks. New generation of satellites to be launched in the next two years will be able to provide high resolution images and data with a latency as low as two hours. This will significantly improve visibility over the network equipment that could be at risk of damage and/or already damaged due to extreme events like flooding, fire, snowstorm etc.

The feasibility study will focus on investigating solutions in the key areas:

1. Asset condition risk assessment

2. Improved visibility during extreme weather events

3. Network damage assessment after the extreme weather event

Asset condition risk assessment

A range of satellite technology can be used to assess network condition, improve visibility of the network, and make it more resilient against climate change impacts.

- Optical sensors can be used for assessing flood risk, vegetation growth control and species classification, bird's nest detection and any change detection, e.g. unauthorised construction, or security breach.
- Synthetic Aperture Radar (SAR) can be used for any change detection during cloudy days and Persistent Scatterer Interferometric Synthetic Aperture Radar (PSinSAR) for land motion analytics preventing tower and underground cable damage risk.
- Thermal sensors can be used for an excessive heat detection and network losses monitoring.
- Climate and atmospheric sensors can be used in predictive modelling of climate and atmospheric parameters and correlation with network fault data.

Improved response during extreme weather effect

In the time of an extreme weather event satellite data can be used to detect assets that are vulnerable and requiring immediate attention or a need to reconfigure the network to avoid a blackout. This will enable to deploy response resources more efficiently while keeping people informed about hazards and improve the resilience of the network.

Network damage assessment after the extreme weather event

After the event fast analysis of the satellite data can allow to detect any damaged towers or lines and effectively deploy teams where they are needed reducing the recovery time. In addition, any foreign objects (e.g. trees or roof part) appeared inside a substation can be detected thus reducing a risk of a system fault or a fire.

Innovation Justification

Opportunity. The satellite data and associated analytics could become one of the key enabling technology for the efficient energy transition and networks resilience delivering both short and long term. In recent years the satellite technology significantly improved from technical as well economics side opening new opportunities for wider industries, e.g. construction, oil & gas and networks. In a near future new generation of satellites will further improve data resolution and reduce the delay to access data to as low as few hours, from today's 24-48 hours' best performance available for commercial use.

Existing applications. Satellite data technology is widely used for meteorology where it provides essential data to model weather forecast and wider effects of climate change. In military applications satellite data provides essential data to plan operations and support teams on the ground increasing visibility of the battlefield and reduce safety risks. More applications exist for deforestation measurement, greenhouse gas emission detection and other.

There are several existing techniques that use the high-resolution multispectral satellite imaging to produce 3D-steorepic image which is used to detect the vegetation growth/height around transmission and distribution lines. This information support vegetation control decision making while reducing a need for manual survey with helicopters or ground teams.

Existing Research. Satellite data are widely used by the Oil and Gas industry, past NIA projects Satellite Infrastructure Monitoring

(NIA_SGN0150) and High Altitude Aerial Surveillance (NIA_NGGT0064) developed by gas networks demonstrated a strong benefit case for using aerial and satellite data analysis. And it is timely to evaluate opportunities for electrical network applications created by recently available space systems such as the mega-constellations Copernicus capability, small satellite constellations such as Iceye (high-resolution commercial radar) and future planned satellite systems. These create new opportunities for cost-effective monitoring of systems within wide geographic distribution.

Research Gap. Emergency response systems by means of satellite data usable by power network is not currently available. The capability of using satellite data can be considered “mature” in areas like weather modelling. However, there has not yet been any verified solutions that applies the satellite data for network condition monitoring, planning and safety control. There is no known useable tool for the network companies on response to extreme weather events from satellite data and how they can be used for the response readiness. Additionally, there is no early alert system for the power network companies for event like land subsidence or slides.

Project Plans And Milestones

Project Plan And Milestones

The project will be delivered by the following Work-Packages (WPs).

WP1. Technical analysis of the solutions for asset condition risk assessment

Identify the existing available data processing technology available for the purpose of power network monitoring and detection of bird's nest, vegetation growth, unauthorised constructions, sediment build up, security breach, etc. A report outlining the usability of the potential applications and technology gap if it exists to identify what quality and frequency of satellite data is required for the purpose of improving asset risk assessment.

Lead party: Spottitt

Support party: Cranfield University and ESA

Deliverable 1: Technical analysis report of the solutions for asset condition risk assessment

WP2. Technical analysis of the solutions to improve response during extreme weather events and damage assessment

Identify the existing available data processing technology to support decision making by response team during extreme weather event and accelerate damage assessing. Evaluate satellite measurement capability relative to the type of extreme weather events. Consider data processing, especially the developing of AI methods, for identified applications.

Lead party: Spottitt

Support party: Cranfield University and ESA

Deliverable 2: Technical analysis report of the solutions to improve response during extreme weather events and damage assessment

WP3. Cost-benefit analysis of the satellite tools applications

Develop a cost benefit analysis for routine monitoring and response to an extreme event satellite tools applications. The baseline costs will be derived from the past published reports as well as short interviews with companies involved in these operations (e.g. contractors, National Grid or other network experts). The estimated costs for the development and use of satellite data analysis tools will be compared against the current practice costs. Depending on the availability of data, we will aim to calculate risk avoided and savings in carbon emissions and explore how these metrics will impact the cost effectiveness of the proposed solutions.

Lead party: NGET (or subcontracted)

Support party: NGGT, ESA and Spottitt

Deliverable 3: Cost-benefit analysis report of the satellite tools applications

WP4. Future Technology Roadmap

Outline a concept for the operational system considering the cost-benefit analysis. The report will contain a roadmap for short-listed technologies with identified key technical challenges, improvement opportunities and how to progress to the next TRL.

Lead party: NGET (or subcontracted)

Support party: Spottitt, NGGT and Cranfield University

Deliverable 4: Future Technology Roadmap report

Route To Market

Supply Chain Engagement

As part of the Discovery phase, we will evaluate the supply chain to deliver the Satellite data analytics systems. This will include a detailed investigation into the type and quality of data available as well as access costs. In next phases of the SIF funding, the intention is to develop network focused and the most cost-effective solutions to demonstrate effectiveness in real network operation while de-risking future business as usual (BAU) investments. We will be keen to hold a dissemination meeting with Energy Networks Association both to share the findings from the project but also discuss how they can be embedded in day-to-day operations from high voltage to low voltage levels.

Roadmap

A road map will be created for implementing the innovation into BAU. Part of this roadmap will include trialling of the new equipment in live operation during the Beta phase of the project. The programme implications of offline trials, parallel trials and first deployment trials need to be considered (as stated in the National Grid Transmission Policy Statement).

Further factors include:

- Training requirements – the new technology will have operational requirements that operatives will need to become familiar with. Training will be rolled out to the workforce, which incurs costs and time.
- Technology impacts on business processes/systems and data - any impacts will need to be determined during the innovation phase, before implementing the new technology as BAU.
- Avoidance of long term, single supplier dependency; technical assurance and capability - the supply chain will need to be evaluated and deemed competitive with a range of providers.
- Cyber security threats will need to be assessed.
- Post-delivery support agreements (PDSA) and system/asset recovery will need to be established for the new technology.
- The recovery of the costs as part of pricing network reviews will also be investigated.

Wider networks application

The range of proposed technology applications can be, with minimal adoption efforts, utilised on electrical, gas, water, and other networks in the UK and overseas. We anticipate that the tools we develop will be adopted by the GB distribution network operators, subject to the availability of sufficient high-resolution data. We will explore the opportunities to disseminate findings through presenting results at industrial workshops and conferences. Cross industry learning can be shared to improve the solutions performance. The algorithms developed and IP generated can be licensed to commercial service providers and royalties generated returned to consumers.

Costs

Total Project Costs

119105

SIF Funding

119105

This project has been approved by a senior member of staff

☑ Yes