# SIF Discovery Round 2 Project Registration

### Date of Submission

May 2023

### Project Reference Number

10061340

## Project Registration

### Project Title

CReDo+ Climate Resilience Demonstrator (extension to new climate risks)

### Project Reference Number

10061340

### Project Licensee(s)

UK Power Networks

### Project Start

Apr 2023

### Project Duration

3 Months

### Nominated Project Contact(s)

innovation@ukpowernetworks.co.uk

### Project Budget

£143,586.00

### Funding Mechanism

SIF Discovery - Round 2

### SIF Funding

£112,284.00

### Strategy Theme

Data and digitalisation

### Challenge Area

Improving energy system resilience and robustness

### Lead Sector

Electricity Distribution

### Other Related Sectors

### Funding Licensees

### Lead Funding Licensee

UKPN - Eastern Power Networks Plc

### Collaborating Networks

UK Power Networks

### Technology Areas

Asset Management, Modelling, Resilience

### Equality, Diversity And InclusionSurvey

Yes

## Project Summary

The original CReDo project produced failure models from elicitation interviews with operatives familiar with the asset and then translating these into a mathematical model. Whilst this generated useful failure models the process was found not to be scalable due to the time and specialist expertise needed to conduct them.

To address this the project will develop a user-friendly tool (e.g. configurable questionnaire or interface) which asset specialists will interact with to generate probabilistic models of asset failure from climate risks, enhancing the digital twin's capabilities and scope for application. This tool will enable asset engineers to better quantify and understand climate risks and networks robustness, enabling more targeted investment to build resilience and robustness and protect supply for customers.

During the Discovery Phase, we will investigate the suitability of different extreme weather conditions (wind or heat) for this work and then focus on the selected condition in the Alpha Phase.

The project addresses Innovation Challenge 3: Improving Energy System Resilience and Robustness, scope 2.

The network innovation lies in the transformative capabilities for DNOs to understand the risks and modalities of asset failure, which currently exists only as tacit knowledge held by asset specialists. Providing quantitative failure risks enables resilience and robustness to be incorporated as a key measure in network operation and planning. DNOs will therefore be able to make more informed decisions for capital investments and asset planning, strengthening their infrastructure to ensure smooth adoption of multi-energy systems and a robust energy transition towards net zero.

This consortium is uniquely well placed to deliver this project:

1.The partners involved delivered the original CReDo, which included the first creation of Bayesian failure models from elicitation interview.

2.UK Research and Innovation - Science & Technology Facilities Council (STFC) through its Hartree Centre and DAFNI platform, will provide the project with crucial data science and software engineering expertise, and secure hosting.

3.UK Power Networks (UKPN) will support the project from a Distribution Network Operator perspective, supplying relevant data and engineering expertise.

4.Computational Modelling Cambridge Ltd (CMCL) will use their experience developing semantic knowledge graphs to represent the critical assets, the impact of asset failure and the cascade of failures throughout the system

5. Connected Places Catapult (CPC) lead the current phase development of CReDo and bring deep experience in identifying market failures and convening stakeholders to solve them.

## Project Description

Electricity networks are at the heart of the critical infrastructure system and individual asset failures can cause a cascade of failure across the entire system. The Committee on Climate Change recently reported that "Connectedness of infrastructure systems means that climate and weather-related impacts in one system can cause large and cascading failures in connected systems" and that "many organisations are struggling to fully assess risks from infrastructure interdependencies."

CReDo is a climate change adaptation digital twin focused on "exploring how infrastructure interdependencies impact system resilience, and how data sharing can improve overall system resilience". However, further innovation is required to enhance its capabilities into additional causes of asset failure under different extreme weather scenarios through the proposed project extension in this bid, CReDo+.

In this project, a 'user-friendly' tool will be developed to extract tacit knowledge from asset specialists to generate probabilistic failure mode models for a selection of prioritised energy network assets, using an extreme weather event (to be selected in the Discovery Phase) as an investigative exemplar climate risk. The value of the proposed approach will be demonstrated by implementing the models into CReDo, enabling asset engineers to identify vulnerabilities and develop mitigation strategies leading up to an event. As CReDo develops, the portfolio of assets modelled, and the types of extreme weather scenarios analysed, will increase to create a system appreciative of the multi-faceted nature of climate resilience. CReDo+ will build on a cross-sector collaboration between utility companies (electricity, water, and telecommunications) to improve granularity of asset interdependencies in their individual networks and unlock the value of climate resilience for both infrastructure and to society.

See the solution diagram appended as a visual overview of the proposal.

This project is valuable and innovative because it will:

1. Create entirely new probabilistic failure models under conditions of extreme weather -- events which will increase in frequency and severity as climate change continues.
2. Increase the granularity of data access available to DNOs for their asset portfolio and its interdependencies with other utilities' assets to prioritise and develop cross-sector shared responsibility models for resilience upgrades.
3. Produce a user-friendly tool to facilitate the creation of models for other assets and risks.
4. Incorporate economic and societal cost data to quantify the implications of failure (e.g. costs of recovery, repair, impact on supply continuity). This will support the business case for investments designed to build resilience.

## Third Party Collaborators

Connected Places Catapult

Science and Technology Facilities Council (STFC) - UKRI

Computational Modelling Cambridge Ltd (CMCL)

## Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

# Project Description And Benefits

## Applicants Location (not scored)

UK Power Networks

Newington House, 237 Southwark Bridge Road, London, SE1 6NP

## Project Short Description (not scored)

CReDo+ (Climate Resilience Demonstrator - extension to new climate risks) is a development on the original CReDo decision support tool by incorporating newly developed models of DNO asset failure risk under extreme weather conditions. This will enhance the ability of network operators and wider connected asset owners to build systemic climate resilience.

## Video description

https://www.youtube.com/watch?v=wL-XqSSGXTA&list=PLrMOhOrmeR6ldr-EVoT8ABGhTCxgyBKqs&index=13

## Innovation justification

Extreme weather events driven by climate change increase the risks of electricity supply disruption causing a cascade of failure across the infrastructure system. DNOs have extensive historical recorded data for faults and incidents that have occurred during extreme weather conditions, as well as specific asset performance information held with experienced engineers. The latter is not digitised and would play an important role in identifying risks and mitigations. The frequency and extremity of weather events is expected to increase, therefore there is a need for elicitation to bridge this gap and aid in pre-emptive mitigation.

CReDo pioneered a new approach to identifying the risks of cascading impacts across energy, water, and telecoms networks, which was demonstrated against flood-risk. This project would build on that foundation by adding in models of risk related to another extreme weather phenomenon.

The project is novel in two ways. Firstly -- building asset failure risk models for a new climate risk. Secondly, through its intent to build a tool to allow other risk models (for other assets and risks) to be constructed more easily.

This tool would generate asset-specific failure risk models through a combination of elicitation interviews with asset specialists and other relevant data where available.

The implementation of the resultant risk models in the CReDo digital twin would provide better predictability, robustness, and quantification of uncertainties under a variety of extreme weather conditions.

This consortium brings together the skills needed to develop the tool (CPC, UKRI, CMCL) with the network management and maintenance expertise of UK Power Networks.

UK Power Networks seeks SIF funding for CReDo+ because:

- The current phase of CReDo require development does not include asset failure models, with funding and development focused on the data sharing architecture to ensure scalable of the approach across all networks whilst maintaining security and data confidentiality.
- The vision to develop a connected digital twin across all infrastructure networks is ambitious and requires significant innovation, technical development, and coordination. Developing power network failure models is a crucial part of achieving this long-term vision.
- A complementary funding application is being made by Anglian Water to the Ofwat Catalyst fund to develop modes of failure under extreme weather conditions for the water sector. A combination of SIF and Catalyst funding would propel CReDo into the next phase and closer to the stage where energy networks are able to take this innovative tool in-house.

## Benefits Part 1

Financial - future reductions in the cost of operating the network
New to market – products, processes, and services

## Benefits Part 2

We expect that a key part of the Discovery Phase is to identify and quantify the benefits further. As noted by Emma Howard Boyd, Chair of the Environment Agency, "global understanding of the costs avoided, and revenue generated by climate resilience is anecdotal and patchy" and this project will support identifying this value.

**Financial -- future reductions in the cost of operating the network:**

Repairs and replacement - Further investigation is needed to have an indicative quantification for the baseline network operating costs per annum allocated for repairs and replacement required due to extreme weather conditions. As a counterfactual, incident reports are measured for network interruptions due to extreme weather, through CReDo+ this number would be tracked to realise improvements through using the tool normalised to the number of events per annum.

Faults related to extreme weather in 2022:

- Solar Heat : ~280
- Wind : 3,700

Customer Interruptions (CI) and Customer Minutes Lost (CMLs) -- DNOs are incentivised to reduce CIs and CMLs since assets more resilient to extreme weather will the improved quality of supply for customers. Once CReDo+ is integrated into BAU to predict asset failures and inform resilience upgrade requirements, CI and CML can be tracked on an annual basis relative to historic baseline figures.

**Risk management -- better warning systems in case of unprecedented events.**

Better risk modelling will enable us to provide appropriate forewarning to our customers of risks to supply disruption (for example in the case of extreme storms such as Storm Arwen), helping them prepare better.

**Social -- increased energy security and social value from energy transition.**

By increasing resilience and robustness of the energy system, the Social Return on Investment (SROI) is improved. Businesses suffer disruptions to operations and hence economic impacts when damage occurs to their utility supplies. By minimising downtime through tailored resilience upgrade investments across utility asset portfolios, social and economic value will be generated. A more robust system will also support the transition to cleaner low carbon technologies and enable DNOs to help customers transition to net zero.

# Project Plans And Milestones

## Project Plan and Milestones

**WP1: Project Management -- (CPC) - £17,586**

1. Mobilisation, governance processes, planning, milestones, risk register

**Deliverables**: PID, plan, events, and risk register

**WP2: Research and Data Gathering - (CPC) -- £37,437**

1. Summarise current practice for making decisions on asset investments to increase system resilience.
2. Summarise how UK Power Networks discovers, categorises, stores, and uses asset failure risk data, particularly climate risks, and the value of doing so to the organisation
3. Understand how asset engineers elicit information from field staff
4. Identify asset experts for elicitation
5. Provide relevant financial data on the implications of asset failure

**Deliverables:** Baseline Performance Approach, Data Catalogue, Success Criteria, Failure Data

**WP3: Stakeholder Mapping - (CPC) -- £14,603**

1. Identify the user personas for the solution.

**Deliverables:** Personas

**WP4: Modelling Principles - (STFC) -- £8.464**

1. Identify pre-existing dataset(s) for likelihood of conditions which result in risk threshold breaches, or propose methodologies to generate suitable dataset(s)
2. Review security arrangements required for CReDo and the application
3. Technical feasibility of integrating failure models into framework (CMCL)

**Deliverables:** Report summarising findings

**WP5: Technical Feasibility, Design Study and Recommendations- (STFC) -- £34,194**

1. Define requirements with key stakeholders
2. Review outputs from earlier work packages
3. Produce journey map based on User Stories
4. Research existing domain space, technologies, hosting and deployment tools, determine core functional and non-functional use cases from the user stories and prioritise (MoSCoW).
5. Produce outline work pack plan for Alpha Phase.
6. Support technical feasibility assessment (CMCL)

**Deliverables:** report detailing design choices and motivation

**Total Project Cost**

£132,401

**Risks:**

The key risk at Discovery Phase is the short time frame of the work and the need for in-depth discussions with a variety of UKPN specialists. This would be mitigated by planning scheduling.

**Risk Management:**

The project management function will maintain a risk log during the project and will exercise standard project management governance to assess strategic, regulatory, financial or operational risks.

The approach to project risk will follow:

- An If... Then... statement.

- Include a likelihood measure of H, M, L
- Include an impact measure of H, M, L
- Mitigation Category (Accept, Avoid, Transfer, Reduce)

## Regulatory Barriers (not scored)

Whilst legal, commercial, and regulatory barriers to data sharing persist across the energy system, the project team will be able to identify any specific regulatory barriers at the end of the Discovery Phase.

We are not aware of any regulatory barriers to sharing the low code tool we aim to develop across the industry, to help other asset owners develop asset-specific failure models.

Considering longer term realisation of the benefits of CReDo, from a policy perspective, there would be value in regulators such as Ofgem and Ofwat coordinating more closely to enable systemic resilience. This was recommended in the National Infrastructure Commission report, Strategic Investment and Public Confidence, which recommended that regulators be given climate change and resilience duties and a duty to collaborate.

In promoting collaboration across utility companies, in the future regulators such as Ofgem may need to consider how to fund innovation in cross sector innovation projects such as CReDo.

# Commercials

## Route To Market

To streamline adoption into BAU practices, the project will work with relevant stakeholders in UKPN to ensure solutions are grounded in current working practices. Supporting documentation will be developed as part of a toolkit to facilitate the change management requirements for BAU adoption.

Within the bounds of commercially sensitive data policies, project outputs a will be made available to utilities companies in a free, open-source format. This will permit rapid adoption through increased commercial awareness via multiple routes including by asset owners directly, their appointed contractors and consultants, digital supply chains, and the CReDo digital twin. The initial phase of CReDo provide an example of how the methodology is shared whilst the asset data kept confidential:Technical Overview - DT Hub Community (digitaltwinhub.co.uk).

We anticipate that asset and risk managers would be the direct users and beneficiaries of the elicitation tool and resulting risk models. Users personas characterising these personnel and their needs will be developed during the Discovery phase. A parallel route to implementation is through model integration with existing asset/risk management software or digital twins provided by third parties to enhance capabilities and increase revenue opportunities. For example, Local Area Energy Planning tools would benefit from including failure scenarios while planning the location of low carbon technology solutions.

The project would enable quantification of the financial impact of failure events and the impact of the tool in reducing these thereby providing evidence to support a business case for adoption. The solution would enable a step-change in the capability of asset management tools by providing the data and failure models required to enable analysis of asset information and risks in greater detail, at scale, using standardised methodologies, and incorporating empirical metrics and probabilistic outputs. Through more informed decision making it is expected to benefit network resilience, robustness, and capital investment efficiency.

Funding for adoption could include network BAU funds and/or externally funded integration of the open-source software by third-party software providers. The long-term commercial model for CReDo is likely to be software-as-a-service, funded and used by network operators, regulators, and insurers.

A concurrent Ofwat funding bid will investigate the impact of extreme heat on water assets. If successful, cross-sector benefits will result from uncovering cascading failure risks between water and energy assets. If this project progresses to Alpha/Beta phase, Anglian Water are willing to integrate their asset failure risk models within CReDo to allow this demonstration.

## Intellectual property rights (not scored)

The parties agree to adopt the default IPR arrangements for this project as set out in section 9 of the SIF Governance Framework, namely that each Project Partner shall retain all rights in and to its Background IPR and that each Project Partner shall own all Foreground IPR that it independently creates as part of the Project. Where IPR is created jointly then it shall be owned in shares that are in proportion to the work done in its creation. The agreement between the partners around the CReDo solution is that code is open and published under a permissive licence and we would expect similar from this project to benefit the sector at large

## Costs and value for money

he total project costs for the Discovery Phase of this project are £143,586 and SIF funding request of £112,284. Collectively the project team are funding a contribution of c.22% of the total project costs which is above the minimum 10% compulsory contribution; this shows commitment from the project partners and provides value for money to customers.

Split as below:

**UK Power Networks**

Total costs: £20,200

SIF Funding Request: £9,686

**Connected Places Catapult**

Total Costs are: £56,311

SIF Funding Request: £45,049

**UKRI / STFC**

Total costs are: £31,000

SIF Funding Request: £24,800

**CMCL**

Total Costs are: £36,075

SIF Funding Request: £32,467

Subcontractors (accounted for in CPC total costs):

**Professor Chris Dent** (University of Edinburgh) -- technical advisor for the project following being the technical lead of CReDo phase 1 (21-22).

**Sarah Hayes** -- project and engagement activities advisor following being the project lead of CReDo phase 1 (21-22) and the engagement lead of 22-23 activities.

This project aims to deliver a tool usable across the industry which should help build network resilience in a more cost-effective way -- the value of this is something we would aim to quantify through the project itself (to increasing levels of accuracy through Discovery, Alpha and Beta).

The project will be demonstrated through implementation into the pre-existing CReDo prototype platform -- a digital twin which already has an ecosystem of investors, contributing up to £1.5m to date, and planned investments up to £1m over the next 18 months. CReDo+ will build on these investments to develop outputs that unlock both economic and social value from climate resilience. As granularity of asset portfolios and potential vulnerabilities are credentialed, the value of engagement between different utility providers will be realised through joint cost-benefit analysis of capital allocation to interdependent assets that delivers enhanced benefits to all.

The project partners have awareness of other projects delivering value that can be integrated with CReDo, for example, the concurrent Anglian Water CReDo Ofwat bid investigating extreme heat. It will be ensured that there is not duplication of effort, that developed products are interoperable, and respective benefits are enhanced.

A recent study by Glasgow City Council found that 'Investments in mitigation and adaptation have benefits that far outweigh their costs. These are much higher than traditional investments -- up to £9 of economic return for £1 spent'

# Document Upload

## Documents Uploaded Where Applicable

Yes

## Documents:

SIF Discovery Round 2 Project Registration 2023-05-30 10_28

SIF Round 2 Discovery - CReDo+ End of Phase (for upload).pdf

SIF Round 2 Discovery - CReDo+ End of Phase (for upload).pdf (1)

SIF Round 2 Discovery - CReDo+ Show and Tell (for upload).pdf

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

☑ Yes