EnergyREV

Lessons from EnergyREV:

THE ROLE OF SMART LOCAL ENERGY SYSTEMS

in a net zero future

This document includes **interactive elements.** Look out for this icon.

UK Research and Innovation

EXECUTIVE SUMMARY

Executive summary

Smart local energy systems (SLES) bring together energy supply, storage, heat, transport and buildings in a local area.

They connect them in a smart way using data and digital technologies, and provide new ways for people, communities, and other local stakeholders to get involved.

SLES can deliver many local and national outcomes including:

- **Energy system benefits** such as grid optimisation, enhanced voltage and frequency control, grid stabilisation, improved energy security, and balancing, capacity and flexibility services.
- **Financial benefits** at the national scale through reduced need for grid reinforcement (up to £2.5bn/year) and from targeted place-specific action unlocking £108bn savings for consumers and £825bn wider social benefits.
- **Economic benefits** from stimulation of local supply chains, employment opportunities, up- and reskilling opportunities, spin-out of innovation, new business model development, and increased local revenue.
- **Household and community benefits** including lowering the cost of energy and bill reduction, fuel poverty reduction, increased thermal comfort, and reduced technology costs or payback periods.
- **Environmental and social benefits** such as carbon reduction and improved air quality, sustainability, regeneration and smarter planning, improved health and wellbeing, community empowerment, social cohesion, and improved sustainability education.
- **Equity and justice outcomes** through public engagement,transparent and participative decision making, inclusive governance and accountability structures, local ownership models, and fairer distribution of costs and benefits.

However, realising this value is complex, and requires aligned actions from many stakeholders across a range of activities.

EnergyREV's research identified a series of recommendations for government policymakers, Ofgem, SLES developers, SLES programme funders, educators and qualifying bodies.

These recommendations outline steps these different stakeholders can take to deliver the *seven building blocks* necessary for unlocking the value in SLES.

- **Develop robust policy, regulation and governance**
- **Create a collaborative environment**
- **Build local skills**
- **Engage and empower the local community**
- **Unlock innovative business models**
- **Ensure market value and interoperability**
- **Underpin with robust cyber-physical infrastructure**

Develop robust policy, regulation and governance

To provide the policy context, regulatory frameworks and governance models needed for SLES to emerge at scale, actions are needed from Government and Ofgem.

Government should:

- Establish long-term policy objectives and instruments for net zero carbon localities and devolve resources and responsibilities for carbon budgets.
- Institutionalise local net zero carbon planning and implementation through statutory powers and devolved resources and capabilities.
- Build capacity for integrated local programmes through investing in local authority net zero teams via long-term government funding.
- Require public procurement to prioritise delivery of net zero.

Ofgem should:

- Place obligations on DNOs to enable SLES through co-ordinating and engaging with LAs and other DNOsand the ESO, and providing open data to support whole system innovation and planning.
- Ensure consumer protection is fit for purpose. As SLES are integrated into power system operation, the interests and protection of prosumers operating within these platforms, as well as consumers operating outside of them, need to be accounted for.

Click building block for more detail.

These recommendations can also be seen for each stakeholder below...

Government | Ofgem | SLES developers | SLES programme funders | Educators and qualifying bodies

To provide the policy context, regulatory frameworks and governance models needed for SLES to emerge at scale, government should:

- Establish long-term policy objectives and instruments for net zero carbon localities and devolve resources and responsibilities for carbon budgets.
- Institutionalise local net zero carbon planning and implementation through statutory powers and devolved resources and capabilities.
- Build capacity for integrated local programmes through investing in local authority net zero teams via long-term government funding.
- Require public procurement to prioritise delivery of net zero.

To engage the public, build support and enable them to shape future SLES, government should:

- Acknowledge and address the gap between expert and public understandings of local energy systems. While some local authorities are incorporating energy education into school and college curricula, this needs to happen more broadly.
- Provide direct funding to support local authorities and community groups engage the public with SLES.

To support the development of a workforce capable of delivering and operating SLES, government should:

- Support training needs within local authorities to grow capacity in building partnerships, manage large sets of stakeholders, make evidence-based decisions and enable technical understanding and decision making related to SLES implementation.
- Stimulate supply chain growth by providing (1) consistent messaging on long-term SLES policies to employers, educators and workers, and (2) stable support for jobs and training mechanisms.
- Regulate to ensure properly certified qualifications for SLES jobs.
- Provide core funding to colleges and qualifying bodies to develop new qualifications and ensure resourcing levels.
- Provide direct financial support to enable SMEs to participate in SLES apprentice programmes.

To support the development of robust and ethical cyber-physical infrastructure, government, working with Ofgem, should:

- Develop and formalise a SLES ontology by building on existing concepts and bringing together domain experts with knowledge engineers to create a common understanding of all the functions of an SLES.
- Set shared technical standards and guidelines to support interoperability.
- Develop and implement good, comprehensive cybersecurity guidelines that cover both physical and cyber infrastructures.
- Support industry to produce more affordable and cyber-secured devices and services, including guidelines on minimum function and security requirements.
- Ensure compliance testing and certifications are in place and carried out by an independent third party to guarantee SLES components are designed to an acceptable security level.
- Embed a stronger consideration of ethical practice into regulation related to the use of machine learning, artificial intelligence and autonomy in energy system operation.
- Create an ethics-conscious corporate culture by supporting companies to invest in programmes and training that raises awareness of ethical considerations.
- Review the effectiveness and appropriateness of data privacy restrictions, given the increasing capabilities and availability of AI tools.
- Invest in detailed sector-specific research around the use of energy data and AI to aid an industry-wide move to adopting dynamic and responsive ethical principles.

To unlock value from SLES through new approaches to market design, including peer-to-peer energy and flexibility trading, government should support Ofgem to:

- Define roles and responsibilities associated with peer-to-peer energy and flexibility trading, including how balancing responsibilities are assigned and network charges are allocated.
- Explore how machine learning techniques and improved modelling of prosumer behaviour can be integrated into traditional market models so they can learn to deal with new scenarios as the number and operation of grid-edge assets evolves.
- Develop an approach, e.g. using multiscale market design, to manage uncertainty, conflicts and flexibility between distribution and transmission networks.

Click stakeholder for more detail.

In addition to the set of specific recommendations for key SLES actors, insights drawn across the seven SLES building blocks revealed cross-cutting challenges. To address these challenges, and ensure SLES are successful and flourish across the UK, key next steps include:

- **Vision** and **strategy**
- **Power** and **resources**
- Better **structures**
- Align **value**
- **Reframe** and **talk**

Click key step for more detail.

NET ZERO AND AN ENERGY REVOLUTION

Net zero and Smart Local Energy Systems (SLES)

Key message:

A smart local energy system brings together energy supply, storage, heat, transport and buildings in a local area. It connects them in a smart way using the data and digital techonolgies, and provides new ways for people and communities to get involved.

As energy systems around the world adapt in response to global climate change, we see a shift towards not only more renewable generation, but smarter systems with greater levels of demand-side flexibility.[1,2]

More decentralised generation and distributed energy resources is driving more local energy operation, as can be seen in the upsurge of microgrids and peer-to-peer energy services. This includes the UK's own transition from Distribution Network Operators (DNOs) to Distribution System Operators (DSOs).[3]

Decarbonising heating also requires a local approach.[4] The placed-based nature of heat demand in homes and businesses calls for changes to individual buildings, potentially engaging millions of independent decision makers.

Local delivery can align decarbonisation activities with other local strategies and plans, as well as local infrastructure requirements and socioeconomic characteristics. Local authorities are well placed to implement these across their own operations, as well as extending to net zero energy systems integrating heat, power, transport and storage at local scale, implementing smart technologies, and reducing overall demand.[5]

The emerging 'smart local energy systems', or SLES, see new collaborations across stakeholders, including local authorities, local enterprise partnerships, community groups and grassroots organisations, as well as the private sector.[6] Bringing together diverse stakeholders locally, SLES can make the transition to net zero faster, cheaper and more equitable.[7,8]

Prospering from a **SLES revolution**

Prospering from the Energy Revolution' (PFER) – a ground-breaking £104m research and innovation programme – ran from 2018 to 2023 supported by the UK's Industrial Strategy Challenge Fund. It set out to explore how local energy systems could create innovative business models to deliver cleaner, cheaper energy in ways that people like, that investors are keen to finance, and that can scale across the UK[9] and beyond.

The PFER programme catalysed three demonstration projects and 10 detailed design projects to provide new business model approaches across the UK. These trials took a portfolio approach to learning, aiming to stimulate knowledge sharing across the programme and beyond. This relied on capturing translatable insights into what worked (and didn't work), for whom and in what context.

The PFER programme also spearheaded the EnergyREV research consortium, a group of 22 UK universities working alongside pilots to pull together learning, create new knowledge and disseminate that knowledge to help the transition to a new world of energy provision.

EnergyREV conducted research along *six main interlinked themes*.

EnergyREV Key Themes:

Infrastructure
Adapting advances in AI, data analytics and controls to enhance smart local energy systems.

Business
Understanding the current local energy business sector to accelerate innovation.

Institutions
Assessing policy, regulation and markets to enable local energy sector change.

Users
Revealing how user preferences and practices evolve over time in relation to local energy systems.

Developing a whole systems understanding
Capturing and synthesising knowledge from all aspects of the value chain and sharing and utilising learnings.

Supporting scale-up
Understanding potential constraints that can prevent scale-up of local energy systems and identifying solutions to overcome them.

Over the duration of the PFER programme, the EnergyREV consortium published more than 50 reports, 60 academic papers, and close to 100 blog posts. It ran two large conferences in London (Sept 2022 and March 2023), supported 131 person-days of engagement with external stakeholders, formed a cross-government policy contact group and launched the Local Zero podcast. These individual outputs are accessible on the EnergyREV website for those looking for detailed insights related to specific parts of the programme.

In this report we consider the bigger picture for SLES, drawing together key insights from across the programme to outline:

1. What smart local energy systems are
2. The value they offer to deliver net zero and other policy priorities
3. What action is required to unlock this value, in places and at scale
4. The challenges remaining and key pathways forward

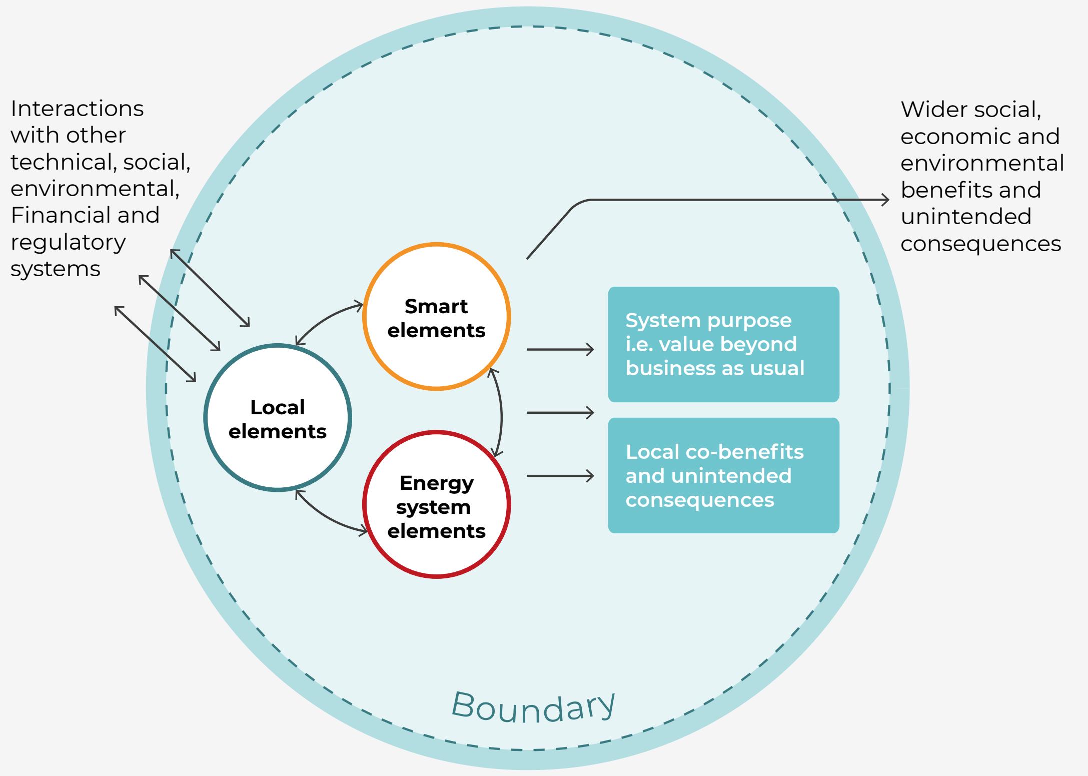
INTRODUCTION TO **SLES**

SLES framework

Key message:

SLES bring together energy supply, storage, demand and infrastructure. They connect them in a smart way, at a local level such as a town, city or region. They are not a specific end-product or technology. Instead, They are an approach to design, build and manage future energy systems. It is the how, not the what.

EnergyREV's SLES framework[10] provides a structure through which stakeholders can explore SLES. It does not produce a single, fixed definition of what a SLES is or should do, but provides a consistent way to explore questions like 'What value or services does the system or project aim to deliver?', 'How is "smartness" understood and delivered?' and 'What makes the system "local" and how are boundaries drawn?



System value: The additional benefits (and unintended consequences) they create, as well as the broader co-benefits they may bring (e.g., creating local jobs, strengthening local decision making, demonstrating local leadership within the UK).

Interactive diagram: Click ●●●● buttons for more detail

EnergyREV SLES Framework. See[10] for full detail

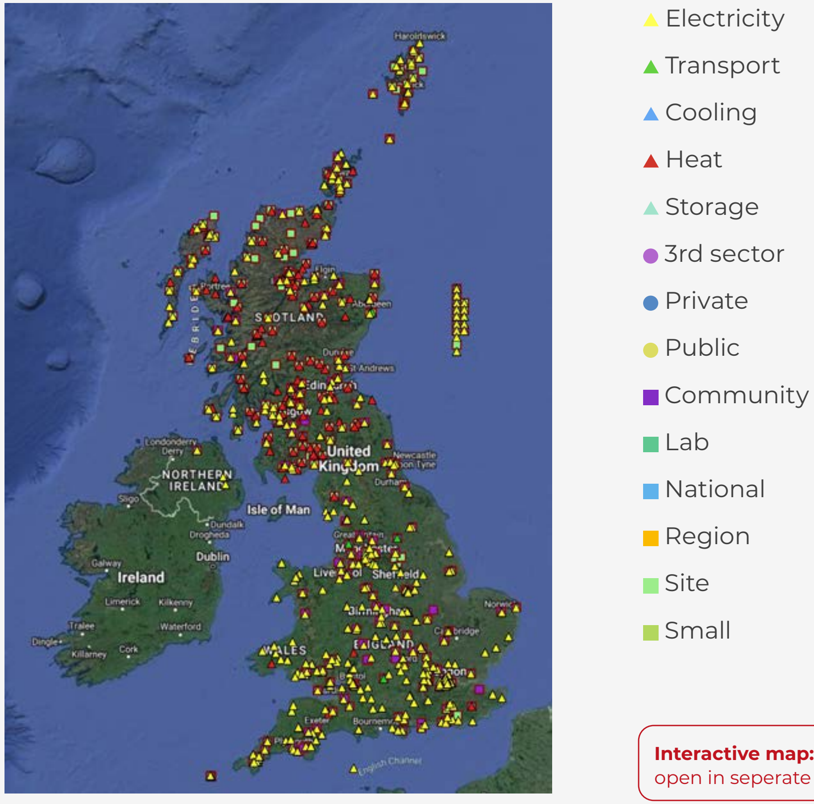
SLES: A brief history

Key message:

Smart Local Energy Systems exist across the UK. They are incredibly diverse, but over time have become more complex and 'smarter'.

Shifting from a conceptual understanding of SLES to a practical understanding of what they look like in practice is challenging. There is wide-ranging diversity in the mix of technologies, geographic scales, actors involved and outcomes desired.

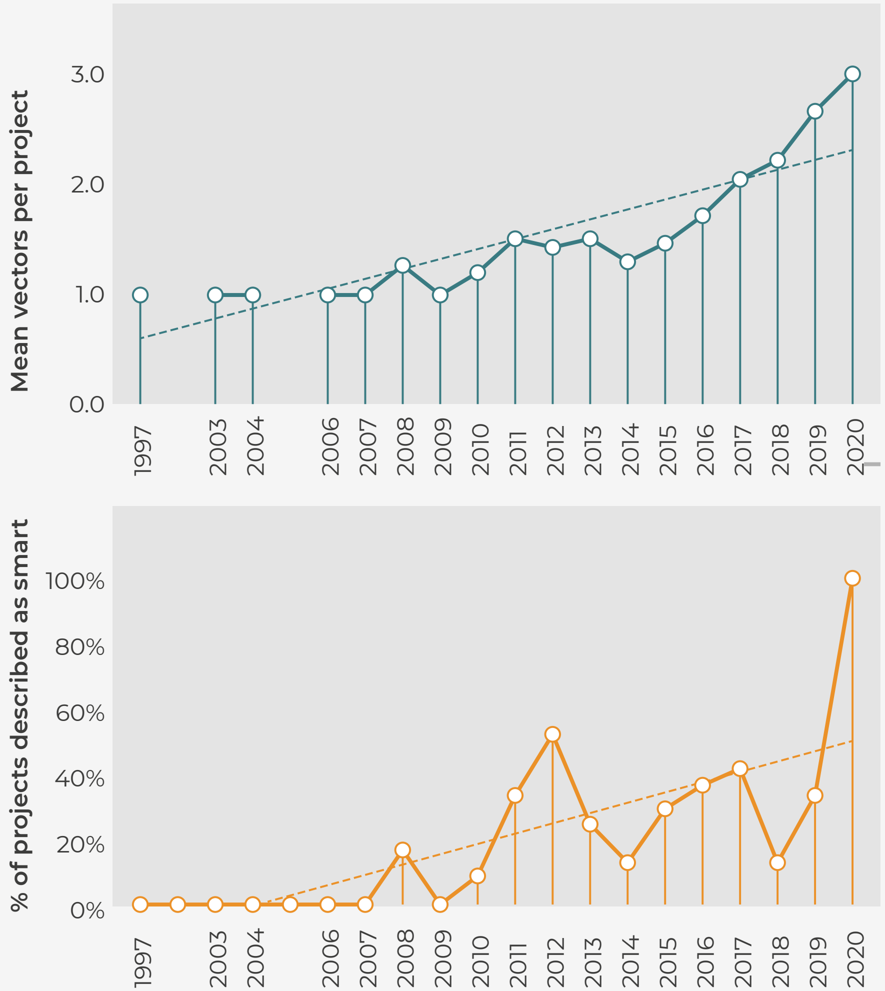
Recent decades have seen a marked increase in the number and variety of local and community-scale energy projects in the UK. These include renewable generation deployment, building fabric improvements, energy efficiency and demand reduction.



Interactive map: Click to open in seperate window

GIS map of local and community energy projects

This diversity can be explored in EnergyREV's interactive database of local and community energy projects in the UK. These 754 projects differed according to location, scale, budgets, funding sources, sectors, energy vectors, technologies, organisations and consumer engagement.



Vectors per project and projects described as 'smart' over time

SLES diversity is both necessary and expected given the 'local' context of these projects; a solution appropriate in one location and for one group of stakeholders may not be needed or appropriate elsewhere.

Analysis of the projects within the database revealed a subset that implemented integrated or 'systems' type solutions across supply, distribution and demand.

Over time, local energy projects have become increasingly complex, combining energy technologies, vectors, services and behaviours in integrated approaches. They have also become increasingly smart, which is an important tool in managing the increasing complexity.

SLES: Diversity

Key message:

The diversity seen in different SLES is related to their specific local context, the type of stakeholders involved and their objectives, and whether they are grant funded or operating on a business-as-usual basis.

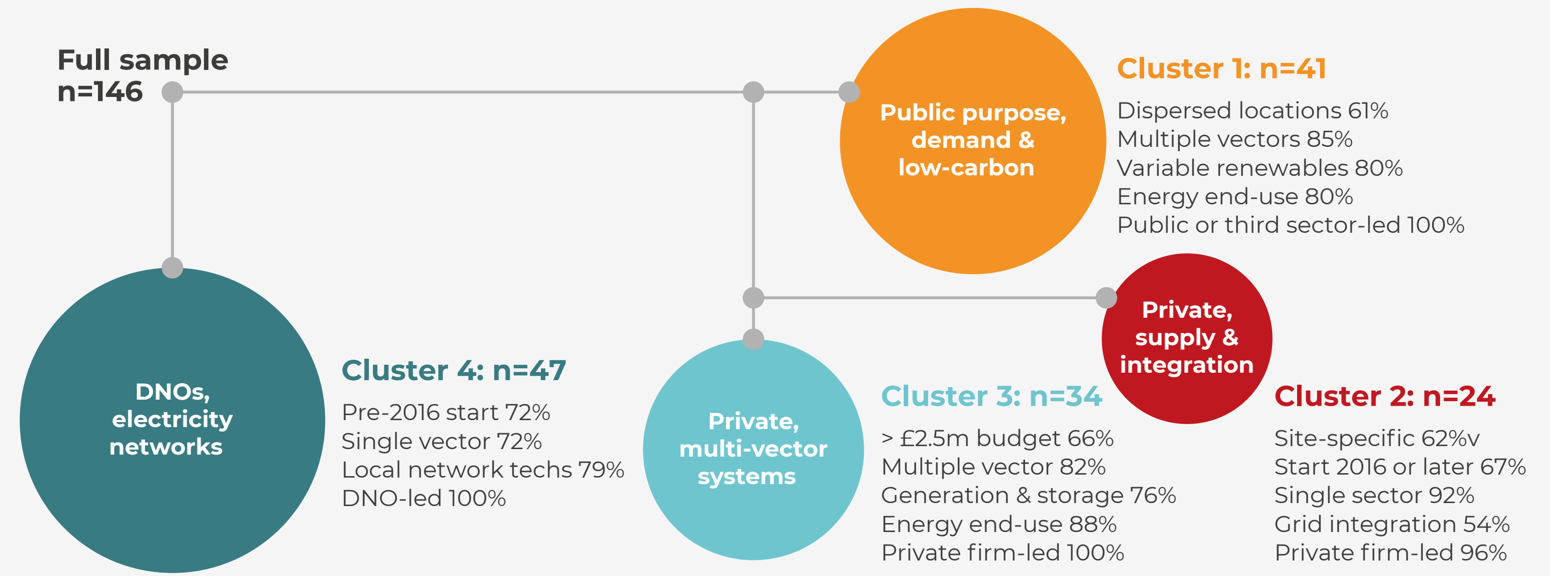
This leads to a range of impacts and outcomes at both national and local levels. Understanding these is important for policy development.

Smart local energy systems cannot be defined by a single set of outcomes, delivery partners or technology combinations. They are rooted in specific local contexts and implemented for a variety of reasons, with varying geographical, technological and institutional characteristics.

Different local contexts and actors give rise to different local goals. For example, some regions may suffer from high levels of fuel poverty and aim to address these through local energy system projects. Other areas may have different pressing needs, such as poor air quality.

Another key distinction stems from the business models and funding sources underpinning the SLES, including whether they are project based (i.e. time-bound and supported via grant or innovation funding) or operating on a business-as-usual basis.

We typically see four common types of SLES projects in the UK [11]



Four common types of local energy systems project. See [11] for more details.

Analysis of 146 local energy system projects showed four common types, distinguished by their geographic scale, the technologies they include, and their institutional characteristics.

More recent projects were more likely to have larger budgets (over £2.5M) and include a larger number of energy vectors, specifically heat and/or transport in addition to electricity. This reflects the shift over time towards addressing flexibility and system integration challenges.

Some SLES projects evolve over time in the same place, securing new funding and adapting to incorporate new learnings, challenges, or opportunities. Others run for shorter periods, do not secure further funding, and once initial funding has run out there is a risk that the projects dissolve. This cycling of projects resulting in short-term learning rather than long-term development forms a major challenge for supporting a widespread net zero transition. Local action needs to move beyond a project by-project focus to systematic area-based programmes.[5]

There are some local energy systems operating on a business-as-usual basis. Across the 29 Business-as-Usual Smart Local Energy Systems we reviewed[1,2] we saw a diversity of activities on the supply side (spanning generation, supply and/or management of electricity and/or heat) and demand side (including energy efficiency, demand side management, flexibility, storage and transport). They brought together a range of different technologies.

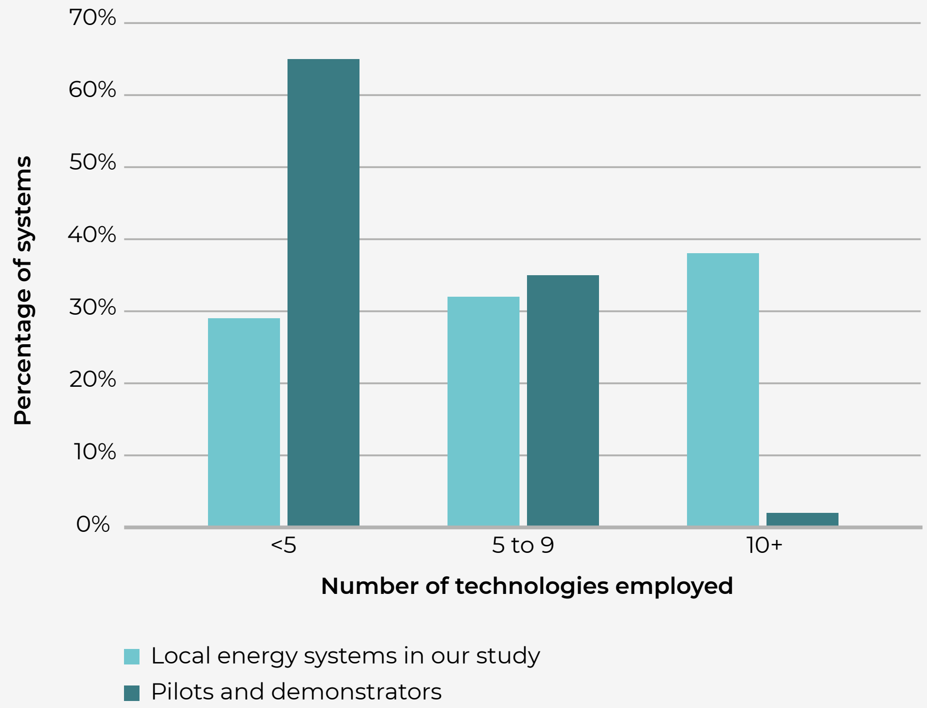
Technology grouping	Technology types included
Local electricity grid management	· Electric microgrid · Direct Current (DC) network · Active electricity network management · Electricity network data acquisition · Smart meters · Electricity demand data acquisition
Electricity grid integration	· LV grid monitoring · Smart grid · Demand response · Electric Vehicle (EV) charging · Vehicle-to-grid (V2G) · Wireless charging
Heating	· Biomass boiler · Heat pumps (any type) · Solar thermal · Heat network · Hybrid gas/electric heating
Hydrogen and alternative fuels	· Fuel cells · Hydrogen generation · Hydrogen storage · Alternative grid fuels · Biofuels
Electricity generation	· Solar Photovoltaics (PV) · Wind · Hydro · Combined Heat and Power (CHP) · Tidal or other marine · Anaerobic digestion
Energy storage	· Battery storage · Thermal storage · Storage heating
Other end user technologies	· Building management system · Low energy building · Smart lighting · Hydrogen vehicle · EVs

Compared to SLES projects, business-as-usual SLES tended to be smaller in geographical scale and less complex in terms of governance, yet they tended to incorporate more individual technologies than grant-funded projects.

These tended to include fewer 'smart' features than the grant-funded projects, and operate on a smaller spatial scale, below the level of a whole town or city.

Understanding this variation across SLES, and how this evolves over time, is important for developing appropriate policy support mechanisms. It is clear that there are no one-size-fits-all solutions. Funding, finance, business model and governance structures need to match the needs and characteristics of the desired SLES and its impacts.

A more nuanced approach is needed to understand how SLES aligns with the wider policy landscape, how its value can be unlocked, and what this means for scaling up to simultaneously meet national and local needs. Understanding the different types of benefits, at both local and national level, created by smart local energy systems is a critical first step.



Technologies employed by SLES projects. See[12] for full details.

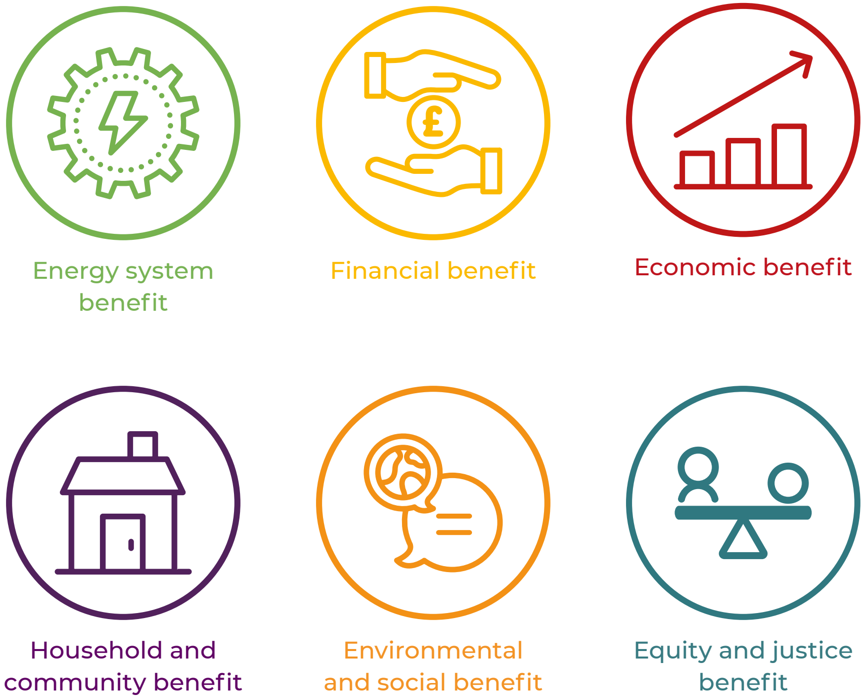
SLES **BENEFITS**

Benefits unlocked by SLES

Key message:

SLES can deliver many national and local benefits. However, not every SLES will deliver against each key outcome. Trade-offs may need to be made between outcomes. Monitoring and accounting for the diversity of outcomes is important to ensure value is fully captured, and that unintended consequences are mitigated against. Reporting what doesn't work, as well as what does, is critical for ensuring projects are delivering against societal outcomes as well as their own project goals.

There is a lot of evidence that points to the potential of SLES to deliver value against a range of policy priorities.[13, 14]



Energy system benefits

SLES can help deliver against the UK's net zero ambitions by providing energy system benefits that support wider integration of renewables. This could be through better grid optimisation; enhanced voltage and frequency control; grid stabilisation; and improved energy security.

With changes to market structures, SLES could also provide substantial balancing, capacity and flexibility services over a range of temporal and spatial scales.[15] This includes long-term benefits such as the deferment of distribution, generation, and transmission upgrades. At the other end of the temporal scale (i.e., the sub-second to hour system operating range), SLES can help increase system security, reliability and prevent blackouts.[16]

Financial benefit

Financial benefits can be captured across multiple scales. At a household level, they can help reduce bills, address fuel poverty, and reduce technology costs or payback periods. SLES can also bring national-scale financial benefits; balancing supply and demand at a local level increases efficiency and minimises grid losses compared to national solutions. This can reduce the spending on grid reinforcement and energy generation that would otherwise be required to meet projected demand growth, providing savings of up to £2.5bn/year.[17]

Work undertaken in the wider PFER programme shows significant financial benefit from taking a place-based approach to decarbonisation. Economic analysis finds that, across the UK, place-agnostic scenarios require £195bn investment to deliver, and release £57bn energy savings for consumers and £444bn wider social benefits. By contrast, a place-specific approach requires only £58bn investment, while unlocking £108bn savings for consumers and £825bn wider social benefits.

Economic benefits

Further economic benefits stem from the development of new business models, spin out of innovation, employment opportunities, and the potential for increased local revenue. The creation and operation of an SLES can stimulate local supply chains, create secure local jobs and opportunities for up- or reskilling, and provide opportunities for local businesses to grow.[18]

These findings are mirrored in more recent techno-economic feasibility studies in Perth and Borders.[19] Through analysis of different resource potential, energy demand and SLES configurations across each region, the studies highlighted the potential for minimising local energy costs and increasing revenue through combinations of local generation, electrification, local flexibility and smart system management. In Borders, seasonal thermal storage and the development of a hydrogen hub was also considered. These studies show the potential for significant local economic benefits from taking a SLES approach to developing locally and contextually appropriate energy solutions.

Household and community benefit

Research of 29 smart local energy systems in operation around the country on a business-as-usual basis[12] showed that they delivered direct benefits to households by lowering the cost of energy, providing price security and protection from energy market price volatility, increasing thermal comfort compared to previous systems, improving face-to-face customer service and, in three cases, increasing customer control over their energy supply through collective ownership of the energy system.

Wider community benefits were seen in a few cases, through the creation of community benefit funds or a local community development trust.

Environmental and social benefit

SLES can also deliver wider environmental and social benefits. This covers a range of outcomes such as carbon reduction and improved air quality, conservation and biodiversity improvements, increased sustainability, regeneration and smarter planning; enhanced siting of infrastructure, warmer homes, improved health and wellbeing, reduced burden on the NHS, community empowerment, social cohesion, and improved energy and sustainability education.

Equity and justice outcomes

This can extend into supporting equity and justice outcomes. The empowerment of marginalised and disadvantaged groups can be at the heart of SLES creation. It is often those who have the most to benefit from a just transition who do not engage with the current energy system; a place-based approach can target these groups to bring in the voices of those usually least heard,[20] for example, through public engagement, transparent and participative decision making, inclusivegovernance and accountability structures, enhanced opportunities for participation, local ownership models and fairer distribution of costs and benefits.

As each SLES scheme will be different in terms of leadership model, technology mix, geographical location and community priorities, it is not expected that all of these co-benefits will be desirable to, or achievable by, every SLES. In some instances, trade-offs will need to be made between the overall SLES design and the range of co-benefits sought.

Understanding the way in which a SLES delivers outcomes across different co-benefit areas is important to evidence how the project is meeting its objectives, and whether there are any unintended consequences to be addressed. These unintended consequences are important to capture and understand, so that over time, we can build insights across SLES projects around what works (and doesn't), for whom and in what context. This will help ensure future SLES are able to maximise positive societal and environmental outcomes, alongside delivering their own project-based goals.

EnergyREV's multi-criteria assessment tool[21] helps projects assess and monitor progress towards achieving the multiple potential benefits against their initial aims and aspirations. They can monitor, benchmark and understand the SLES project across six thematic areas of energy system technology, digitalisation, economics, management, and environmental and social impacts.

The **value-complexity** challenge

Key message:

Locally led, smart approaches can unlock significant value in a variety of outcome areas at both national and local scale. However, unlocking this value is complex, and requires aligned actions from many stakeholders across a range of activities.

SLES are able to deliver local and national benefits by taking a smarter and local approach to developing and managing net zero energy systems. By integrating local knowledge, building engagement and trust, enabling co-ordinated planning, and aligning action with existing local strategies, they can target action to where is it most needed and unlock local co-benefits. Scaling up allows these benefits to be unlocked at the national level, through knowledge sharing and the replication of innovative solutions.[22]

The Smart Local Energy System Prism. See[22] for full details.

There are aligned actions from many stakeholders across a range of areas. These include technology and system co-ordination activity, activities focused on people, organisations, skills and finance, as well as joining up power systems with heating and cooling, mobility and wider natural ecosystems. This complexity is depicted in EnergyREV's Theory of Change.

Within each layer, a range of activities are required to support the development of both the necessary conditions for creating a SLES and the conditions for delivering good outcomes. There are also many interlinkages between layers.

Creating SLES and unlocking value locally and nationally requires a whole-system approach that accounts for interactions across power, heat, mobility and natural ecosystems. To support this, organisations working across these key services must collaborate, engage users and develop innovative finance models. Appropriate skills need to be built to support these new ways of working, and new forms of data and infrastructure is needed to underpin operation.

Layer	Area	Necessary conditions for SLES	Development of Smart Local Energy Systems	Necessary conditions for outcome
Technology and systems coordination	**Technology/ systems interactions**	Markets and other control strategies harmonise across different SLES and with national structures.		Smart technologies, widely adopted, interoperable within and across SLES, to unlock local multi-vector flexibility.
	Data and digital	New products and services create economic value (savings and revenues) and social value.		Sensing and IoT leading to new data. Products and services developed to use data and operate SLES.
People and organisations	**Users**	Users and SLES interact in a way that supports both system operation and user benefits.		Local users participate in SLES and understand, support and champion value of SLES to community.
	Skills	Operating and maintaining SLES provides reliable and high-value local employment opportunities.		Workers with relevant skills are trained and present locally. Also presence of more general skills.
	Business, finance and organisations	Organisations sustain and grow revenues, create new businesses and benefit employees.		Organisations collaborate to design and develop SLES. Affordable finance available to developers.
Key services	**Heating and cooling**	Investment returns support growth. Benefits in reduced emissions, improved comfort and health.		Heating and cooling products and services adopted by users and operated to provide flexibility.
	Mobility	Mobility emissions reduced, positive health outcomes. Lower mobility costs increases disposable income.		EV uptake and operation to support local grid balancing. Reduced demand through active transport.
	Natural ecosystems	Enhanced ecosystem services and natural capital. Health improvements through access to green space.		Land use changes (e.g. for solar farms) provides opportunity to improve environmental outcomes.

Development of investable, scalable SLES that:

- Delivers cleaner cheaper energy services
- Builds more prosperous and resilient communities
- Benefits the whole energy system
- Uses integrated intelligent approaches
- Unlocks investment and accelerates commercialisation of new products and services

A simplified version of the EnergyREV Theory of Change

SLES
BUILDING BLOCKS

Building blocks **overview**

Key message:

Unlocking the value of SLES isn't about creating specific technology configurations to be rolled out through a place-agnostic approach. Instead, it's about building the right socio-technical environments that allow contextually applicable SLES to be created and delivered effectively across the UK.

Looking across the volume of EnergyREV research, insight reports and academic papers, we identify seven key areas where action is needed to drive the development and scale-up of SLES across the UK. These seven areas form our SLES building blocks of action.

Seven SLES building blocks are key to unlocking action:

- **Develop robust policy, regulation and governance**
- **Create a collaborative environment**
- **Build local skills**
- **Engage and empower the local community**
- **Unlock innovative business models**
- **Ensure market value and interoperability**
- **Underpin with robust cyber-physical infrastructure**

Click building block for more detail.

Develop **robust policy, regulation** and **governance**

Key message:

Local authorities and distribution network companies have important roles to play in delivering SLES. Strong government policy combined with rigorous governance and regulation are critical to ensure joined-up planning and integrated operation of SLES. An independent co-ordination function is an important but missing element. This is required to oversee and ensure net zero, and provide co-ordination between national and local action.

Local authorities, distribution network companies and government have key roles to play to support widespread development of SLES consistent with a net-zero energy system.

Interactive diagram: Click tabs for more detail

Local authorities | Distribution network companies | Government

Local authorities have a key role to play in delivering SLES.

Many have net zero carbon targets for both their own operations and regions. Some include plans for clean energy systems integrating heat, power, transport and storage at local scale. This can create enabling conditions for SLES through local strategic investment and planning.

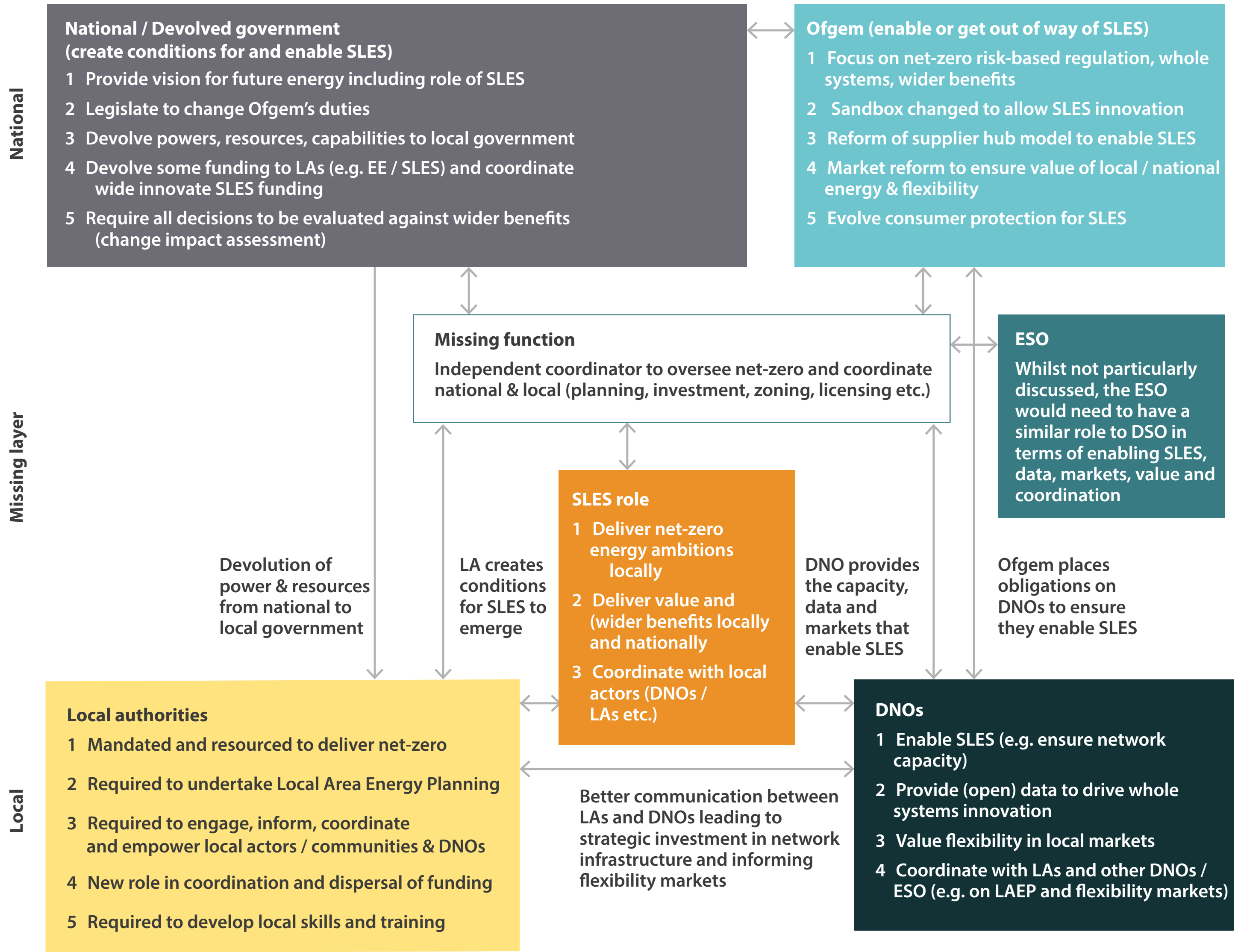
Local authorities can access grant funding, leverage wider investment in the region and bring institutional investors on board. Local infrastructure expenditure and public procurement provide major routes for local authorities to shape supply chains and markets, growing SLES in their areas. Further embedding SLES in planning processes, such as local area energy planning, can help align investments, shifting from a project-by-project approach to a more strategic regional approach.

However, across the UK there is a real patchwork of provision. While many places have strong ambitions, unlocking action often relies on the presence of finance teams, development plans, regeneration plans and strong links with community partners. Consequently, many local authorities lack the powers, resources and capabilities to effectively deliver the energy system planning role.[23]

Stronger co-ordination between local and national actors is important, for example, around planning, investment, zoning and licensing.[25]

Innovation programmes like PFER have helped catalyse the development of these relationships, but more structure and support are important to foster improved communications between local authorities and network companies and enhance strategic infrastructure investment.

Stronger governance is needed to promote transparency and accountability in the administration of local energy systems. This could be facilitated by a new body that sits between national and local energy systems.*



Summary of key decisions needed to enable SLES. See[24] for full details.

*This missing function could be provided by Regional Energy Strategic Planners (RESPs) in a new approach to energy planning, which will see RESPs create clear plans for how local energy systems need to be developed to reach net zero.

To develop **robust policy, regulation** and **governance:**

SLES sit across a range of key stakeholders and cut across existing policy silos.

This means that, while many people are interested in SLES, there is no 'policy owner' to support their development. Instead, they fall through the cracks between stakeholders, and even between teams within a single organisation.

To provide the structure needed for SLES to emerge at scale:

Government should...

- Establish long-term policy objectives and instruments for net zero carbon localities and devolve resources and responsibilities for carbon budgets.
- Institutionalise local net zero carbon planning and implementation through statutory powers and devolved resources and capabilities.
- Build capacity for integrated local programmes through investing in local authority net zero teams via long-term government funding.
- Require public procurement to prioritise delivery of net zero.

Ofgem should...

- Place obligations on DNOs to enable SLES through co-ordinating and engaging with LAs and other DNOs and the ESO, and providing open data to support whole-system innovation and planning.
- Ensure consumer protection is fit for purpose. As SLES are integrated into power system operation, the interests and protection of prosumers operating within these platforms, as well as consumers operating outside of them, need to be accounted for.

Create a **collaborative environment**

Key message:

Collaboration between different stakeholders involved in developing and delivering SLES can be supported through ensuring mutual advance or gain from working together, good communications, trust building, legitimacy in decision making, and strong leadership with clear governance structures.

Analysis of 147 SLES projects[11] and 29 business-as-usual SLES[12] shows the diversity of stakeholders engaged across public and third sector organisations, private firms and network companies.[28]

However, not all stakeholders have the same priorities when it comes to SLES projects.[29] Those who are more locally embedded (e.g. councillors, community energy groups) tend to focus on how SLES can deliver both local and non-local outcomes equally. Non-local stakeholders (particularly industry partners) often have a primary goal to produce replicable models that can be scaled up elsewhere. Both are important to cultivate SLES, at scale, that meet local and national priorities.

A review of the literature and analysis of case studies[30] highlights five critical factors underpinning successful collaboration.

- Mutual advantage or gain
- Communication
- Trust
- Legitimacy
- Leadership

Interactive diagram: Click factor for more detail

To create a **collaborative environment:**

SLES developers should...

- Establish strong project management practices, including clearly defined roles, responsibilities and governance structures,early in the process. This will support good communications and trust between partners.
- Develop agreed upon goals, objectives, milestones, deliverables, and success metrics.
- Set up transparent and fair procedures for decision making and accountability.

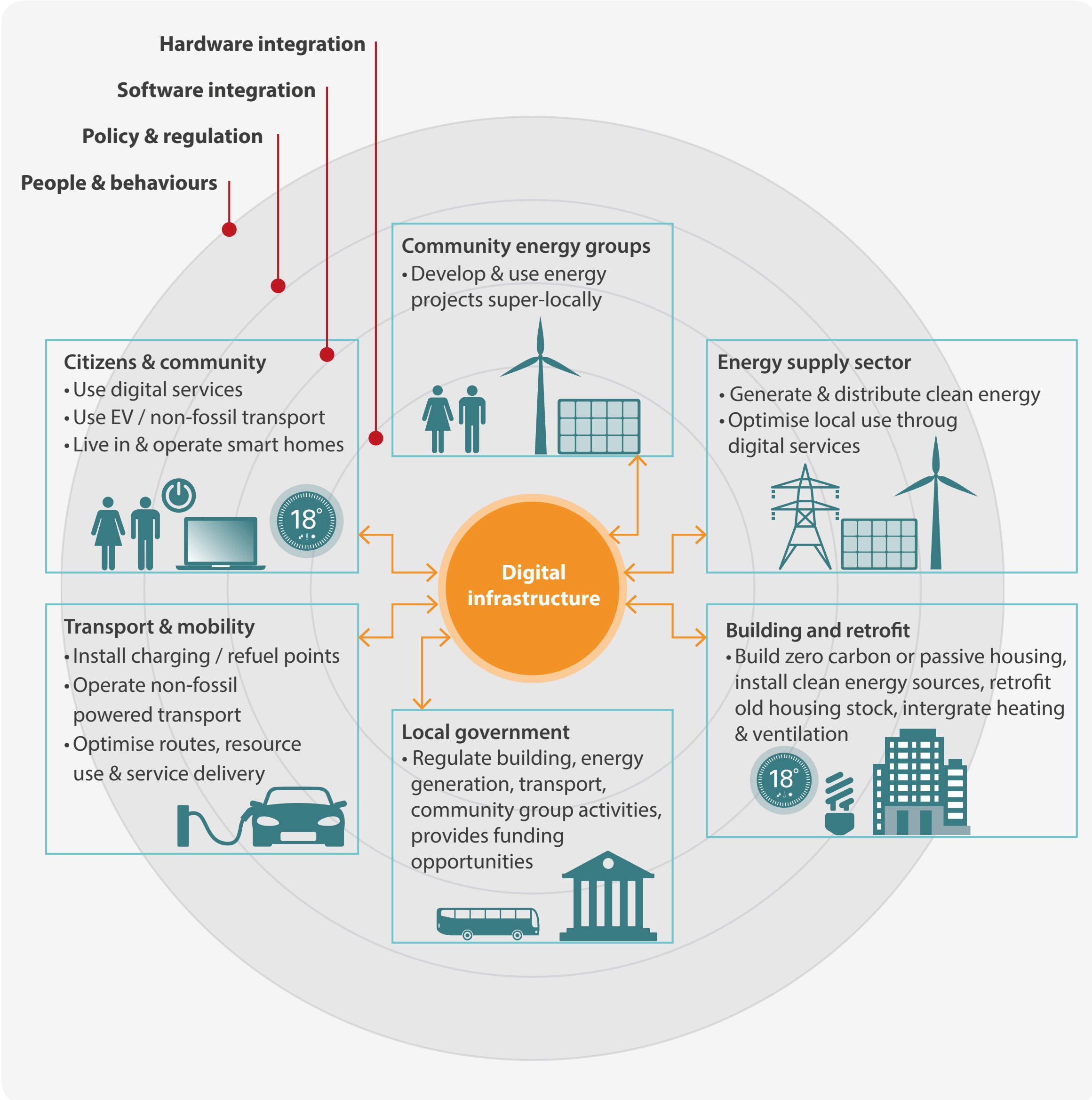
Build **local skills**

Key message:

New skills are needed in a range of areas to support the successful delivery of integrated SLES. These need to be present locally. Flexible and modular training is required to build a workforce responsive to rapidly changing technologies, needs and contexts.

Smart local energy systems bring together new technologies, operate across multiple energy vectors, integrate new stakeholders (including the public) and rely on new forms of system governance and management. Developing and operating smart local energy systems therefore requires new skills across a range of different areas.

Case studies in Bristol, Oxford, and Orkney identified six SLES sectoral subsystems, connected through a seventh subsystem: digital infrastructure.



SLES subsystems and connecting interfaces. See[33] for more detail.

For each subsystem, there is a need for skills development in areas of:

Engineering including electrical, software, data analytics, AI, civil engineering infrastructure, building management.

Trades for installation and maintenance of a whole range of new technologies, e.g. heat pumps, EV chargers, renewables, retrofit and smart meters.

Management to oversee large projects, bring together various stakeholders, understand technical and regulatory issues and manage risk.

Business and financial skills for new business models, innovation in financing, commercialisation and procurement.

Policy and legal specialists developing new approaches, contract types, compliance (e.g. GDPR, quality standards) and regulation for innovation.

Soft skills, such as communication, negotiation, building collaboration, engaging the public.

In addition to developing subsystem-specific skills, there are three key cross-subsystem skills needed to create integrated SLES.[31]

1. **Subsystems integration skills** to support physical interconnections and data exchange across different subsystems.
2. **SLES governance and operation skills** to bring together the subsystems in developing common goals and interoperability.
3. **Stakeholder and citizen engagement skills** to help to develop common understanding and support new business models emerge.

These skills need to be developed across the UK. Analysis of 29 business-as-usual SLES[12] showed that, in several instances, local partners and contractors were not available. Instead, national contractors had to be used for particular aspects of system maintenance or operation. This raises operational challenges if things go wrong. The presence of local staff and contractors to fix problems would be an advantage, particularly for essential services like heat and power.

Training to support the development of these skills is important. EnergyREV researchers[32] identified four main types of training avenues:

- **Formal training** at school, college and university with well-regarded, certified and clearly defined qualifications.
- **Short courses**, (sometimes) leading to recognised qualifications and adding to pre-existing skills. This might be to fulfil a particular role or to work with particular equipment, e.g. plumbers learning to install heat pumps or electricians to install EV chargers.
- **On-the job-and peer learning.** Informal and job-specific training avenues, developing particular skills needed to do a job by learning from colleagues, secondments or shadowing.
- **Wider knowledge acquisition,** whereby learners seek to grow their understanding through reading, attending conferences, public engagement, etc.

However, three key barriers must be overcome to develop and grow SLES training opportunities:

Barrier 1: Lack of demand for new skills.

This is in part due to uncertainty over which technologies will continue to grow and be in demand. Additionally, students are not aware of some new technologies and employers do not have the current expertise to apply them at scale. This, in turn, suppresses demand. In other cases, workers have enough work using current skills and see no need for taking time out for additional training.

Barrier 2: Qualification accreditation processes.

Colleges can only offer what is currently accredited. New courses take time and resource to be developed and approved, requiring consultation with industry and approval by awarding bodies.

Barrier 3: Lack of flexibility.

SLES call for skills from across a range of traditional qualifications, but learners are not able to combine courses to meet these needs. A more agile qualifications structure would allow for a hybrid approach – accumulating recognised credits to reach the desired qualification level from across various programmes.

To build **local skills:**

Government should...

- Support training needs within local authorities to grow capacity in building partnerships, manage large sets of stakeholders, make evidence-based decisions, and enable technical understanding and decision making related to SLES implementation.
- Stimulate supply chain growth by providing (1) consistent messaging on long-term SLES policies to employers, educators, and workers, and (2) stable support for jobs and training mechanisms.
- Regulate to ensure properly certified qualifications for SLES jobs.
- Provide core funding to colleges and qualifying bodies, to develop new qualifications and ensure resourcing levels.
- Provide direct financial support to enable SMEs to participate in SLES apprentice programmes.

Educators should...

- Steer the future workforce by (1) keeping up to date with evolving career pathways and (2) ensuring technological advances are brought into degree programmes and develop/amend programmes to target emerging training or upskilling needs.

Qualifying bodies should...

- Work with the wider SLES industry to develop courses and qualifications that meet both upcoming and emerging needs and skills gaps.
- Make awarding processes more flexible, through a hybridised qualifications framework.
- Allow for technology substitution during teaching delivery as technologies evolve.
- Recognise and accredit life-long learning and training activities related to SLES.

Engage and **empower** the **local community**

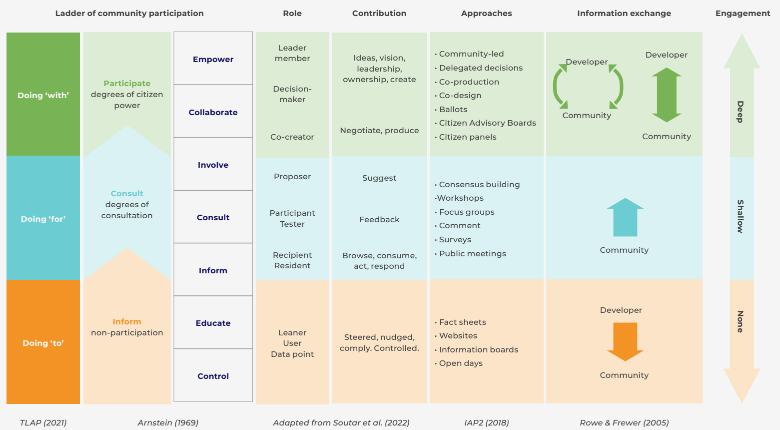
Key message:

Community members and end users have important roles to play in SLES. However, they are typically viewed as customers or 'testers' of new technologies. To support widespread transition that impacts people and communities, it is essential to engage them earlier and through participatory approaches. Outside of specific SLES projects, awareness of SLES across the UK is low. People do not understand either the concepts or the specific solutions SLES may offer. To help SLES fulfil their potential, national and local actors must engage the public, build support, and enable them to shape future SLES.

When it comes to SLES, people are talked about in a variety of ways encompassing their role as a citizen, customer, consumer, prosumers, member of the community, and market actor.[33] What is clear is that they have a key – and evolving – role to play in smart local energy systems of the future.

Consent and active participation are critical if we are to see the shifts in how and when households use energy. Demand side flexibility, including things like smarter and automated heating or car charging, is needed to unlock the benefits of SLES12. This requires people to trust and consent to changes in how they use and manage their homes at a time when trust in energy utilities is at a low.

Decades of social science research shows us that early and participatory approaches to engaging people, doing SLES 'with' them rather than 'to' or 'for' them, is likely to lead to SLES that better meet their needs and values and drive stronger levels of support.



Schematic "ladder" of community participation. Adapted from. [46]

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However, research on 122 past smart local energy system projects[34] showed evidence of public engagement in less than half, with almost all activities focussed on consultation and information activities such as one-off workshops, meetings, exhibition fairs, or events, as well as the use of media, social media, consultations, drop-in sessions, and communication via trusted stakeholders.

Research with PFER projects[35] provides useful insight into how and why different engagement practices were developed. Through a series of semi-structured interviews with individuals from 23 project partners across 12 SLES projects, we saw that stakeholders differ widely in a) who they understand 'the public' to be, and b) what they regard 'good' engagement to look like.

Projects targeted two distinct groups of people in their engagement practice: (1) SLES users, including drivers, fleet managers, housing developers, local authorities, commercial users, homeowners and other residential users such as social housing tenants; and (2) communities with an interest and/or influence in energy system change.

Projects also rationalised their engagement practices in different ways.

A small number of projects outlined the importance of users and communities as co-creators, allowing projects to beta-test novel SLES technologies, such that SLES projects can be shaped around their interests and needs. This type of engagement needs to happen early, before technological characteristics of projects are finalised.

Some projects positioned the public as recipients or testers of pre-conceived solutions, whereby users and communities are beneficiaries of solutions designed by experts for them.

Project partners talked about 'taking people on a journey', but focused this around provision of information about the SLES and associated technologies.

People were also often viewed as consumers or customers, to whom SLES products and services can be marketed.

They viewed users as being driven by self-interest, apathetic with regard to system-wide or community benefits.

The ways in which projects viewed users and communities led to different types of engagement outcomes.

Those who viewed users as consumers focused more on one-way communication from the perspective of marketing and public relations. Those who viewed users as key partners led to them playing a more central role through two-way engagement.

Across most projects, ideas about user engagement appeared to be based primarily on pre-existing beliefs about what users are like, rather than on direct experiences of local publics. There was also limited sharing between projects, meaning that valuable lessons about what does and doesn't work in engagement are not maximised.

To support the development of SLES at scale, public engagement needs to extend beyond specific SLES projects.

- Insights from a national survey showed that the public are not familiar with SLES. They typically understand SLES as renewable infrastructure like wind and solar generation, at a neighbourhood, town or city scale. Heat is very rarely thought about, and the 'smart' data and digital aspects are also overlooked.

- People are not only unfamiliar with the concept of SLES, but also with the specific propositions it brings, such as heat pumps with automated demand response, or EV chargers that can feed power back to the grid at times of need. This could lead to a widening gap between those who are able to engage with SLES and those who can't.

- Taking advantage of SLES propositions mean that people will need to adopt new ways of operating household devices. However, this requires knowledge and skills to choose between different low carbon energy technologies and tariffs, and engage with apps or platforms that support optimisation and automation. Older people are likely to lack the digital skills necessary to understand, customise and control technology.[36]

- In addition, some people may not be able to participate in SLES due to cost of technologies (such as solar PV, batteries, EVs, heat pumps and smart appliances) or housing tenure due to the inability or unfeasibility of adapting rented properties.

- Locally and community-led initiatives can help address these potential injustices in terms of ability to participate in and benefit from SLES.[37] These organisations are among the most trusted and are regarded as legitimate actors to be involved in future local energy systems.

- To help SLES fulfil their potential, national and local actors must engage the public and build support. Ensuring that households, communities and the wider public understand and can shape future SLES will help overcome potential injustices and opposition, supporting accelerated diffusion.

To **engage** and **empower** the **local community:**

Government should...

- Acknowledge and address the gap between expert and public understandings of local energy systems. While some local authorities are incorporating energy education into school and college curricula this needs to happen more broadly.
- Provide direct funding to support local authorities and community groups engage the public with SLES.

SLES programme funders should...

- Provide funding to support learning between projects, transferring lessons about what forms of engagement 'work' or 'don't work', in different contexts.
- Place engagement more centrally in visions of success, explicitly deter box-ticking approaches, and promote ideas of users that include, but are not limited to, consumers or customers.

SLES developers should...

- Engage the public early to ensure that SLES evolve in a way that accounts for their values and needs.
- Focus on demonstrating value to SLES to households as well as for the energy system.
- Support households develop the skills needed to engage with new technologies and processes to benefit from SLES.
- Provide opportunities for the public to learn about SLES and interact with novel interventions before they adopt them.
- Leverage tools like LEMAP, which can help engage households with local energy systems.

Unlock **innovative business models**

Key message:

Investment is a major barrier for SLES. This is because they have diverse assets, ownership and cashflow structures, which hinders their attractiveness to investors.

New business models are needed. Citizen crowdfunding may have a role to play for smaller investments.

Other approaches, such as asset securitisation, are needed to attract larger or scalable investment.

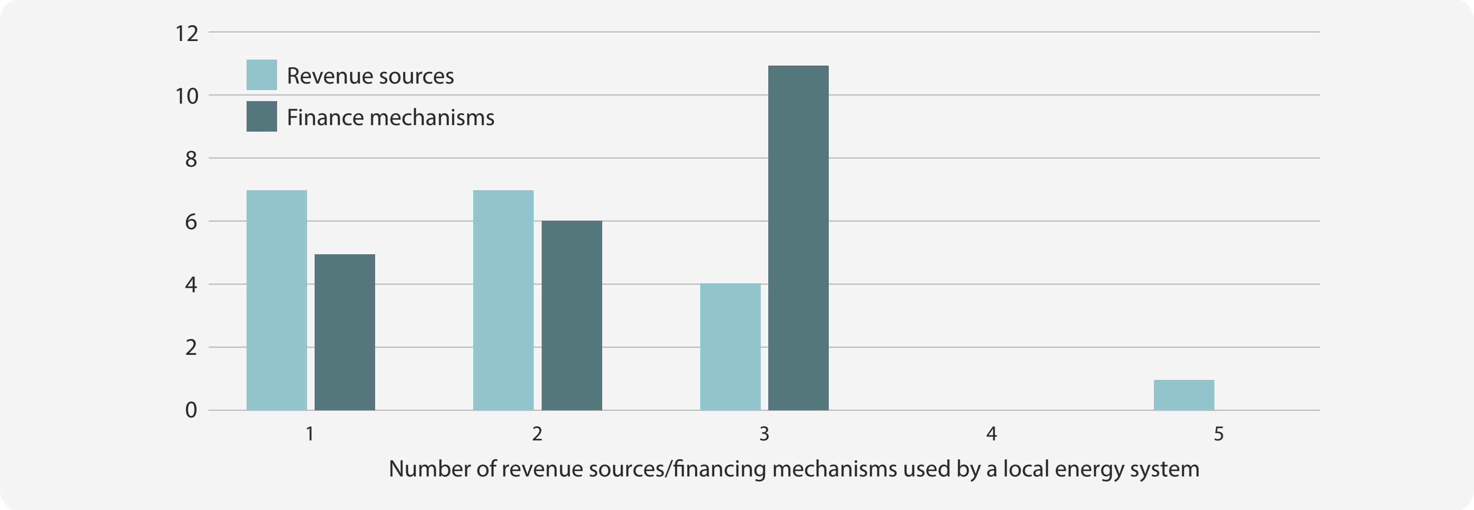
Strong corporate governance and risk management strategies must underpin these business models.

The ability to attract investment, and to create and capture sufficient economic value through revenues, will be key to the success of the SLES sector. Analysis of existing SLES shows that most relied on a range of finance mechanisms and revenue streams.[12]

To date, finance has mainly come from system operators using their own reserves. Grants from the public sector or charitable organisations were also common, as was direct 'citizen finance' in the form of crowdfunding or community shares.

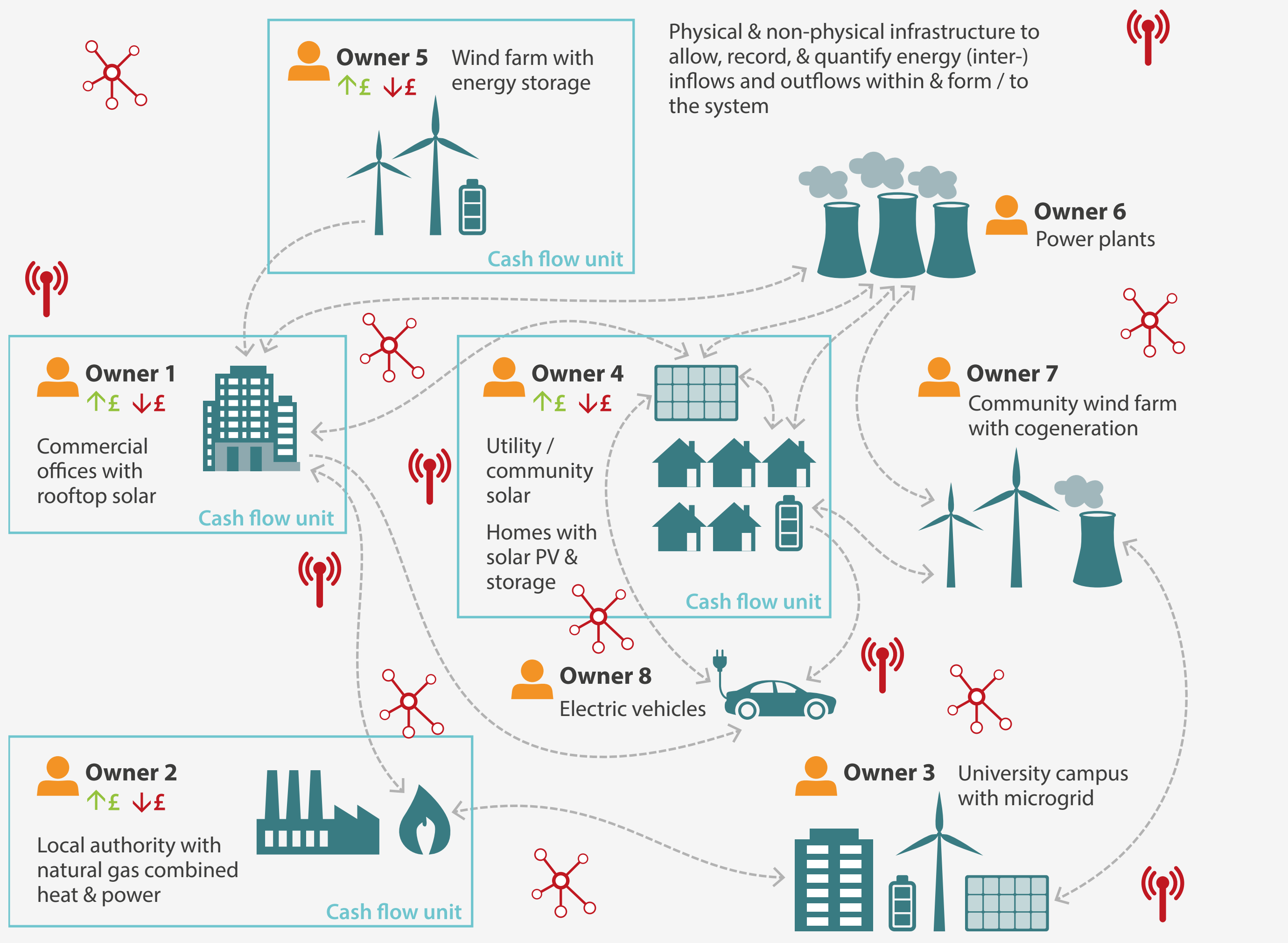
The scale of citizen finance is well suited to smaller investments of less than £5M.[38] It has a role to play in tried-and-tested elements of SLES, such as renewable electricity generation. However, it is not as well suited to more novel, complex and riskier projects, where larger-scale financial investment will be needed.

The nature of SLES, which bring together a diversity of revenue stream across a variety of assets (and ownership structures), makes the business model highly complex. In addition, no two SLES are exactly the same. This lack of replicable financial models across the SLES space hinders their attractiveness to larger investors. To address this, new types of financial instruments and business models are needed.



Asset securitisation is a type of financial instrument that may make SLES investments more attractive to larger investors.[39] It helps standardise and simplify transactions consisting of multiple different cashflows and increases the likelihood of raising finance for SLES through financial market offers.

Asset securitisation consists of pooling and aggregating different energy assets and their cashflows. These are then converted into an asset-backed security (ABS) that is typically traded in a financial market. This means any SLES could operate as a single organisational, business and financial unit, equivalent to an energy company providing diverse energy services to customers, with its costs, benefits and risks.



SLES conceptualisation and systemic future cash flow structure. See [39] for full details.

For SLES asset securitisation to succeed it must be properly managed. A corporate governance and risk management framework is needed to build trust, transparency and accountability. This must include:

- **Culture:** The key ideas and pathways governing SLES energy services, business practices and conduct of employees or partners.
- **Leadership:** The characteristics for effective leadership needed to manage the SLES.
- **Structure:** The requirements for key roles, responsibilities and functions for governance and risk management.
- **Localism:** How a SLES engages with localities and other interested parties, following good practices of governance and risk management.
- **Cashflow-lock:** Fundamental risk management and governance activities to secure robust cashflows that ensure that investors are paid back on time.
- **Smartness:** The operation of the SLES digital infrastructure and minimising risks.
- **Alignment:** Consistent and coherent use of governance and risk management best practices.

When leadership, culture, smartness, structure, localism, and cashflow-lock are aligned, the SLES commitments and strategies to achieve those are coherent.

To unlock **innovative business models:**

SLES developers should...

- Compare asset securitisation to other financing mechanisms, e.g. equity, project finance, etc, to identify the most appropriate financing options for large-scale SLES investment.
- Identify any regulatory and legal implications of a securitisation mechanism for SLES and raise with appropriate bodies.
- Implement a strong corporate governance and risk management framework.

Ensure **market value** and **interoperability**

Key message:

Current market structures prevent SLES being fully rewarded for the benefits they bring. Local energy markets, such as peer-to-peer energy trading, can unlock value but are held back by challenges related to managing uncertainty, dealing with conflicts and constraints between transmission and distribution levels, and failing to integrate flexibility and planning. A new approach to market design can overcome these challenges, but implementation requires regulatory change, new cyber-physical approaches, improved data and modelling, and improving consumer protection.

Well-designed market structures are critical for unlocking the value of SLES. They are necessary to help co-ordinate the multiple assets at the grid edge (e.g. EV chargers, household storage and demand-side response, etc) as well as provide an economic incentive for 'grid-friendly' uptake and use of clean energy assets.

An important step towards this is the emergence of local flexibility markets. They provide new opportunities to incentivise demand-side flexibility to enhance system operation and are being trialled by networks across the UK. However, existing market structures present challenges for SLES for three main reasons.

1. **Mechanisms for managing uncertainty are not clear.** Uncertainty can arise due to the intermittency of renewable generation, the behaviour dependence of flexible loads, upstream energy prices and network congestion. Forcing SLES market participants to individually hedge against uncertainty will lead to overly conservative – and inefficient – operation.

2. **Conflicts and constraints between transmission and distribution networks need to be managed.** These arise due to the decoupling between local SLES markets and system-level markets. The aggregate operation of SLES markets needs to be integrated into system-level operation for effective co-ordination.

3. **There are risks that planning decisions undermine the value of SLES.** If network investment and local flexibility decisions are not integrated, there is a risk of over investment in the network. Flexible resources could be under-utilised, ultimately leading to higher bills for consumers.

To overcome these challenges, EnergyREV researchers developed a novel approach to multiscale market design, integrating peer-to-peer (P2P) energy and flexibility trading as a core part of how power systems are designed and operated.[16]

1. **Uncertainty is managed** through mechanisms that allow an agreed amount of uncertainty to propagate from lower-level market platforms to higher-level ones, where it can be handled by aggregation and additional sources of flexibility. More granular data from smart meters and substation monitoring further helps to improve forecasts.

2. By carefully designing transaction fees, **conflicts between distribution and transmission networks** can be managed. This approach means that network constraints within SLES trading platforms are dealt with without requiring a central authority to check and approve transactions.[40]

3. **Integrating flexibility into network planning** is supported through an optimisation approach in which the system operator solves an 'upper level' investment project accounting for 'lower level' operation. Operational forecasts of SLES energy trading platforms are integrated into network planning and investment decisions via a multi-resolution nested architecture that accounts for relationships between investment and real-time operation.

Although a multi-scale market design framework is challenging to implement, it is increasingly valuable as more distributed energy resources are deployed in the energy system. Addressing these issues and implementing a multiscale design framework requires cooperation between energy market regulators, TSOs, DSOs and developers of SLES energy trading platforms.

To ensure **market value** and **interoperability:**

Ofgem, working with government, should:

- Define roles and responsibilities associated with peer-to-peer energy and flexibility trading, including how balancing responsibilities are assigned and network charges are allocated.
- Explore how machine learning techniques and improved modelling of prosumer behaviour can be integrated into traditional market models so they can learn to deal with new scenarios as the number and operation of grid-edge assets evolves.
- Develop an approach, e.g. using multi-scale market design, to manage uncertainty, conflicts, and flexibility between distribution and transmission networks.

Underpin with **robust cyber-physical infrastructure**

Key message:

Information and communications technology (ICT) is essential for SLES. This cyber-physical system must be flexible, scalable and reusable to future proof SLES. As SLES become increasingly complex, the development and use of data ontologies becomes more important.

This complexity can also be supported through breaking the SLES down to scales (household to nation) and layers (physical, control, market and service). Cybersecurity must sit on top of these layers to ensure safe and efficient operation. SLES users should be engaged in this process to alleviate their privacy and security concerns. Greater attention to cybersecurity elements, particularly around artificial intelligence and ethics, should be taken by government and regulators.

ICT is essential to fulfil ‘smart’ operation of SLES and ensure they are capable of delivering the outcomes intended. There is no ‘magic bullet’ ICT solution. Instead, the configuration of these elements required depends on the energy vectors included, the mix of technologies, the key objectives and constraints, and the time horizons and resolutions of managing the SLES.[41]

Features of smart local energy systems

Energy vectors
- Electricity
- Gas
- Heat

Technology mix
- Generation
- Demand
- Storage
- Network

Objectives & constraints
- Economy
- Environment
- Demand side management

Time horizons & resolutions
- Yearly
- Monthly
- Day / hours ahead
- Real-time

ICT infrastructure of smart local energy systems

Measurements
- Power / energy generation / consumption
- Energy storage level
- Network operating states (e.g. voltage, current, …)

Communications
- Technologies (wired / wireless)
- Communication time intervals
- Communication networks configuration

The mapping between SLES features and the corresponding ICT infrastructure See[41] for full details.

Most existing ICT solutions are dedicated to specific devices, system configurations or objectives. However, future ICT infrastructure needs to be designed and operated from a whole-system and forward-looking perspective.

Understanding and evaluating these cyber physical systems during the design process can also enhance performance and ensure the SLES can withstand the test of time. A two-stage, 10-step process can help developers identify key components to add to existing SLES to improve or extend their operation.

Critical to support future-proof operation, cyber physical systems should provide key capabilities:

- **Flexibility:** Throughout their lifecycle, SLES will be subject to a growing set of use cases; connection of new devices and assets; new data systems/data analysis requirements; increased end users. Flexible systems accommodate these changes without a re-engineering of the underlying ICT system.
- **Scalability:** SLES will need to deal with physical extensions through additional generation technologies or energy delivery devices. They may also be extended through additional energy vectors to be taken onboard.
- **Replicability:** The overall system may need to be transplanted to similar problems in other locations.

A lack of flexibility, scalability and replicability built into SLES is causing extensive, time-consuming and costly re-engineering.[32]

In addition, adding capability to an energy system to predict consumption and generation is a key element of providing resilience and efficiency within SLES.[34] Optimisation through the use of big data and artificial intelligence offers the potential to deliver new control, market and digital services, providing benefits at local and national levels.

To unlock this, a distributed approach, taking small units and making them cooperate according to established metrics, allows goals and objectives to be defined for a network at different scales. These 'plug and play' capabilities can be supported through the implementation of maturing technologies such as multi-agent systems.[42]

Such tools will evolve over time, but the key point is that they are able to plug SLES into the wider energy system to support control decision making. Common data structures, standards and languages – or in other words, data ontologies – are critical to underpin plug and play interoperability.[43]

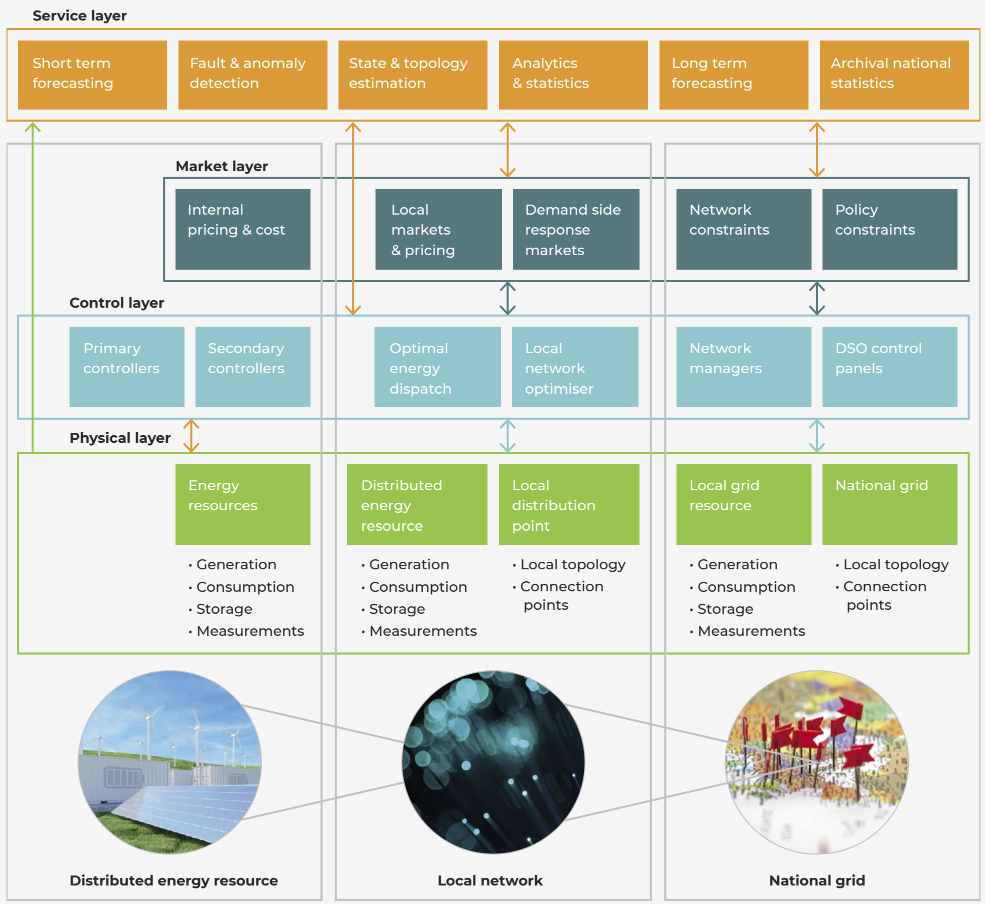
As more elements are added to the network, describing a network in terms of scales and layers allows us to tackle the increasing complexity of a SLES across physical, control, market and service layers.[44]

Service layers receive data from the physical, control and market layers of the energy system and store, process and archive that data. This layer takes the received data and produces required information about past, current and future performance, health and behaviour. The scale of the services can grow from single system forecasts and metrics to regional forecasting, topology analysis and system identification.

Market layers provide the controllers with costs and other requirements based on data from the service layer. The market component enables the trading of resources, the rewarding of certain behaviours and the satisfaction of grid constraints.

Control layers are the decision-making part of the systems. Layered controllers make decisions and optimise set points based on market and service information.

Physical layers consist of the energy generation and consumption assets, along with the devices, plant and equipment for the transmission and distribution of the energy vector. There are also physical communication assets in the network. They are responsible for transmitting data to other components and enacting commands.



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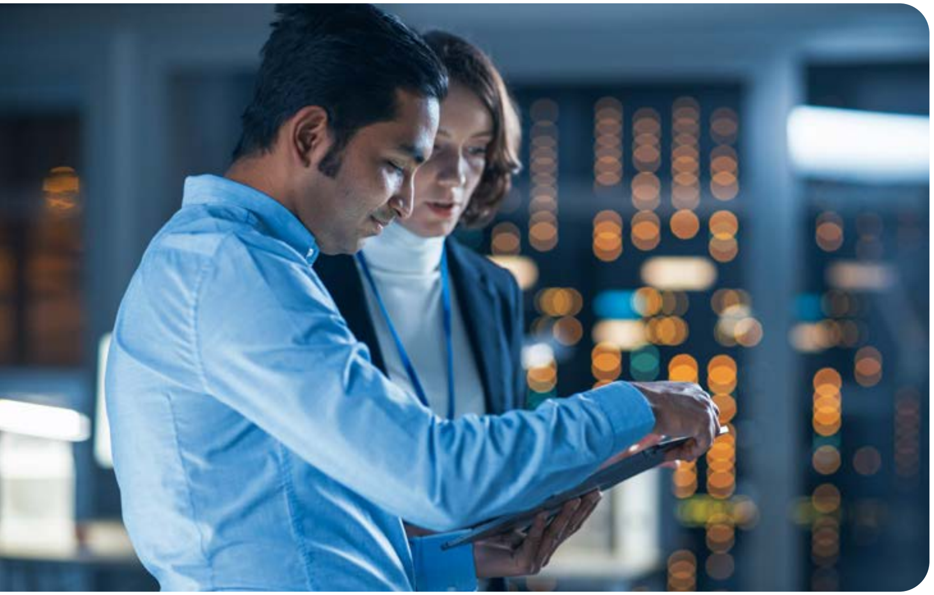
Abstraction layers and their components in digitised energy systems. See[44] for full details.

Safe and effective operation of SLES will also be heavily reliant upon a security layer on top of smart entities.

A good, comprehensive cybersecurity guideline should include a range of functions across physical, control, market and service layers, as well as wider management, governance and communications systems and processes.

In addition, privacy and security strategies should engage SLES users, to alleviate their concerns around how their data may be accessed and used.



The following principles should be followed by SLES providers:

- Recognise the mutual benefits of data sharingfor SLES and work with customers as partners.
- Involve people in the design of data-sharing technologies from the start.
- Give people a say on the third parties that they are happy to share data with.
- Empower people to set the boundaries around the flow of information about themselves.
- Ensure that the purpose and value of the data collected is transparent and fair.
- Ensure that everyone affected by sharing of data gives their informed consent.
- Recognise that technologies for revealing and monitoring behaviours in the home can be used in unexpected and unwanted ways and anticipate this in service design.
- Ensure there are channels of feedback and ongoing communication to continuously improve service delivery.

This is particularly important as the use of artificial intelligence (AI) and machine learning in the energy sector increases, raising challenges related to ethical use of data.

To **underpin** with **robust cyber-physical infrastructure:**

Greater attention to cyber-physical infrastructure, particularly around artificial intelligence and ethics, is needed from government and regulators. This should build on the existing work of the Energy Digitalisation Task force.**

Government, working with Ofgem, should...

- Develop and formalise a SLES ontology by building on existing concepts and bringing together domain experts with knowledge engineers to create a common understanding of all the functions of a SLES.
- Set shared technical standards and guidelines to support interoperability.
- Develop and implement comprehensive cybersecurity guidelines that cover both physical and cyber infrastructures.
- Support industry to produce more affordable and cyber-secure devices and services, including guidelines on minimum function and security requirements.
- Ensure compliance testing and certifications are in place and carried out by an independent third party to guarantee SLES components are designed to an acceptable security level.
- Embed a stronger consideration of ethical practice into regulation related to the use of machine learning, artificial intelligence, and autonomy in energy system operation.
- Create an ethics-conscious corporate culture by supporting companies to invest in programmes and training that raises awareness of ethical considerations.
- Review the effectiveness and appropriateness of data privacy restrictions, given the increasing capabilities and availability of AI tools.
- Invest in detailed sector-specific research around the use of energy data and AI to aid an industry-wide move to adopting dynamic and responsive ethical principles.

** The joint BEIS, Ofgem and Innovate UK response to the Energy Digitalisation Taskforce report in July 2022 summarises government's progress made and plans for next steps. These include steps to deliver interoperability, to adopt digital security measures, to regulate energy smart appliances, and stimulate greater innovation in this space. For further information see here.

CHALLENGES AND NEXT STEPS

Challenges and **next steps**

It's clear that SLES can offer substantial social, environmental and economic benefits to the UK as a whole, as well as to local places and people participating in SLES. However, there are actions needed to unlock these benefits, and challenges that must be overcome. To address these challenges and ensure SLES are successful and flourish across the UK, key next steps include:

- **Vision** and **strategy**
- **Power** and **resources**
- Better **structures**
- Align **value**
- **Reframe** and **talk**

Click key step for more detail.

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Analysis and report by:
Rebecca Ford, Head of demand and flexibility, Regen

Approved by:
Tamar Bourne, Head of innovation, Regen

Regen
Bradninch Court, Castle St,
Exeter EX4 3PL

UK Research and Innovation