SIF Round 4 Project Registration

Date of Submission

Jan 2025

Project Reference Number

10145456

Initial Project Details

Project Title

FLEX-STORE: FLEXible STORE of electrified thermal energy

Project Contact

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Challenge Area

Greater heat flexibility

Strategy Theme

Flexibility and market evolution

Lead Sector

Electricity Distribution

Other Related Sectors

Electricity Transmission

Project Start Date

01/01/2025

Project Duration (Months)

5

Lead Funding Licensee

NPg - Northern Powergrid (Northeast) Limited

Funding Mechanism

SIF Discovery - Round 4

Collaborating Networks

Northern Powergrid

Technology Areas

Energy Storage and Demand Response

Project Summary

Our project addresses the challenges of transitioning to a predominantly electrified energy system from a multi-vector system reliant on gas and diesel. We propose using electrified thermal storage solutions, such as phase change materials and thermochemical storage, to enhance grid stability and provide backup during supply disruptions. This approach ensures reliable heating for vulnerable customers while offering additional benefits like cost savings, reduced peak demand, and improved heat and grid flexibility. By actively managing heat storage based on grid signals, the project supports decarbonisation efforts and explores market opportunities for integrating thermal storage into the future energy landscape.

Add Preceding Project(s)

NIA2_NGESO012 - COMMANDER – Coordinated Operational Methodology for Managing and Accessing Network Distributed Energy Resources

NIA2_NGESO068 - Market Signals for the Electrification of Heating

Add Third Party Collaborator(s)

WSP UK Limited

University of Birmingham

Together Housing Association Ltd

Project Budget

£177,008.00

SIF Funding

£148,816.00

Project Approaches and Desired Outcomes

Animal testing

- ○ Yes
- ⦿ No

Problem statement

The transition from a multi-vector energy system to one dominated by electricity presents significant challenges, particularly for users in areas with constrained grid connections and regions prone to fluctuations in peak demand. This transition increases the vulnerability of both domestic and non-domestic users, especially those reliant on stable electricity supply for critical heating services. The mismatch between current electricity consumption patterns and grid capacity results in peak demand spikes that can exceed average consumption by up to six times, placing significant strain on the network.

Our project aims to address these challenges by leveraging electrified thermal storage systems, such as phase change materials and thermochemical heat storage, to provide flexibility in energy management. Unlike electrified heating solutions like radiators and heat pumps, which directly supply heat, these thermal storage systems can store excess energy when the grid has surplus electricity and release it when demand peaks, reducing grid stress. This approach helps prevent critical demand spikes and provides resilience during power outages, ensuring continuity of heating for vulnerable customers and critical infrastructure.

The project directly aligns with the primary Innovation Challenge aim by addressing grid resilience and flexibility, focusing on the challenge of maintaining energy stability as the system becomes more electrified. Our approach enhances heat flexibility, which is a key focus area, and supports decarbonisation efforts by reducing reliance on high-carbon backup generation sources during periods of peak demand.

The potential users of this innovation include vulnerable customers, energy providers, and grid operators. By ensuring a stable and reliable heating source during grid disruptions, our project directly addresses the needs of vulnerable households, while energy providers benefit from reduced peak demand and new opportunities for flexibility services. Grid operators will experience lower stress on the network, supporting the transition to a more sustainable, electrified energy system.

Relevant previous work includes WSP's projects such as Market Signals for the

Electrification of Heating (with National Grid ESO). Additionally, COMMANDER -Coordinated Operational Methodology for Managing and Accessing Network Distributed Energy Resources has provided insights into enabling flexibility in the grid. We will also engage with the DESNZ LODES programme, particularly the Extend and Absorb projects, to build on their findings and integrate innovative solutions into our project. Additionally, lessons learned from the Diversified Flexible Queue Management Discovery & Alpha (with Northern Powergrid) are being applied in the Beta phase, further informing our approach.

Video Description

https://youtu.be/BKkyE0xLrEY?si=zc4Xs7_X4imfoMfi

Innovation justification

Our project introduces innovative energy storage solutions using phase change materials (PCMs) and thermochemical heat storage systems to tackle long-term and flexible heating challenges. While PCMs and thermochemical storage are used in areas like building insulation and solar plants, they are underutilized in the energy grid's flexibility market. By advancing these technologies for short- and long-term heat storage, the project aims to improve energy efficiency, affordability, and reduce waste compared to conventional batteries and water tanks.

Core Innovation:

Unlike existing battery systems, PCMs and thermochemical storage solutions offer several advantages:

Higher energy density, allowing more energy to be stored in a smaller space.

Lower self-discharge rates, which means less stored energy is wasted over time.

Lower unit cost, making them more affordable for widespread adoption.

Longer heat supply duration, making these systems ideal for long-duration energy storage, thus enhancing grid flexibility.

This innovation explores untapped potential for long-duration storage, developing pathways for integration into the energy flexibility market. Additionally, it aims to

provide ancillary grid services such as load shifting and peak demand management, further supporting heat decarbonisation.

Technical Readiness
While the underlying technologies exist (technology readiness levels, TRL, 6-7), their application in energy flexibility remains underdeveloped. PCM technologies already have off-the-shelf products, but thermochemical storage requires further development, with integration timelines projected at 1-3 years (integration readiness levels, IRL) and 3-5 years (commercial readiness levels, CRL). This phase will elevate readiness levels through trials, paving the way for long-term commercialization and grid integration.

Suitability for SIF Funding
The scale and nature of the project make it suitable for SIF funding because it requires multiple trials across different scenarios to assess real-world viability and derisk uncertainties. Unlike other funding sources, SIF supports projects that need comprehensive testing in the Discovery and Alpha phases to progress to a Beta phase. This phased approach enables the safe, cost-effective development of innovative grid solutions without the financial risk typical of large-scale rollouts.

Counterfactual Solutions
Two primary counterfactuals were considered:

1. Non-thermal solutions (e.g., batteries and electric vehicles), which are proven but limited in long-term heat storage and cost-effectiveness.

2. Conventional thermal storage solutions, which exist but on a smaller scale as off-the-shelf products, have yet to be proven in flexibility markets. Our solution opens new pathways for thermal storage to contribute to grid flexibility and heat decarbonisation, offering an alternative to existing technologies.

Impacts and benefits selection (not scored)

Financial - future reductions in the cost of operating the network

Financial - cost savings per annum on energy bills for consumers

Financial - cost savings per annum for users of network services

Environmental - carbon reduction – direct CO_2 savings per annum

Revenues - creation of new revenue streams

Others that are not SIF specific

Impacts and benefits description

Pre-Innovation Baseline
Currently, energy networks struggle to manage peak demand, especially after the rollout of electrified heating during winter. Conventional energy storage systems, such as batteries and water tanks, offer limited flexibility for long-duration storage and peak shaving. This inefficiency leads to increased grid reinforcements cost, along with higher energy bills for consumers. Vulnerable customers, often facing energy poverty, are particularly affected, relying heavily on stable heating solutions. Key metrics for the baseline include peak demand surges, consumer energy bills, and CO_2 emissions from high peak-time consumption.

Forecasted Net Benefits to Consumers
Electrified thermal storage systems, if implemented as a business-as-usual solution, can deliver substantial benefits:

Reduction in Network Reinforcement Costs: Electrified thermal storage systems can store and discharge energy during peak periods, helping to delay expensive grid reinforcements. This can save network operators significant costs by postponing the need for infrastructure upgrades to manage peak demand.

Consumer Cost Savings: Vulnerable customers will benefit from lower energy bills as these systems allow heat to be generated during off-peak times when prices are lower, potentially leading to savings of 5-10% per annum.

Support for Vulnerable Customers: During power outages, electrified thermal storage systems can still provide essential heating services, ensuring continuity for those most at risk.

Lower Upfront Costs: Compared to traditional battery storage, electrified thermal storage systems are more affordable, reducing initial capital expenditure for consumers and network operators.

Carbon Reduction: By balancing demand and storing energy efficiently, these systems could save thousands of tonnes of CO2 annually, contributing to decarbonisation goals.

Benefits Realised Through Project Delivery
In the Discovery phase, preliminary assessments will show potential reductions in peak demand for various electrified thermal storage types, demonstrating their ability to alleviate grid stress. Initial feasibility studies will confirm their effectiveness in providing consistent heating and/or cooling to vulnerable customers and in integrating with flexible services and any other potential business cases, creating new revenue streams for DSO, energy providers and end customers.

Other Benefits
Seasonal Energy Storage: These systems can store thermal energy long-term, using surplus energy generated in summer during winter.

Load Balancing: Responding to grid signals, these systems help manage peak demand, enhancing stability.

Higher Energy Density: Electrified thermal storage systems provide more compact energy storage, making them suitable for space-constrained environments.

Cooling Solutions: These systems also offer cooling capabilities, broadening their applicability across various sectors and improving overall energy management.

Teams and resources

Who is in the Project team and what are their roles and responsibilities?

The team brings together a diverse group of partners with the skills and expertise essential for the successful delivery of this initiative. It combines pre-existing collaborations and new partnerships, chosen for their capabilities in addressing the technical, research, and social aspects of electrified thermal storage.

Lead Partner: Northern Powergrid (Northeast) Plc (NPgN) -- Steve Newall NPgN leads the project, ensuring alignment with grid operations and infrastructure. With extensive experience in working with local communities and vulnerable consumers, and their involvement in flexibility services, they will oversee the integration of thermal storage solutions to meet network needs and regulatory requirements.

Partner 1: WSP UK Limited -- Jianing Li
WSP brings multidisciplinary expertise in energy policy, technical design, and stakeholder engagement. Their strong track record of working with energy stakeholders across the UK makes them well-equipped to contribute to technical feasibility, market analysis, and grid impact studies. WSP's experience with demand flexibility projects, including work with NPg, strengthens their role in the project.

Partner 2: University of Birmingham Enterprise (UOB) -- Yongliang Li
The Birmingham Centre for Energy Storage (BCES) at the University of

Birmingham is a core member of the Energy Storage Supergen Network+, a multimillion-pound EPSRC-funded initiative that fosters collaboration and knowledge sharing across leading energy storage researchers. BCES brings together multidisciplinary experts with deep knowledge of energy storage technologies. Their involvement in the Supergen Network+ will benefit this project by providing access to cutting-edge research, fostering knowledge exchange, and ensuring that insights from across the wider energy storage community are integrated into the feasibility and performance assessments of electrified thermal storage systems. Partner 3: Together Housing Association Limited (THA) -- Gemma Voaden

THA, as a social housing provider, will facilitate end-user engagement to ensure the project meets the needs of vulnerable customers. Their involvement allows for trials of electrified thermal storage solutions in real homes, collecting valuable data on user experience and performance. This pre-existing relationship builds on collaborative efforts to support vulnerable customers in energy transition projects.

Resources and Facilities:

The project will utilise WSP's technical analysis tools, the UOB's energy storage labs, and NPgN's grid management expertise. Together Housing will provide data and access to vulnerable customers and homes for field trials for future stages. All partners have the necessary resources ready for the current phase, and external stakeholders, including vulnerable consumers and energy service providers, will be engaged to ensure broad input and successful project outcomes.

Project Plans and Milestones

Project management and delivery

Project Management Approach
The project will follow a structured, collaborative approach for successful outcomes. Key methodologies include phased execution of workstreams (WS1-WS5) with milestones tracked and risk registers. Agile methodology will allow for flexibility and iterative improvements, particularly in trials and stakeholder engagement. Regular steering committee meetings with all partners will ensure alignment, clear roles, and efficient resource allocation, promoting timely delivery and continuous refinement of outputs.

Work Package Dependencies

The workstreams are interlinked to ensure seamless progress:

WS1 (Feasibility) informs WS2 (Supporting Vulnerable Customers) and
WS3 (Market Mechanisms), providing insights on technology performance and grid impact.

WS2 (Vulnerable Customers) feeds into WS4 (Alpha Phase Planning) to accommodate specific customer needs in the technical framework.

WS3 (Market Mechanisms) provides insights for Alpha phase planning to align market opportunities with technical solutions.

WS5 (Dissemination) will share findings from all workstreams to promote adoption.

These interdependencies ensure cohesive project flow, with reviews at each milestone to identify bottlenecks and make necessary adjustments.

Risk Management Strategy
A risk management framework will include a risk register to monitor and mitigate risks, such as stakeholder engagement delays, limited flexible assets, and regulatory challenges. Mitigation strategies involve early engagement with stakeholders (NESO, Ofgem), proactive market outreach, and a regulatory risk review. Regular audits will ensure project compliance and timelines. Alpha phase trials will prioritise minimising customer impacts, with solutions for both new builds and retrofits designed to avoid supply interruptions.

Policy and Regulatory Risks
The project acknowledges regulatory risks around market mechanisms and grid flexibility. Collaborations with NPg (DSO), NESO and Ofgem will address challenges in deploying new storage technologies. We will also engage and inform policy leaders in DESNZ to inform future policy development in flexibility and heat.

Consumer Impact and Engagement
THA will engage vulnerable customers to ensure their needs are met during grid outages. We will engage wider citizen stakeholders, including consumer advice organisations, to ensure public awareness and alignment with ongoing initiatives in the energy resilience space.

Our solution is designed to provide an uninterrupted energy supply during outages, ensuring that consumers, particularly vulnerable groups, have access to reliable heating and cooling when the grid is down. Solutions will avoid supply interruptions and minimise disruption for both new builds and retrofits. Consumerfriendly designs will be developed and planned in the Alpha phase, ensuring smooth implementation. Stakeholder feedback will guide development to enhance customer experience and improve energy resilience.

Key outputs and dissemination

Key Outputs and Dissemination Plan
By the end of the Discovery Phase, our project will deliver several key outputs to advance the integration of electrified thermal storage systems into the energy market:

1.Assessment of Electrified Thermal Storage Products: Evaluation of the efficiency, specifications, and performance characteristics of existing and emerging electrified thermal storage products to determine their suitability for grid integration. This work will be led by UoB.

2.Backup Heating and Cooling for Vulnerable Customers: Demonstration of electrified thermal storage systems' ability to provide reliable backup during grid outages, ensuring vulnerable groups are safeguarded. THA and WSP will play a pivotal role in engaging these customers.

3.Market Mechanisms Exploration: Investigation of innovative market mechanisms to facilitate the adoption of electrified thermal storage for demandside flexibility services, with WSP responsible for exploring regulatory and commercial frameworks

4.Alpha Phase Planning: A plan for the Alpha phase, including technical assessment, cost-benefit analysis, and stakeholder engagement. UoB will lead on the technical aspects, while WSP will handle stakeholder engagement and economic analysis.

5.Dissemination of Findings: Communication of project results through multiple channels, including a lesson learnt report, media releases, webinars, and conference papers, ensuring transparency and stakeholder engagement throughout the project. WSP will lead dissemination efforts, with support from NPg and UoB.

Dissemination Strategy The dissemination plan targets key stakeholders, including networks, academia, and consumers, while also engaging wider bodies responsible for vulnerable consumers and local planning, such as Citizens Advice and local government, to ensure public awareness and alignment with broader energy resilience efforts. Main activities include:

- Lesson learnt: A detailed summary of the project's findings and challenges, providing a clear implementation plan for future phases.

Media Release: A public-facing overview of the project's outcomes, distributed by key partners to raise general public awareness.

Show & Tell: A Show & Tell session presenting key findings and technical solutions to DNOs, academics, and industry professionals.

Conference Paper: A peer-reviewed paper showcasing the project's innovative aspects, submitted to conferences like CIRED to encourage knowledge exchange.

Promoting Market Competition The project will promote rather than undermine competitive markets by fostering innovation in thermal storage solutions. By developing flexible, cost-effective systems, we aim to create market conditions where multiple providers can offer diverse energy storage solutions. Our engagement with key stakeholders, including regulators like Ofgem, will provide policy makers with a key source of evidence to inform future policy and regulation.

Commercials

Intellectual Property Rights (IPR), procurement and contracting (not scored)

Intellectual Property Rights (IPR) (not scored)
For the Discovery phase of our project, we will adhere to the default Intellectual

Property Rights (IPR) arrangements as outlined in Chapter 9 of the SIF Governance Document. This approach is aligned with the project's collaborative nature and the diverse contributions of all partners involved.

Lead Partner and Stakeholder Collaboration
Northern Powergrid, as the lead partner, will take primary responsibility for managing IPR matters throughout the project. As a DNO, they will be the main entity responsible for integrating the outcomes of the project into existing infrastructure. Their role is crucial for ensuring that the project aligns with regulatory requirements and delivers tangible benefits to consumers.

Other Partners' Role in IPR
WSP UK, University of Birmingham and Together Housing will not retain any ownership of the IPR generated during the project. Their contributions will primarily consist of analytical inputs, data processing, and modelling based on standard software. Since the insights derived from the project will be rooted in inputs from Northern Powergrid and feedback from customers, it is appropriate that the ownership of any resulting IPR is assigned to Northern Powergrid and shared as necessary with other stakeholders.

Customer Input and Data Utilisation
Given that the project will involve extensive engagement with customers, their insights will play a vital role in shaping the development of electrified thermal storage solutions. Any intellectual property resulting from these customer interactions will also fall under the ownership of Northern Powergrid, ensuring that the benefits are maximised for network users and consumers alike.

Justification for Default Arrangement
Utilising the default IPR arrangement simplifies the management of rights and responsibilities, allowing all partners to focus on achieving the project's objectives without the complexities of negotiating alternative agreements. This approach will facilitate collaboration, data sharing, and integration of findings into practical applications. It also ensures that innovations arising from the project can be implemented effectively, benefiting both the network and consumers, especially vulnerable customers who are heavily reliant on stable heating solutions.

Investment Needs

NIA RIIO-2 (NIA2_NGESO068): Market Signals for the Electrification of Heat
Amount: £400,000

Lead Organisation: NGESO (with WSP as a primary partner)

Description: This project investigates how flexibility market signals can encourage electrification of heating. It focuses on understanding necessary signals that the NESO should develop, alongside research into the adoption of flexible heating practices by domestic consumers.

NIA RIIO-2 (NIA2_NGESO012): COMMANDER
Amount: £500,000

Lead Organisation: NGESO (with WSP as a primary partner)

Description: Building on Open Networks and Regional Development programmes, this project investigates international trends and defines a roadmap for implementing schemes across Great Britain. Its relevance lies in enabling the flexibility of heat across the network, an area where WSP has significant experience.UKRI (EP/T022701/1): GREEN-ICEs

Amount: £1,204,099

Lead Organisation: University of Birmingham (UoB), Principal Investigator:

Professor Yongliang Li

Description: This project developed a novel integrated system for cold energy generation and storage using CO_2 hydrate. As a promising power-todispatchable cold solution, it contributes to grid flexibility and resilience, addressing key technological challenges. The project is now complete.

UKRI (EP/V041665/1): HARVEST
Amount: £1,504,773

Lead Organisation: UoB, Principal Investigator: Professor Yongliang Li

Description: This project focuses on developing next-generation power-to-heat technology through microwave heating for thermochemical energy storage, aiming for long-duration energy storage. It addresses significant scientific and technological challenges.

European Commission (101007976):

Amount: €892,400

Lead Organisation: UoB, Project Coordinator: Professor Yongliang Li

Description: This Research and Innovation Staff Exchange project aims to develop renewable and thermally driven cooling technologies. The focus is on leveraging renewable electricity/heat or waste heat for sustainable cooling solutions.

SIF (NPG_SIF_002/5): Diversified Flexible Queue Management Discovery and Alpha phase
Amount: £450,000

Lead Organisation: NPg (with WSP support)

Description: This project assesses customer load variation and asset flexibility while identifying existing and potential network capacity, enabling faster connections. It highlights the pre-existing relationship between NPg and WSP, leveraging their experience from prior SIF-funded projects.

Value for money

How much will the Project cost for the Discovery Phase and how does it represent value for money for the consumer?

The total project cost will be £177,008 with a total of £28,192 from the partners with a request for a SIF funding of £148,815. The breakdown of cost for each work package is summarised below:

WP1: Feasibility of Electrified Heat Storage Products
Total cost: £34,510.00 (23.4%)

*NPg: £1,350

*WSP: £5,360.00

*UoB: £27,800

*THA: £0

WP2: Supporting Vulnerable Customers During Grid Outages
Total cost: £36,991.00 (25.0%)

*NPg: £1,350

*WSP: £30,204.44

*UoB: £5,400

*THA: £0

WP3: Exploration of Market Mechanisms
Total cost: £29,746.00(20.1%)

*NPg: £2,700

*WSP: £27,000.62

*UoB:£0

*THA: £0

WP4: Planning of Alpha Phase
Total cost: £21,443.00 (14.5%)

*NPg: £1,800

*WSP: £15,148.16

*UoB: £4,500

*THA: £0

WP5: Dissemination and Communication
Total cost: £26,125.00 (17.1%)

*NPg: £2,700

*WSP: £18,945.69

*UoB: £3,600

*THA: £0

Contribution and SIF funding requested:

*NPg will contribute 12% of their time, with a contribution of £1,350. They request a total of £9,900 from SIF funding.

*WSP will contribute 10% off their rates, with a contribution of £10,870, requesting a total of £97,615 from SIF funding (effectively 9.51% after considering travel expense)

*UoB will contribute 10% of their time with a contribution of £4,588.89. They request a total of £41,300 from SIF funding.

*THA will contribute 100% of their time, contributing with an in-kind contribution of £12,000, therefore 100% of their project costs.

The project does not plan to have subcontractors or has additional funds.

The project will utilise existing research facilities at UoB to conduct feasibility assessments and tests, maximising resource efficiency. Upon successful completion, we plan to commercialise the innovation by integrating it into standard operations, to be planned at the Alpha phase. This will ensure it contributes to the energy market's flexibility and resilience, ultimately benefiting consumers by providing uninterrupted energy supply during outages.

Supporting documents

File Upload

SIF Round 4 Project Registration 2025-01-07 12_49 - 71.7 KB

Documents uploaded where applicable?

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