Energy Innovation Basecamp 2024
Problem Statement EIP123

How can we use our existing infrastructure to transmit more power (and avoid reinforcement)?

The following problem statement has been developed by the innovation teams within the UK's Gas and Electricity Networks for the 2024 Energy Innovation Basecamp.

Theme: Maximising Use of Existing Infrastructure

Network Areas: Electricity Transmission, Electricity System Operator

What is the problem?

The existing transmission network is increasingly curtailed due to a limited amount of electrical energy that can be transferred by existing circuits. The cost of curtailment is expected to peak between £1-2.5bn a year by 2025. The majority of curtailed generation from renewable sources is due to positioning at network extremities combined with variable generation.

The current practice relies on long-standing ratings of OHL and substations. SSEN-T are currently working on a strategy for: Active Network Management, Dynamic line rating and revising the current static line rating methodology.

What are we looking for?

We are looking for ideas related to the holistic assessment of integrated system capacity and potential for transmitting more power -

- If we increase the rating of lines, what is the impact on connected equipment?
- Cost-effective methods for uprating existing equipment
- How do modify the substations and switchgear to allow more power to be transmitted?
- New designs for overhead lines
- How do we validate novel materials overhead lines?
- Novel ideas that contribute to our existing projects in DLR, ANM and revised line rating.

What are the constraints?

We already have ongoing projects related to -

- Dynamic Line Rating
- Revised line rating methodology (static line rating)
- Active Network Management to maximise utilisation and reduce spare capacity.

Proposals should be aware of existing projects and should demonstrate how the idea can complement existing projects and build on previous work. We are interested in proposals that remove barriers that prevent previous solutions from becoming BAU (please see below).

Who are the key players?

- Transmission network operator
- ESO/FSO
- Equipment manufacturers
- Ofgem
    - Regulation and codes

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Does this problem statement build on existing or anticipated infrastructure, policy decisions, or previous innovation projects?

Previous projects:

- **Retrofit Insulated Cross Arms (RICA):** By replacing metallic cross arms with insulated cross arms (ICA) the Retrofit ICAs (RICAs) solution through increased clearance to earth will allow licensees to upgrade the voltage rating of existing 275kV towers to operate at 400kV. Retrofit Insulated Cross Arms (RICA) | ENA Innovation Portal (energynetworks.org) also: Composite Cross-Arms Study | ENA Innovation Portal (energynetworks.org) also: 132kV Insulated Composite Crossarm Trial | ENA Innovation Portal (energynetworks.org), also Insulated Composite Crossarm | ENA Innovation Portal (energynetworks.org); also Composite Cross Arms Study | ENA Innovation Portal (energynetworks.org)
- **Overhead Line Sagging Monitoring Using 5G Signals**: All overhead lines in the GB transmission network must maintain statutory clearances to ground. To maintain these clearances the line; sag needs to be monitored. Also, if the line sag can be monitored easily and with great frequency (dynamically), it is possible to provide valuable inputs to the dynamic thermal rating of the overhead line. Current methods use either sensors installed on the line to directly measure temperature/sag or weather stations nearby to indirectly calculate temperature/sag. This project aims to design a new method by exploiting the fifth generation (5G) cellular signals to directly monitor and measure the line sagging but without sensor installation on the line. Overhead Line Sagging Monitoring Using 5G Signals | ENA Innovation Portal (energynetworks.org)
- **Hydrogen Production for Thermal Electricity Constraints Management:** Thermal constraints are forecast to cost consumers between £500m and £3b a year between now and 2030, owing to an increase in renewable generation and a lack of capacity on the transmission system to transfer power from where it generated to where it is used. Hydrogen Production for Thermal Electricity Constraints Management | ENA Innovation Portal (energynetworks.org)
- **Analysis of the Thermal Influence of Cable Surroundings (AnTICs):** The power flow capacity of high voltage cables is limited by the heat dissipation ability of their immediate surrounding environment. However, despite the large number of projects built in the past, the surrounding environment's thermal properties are often poorly understood. Typical assumptions are often excessively conservative, which may have led to excessively large cables costing extra. This project proposes to use expert geological and oceanographic analysis to build bespoke numerical models of cable systems, which can then be validated using Distributed Temperature Sensing (DTS) data. Current design approaches can be tested and establish if the level of conservatism in cable system design can be safely reduced. This project would also propose new methods to rate and size cable systems that can best inform business decisions. Analysis of the Thermal Influence of Cable Surroundings (AnTICs) | ENA Innovation Portal (energynetworks.org)
- **SCOHL**: This project aims to assess the potential for implementing novel high-temperature superconductor (HTS) technology on National Grid's overhead line (OHL) assets. Meeting Net Zero goals requires £21.7 billion for 94 onshore network reinforcement projects by 2030, with additional build-out by 2050 (NOA 2021/22 Refresh). However, the required pace of network expansion is unprecedented and regulatory processes and public resistance can slow deployment, especially for new OHL routes which have high visual impact. SCOHL | ENA Innovation Portal (energynetworks.org)
- **Cost effective removal of conductor crossing clearance constraints**: The scope of this project is to develop the installation methodology for raising the height of the bottom phase conductor on a tower by installing semi tension insulators on two consecutive towers in order to reach an overall increase in overhang clearance by 5m. This methodology will then be tested by raising the overall height by 5m of two consecutive towers over a river crossing. Cost effective removal of conductor crossing clearance constraints | ENA Innovation Portal (energynetworks.org)
- **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. UltraWire | ENA Innovation Portal (energynetworks.org)

- **Unlocking Transmission Transfer Capacity**: It is proposed to investigate the use of Energy Storage systems to economically unlock the inherent transmission network capacity. Strategic locating and sizing of storage resources will allow the network operators to load the network to a synthetic N-0 capacity, and when necessary to utilise the strategic storage resources to absorb/inject power post contingencies up until a system re-dispatch is affected. Unlocking Transmission Transfer Capacity | ENA Innovation Portal (energynetworks.org)
- **Increasing Transmission Boundary Power Flows using an Active Power Control Unit**: This project proposes to assess the performance of a novel power electronic asset called the Active Power Control Unit (APCU). The APCU is a technology based on power electronics that can control active and reactive power flows in power lines both at transmission and distribution levels. The ability to control active and reactive power, provide the APCU with the ability to utilise existing capacity within the network. https://smarter.energynetworks.org/projects/nia_ngto023/
- **Flexible rating options for DC operation**: Modelling the complex interactions of thermal and electrical parameters is essential if National Grid is to make a thorough assessment of tenders for HVDC cable schemes. The modelling of transient thermal conditions and the behaviour of the cable insulation under reversals of power flow will provide guidance for the development of dynamic rating algorithms and operational regimes suitable for high power HVDC cable circuits. The thermal and electrical models will be constructed in such a way that the outcomes of planned R&D work on pressure transients and partial discharge ageing can readily be incorporated at a later date. Flexible rating options for DC operation | ENA Innovation Portal (energynetworks.org)
- **Advanced Line Rating Analysis (ALiRA):** Current overhead line (OHL) ratings are applied on a seasonal basis and do not consider the geographical location of the assets and associated variances in meteorological conditions. As such, line ratings may be unnecessarily constrained, limiting power flows and prompting unnecessary investment for load related upgrades. https://smarter.energynetworks.org/projects/nia_ngto014/
- **Enhanced Weather Modelling for Dynamic Line rating (DLR):** This project aims to establish the spare thermal capacity in overhead lines that exists as a result of the actual weather parameters compared to seasonal values, and forecast the capacity that will be available ahead of real-time. As such, operational decisions will be able to be made which will reduce the cost of operating the system and potentially avoid or defer reinforcement works following the connection of new low carbon generation. Enhanced Weather Modelling for Dynamic Line rating (DLR) | ENA Innovation Portal (energynetworks.org)
- **Dynamic Line Rating CAT1** (SSEN-T): To install a CAT-1 Transmission Line Monitoring system on a SHE Transmission line and demonstrate whether it can enable dynamic line rating resulting in safe and cost-effective line operation close to its thermal rating. Dynamic Line Rating CAT1 | ENA Innovation Portal (energynetworks.org)
- **Dynamic Ratings for improved Operational Performance (DROP):** This issue is to improve on providing a concise cable rating sheet as part of the CUP package which can be readily used by Network Operations. While this approach works well where the level of load to be transferred is known in advance, it provides for only a limited number of rating combinations based on a series of assumptions about the cable system thermal environment. Given the increasing variability of the UK climate, coupled with the trend towards higher generation of electrical energy from renewable sources, this may not always lead to the best utilisation of a cable asset as its true power transfer capability over periods of 24 hours or less may be under-estimated through this traditional approach. Dynamic Ratings for improved Operational Performance (DROP) | ENA Innovation Portal (energynetworks.org)
- **New Suite of Transmission Structures** (SSEN-T): The intention of this project is to leverage innovations (for example: ICAs and low-sag conductors) to design a new suite of transmission structures to exploit fully their potential. https://smarter.energynetworks.org/projects/nia_shet_0010/
- **The Role for Hydrogen as an Electricity System Asset** (NGESO): There is a need to understand how the development of hydrogen markets will interact with the electricity system, and how targeted hydrogen investment can more effectively support the electricity system. The Role for Hydrogen as an Electricity System Asset | ENA Innovation Portal (energynetworks.org)

- **Implementation of Real-Time Thermal Ratings**: The scope of this project is to implement a dynamic real-time thermal rating system for overhead lines that gives the control room operators greater visibility of the actual thermal operating status of their network. https://smarter.energynetworks.org/projects/spt1001/
- **Temperature Monitoring Windfarm Cable Circuits**: Three windfarms are to be connected at 33kV to East Kilbride South 275/33kV substation in an area where there is significant windfarm activity. In order to minimise costs the three cable connections will share a common trench for the initial 10.7km length from the substation. This shared cable route has been influenced by the need to ensure thermal independence from an existing adjacent 275kV cable that supplies Whitelee Windfarm. Each windfarm cable connection is made up of three single core cables laid up in trefoil. Given the close proximity of the three 33kV windfarm cable circuits each has been de-rated to 32.2MW. Temperature Monitoring Windfarm Cable Circuits | ENA Innovation Portal (energynetworks.org)
- **Aluminium Carbon Core Conductor (ACCC):** Due to increase in load, reinforcement of the transmission infrastructure between Peterhead substation and St Fergus switching station is required. This would involve a new 3rd 275 / 132kV transformer and associated equipment along with the construction of a 3rd circuit of approx. 14km (11km of overhead line, using ACCC conductor). Aluminium Carbon Core Conductor (ACCC) | ENA Innovation Portal (energynetworks.org)
- **275kV Alternative Conductor**: An overhead line project has been identified which requires a second circuit to be strung to allow for the export of power from the wind farm connections. Planning's request was for 700mm2 All Aluminium Alloy Conductor (AAAC) operating at 50Deg C giving 1240A pre-fault continuous rating (1470A post fault). Tower analysis revealed that the conductor would overload the towers and would have approx. 50 ground clearance issues requiring towers to be increased in height. This proposal is to cover the development of an alternative conductor to reduce the clearance issues and reduce the loading on the towers without decreasing the rating. 275kV Alternative Conductor | ENA Innovation Portal (energynetworks.org)
- **Dynamic Sag Monitor**: There has been growing interest in the use of dynamic ratings for transmission circuits. This is the concept of varying the thermal rating of part or all of a circuit according to the ambient conditions. A number of systems have now been developed varying in complexity from using macro weather data to online dynamic measurements of circuit parameters. This project will assess current available technologies and how these can be integrated within the system operators display and functional tools. The implications of deploying these systems will be investigated with regards to load management and system planning. Dynamic Sag Monitor | ENA Innovation Portal (energynetworks.org)

What else do you need to know?

We expect innovators to be familiar with current and previous projects and there needs to be a demonstration of how any new ideas complement or build on existing ideas and previous work.

Innovator submissions to this problem statement will be open here during March and April, but we encourage you to submit your response as early as possible, as networks will be able to review submissions as soon as they come in.

You can also use the virtual Q&A on the Smarter Networks Portal to ask for more information about this problem statement. Questions may be answered online or at the ENA Problem Statement Launch in March 2024. More information on last year's Basecamp programme can be found here.