EnergyREV

The funding calls needed to advance the implementation of Smart Local Energy Systems

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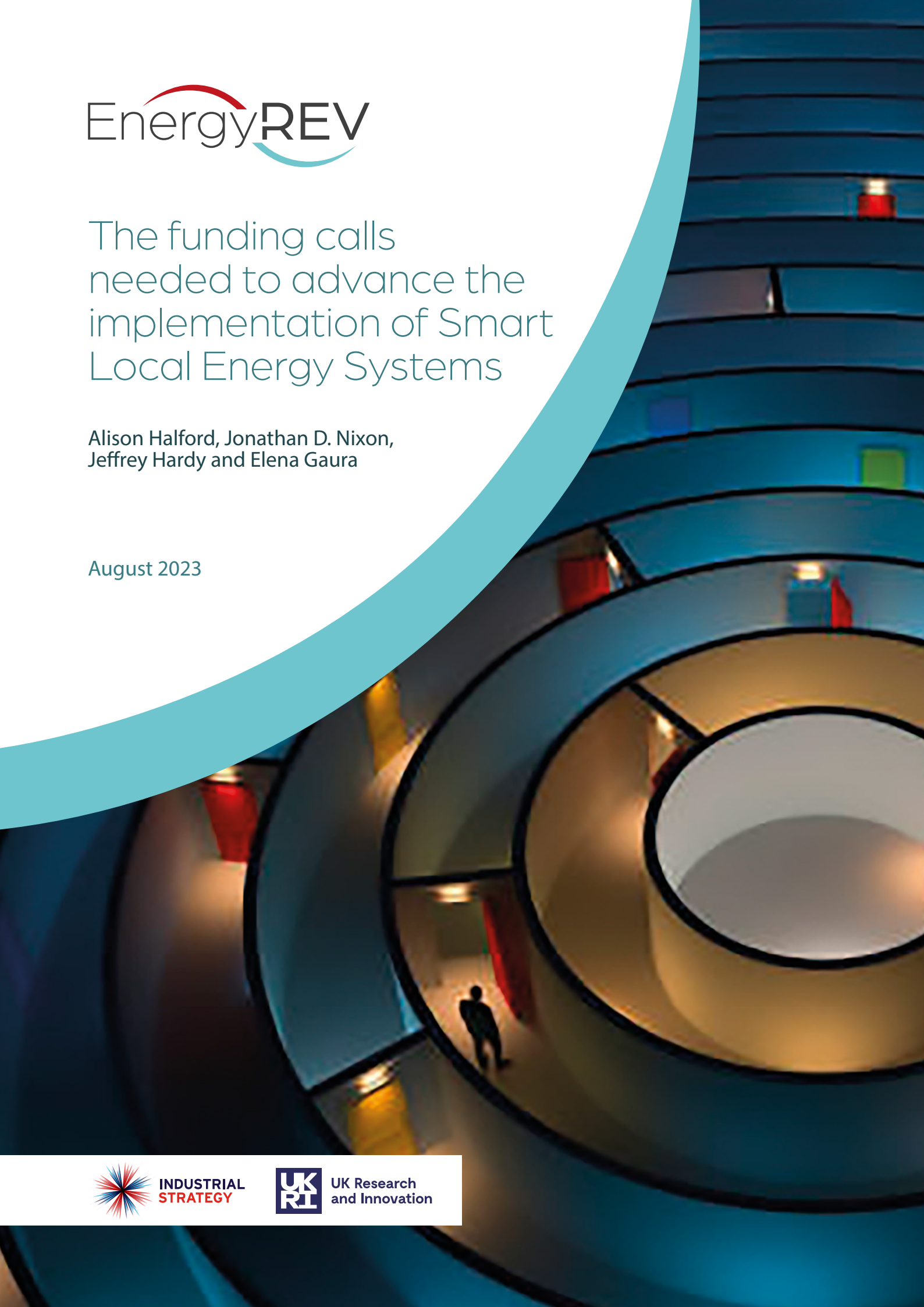

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Background

This paper is the outcome of a workshop delivered as part of the Energy Revolution Research Consortium (EnergyREV) 'Energy Smart Places: Insights from research and the challenges ahead' summit held in March 2023, in London. Funded by the Prospering from the Energy Revolution (PFER) Industrial Strategy Challenge Fund, EnergyREV delivered research to accelerate the uptake and increase the value and impact of Smart Local Energy Systems (SLES). From 2019-2023, over 60 researchers from 22 UK Universities contributed multi-disciplinary expertise and delivered new tools and insights on infrastructure, policy, regulation, user engagement and digitalisation of energy systems to support whole-system integration of SLES.

Purpose of the paper

SLES can provide resilient, sustainable, and affordable energy systems to improve the well-being of all. However, there are still challenges that prevent rapid uptake and wider deployment of viable SLES solutions (Fell et al., 2020). On 14th March 2023, researchers from the EnergyREV workstream on Cyber-Physical Advances in Smart Local Energy Systems organised a Decision Theatre workshop for energy stakeholders to identify some of the challenges to transition to fully digitised, flexibly interconnected, multi-layer plug-and-play architectures.

This paper is a summary of the Decision Theatre outcomes. These outcomes can aid funders, researchers, and other bodies, such as the Department of Energy Security and Net Zero (DESNZ), in the following ways:

1. Providing insights into gaps in knowledge and challenges to architecting, implementing, and embedding SLES.
2. Suggesting multidisciplinary research opportunities that produce new methods and approaches to accelerate the UK energy digitisation and digitalisation.
3. Offering guidance for future research that looks to address the barriers to, and realise the benefits of SLES, to support UK net-zero objectives.

Why a Decision Theatre?

The workshop delivery method was a Decision Theatre – a method proven by other EnergyREV work streams to be useful when working with energy stakeholders to identify and prioritise, actions, policies, and innovations that enable the implementation of SLES (Hardy and Morris, 2022). In particular, Decision Theatres have the capacity to bring a wide range of stakeholders together to facilitate collective decision making that promotes inclusion and diversity of thought.

Participants with expertise in cyber-physical systems, data pipelines and digital architectures were invited from across industry and academia. This diverse cohort reflects the complexity of SLES, which involves interactions between data, users, and physical network infrastructure that responds to social, environmental, financial, and regulatory impacts (Ford et al, 2021). Some of the participants were familiar with EnergyREV, having been involved in some capacity with previous research. For others this was their first encounter with the project. To ensure all participants could contribute fully to the discussion before the Decision Theatre, each participant was sent an overview of EnergyREV Cyber-Physical workstream outputs. In addition to clarifying the aims, objectives, and outcomes of EnergyREV, this briefing shared some of our research findings on developing a flexible, robust digital architecture that can optimise energy systems and current practices around energy data (Verba et al, 2021). Bearing in mind those insights, participants were asked to identify and submit at least one challenge facing cyber-physical systems for the next generation of smart places. The challenges were then reviewed by us and mapped around three themes; Energy communities and smart energy places; Cyber-physical systems and energy data; Cyber-physical architectures (see Table 1).

At the start of the Decision Theatre, the participants were given time to reflect on all the challenges identified and asked:

Imagine you have complete authority to develop a funding call to address these challenges.

- What is the title of this call?
- What would be the call's key features?

The intent was not to produce funding calls but rather for participants to collectively identify potential funding call titles, their vision and key features of research funding opportunities that could respond to the identified challenges.

Table 1: Participant challenges mapped within themes

Energy communities and smart energy places	Cyber-physical systems and energy data	Cyber-physical architectures
Those working with cyber-physical systems are not adequately prepared to increase public understanding of data and AI and to listen to their concerns	Existing policymaking and regulation practices are not sufficient and appropriate to keep up with technological advances	Black-box AI models do not offer intuitive explanations for their decisions
People's engagement and interfaces with digital energy tools are not sufficiently developed to foster improved well-being	There are insufficient incentives to encourage companies to share data and co-benefit from system integration	The control and management of flexibility across multiple interconnected energy networks needs to be improved

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Energy communities and smart energy places	Cyber-physical systems and energy data	Cyber-physical architectures
System designers lack sufficient understanding to ensure human factors are considered and customers are educated so that smart energy is of benefit to them	New methodologies need to be developed that use digital technologies and data to handle complex decisions	The selection and use of the right data types from different ICT devices and locations needs to be improved to provide more scalable and informed decision making
There is insufficient attention on other tangible benefits of AI energy systems that can be shared with the public	There is concern about the safety and security of people's homes and properties due to the increasing use of IoT and smart energy	More understanding is needed around flexible consumption to address the electrification of the heat and transport sectors
Concerns around the privacy of people's data and lifestyle result in them not feeling in control of their data and decisions	Companies' are unwilling to share performance data from their energy generating assets	There is not enough proper and effective condition monitoring of cyber-physical infrastructures to guarantee the reliable operation of SLES
There is uncertainty on how smart local energy systems and customers will interact in the future	More needs to be done to ensure safe and privacy-preserving AI practices around energy data usage for consumers	More development of system wide interoperability and plug and play capabilities are needed to future-proof smart energy applications
There is not enough understanding of the role organisations and institutions have in increasing public awareness around smart local energy systems.	There is a lack of robust data from off-grid energy generating assets	A renewed focus on Cyber-physical infrastructures at the operational level is needed to support the delivery of our future energy system
There are difficulties in engaging public understanding and trust of advances in energy systems – without leading to them feeling 'out of touch'	More data-driven approaches to develop and deploy CPS and/or future energy system designs that incorporate safeguards to preserve the privacy of individuals are needed	Actions to address robustness, uncertainty, and interpretability challenges in applicable AI / Machine Learning are required adequately support future energy systems
Users' needs and interactions are not considered sufficiently when developing and implementing new technologies and advances in AI	There is not enough support for companies willing to share data to create co-benefit from system integration	Concepts of where AI and data can help our energy system need to move forward into "business as usual" benefits

Individual to collective: negotiations and alliances

During the Decision Theatre, each participant produced a title and several key features that they would like to see in a funding call to address the challenges presented in Table 1. Through participants forming alliances and negotiations, the fifteen call titles became the basis of four new titles. These titles are intended to provoke new ways of thinking when conceptualising research themes and generate creative methodological approaches to real-world challenges.

Table 2: The fifteen titles, which participants combined through voting and alliances to arrive at 4 new call titles

Call 1: Business legal models of integrated AI data analytics	**Call 2: Scalable AI: energy for all**
Business and legal models for AI in SLES – addressing the complexity that is holding down advances AI for grids future services – validation driven, robust, resilient, safe net-zero systems	Virtual power plant and energy data – use data from a virtual power plant to build and demonstrate best use of energy data practice All for AI, AI for all – scalable AI models, discrete to community protocol, open-source model, and data AI from zero–integrated approaches to Net Zero – novel approaches for system that is AI enabled Integrating community in SLES – Bigger scale demonstrators, impact on, and involvement of people, real data from real users AI and diversity of customers – test pilots and deploy communications
Call 3: Community powered AI, for the people, by the people	**Call 4: Data for the future of smart energy systems**
Community powered AI – understandable, local Explainable AI – understanding data, recognising the role of all different stakeholders and minorities Educating end users on SLES – adopt and develop new institutions How to humanise energy transition – address social acceptance by capturing human-digital interaction needs	Creating integrated SLES – optimising energy resources, interoperable AI devices and service-driven by needs Integrated energy hub – access to energy data from smart meters, pull data from different sources, work with DNOs Net-zero energy data architecture – sharing data to support energy trading and data security Data for future SLES – Collection of large-scale data to validate our answers. Collection and pipelines must be challenge-driven rather than phishing from the data

Future funding calls: Shaping the future role of AI, cyber-physical systems and digitalisation in the energy sector

The final four titles, vision, and key features.

Call 1: Business legal models of integrated AI data analytics

Vision

A multidisciplinary project that brings AI, legislation, and economics together to address current legal and economic challenges that limit integrated AI data analytics in the energy sector.

Key features

- Introduces new regulatory and legal models that address legal and business implications for stakeholders when implementing new technology, including innovative approaches to data profit sharing.
- Interrogates the extent to which businesses have access to sufficient resources, regulations, and agility to ensure responsibility and accountability in increasingly interoperable energy systems.
- Identifies regulatory barriers around data to ensure systems/practices/legislation/policies are flexible and responsive to deal with advances in the application, management, and distribution of fully digitalised systems.

Call 2: Scalable AI; energy for all

Vision

To develop a meaningful large-scale demonstrator which offers interfaces designed with common languages that evidence scalability and allow for public interaction to encourage a more energy and AI-aware population.

Key features

- Incentivises communities to learn more about energy and data to become more energy digital literate.
- Promotes industrial scalability of energy systems by identifying gaps and barriers to upskilling, training, and education.
- Develops a large-scale demonstrator that has real-world applications and upscalable AI models that can be transferable to multiple settings including schools, homes, businesses.
- Delivers high quality AI protocols that are accepted and bolstered by community support, thereby creating a classification model for successful applicability of AI models (Class A, B, C etc.)

Call 3: Community powered AI, for the people, by the people.

Vision

To promote a democratisation of the energy transition by supporting community involvement in the decision making and development of sustainable, replicable AI models that have real-world implications.

Key features

- New models (policy, financial, technological, and community-based) that incentivise members of the public to get involved in energy decision making.
- Develops a common framework around an 'explainable AI' language that demystifies technical references to allow for collective knowledge across a variety of learner levels.
- Prioritises voiceless communities, who are traditionally marginalised in energy decision making, by exploring how to involve them in the development and implementation of AI models.
- Considers new data ownership models that shift away from the data IP held within siloed organisations and towards shared ownership of data with the consumer.

Call 4: Data for the future of smart energy systems

Vision

To increase societal and sectoral trust in machine learning systems/data processes through improving data processes that lead to robust, ethical, and resilient foundations for more useful future applications of Virtual Power Plants and digital twins.

Key features

- Adopts a hypothesis-driven data collection that supports a whole systems approach to improve data pipelines.
- Generates new understandings around structured, purposeful data collection that can drive energy decision making, optimization and scalability.
- Develops a demonstrator that shows how to make better decision-making using hypothesis- driven data collection.

Post-Decision Theatre, we reviewed and mapped the challenges against the four titles to understand to what extent the features addressed these challenges.

Table 3: The four titles mapped to the challenges

Challenge themes and titles to address them	Business legal models of integrated AI data analytics	Scalable AI; energy for all	Community powered AI, for the people, by the people	Data for the future of smart energy systems
Cyber-physical systems and energy data				
Manage safety and security risks arising from new cyber-physical infrastructure data streams	x			x
Encourage companies to share energy data and co-benefit from system integration	x	x		

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Challenge themes and titles to address them	Business legal models of integrated AI data analytics	Scalable AI; energy for all	Community powered AI, for the people, by the people	Data for the future of smart energy systems
Implement AI practices that preserve privacy	x		x	
Develop new robust methodologies for using big data to handle complex decisions				x
Identify and select the right data types for scalable and informed decision making			x	x
Cyber-physical architectures				
Improve control and management of multiple interconnected energy networks	x	x		
Plan for the electrification of the heat and transport sectors	x			
Optimally manage flexible network planning and operations	x	x		
Implement effective condition monitoring of cyber-physical infrastructures				x
Avoid black-box AI models that do not offer intuitive explanations for their decisions				x
Consider human factors within cyber-physical architectures		x	x	x
Energy communities and smart energy places				
Promote policymaking and regulation that keep up with technological advances	x		x	
Interact with the public on AI to understand needs and build trust			x	
Increase public awareness around smart local energy systems and their tangible benefits		x	x	
Develop new inclusive digital tools to engage and interface with people and communities			x	
Ensure privacy of people's data and lifestyles and make consumers feel in control			x	x

Next steps

In the process of making decisions during the workshop, inevitably more questions and challenges emerged regarding the extent to which existing institutional and organisational practices support multidisciplinary efforts. Promoting interesting and innovative research partnerships can result in a shift away from a singular technological approach and move towards an explicit focus on how advances in cyber-physical systems impact the everyday lives of people and communities. By providing inclusive spaces that facilitate cross-sectoral exchange and diversity of thought in the energy ecosystem, the Decision Theatre is a useful tool to drive research ambition by translating real-world challenges into research opportunities.

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About EnergyREV

EnergyREV was established in 2018 (December) under the UK's Industrial Strategy Challenge Fund Prospering from the Energy Revolution programme. It brings together a team of over 50 people across 22 UK universities to help drive forward research and innovation in Smart Local Energy Systems.

ISBN

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