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GreenSCIES

Exploring Economic & Policy Challenges for SLES

Feb 2022

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1.1.1.7 Document Revisions

No.	Details	Date
1	GS Partners' version	23/02/22

Contents

Abbreviations

AFLC	Access and Forward-looking charges
ANM	Active Network Management
AS	Ancillary Services
ATES	Aquifer Thermal Energy Storage
BEIS	Government's Department for Business Energy and Industrial Strategy
BM	Balancing Mechanism
BSC	Balancing and Settlement Code
BSUoS	Balancing Services Use of System
BTES	Borehole Thermal Energy Storage
BTMG	Behind the meter generation
BUS	Boiler Upgrade Scheme
CEM	Common Evaluation Methodology
CfD	Contracts for Difference
CHAMP	Cooling Heat and Mobility Power
CM	Capacity Market
CRM	Capacity Renumeration Mechanism
DC	Dynamic Containment
DCC	Data Communications Company
DER	Distributed Energy Resources
DLC	Direct Load Control
DNO	Distribution Network Operator
DSR	Demand-Side Response
DSO	Distribution System Operator
DTS	Data Transfer Service
DUoS	Distribution Use of Service
DWG	Design Working Group
EHV	Extra High Voltage
ENA	Electricity Network Association
EPC	Energy Performance Certificate
ESO	Electricity System Operator
ETS	Emissions Trading Scheme
EV	Electric Vehicle
FFR	Firm Frequency Response
FiT	Feed in Tariff

FSO	Future System Operator
GreenSCIES	Green Smart Community Integrated Energy Systems
HCC	High Cost Cap
HHS	Half-Hourly Settlement
GSO	Gas System Operator
HUG	Homes Upgrade Grant
HV	High Voltage
IRMB	Integrated Rule Making Body
LBI	London Borough of Islington
LOLP	Loss of Load Probability
LV	Low Voltage
MHHS	Market wide half-hourly settlement
MPAN	Meter Point Administration Number
NGESO	National Grid Energy System Operator
MW	Mega Watt
NZMR	Net Zero Market Reform
OfGEM	Office of Gas and Electricity Markets
P2P	Peer to Peer
PFER	Prospering from the Energy Revolution
PV	Photvoltaic
REGO	Renewable Energy Guarantee of Origin
RO	Renewables Obligation
RSVP	Reserve Scarcity Price
SAP	Standard Assessment Procedure
SBEM	Simplified Building Energy Model
SCR	Significant Code Review
SDG	Small Distribution-connected Generation
SLES	Smart Local Energy System
SSFP	Smart System and Flexibility Plan
TCR	Targeted Charging Review
TDR	Transmission Demand Residual
TEC	Transmission Entry Capacity
TER	Target Emission Rate
TNUoS	Transmission Network Use of System
TOM	Target Operating Model
UKPN	UK Power Networks

V2G	Vehicle-to-grid
VLP	Virtual Lead Party
VOLL	Value of Loss Load
WM	Wholesale Electricity Market

Executive Summary

This paper reviews the current energy system policies relevant to Smart Local Energy Systems (SLES) and aims to identify the current policy and market structure blockers of SLES. It also examines proposed policy changes and the impacts of them on SLES, using the Green Smart Community Integrated Energy Systems (GreenSCIES) project as a case study. The GreenSCIES project is funded by Innovate UK and is set up to deliver a design for innovative and investable business model approach of SLES for a population of 33,000 localised in the London Borough of Islington. The major project's technological innovation is the application of the 5th generation (5G) of the district heating network integrated with shared mobility and power.

Current policy

Over the last 5 years, the energy system has taken a major step forward; 25 out of 38 actions committed in the 2017 Smart System and Flexibility Plan (SSFP) towards delivering a smarter and more flexible energy system had been implemented by 2020. National Grid ESO has announced that they will be able to operate a zero-carbon electricity system, whenever there is sufficient renewable generation, by 2025. Nevertheless, a considerable journey towards a smarter, more flexible energy system remains ahead. A list of SLES revenue streams and a policy accessibility status is provided in the table below.

SLES Revenue Stream	Accessibility Status
Load Shifting	Amber 🟡
Imbalance Exposure	Amber 🟡
DNO procurement of flexibility & demand reduction	Amber 🟡
Self-consumption of PV energy	Green 🟢
Wholesale (SPOT) market trading	Amber 🟡
Capacity Market	Amber 🟡
Balancing Mechanism	Amber 🟡
Ancillary Services	Green 🟢
Network Connection Charges & Access Rights	Red 🔴
Network Charges	Amber 🟡
Inter-seasonal storage of heat using the aquifer	Green 🟢
Peer to Peer trading	Red 🔴
Heat Sales	Green 🟢
Cooling Sales	Green 🟢

To drive the uptake of SLES, more certainty in terms of roles and responsibilities over SLES and coordination between national and local electricity markets are needed. Whilst flexibility markets and related policy have been evolving, there is considerable uncertainty over future flexibility revenue.

There are a number of industry code changes progressing that provide mechanisms for consumers to engage with both the wider energy system and SLES. Market-wide half hourly settlement, which will be completed by October 2025, will significantly improve the value of flexibility for SLES. Recent regulation changes have also been removing barriers for distributed storage in the energy system.

With government ambitions to phase out the installation of gas boilers, heat networks will become increasingly important. Current consultations are encouraging for heat network developments. And an ongoing consultation on V2X also shows a desire to get the most from this emerging technology.

And the UK's first Energy Digitalisation Strategy show a good level of engagement to update the energy system to be smarter and more flexible.

Future policy

Heating and cooling are the most significant revenue streams for GreenSCIES. Therefore, policy changes that affect the relative prices of gas and electricity will be material for GreenSCIES. One such policy change is the possibility of levies being moved from electricity to gas.

Revenue from EV charging and sales of power into either the capacity market or balancing market are expected to be a relatively minor proportion of overall scheme revenues – so policy changes affecting the scheme's ability to access these revenues or to increase them are a potential upside factor – but unlikely to be critical to the overall business case for the scheme.

Ofgem's current position is to introduce increased network access rights at the distribution level. In constrained areas where Distribution Network Operators roll out active network management solutions, they may also offer flexible network connections. This would provide additional value for flexible SLES assets.

Another significant change could be the creation of zonal or nodal electricity pricing. This would increase wholesale prices in London, shifting value from the Balancing Mechanism and TNUoS to the Wholesale Market. This would drive a need for local balancing services, potentially benefiting GreenSCIES.

And finally, though unlikely, reforms to the supplier hub concept and the supply license framework could open new business model opportunities and greater scope for GreenSCI

1 Introduction & Acknowledgements

This paper has been a collaboration between Cenex and the Energy Systems Catapult.

Cenex was established as the UK's first Centre of Excellence for Low Carbon and Fuel Cell technologies in 2005.

Today, Cenex focuses on low emission transport & associated energy infrastructure and operates as an independent, not-for-profit research technology organisation (RTO) and consultancy, specialising in the project delivery, innovation support and market development.

We also organise Cenex-LCV, the UK's premier low carbon vehicle event, to showcase the latest technology and innovation in the industry.

Our independence ensures impartial, trustworthy advice, and, as a not-for-profit, we are driven by the outcomes that are right for you, your industry and your environment, not by the work which pays the most or favours one technology.

Finally, as trusted advisors with expert knowledge, we are the go-to source of guidance and support for public and private sector organisations along their transition to a zero-carbon future and will always provide you with the insights and solutions that reduce pollution, increase efficiency and lower costs.

To find out more about us and the work that we do, visit our website:

www.cenex.co.uk

Energy Systems Catapult was set up to accelerate the transformation of the UK's energy system and ensure UK businesses and consumers capture the opportunities of clean growth.

The Catapult is an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia and research. We take a whole-systems view of the energy sector, helping us to identify and address innovation priorities and market barriers, in order to decarbonise the energy system at the lowest cost.

This paper was produced by the **GreenSCIES** project, funded by UK Research and Innovation and the Engineering and Physical Sciences Research Council through the Industrial Strategy Challenge Fund. In addition, funding for internship was provided by the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie Actions, Innovate Training Networks, Grant Agreement No.812730.

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2 Introduction and the Role of Smart Local Energy Systems

Decentralisation of the energy system into Smart Local Energy Systems (SLES) has the potential to be a cost-effective way of decarbonising the energy system, using small-scale energy resources to facilitate flexibility, rather than building large-scale assets[1]. SLES are defined as community-based initiatives, with integrated heat, power and transport technologies, which enable the delivery of low-carbon, secure and affordable energy supply at a local level, thereby enhancing cost and emission savings at the national level[2].

The increase in the distribution of renewable and secondary energy sources and other energy assets, like heat pumps, electric storage, and Electric Vehicles (EVs) have provided a range of solutions that both encourage and facilitate flexible energy operation. A SLES-based approach involves increasing flexibility capacity through residential demand response, encouraging consumers to actively participate in energy related decision making and through this, contributing to emissions reductions and bill savings.

Over the last 5 years, the energy system has taken a major step forward; 25 out of 38 actions committed in the 2017 Smart System and Flexibility Plan (SSFP) towards delivering a smarter and more flexible energy system had been implemented by 2020[3]. Further 38 actions have been set out in the recent 2021 SSFP[4] aiming to reform the energy system to reach the Net zero target and, in particular, to facilitate flexibility from consumers, remove barriers to flexibility through electricity storage and connection, reform markets to reward flexibility and digitalise the energy system[5]. National Grid ESO has announced that they will be able to operate a zero-carbon electricity system, whenever there is sufficient renewable generation, by 2025.[6]

The next challenge will be to operate such an electricity system 24/7, every day of every year, and this will need to be achieved by 2035 in accordance with the Government's commitment to fully decarbonise GB power. Decarbonisation of other sectors of the economy strongly depend on clean electricity if a Net Zero economy is to be achieved by 2050. Rapid decarbonisation of the power sector by 2035 will likely require more fundamental reforms to electricity market design and the overlying policy and regulatory framework.

Consequently, a considerable journey towards a smarter, more flexible energy system remains ahead. To accelerate the use and adoption of distributed energy resources (DER) and the deployment of SLES, market design reforms and regulatory/policy change are needed to drive investment and ensure efficient dispatch, but in a way that enables innovation and new business models to develop. This paper reviews the current energy system policies relevant to SLES (Section 3) and then aims to identify the current policy and market structure blockers of SLES (Section 4). We then examine proposed policy changes and the impacts of them on SLES, using the Green Smart Community Integrated Energy Systems (GreenSCIES) project as a case study (Section 5). A summary of the policy blockers and future changes is

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[1] University of Exeter.2020. http://www.challenging-ideas.com/wp-content/uploads/2021/01/ReCosting-Energy-Powering-for-the-Future.pdf

[2] Energy White Paper. 2020.

[3] BEIS and Ofgem.2020. https://www.ofgem.gov.uk/ofgem-publications/166313

[4] See ESC's analysis of the SSFP and what it means for SLES, see https://es.catapult.org.uk/report/smart-systems-and-flexibility-plan-2021-what-it-means-for-smart-local-energy-systems/

[5] BEIS and Ofgem. 2021. https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021

[6] National Grid ESO. 2019 https://www.nationalgrideso.com/news/zero-carbon-operation-great-britains-electricity-system-2025

provided then provided (Section 6). This project aims to deliver one of the largest smart energy systems in the UK, intending to enable wide-scale replication.

3 Review of Energy System Policies Relevant to SLES

In this chapter we will review the current energy system policies that have relevance to the SLES concept, along with any proposed changes to these policies.

3.1 Overview of the UK energy system governance

The UK's energy market involves the generation, transmission, distribution, and supply functions carried out by private companies. Regulation of these companies is carried out by a non-ministerial department, the Office of Gas and Electricity Markets (Ofgem), taking decisions on price controls and enforcement. The market is also regulated by the policy mechanisms implemented by the UK Government's Department for Business Energy and Industrial Strategy (BEIS). Overview of current institutional arrangements and roles in the UK energy sector can be found in the Energy System Catapult's report[7].

3.2 Regulatory changes in energy code and system operation governance

The government has recognised the need to reform organisational functions for energy code and system operation governance to lower barriers to competition, improve transparency and accountability, and drive innovation[2]. Addressing these barriers can enable demand side flexibility to develop, benefitting both the wider energy system and SLES concepts such as the GreenSCIES project. BEIS and Ofgem have launched a consultation on the proposal of a new energy code governance framework bringing central system delivery bodies into scope with the gas systems operated by Xoserve, the electricity systems operated by Elexon, the smart systems operated by the Data Communications Company (DCC), and the Data Transfer Service (DTS) operated by Electralink[8].

Based on feedback from a consultation in 2019[9], two options for energy code governance framework are proposed. The first institutional governance option, which is noted as preferred by BEIS and Ofgem, would be designating Ofgem as the 'strategic body' and having separate code managers. This has been stated as the preferred option by BEIS in the Energy code reform: governance framework consultation in July 2021[10]. Ofgem's function would include development of a strategic direction for codes by approving or leading code changes, publishing it annually, and ensuring its delivery by codes managers. If this option is adopted, the delivery of codes consolidation is anticipated to begin in 2024 under option 1, or in 2026 under option 2.

The second option combines two roles of the strategic body and code managers into an Integrated Rule Making Body (IRMB) that will be named as Future System Operator (FSO).

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[7] ERIS. 2019. https://es.catapult.org.uk/reports/the-policy-and-regulatory-context-for-new-local-energy-markets/

[8] BEIS and Ofgem.2021. https://www.gov.uk/government/consultations/energy-code-reform-governance-framework

[9] BEIS.2019. https://www.gov.uk/government/consultations/reforming-the-energy-industry-codes

[10] BEIS and Ofgem. 2021 https://www.gov.uk/government/consultations/energy-code-reform-governance-framework

In parallel and in addition to proposals around the energy code governance framework BEIS and Ofgem also published a consultation on the Energy Future System Operator (FSO)[11]. The FSO is proposed as being independent from the operational control of government and other commercial energy interests, undertaking responsibilities across both the electricity and gas systems. All functions of the current National Grid Electricity System Operator (ESO) are proposed to be undertaken by FSO. For gas system, the FSO is proposed to carry out either strategic network planning, long-term forecasting, and market strategy functions in option 1 (noted as preferred by BEIS and Ofgem) or all responsibilities of Gas System Operator (GSO), as with ESO, in option 2[12].

A new approach to the system operation governance is being set up. The transition from Distribution Network Operator (DNO) to Distribution System Operator (DSO) is underway aiming to shift from the traditional network owner role, to one which takes a proactive role in balancing and managing the energy system using the flexibility of connected assets[13]. The DSO functions intend to include coordination between the DSO and the ESO, other DSOs/Independent DSOs, and SLES as well as developing a common contract for flexibility and coordinating use for DER[14].

The Electricity Network Association (ENA), which is the industry membership body that represent the 27 local electricity distribution businesses, is playing a key role in the DNO to DSO transition and determining future actions and timeframes. Ofgem plan to review DSO governance arrangements in 2022 and make recommendations on changes to the price control, distribution licence, or institution, if necessary, by 2023[14]. There is not a definite timeframe of actions towards the DNO to DSO transition, but the majority of development activities, outlined in the DSO Implementation Plan, are planned to be advanced within the current RIIO-ED1 (2015 to 2023) price control period in order to enable offering market services to the following RIIO–ED2 (2023 to 2031) price control period[14].

The DNO to DSO transition could be a market enabler, redefining how energy networks, system operation and will operate in the future opening significant potential for SLES[15]. There are planned activities, mentioned in the DSO Implementation Plan, such as development of coordination of the use of DER, real-time data exchange, digitalisation of the energy system, increasing transparency and visibility of network operations, all of which will impact expanding the delivery of SLES. Nevertheless, the majority of activities focus on a whole energy system approach. However, to drive the uptake of SLES, more certainty in terms of roles and responsibilities over SLES and coordination between national and local electricity markets are needed.

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[11] BEIS and Ofgem.2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1004044/energy-future-system-operator-condoc.pdf

[12] BEIS and Ofgem. 2021. https://www.gov.uk/government/consultations/proposals-for-a-future-system-operator-role

[13] Cornwall Insight.202. https://www.cornwall-insight.com/newsroom/all-news/dno-to-dso-a-work-in-progress

[14] ENA.2021. https://www.energynetworks.org/industry-hub/resource-library/open-networks-2021-ws3-p1-dso-implementation-plan-report-(31-mar-2021).pdf

[15] Ofgem.2018. https://www.ofgem.gov.uk/sites/default/files/docs/2018/10/transition_fsp_v3_compliance_notes.pdf

3.3 Flexibility and Electricity markets

The wholesale electricity market is where the majority of supply and demand matching occurs in the GB electricity system. The balancing mechanism, ancillary services and local markets for flexibility are supplementary markets and signals that complement the national wholesale electricity market[5]. These markets ensure that the maintenance of the system's balancing needs, network capacity and stability is met.

Price signals for flexibility are additionally influenced by:

- Government support mechanisms such as the Capacity Market (CM) and Contracts for Difference (CfD) scheme aiming to incentivise investments to DER deployment;
- A carbon price which incentivises low carbon solutions;
- The methods under which network and policy costs are recovered from customers via energy suppliers

Flexibility is a key potential value stream for SLES concepts. Whilst SLES are frequently driven by values rather than profits, it is difficult to build a scheme that doesn't stack up financially. The GreenSCIES project aims to not only achieve a significant reduction of carbon emissions but also to develop a commercial business model that generates revenue streams through maximizing integration of DER and unlocking valuable sources of flexibility.

A lesson learnt from one of the SLES pilot programs - 'The FlexLondon project' is that the value of flexibility to the DNO is very location dependent and the value from carbon savings or air quality improvements can be challenging to build into business cases[16]. Another SLES demonstration project named 'Leo' highlights that there are many uncertainties about the value of DSO flexibility and that it is important to establish a framework regulating how to cope with failures or delays in energy generation supply services[17]. To understand how to unlock the full values of local flexibility and how to avoid market challenges that may hinder deployment of SLES at scale, a SLES 'leader' that can play a role in supporting its delivery can be essential. For example, Carbon Trust suggest that DNOs play an enabling role in supporting local stakeholders and delivering SLES[18].

3.4 Code governance

The governance of the codes is also in the scope of the ongoing reform process. A significant code review of the 12 current electricity and gas codes and relevant engineering standards is underway to ensure that they do not distort energy markets and prevent a level playing field for generators. This section outlines amendments made in the Balancing and Settlement Code, Market Wide Half-Hourly Settlement and Access and Forward-looking Charging Significant Code Review.

3.4.1 The Balancing and Settlement code

Code changes in the balancing mechanism have been implemented to broaden and encourage access to markets for smaller assets, which is essential to facilitate flexibility from consumers. Modifications to the Balancing and Settlement code are outlined in table 1.

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[16] Carbon Trust.2021. https://www.carbontrust.com/news-and-events/insights/a-flexible-outlook-on-energy

[17] Leo.2020. https://project-leo.co.uk/wp-content/uploads/2020/07/LEO-Year-1-annual-synthesis-report-master-040620-for-web.pdf

[18] Carbon Trust.2021. https://www.carbontrust.com/news-and-events/insights/a-flexible-outlook-on-energy

Table 1. Balancing and Settlement Code (BSC) modifications

BSC	Modifications	Implementation date
P398 'Increasing access to BSC Data'	All BSC data is now presumed open that can be requested without the needs to be a BSC Party through completing a data request form	24 June 2021
P375 'Metering behind the Boundary Point'	Asset meters will record electricity flows to (or from) assets, including those owned by embedded generators, DSR providers, or owners of EV chargepoints	30 June 2022
P376 'Utilising a Baselining Methodology to set Physical Notifications'	The source of data used in settlement calculations is proposed to be changed	The BSC Panel recommends its approval, currently in the report phase. Planning date - 2022
P415 'Facilitating access to wholesale markets for flexibility dispatched by Virtual Lead Parties'	The arrangements of Virtual Lead Parties (VLP) are proposed to be extended to directly access the wholesale electricity market	In the assessment procedure
Modification P379 'Multiple Suppliers through Meter Splitting'	The assessment has shown that the implementation costs would significantly outweigh the benefits	Withdrawn on 10th March 2021

From 24th June 2021, P398 'Increasing access to BSC Data' makes all BSC data available for request unless there is a reason otherwise in order to reduce barriers to innovation and increase competition and productivity[19]. Before requested data is opened, it will be checked for transparency against criteria including consumer privacy, negative consumer impact, security or commercial impact. When data is checked, it will be classified as either open, public, shared or closed that will be made available for all, with some restrictions, for a limited group, or with a single organisation to use accordingly.

Modification P375 'Metering behind the Boundary Point' will use Metering Equipment 'behind' the defined Boundary Point for Balancing Services ('behind the Meter') for Settlement purposes, rather than the Boundary Point Meter[20]. This offers more opportunities for smaller asset owners to achieve greater visibility in settlement that will help local DSOs to dispatch assets with greater control and efficiency[21]. To benefit from the changes, independent aggregators need to use asset meters which meet the specifications defined in the newly created Code of Practice 11 (CoP11). The changes could also assist developers of heat networks as part of a wider integrated energy system. Data from asset meters fitted at units behind the boundary will be used in settlement from 30 June 2022[22].

[19] Energy Data Taskforce. 2019. https://es.catapult.org.uk/news/energy-data-taskforce-report/

[20] https://www.igt-unc.co.uk/wp-content/uploads/2020/11/CACoP_19_1310-Final-Minutes.pdf

[21] Elexon.2021. https://www.elexon.co.uk/article/modification-p379-is-withdrawn-but-learnings-can-support-future-change/

[22] https://www.elexon.co.uk/article/ground-breaking-modification-to-support-the-energy-transition-is-approved/

Modification P376 'Utilising a Baselining Methodology to set Physical Notifications' proposes to change the source of data used in settlement calculations from the final physical notifications to a new 'Settlement expected volume' to ensure that BSPs are more accurately compensated for the delivery of flexibility volumes. The change also intends to remove a barrier to balancing mechanism participation, allowing more types of party to provide balancing services to the Electricity System Operator (ESO)[23].

Currently, consumers of electricity can only access power exchanges and be rewarded for flexibility only though their supplier. Modification P415 'Facilitating access to wholesale markets for flexibility dispatched by Virtual Lead Parties' proposes to allow Virtual lead parties (VLP), who are aggregators of registered units, to trade electricity from demand-side response (DSR) providers directly in the wholesale electricity market, rather than through suppliers. The modification is under the assessment stage; the implementation date is provisionally targeted for November 2022[24].

Modification P379 'Multiple Suppliers through Meter Splitting' was closed on 10th March 2021, which aimed to create competition and supply innovation for a consumer's energy volumes behind a settlement meter, removing requirements to arranging agreements in advance between the suppliers[25]. The modification has been withdrawn after the assessment procedure in which cost benefit analysis over a ten-year implementation period showed that the costs for its implementation would significantly outweigh the benefits[26]. The analysis also concluded that some of the desired outcomes would already be delivered through other modifications mentioned above such as P375, P376, P415, and as further discussed Market wide half-hourly settlement (MHHS). However, the analysis points out that reconsidering the case for multiple suppliers in approximately five years could be worthwhile when sector's changes may change the costs and benefits of P379.

The above code changes and review provides some of the mechanisms for consumers to engage with both the wider energy system and SLES. The GreenSCIES project aims to design a customer-centric business model that relies on consumer engagement with the energy market affecting the cost of utility bills and the amount of energy used. For SLES, the approved code modifications may increase access for smaller generators and flexibility providers to the balancing market and ancillary services; open BSC data may help to identify the best locations to invest and provide the basis for a more robust business case analysis. The proposed code modifications can enable SLES customers to directly access the wholesale electricity market without transacting through a licensed energy supplier. Nevertheless, the withdrawn P379 modification, proposing to allow customers to have multiple suppliers at a time, might prevent new entrants of potential business models entering to the local market by blocking a potential value of SLES.

[23] Cornwall Insight. 2021. https://www.eprg.group.cam.ac.uk/wp-content/uploads/2021/01/S.-Littlechild_OCS-scores_Aprl2021.pdf

[24] Elexon.2021. https://www.elexon.co.uk/mod-proposal/p415/

[25] https://www.elexon.co.uk/mod-proposal/p379/

[26] CEPA.2020. https://www.elexon.co.uk/documents/change/modifications/p351-p400/p379-stakeholder-workshop-slides-cepa/

3.4.2 Market-Wide Half-Hourly Settlement (MHHS)

MHHS is expected as a key component of developing a smarter, more flexible energy sector[27]. In 2017, Ofgem announced that the whole electricity market should move to a half-hourly settlement[28]. From the same date, all businesses in profile classes 5 to 8 were required to have their energy use recorded every half hour[29]. MHHS intends to use smart metering infrastructure and previous work on half-hourly settlement to bring benefits including more accurate demand forecasting, more accurate settlement and better network management. This will lead to lower system costs.

In April 2021, Ofgem approved modification P413 'Market-wide Half Hourly Settlement Programme Manager' that entails Elexon to undertake MHHS implementation involving responsibilities for establishing, operating, and managing appropriate programme structures and governance. To enable Elexon to recover the costs of the MHHS implementation programme, a new monthly charge (on 10 June 2021- £0.03847/Supplier Volume Allocation MSID) from BSC suppliers on a per meter point basis is established and has been implemented from July 2021[30].

On 20th April 2020, Ofgem published Full Business Case decision outlining how and when MHHS will be implemented[13]. Ofgem has decided to introduce MHHS, based on the design working group's (DWG's) Target Operating Model (TOM), for all meter point administration numbers (MPANs) with a transition period of about 4 years 6 months from April 2021 to October 2025.

MHHS should help to shift electricity load from peak hours to non-peak hours. In both in the wider energy system and in SLES, MHHS could improve incentives for installation of storage, V2G functionality or demand side response and, in turn, provide a more flexible smart energy system.

3.4.3 Access and Forward-looking Charging Significant Code Review

As a result of the significant code review, in June 2021 Ofgem has proposed changes for the three key areas.[31] These were subsequently updated in an update to their minded-to position in January 2022.[32] The current position is summarised below, proposed for an April 2023 implementation:

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[27] Ofgem.2021. https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/mhhs_full_business_case_final_version_for_publication_20.04.01.pdf

[28] https://www.elexon.co.uk/operations-settlement/market-wide-half-hourly-settlement/

[29] Ofgem. 2021. https://www.ofgem.gov.uk/publications/moving-half-hourly-energy-reads-bsc-p272-and-p322-guide-businesses

[30] Elexon.2021. https://www.elexon.co.uk/article/introduction-of-mhhs-implementation-monthly-charge/

[31] Ofgem.2021. https://www.ofgem.gov.uk/publications/access-and-forward-looking-charges-significant-code-review-consultation-minded-positions

[32] Ofgem 2022. https://www.ofgem.gov.uk/publications/access-and-forward-looking-charges-significant-code-review-updates-our-minded-positions

1. Distribution connection charging:

   - Introducing a 'shallow' connection charging boundary for demand, where the connecting customer would no longer receive a connection charge for reinforcement of the shared network, and only for their extension assets;

   - A 'shallower' connection charge for generation, where the connecting customer would receive a reduced charge for reinforcement of the shared network, plus their extension assets;

   - Protections for DUoS bill-payers that require the connecting customer to contribute more to the cost of connection under some specific circumstances. The aim being to help to protect DuoS bill-payers from the potential for large overall cost increases as a result of these changes.

2. The definition and choice of network access rights:

   - Non-firm access arrangements available to customers and defined in terms of number of hours (% of time) that a connecting customer has agreed to be curtailed;

   - Curtailment limits for non-firm connections, agreed between the network operator and the connecting customer based on maximum overall network benefit. If a network operator needs to curtail above this limit, that service must be procured from the market;

   - End dates for non-firm arrangements after which the connection needs to be made firm unless a customer has not requested a firm connection or where the high-cost cap is triggered, and the customer does not wish to contribute to reinforcement costs above the cap.

3. Transmission charges for small, distributed generators:

   - Whilst Ofgem stand behind the principle that smaller generators should be charges equivalent to larger generators, they do not intend to direct changes to TNUoS for April 2023 under the Access SCR.

There is still a lack of detail on many decisions to be taken by Ofgem, but these changes will be an important starting point for informing the RIIO-ED2 price control proposals and the service provided by DNOs and their further implementation. Notably, this policy gap provides scope for stakeholders to present their views on design of SLES and its successful integration with the wider energy system.

3.5 Electricity storage

Energy storage and flexibility is one of the ten priority areas of the Net Zero Innovation Portfolio[33]. In the Ten Point Plan it is mentioned that £100 million will be allocated to fund energy storage and flexibility innovation challenges. In the 2021 Smart System and Flexibility Plan in the mid-2020s it is aimed to create a best-in-class regulatory framework for electricity storage at all scales to facilitate its deployment. To date, around 4GW of electricity storage operates in the UK, from which 3GW is pumped hydro storage and 1GW is lithium-ion battery storage[34]. By 2030 and beyond, significant flexibility is planned to be provided to the electricity system by 13GW of electricity storage in combination with flexible demand [5].

[33] HM Government. 2020. https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution

[34] ESN and Regen.2020. https://www.regen.co.uk/wp-content/uploads/ESN-Pathways-to-a-Net-Zero-Future.pdf

Electricity storage plays an important role in system flexibility, helping to maintaining energy security, shifting when generation is needed, alleviating constraints, and providing system stability services, driving down the cost of intermittency and increasing the expansion of renewable energy. Recently, notable regulatory changes accelerating investment attractiveness in battery storage have been applied. From 29 November 2020 'electricity storage' and 'electricity storage facilities' are defined in the electricity generation licence[35]. This change clarifies that electricity storage is treated as other forms of generation and allows the avoidance of unnecessary duplication of regulations.

The electricity generation licence covers the list of technologies that are considered as electricity storage (electrochemical batteries, gravity energy storage etc.) and that are not (transformers, inductors etc.). The list is acknowledged to be inexhaustive and will be added to acknowledging potential technology innovation. It is also mentioned that a definition of electricity storage would be set out in primary legislation when parliamentary time allows.

Since storage is categorised not as a final consumer of electricity, licence holders are exempted from the payment of final consumption levies[16]. Consequently, a new licence condition E1, applicable only to licence holders, is introduced in the electricity generation licence. Accurate information regarding the electricity storage facility to suppliers is required to ensure that the correct identification of licensed facilities as electricity storage and that the correct calculation of certain charges is provided[16].

On 1st April 2021, double charging of Balancing Services Use of System (BSUoS) charges for electricity storage was removed[36]. Before this came into effect, storage paid BSUoS charges both for the electricity imported from and exported to the grid. Currently, electricity storage facilities are exempted from BSUoS charges on imported electricity and are only charged for the BSUoS charges on exported electricity. The end of double charging of electricity storages removes the competitive disadvantage with conventional generation assets.

Another barrier to deployment of electricity storage distorting sizing and investment decisions was removed on 2nd December 2020. In the planning regime electricity storage, except pumped hydro, was subject to the 50MW capacity threshold for the Nationally Significant Infrastructure Projects regime[37]. This regime required a Development Consent Order from the Secretary of State involving a pre-consultation, submission, and examination process on the national level for the electricity storage over the 50MW. The removal of complexity within a planning system should ease time and labour intensity of the process and contribute to the growth of investment decisions for larger electricity storage projects. These amendments in the regulation classify the charging status of electricity storage and encourage the deployment of energy storage projects.

Energy storage plays a significant role in unlocking the benefits of SLES helping to enable the effective integration of renewable energy, promote energy reliability, and create new revenue models from distributed generation. Nevertheless, costs of energy storage are high, so policy changes that make the business case for storage stronger will facilitate investments required for SLES.

3.6 Heat networks

Comparing with gas and electricity sectors, the market and regulatory framework for heat networks is currently in the early stages of development. A detailed review of near and

[35] Ofgem.2020.

[36] Ofgem. 2020. https://www.ofgem.gov.uk/system/files/docs/2020/05/cmp281_d.pdf

[37] BEIS.2020. https://www.legislation.gov.uk/uksi/2020/1217/pdfs/uksiem_20201217_en.pdf

medium-term policy and regulatory changes in relation to heat networks has been provided by the ESC[38].

In February 2020, government launched a consultation for a market framework for heat networks and proposed the following[39]:

- Producing standardised documentation to ease developers' burdens and costs;
- Establishing Ofgem as the regulator;
- A new definition of heat network covering ambient temperature networks having both heating and cooling and including decentralised generation and storage;
- A general authorisation with optional licence for rights and powers as a regulatory design approach.

Expected in 2022, a market framework will seek to encourage private investment and establish a regulatory framework for the Heat Networks[40].

3.6.1 Heat Network Policy Development

It is worth noting the proposals put forward in the recent Heat Network Zoning consultation, suggesting that where an area is identified as suitable for a heat network zone, all new buildings, large public sector and large non-domestic buildings – as well as communally heated large domestic buildings would be required to connect within a given time period. Further, BEIS have consulted on new powers and enforcement options for local level actors to develop the zoning approach and central zone identification process, signifying an important role for Local Authorities in such decisions. It also stipulates that, exemptions could be sought where it may not be cost-effective to connect, compared to an alternative low carbon solution.[41]

The Ten Point Plan and the Energy White Paper support phasing out the installation of gas boilers by the mid-2030s to achieve Net Zero[42,2]. The UK government set an ambition to develop manufacturing and investment to the heat pump market, aiming to install 600,000 heat pumps per year by 2028[Error! Bookmark not defined.].

In Autumn 2021 government published the Heat and Buildings Strategy, setting out its broad plan and a series of policy proposals to decarbonise the UK's building stock. The Strategy outlines government's ambition to stimulate markets through innovation funding, proposes a gradual tightening of regulations across social housing, off-gas and the private rented sector and introduces a new Boiler Upgrade Scheme (BUS) and Homes Upgrade Grant (HUG),

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[38] ESC.2021. GreenSCIES Task 6 – Policy and Regulatory Context for Heat Networks

[39]BEIS.2020. https://www.gov.uk/government/consultations/heat-networks-building-a-market-framework

[40] UK Parliament.2020. https://post.parliament.uk/research-briefings/post-pn-0632/

[41] BEIS, 2021, Heat Network Zoning Consultation https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1024216/heat-network-zoning-consultation.pdf

[42] The ten Point Plan.2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf

supplemented by proposals for a market-based mechanism, and confirmed innovation funding for the previously announced Heat Networks Transformation Programme (£338m).[43]

The Future Homes Standard is planned to be introduced by 2025 that will require new buildings to have low carbon heating[44].

Establishing a clearer market and regulatory framework for heat networks will be a significant step change, moving the sector forward, in particular, among SLES developers and investors. Nevertheless, while gas prices are lower than electricity prices, moving away from fossil fuel-reliant technologies will remain a considerable challenge; however there have been recent signals in the BEIS Net Zero Strategy to explore options on reshaping the policy levies placed on electricity prices to be shifted across to the more carbon intensive gas price.

3.7 EV charging

EVs are designed to provide low carbon transport solutions. However, they are also able to be used as distributed flexible demand or even storage assets when combined with smart or Vehicle-to-grid (V2G) charging technology. This flexibility can be used for purposes such as:

- Optimising consumption of on-site renewables;
- Energy arbitrage;
- Energy import capacity constraint management;
- Offering energy network flexibility.

BEIS has launched a consultation calling for evidence about the role of V2X (an almost equivalent term to V2G) technologies in a future smart, flexible, and decarbonised system and the potential barriers to their deployment[45]. Although the consultation does not propose any technical or regulatory aspects, this call may help to understand potential business models for SLES.

In July 2021 the government published following outcomes to EV smart charging consultation[46]:

- Smart charging will be defined within legislation and mandate new private chargepoints to include smart functionality.
- The roll-out of smart charging will be approached over two phases.
    - Phase 1: In Autumn 2021 the government intend to place a minimum set of requirements to the sale of private (domestic and workplace) chargepoints 50 kW or below under secondary legislation of the Automated and Electric Vehicles Act 2018.

[43] BEIS, 2021, Heat and Buildings Strategy https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1036227/E02666137_CP_388_Heat_and_Buildings_Elay.pdf

[44] MHCLG.2021. https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings

[45] BEIS.2021. https://www.gov.uk/government/consultations/role-of-vehicle-to-x-technologies-in-a-net-zero-energy-system-call-for-evidence

[46] DfT and OLEV. 2021. https://www.gov.uk/government/consultations/electric-vehicle-smart-charging

- Phase 2: By 2025 the government intend to place requirements to entities that can control chargepoints, such as chargepoint operators, electricity aggregators, and electricity suppliers.

V2X and smart technologies could reduce new energy generation capacity and minimise peak demand from EVs, benefitting the energy system. To maximise the use of V2X and smart charging technologies in both the wider energy system and in SLES, distinguishing billing of both a charging service and a dispatchable demand response service, is needed in the current regulation. Proper treatment for various services delivered by chargepoints will boost engagement in participation in local flexibility markets.

3.8 Digitalisation

Recently, the UK's first Energy Digitalisation Strategy (Taskforce with Ofgem, spring 2021) has been published, developed by BEIS, Ofgem and Innovate UK.

Digitalising the energy system is highlighted in the strategy as essential to enable the energy system to operate flexibly, optimising low carbon assets including solar PV, EVs, heat pumps and battery storage across networks, and to integrate them at least cost to consumers[47]. It is estimated that from 2020 to 2050 a flexible energy system can reduce system costs by £30-70bn. To create a flexible energy system, it is emphasised that it is crucial to apply a 'whole system approach' involving digitalisation of all four main parts of the energy system such as the generation, transmission, distribution, and supply.

The strategy focuses on 3 main actions such as providing leadership and coordination, ensuring regulation and policies incentivise digitalisation and developing digital tools and infrastructure. The list of actions is summarised in Table 2.

Table 2. Summary of actions planned towards digitalisation of the system

N	Key areas	Actions planned
1	Leadership and coordination	- Review of energy datasets and data management processes in the consistence with Energy Data Best Practice (the end of 2021); - Data and Digitalisation Strategic Change programme development; - Review of how to give greater visibility, embedding Energy Data Best Practice principles, and end-of-phase summaries; - A Catalogue of Projects on Energy Data prototype (summer 2021); - Recommendations of Energy Digitalisation Taskforce regarding next steps and priorities towards digitalisation (winter 2021/22);
2	Incentivising digitalisation	- Including data and digitalisation expectations to the design of the RIIO-ED2 price control; - Ensuring that the methods of exchanging data between Ofgem and energy networks are modernised; - Publishing a cost benefit analysis of enhanced asset monitoring (December 2021); - Reforming the Long-Term Development Statement;

[47] BEIS, Ofgem, Innovate UK.2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1004011/energy-digitalisation-strategy.pdf

		- Identifying market trends through reviewing new and existing data and digital monopolies (2021/22); - Developing options to simplify data collection;
3	Development of digital solutions	- Creating a standard for data sharing and a governance platform for user verification; - The tool holding the metadata for datasets across the sector; - The map presenting datasets shared by network companies;

The impacts of this regulation are relevant to SLES because smart control is one of the cores of the SLES concept that requires exposing users' data. Smart platforms are needed to offer greater flexibility, interoperability and utilisation of infrastructure and technology. Revenue available to local DER providers can depend on the design of smart platforms and its interaction with the wider system[48]. In the future, managing a highly decentralised energy system and dealing with potentially many thousands of prosumers and active customers might depend on DSOs' ability to digitalise an operational market and the management of SLES[49]. Therefore, more certainty in terms of the use of smart platforms adapted to SLES conditions is crucial for its development and deployment and should be considered at an early design stage.

3.9 Summary

SLES is a relatively new concept from a regulatory perspective which significance is clearly pointed out in the White Energy Paper, albeit it is devoid of detail and commitment on how to support it. To facilitate participation and engagement of SLES developers and to drive its uptake, the development of regulation enabling distributed generation and local energy trading and removal of barriers restricting access to values including financial is crucial. Innovative projects such as GreenSCIES can help to identify potential policy gaps for SLES and solutions for them and to understand how best to maximise values that SLES may offer. In turn, Guidance or Implementation Roadmap for SLES is needed to bring more certainty and clarity in operational market and management.

[48] LEO.2020. https://project-leo.co.uk/wp-content/uploads/2020/07/LEO-Year-1-annual-synthesis-report-master-040620-for-web.pdf

[49] RAP.2020. https://www.raponline.org/wp-content/uploads/2020/05/rap-baker-dso-challenges-june-2020-final.pdf

4 Impact of Current Policy on SLES

In this chapter we will explore the impact of the current policy arrangements on the GreenSCIES SLES proposal.

4.1 GreenSCIES proposal and value

The GreenSCIES project is funded by Innovate UK and is set up to deliver a design for innovative and investable business model approach of SLES for a population of 33,000 localised in the London Borough of Islington. The major project's technological innovation is the application of the 5th generation (5G) of the district heating network integrated with shared mobility and power.

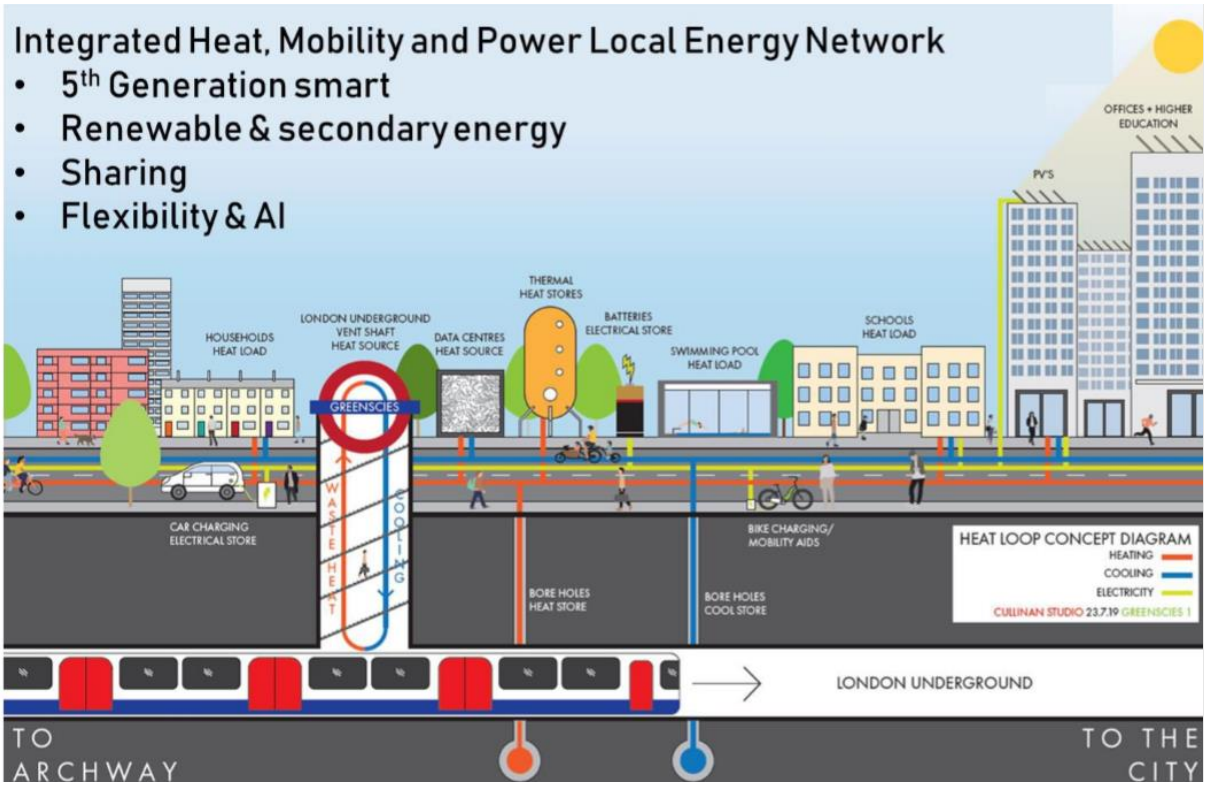

Figure 1: GreenSCIES Conceptual Proposal

One of the Climate Change Committee's priority recommendations is shifting away from fossil heating towards low-carbon heating such as heat pumps and heat networks[50]. The proposed 5G energy network will use renewable and secondary energy with the use of a range of assets as heat pumps, EVs and V2G, PV, waste heat, smart control for demand-side response (DSR), and thermal storages as aquifer thermal energy storage (ATES), borehole thermal energy storage (BTES) and phase change material thermal storage and can significantly contribute to the delivery of Net Zero target.

The GreenSCIES proposes to install the heating network operated at low temperature (15-25°C) ambient loop system that will use waste heat from local data centres and the London Underground as a heat source to reduce operation costs and greenhouse gas emissions. It is aimed to design a business model approach that will:

50 https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf

- reduce carbon emissions;
- improve air quality;
- contribute to the electricity network;
- reduce energy costs for end-users;
- able to be replicated nationally.

The GreenSCIES proposal includes the so-called CHAMP (Cooling Heat and Mobility Power) model where revenues are derived from each one of these components. The proposal will incorporate newly installed technology within Islington, with new platforms and work with new business models to make and share the value. (Figure 2).

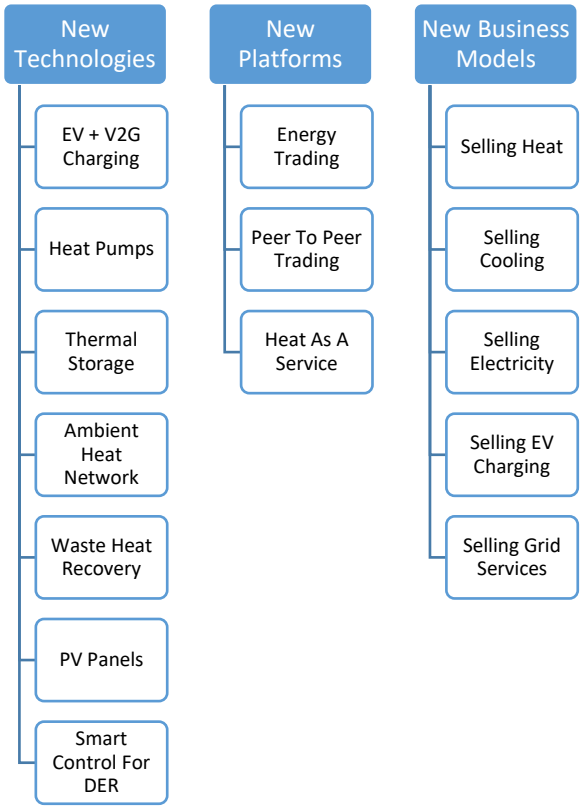

Figure 2: The GreenSCIES Proposal

The project also aims to be commercially viable and benefit from 25% reduction in energy bills through flexibility, energy efficiency measures, energy trading and savings for the end user from Transmission Use of System Charge (TUoS), Distribution Use of System (DUoS), TRIAD avoidance, various National Grid Ancillary services, and Climate Change Levies. Nevertheless, the GreenSCIES project's concept may offer more potential benefits to the end users of the local community through generating, consuming, sharing and selling not only electricity, but also heating, cooling and EV charging and though maximising reduction in energy bills and carbon emissions. A list of the various value streams that GreenSCIES is seeking to access is given below:

- Selling heat and cooling services
- Selling electricity
- Selling EV charging services
- Optimising electricity consumption against time varying pricing
- Optimising network charges

- Maximising consumption of locally produced photovoltaic (PV) power
- The Capacity Market
- The Balancing Mechanism
- Ancillary services such as the firm frequency response (FFR) and dynamic containment (DC)
- Inter-seasonal storage of heat via the aquifer
- Distribution network flexibility services

4.2 GreenSCIES and the current policy landscape

To maximize value and design a commercially viable business model, it is important to consider the relationship between the GreenSCIES project, current policy, network charging and market design. The current regulation, network charging and market structure do not always fully value local flexibility but rewarding such concepts can unlock full potential values of SLES and lead to their wider implementation.

Table 1 shows the value streams in which the GreenSCIES project may participate in under current market, policy and regulatory arrangements.

Table 1 Potential revenue streams under existing market/policy arrangements and participation blockers for GreenSCIES

Market/Revenue Stream	Included in Current GreenSCIES Proposition?	Blockers to participation	Comments
Load shifting through smart tariffs – either customer-controlled (automated) or direct load control (DLC) through supplier/intermediary	Yes	Lack of market-wide half hourly settlement (MHHS). Sites without half-hourly settlement will gain no advantage by load shifting. Underlying price signals of network costs and policy costs (i.e. levies for CM, Renewables Obligation (RO), CfD, Feed in Tariff (FiT)) not fully passed through, even in dynamic tariffs, particularly for domestic consumers. Underlying price signals not yet accurately cost-reflective. Underlying price signals sent to suppliers but could in theory be sent to other intermediaries in future - supplier hub concept currently prevents this.	Many larger consumers already have half-hourly settlement (HHS). Suppliers can settle domestic customers on a half-hourly (HH) basis but most choose not to. Market-wide half hourly settlement (MHHS) and smart meter roll out will be completed by October 2025. Wider market design and policy framework can incentivise or disincentivise suppliers and intermediaries to enable demand-side flexibility (see Table 3). The BEIS Alternative Energy Market programme is looking at how to make policy costs (such as renewable support scheme costs) more dynamic. For example, in ways that more accurately reflect the system costs and carbon emissions impacts that result from consumer energy choices. Such changes would likely increase the value of load shifting.
Imbalance exposure/payments	No	Suppliers (balancing responsible parties - BRPs) will face penalties if their notified contractual position differs from their physical position at gate closure. Suppliers will pay for service providers to avoid these penalties. Balancing market costs are currently extremely high and under review by NGESO – suggests that incentives for BRPs to be in balance might not be sufficiently strong and if they would be strengthened, could increase revenues for GreenSCIES flexibility provision.	Elexon develops the methodology for imbalance pricing, including calculations for RSVP, VOLL, LOLP: https://www.elexon.co.uk/operations-settlement/balancing-and-settlement/imbalance-pricing/ Suppliers and intermediaries could also be more incentivised to use flexibility through market design and policy/regulations (covered in Table 3).

Market/Revenue Stream	Included in Current GreenSCIES Proposition?	Blockers to participation	Comments
DNO procurement of flexibility and demand reduction	No	Ofgem's guidance for RIIO ED-2 is pushing DNOs to be more open about the evaluation methodology the DNO will use to compare different solutions, including flexibility and energy efficiency, for meeting network needs. One of the main activities Ofgem expects of the DNOs is to "Facilitate efficient dispatch of distribution flexibility services." Ofgem is trying to incentivise DNOs to procure non-wires alternatives, preventing or delaying reinforcements. UKPN's Final Business Plan 2021 highlights that its strategy for ED2 is to "to maximise the utilisation of the existing network first, to foster energy efficiency, and to promote the use of flexibility and market-based solutions. Only when we have exhausted all other options will we invest to upgrade the networks". UKPN are aiming to defer up to £410m of load related investment on the primary and secondary network in ED2 by making greater use of flexibility. The ENA is actively pursuing multiple workstreams examining DNO flexibility procurement through its *Open Networks* project. Of particular note is 'Workstream 1A – Flexibility Services' which has numerous products such as: Enhancing the Common Evaluation Methodology (CEM) (and tool) used to evaluate flexibility and traditional intervention options; Alignment of Flexibility services procurement processes across DNOs and ESO, including pre-qualification and planning move to real time procurement; Review of existing and new Flexibility products and undertaking further analysis on	Although UK Power Networks (UKPN) is not *currently* procuring for flexibility services in the Islington area, this is not to say that such services will not be needed in future (particularly given the pressure to move to 'flexibility and energy efficiency first' principles before traditional reinforcement). With growth in Distributed Energy Resources (DER), the DNO will become more active in procuring flexibility (mainly the services Secure, Sustain and Dynamic). During their 2021 summer flexibility forum, UKPN reported continued rises in flexibility procurement: 2019 = 19.3 MW (£0.5m) for 11 zones 2020 = 123MW (£14m) for 57 zones (42 HV & 15 LV) 2021 = 350MW (£30m) for 137 zones (77HV and 60LV) For its February 2021 Flex tender, 71% of capacity was met with EVs and domestic storage, with 18% gensets, 7% batteries, and 4% DSR.

Market/Revenue Stream	Included in Current GreenSCIES Proposition?	Blockers to participation	Comments
		stackability to address barriers; Improvement to existing Standard agreement for procuring Flexibility services across DSO and ESO.	
Self-Consumption of PV energy	Yes	None	By timing the demand of flexible assets behind the meter, self-consumption of PV generated on-site can be increased. Any exported PV energy would be paid for likely via the Smart Export Guarantee, but likely at a far lower rate than avoided imported energy.
Wholesale (SPOT) market trading	Yes	Customers can only access power exchanges (and other markets that require notification of contracts under the BSC) though their Supplier. This contrasts with Balancing Services, the Balancing Mechanism, and the Capacity Market, all of which allow a customer's flexibility to be offered by an aggregator without the involvement of the Supplier so long as the resources meet eligibility criteria. However, all GreenSCIES resources can respond to wholesale market prices if the price signals are passed through in some way via smart tariffs (i.e. implicit demand response, as opposed to explicit demand response in the spot market).	This currently requires a relationship with a Balancing Responsible Party/supplier Wholesale prices are directly impacted by interactions with policies, particularly the renewable energy support schemes (e.g. CfDs) and lack of flexibility (among other things).
Capacity Market	Yes	Certain technologies (e.g. electric vehicles connected to the grid; demand reduction) are not currently eligible to participate in CM auctions. Heat pumps are permitted. Capacity Market costs are currently recovered from electricity demand as a p/kWh levy on winter weekdays 4-7pm. This price signal is typically not passed through to domestic consumers in smart tariffs. This price signal,	The BEIS consultation on "new generating technologies in the Capacity Market" (results published December 1st2021) highlighted that BEIS is seeking views on the progress of "electric vehicles connected to the grid" as a potential technology to contribute to security of supply. BEIS stated they will continue to consider these emerging technologies with the ESO and how best to assess their potential future participation in the CM. No update has been provided since.

Market/Revenue Stream	Included in Current GreenSCIES Proposition?	Blockers to participation	Comments
		however, is becoming less reflective of system conditions as net demand becomes more difficult to predict with growth in variable renewables and DER. The BEIS Alternative Energy Market programme is exploring how to improve the cost-reflectivity of, and consumer response to, these price signals.	
Balancing Mechanism	Yes	ESO has been actively widening access to the BM: https://www.nationalgrideso.com/industry-information/balancing-services/balancing-mechanism-wider-access VLPs as independent aggregators – can now enter the BM: https://www.elexon.co.uk/documents/training-guidance/bsc-guidance-notes/virtual-lead-party-vlp-entering-the-market/ Behind the meter assets are limited in their participation, however, since changes in other behind-the-meter demand can negate the actions of flexible assets. BSC Issue 94 looked at 'Assessing barriers to entry to the BM for sub 1MW providers and decimal bids' https://www.elexon.co.uk/smg-issue/issue-94/ Due to transmission congestion and other factors, BM market value is rising.	The recently adopted code change P375, which enables asset-metering, will improve this. The Workgroup for Issue 94 concluded that no Code Modifications or Change Proposals are required but that there could be future direct or consequential Code Modifications required as part of the work to remove barriers to entry to the Balancing Mechanism.
Ancillary Services (FFR, DC)	Yes	Efforts are being made to widen access to the Ancillary Services markets (frequency response, reserve, thermal, reactive power, restoration, stability), to increase transparency and procure nearer to real time. While ongoing changes to Ancillary Services are making it easier to participate, need to check eligibility criteria for different assets for different markets.	New markets being created as power system needs change e.g. stability, restoration (including bottom up through DER). For roadmaps of all markets, see https://www.nationalgrideso.com/document/188666/download

Market/Revenue Stream	Included in Current GreenSCIES Proposition?	Blockers to participation	Comments
Network Connection Charges & Access Rights	No	Network access is normally offered at a fixed capacity except in Active Network Management zones.	Connection charges can influence siting of demand and generation and choice of voltage level to connect to. Network connection charges and access rights are undergoing review and reform (see Table 3). Flexible connection agreements with the DNO would benefit SLES, as they can respond flexibly. Maybe even shared connections, where a group of sites in a SLES agree not to exceed a certain limit.
Network charges	Yes	Due to the Targeted Charging Review (TCR), the share of fixed charges in network charges has increased. Following the TCR, the Transmission Demand Residual (TDR) charges were recently updated with bandings that vary charges by voltage level: https://www.nationalgrideso.com/industry-information/codes/connection-and-use-system-code-cusc-old/modifications/cmp343-and-cmp340 TNUoS charges to generators are based on their transmission entry capacity (TEC). TNUoS charges to electricity suppliers and large industrial customers are based on their electricity demand at peak times. Following TCR reforms, from February 2023 the opportunity for large consumers to reduce their TNUoS charges through demand response during a Triad (i.e. top three half-hourly peaks of national energy demand across the grid, separated by ten clear calendar days between 1 November and 1 March) will be greatly reduced.	Opportunities to avoid network charges have recently been reduced with reforms to the residual part of network charges that increase fixed charges and will substantially reduce demand response revenues via Triads. While Ofgem aims to ensure equal treatment of resources and use of network at different voltage levels, this is not yet achieved; this is highly relevant for GreenSCIES assets, where for example, connection of HPs at HV level instead of LV level could be more efficient from a whole system perspective. The TDR banding can strongly influence choices regarding voltage level for connections, encouraging connection at lower voltages (goes against business models based on aggregated DER, wanting to connect at higher transmission voltages to allow for growth). Value could be obtained by coordinating control of assets to reduce network losses, reduce network congestion or avoid/delay reinforcement. Reforms to DUoS are underway and whether to reform TNUoS is currently being considered by Ofgem. TEC charges are being criticised for creating misaligned incentives for batteries – they currently provide income for

Market/Revenue Stream	Included in Current GreenSCIES Proposition?	Blockers to participation	Comments
		A link to NGESO's Five Year View of TNUoS tariffs for 2021/22 to 2025/26 can be found here: https://subscribers.nationalgrid.co.uk/t/d-7F984A8FF5DF13022540EF23F30FEDED DUoS charges are volumetric and vary to some extent by location and time but are criticised for not being cost-reflective. There is currently no mechanism for a group of demand/generation customers to co-operate to reduce impact on the transmission system.	batteries in the south but impose costs in the north/Scotland so this may be reviewed in future.
Inter-seasonal storage of heat using the aquifer	Yes	None	Whilst not an explicit market, by storing excess heat in summer months, and extracting in winter months the heat network can create additional value.
Peer to peer (P2P) energy/balancing/capacity trading	No	The supplier hub model prevents effective peer to peer trading of energy products and services. This could be a means to increase system efficiency and reduce costs by reducing energy losses, among other benefits.	There is considerable research and demonstration activity taking place across the UK on local electricity markets, including P2P trading (see Table 3). However, the value of this may not be large, considering the size of the change required. The ENA Open Networks project is looking at the potential of both capacity and generation trading.
Heat Sales	Yes	Existing policies on Heat and Buildings: Energy Efficiency, Retrofit, Part L Building Regulations, EPC & SAP. District heating produces fewer carbon emissions than heat from natural gas - however this is not reflected within SAP / current effective carbon pricing Heat decarbonisation policy has centred around energy efficiency standards and retrofitting existing buildings	This is a key revenue stream for the GreenSCIES proposition

Market/Revenue Stream	Included in Current GreenSCIES Proposition?	Blockers to participation	Comments
		through Part L of the Building Regulations. Historically, retrofit policy mechanisms have centred around obligations on energy suppliers. EE policy is relevant as it will impact how much heat could be sold, and retrofitting existing buildings may impact heat supply. Pricing for heat sales will be impacted by policies for competing alternatives such as Gas and Hydrogen, however these are all contingent on the scale of assets within the GS scheme. Relevant existing policies in relation to heat and buildings are set out below: • The Energy Company Obligation (ECO) has been a significant policy in reducing carbon emissions through energy efficiency measures, however this is now focused on fuel poverty. • Minimum Energy Efficiency Standards (MEES), set out energy efficiency standards for privately rented domestic properties • Part L requires that new and existing buildings improve energy efficiency when undertaking major works • New buildings require compliance with a Target Emission Rate (TER), calculated through the Standard Assessment Procedure (SAP) methodology or Simplified Building Energy Model (SBEM) for non-dwellings • 5th generation district heating produces fewer carbon emissions than heat from natural gas -	

Market/Revenue Stream	Included in Current GreenSCIES Proposition?	Blockers to participation	Comments
		however the intensity of these carbon factors are not reflected within the current version of SAP therefore impacting the business case. • SAP 2012 (current) assumes higher carbon emissions factors for electricity (0.519 kgCO2/kWh) than for mains gas (0.216 kgCO2/kWh) • Proposed version of SAP 10.1 assumes a lower carbon factor (0.136 kgCO2/kWh) which will not be used for any official purpose until June 2022 • In future, dynamic cost reflective pricing could be one way to remedy this issue. • Indication to phase out of fossil fuel heating off the gas grid during the 2020s • No existing policies for hydrogen heating however a strategic decision will be made on its implementation in 2026	
Cooling Sales	Yes	No known policy barriers	Whilst cooling load is highest in the summer, it is required for most of the year.

5 Potential Policy Change

In this chapter we set out how potential policy change might impact the GreenSCIES proposition both in relation to policy changes that are already underway, and those that may arise in medium and longer term.

In Table 3 below, the second column captures policy change underway and the current direction of travel indicated by the Government and Ofgem. The third column explores longer term possibilities for changes to market design or policies and regulations. In the fourth and final column, potential impacts on the GreenSCIES proposition are summarised.

This information and analysis can inform the GreenSCIES consortium's decision-making relating to:

- priorities for policy reform proposals and advocacy that the GreenSCIES consortium may wish to adopt in its communication and engagement with policy makers and regulators
- further revenue/economic analysis scenarios that the consortium may wish to carry out to test and explore the robustness and sensitivity of the GreenSCIES business model to potential changes in the policy and regulatory environment.

5.1 The Scheme context for considering the impact of policy changes

In considering which policy changes are likely to be most material to the GreenSCIES business model it is also useful to take account of the broad shape of expected revenues for the scheme as currently conceived and reflected in the core modelled scenario developed for the scheme using EnergyPRO.

The design, in its basic concept generates revenue through four main sources; Cooling sales, Heat sales, Mobility fees and Power market revenues (or 'CHAMP') as outlined in the commercial model below:

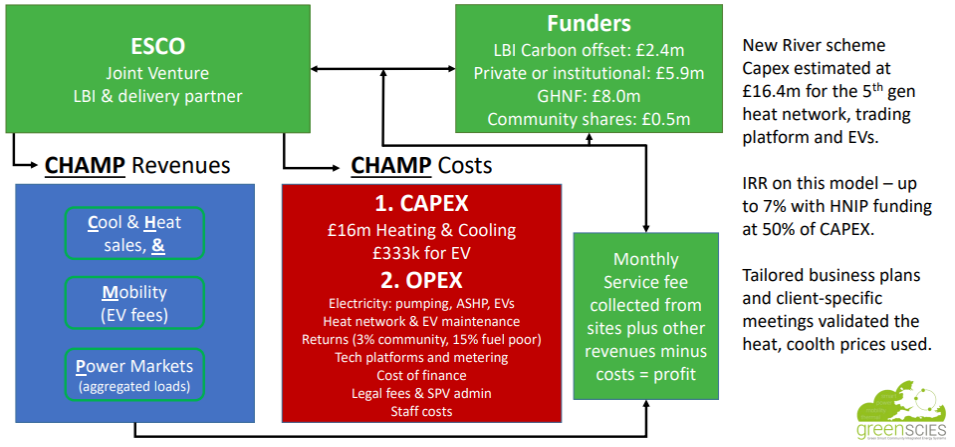

Figure 3: GreenSCIES CHAMP model

The core modelling scenario assumes an organisational structure of a Joint Venture partnership, funded partly through a public grant.

The current financial modelling carried out for the scheme suggests that scheme revenue is likely to be dominated by sales of heat and coolth, respectively 39% and 46% of total projected scheme revenue (excluding resales of electricity at cost mainly to Lumen). Coolth sales are expected to be dominated by coolth demand from the Lumen Data Centre (accounting for over 50% of total expected heat and coolth revenue).

Table 2: Expected scheme revenues

Proportions of future revenue from different sources under current core scenario assumptions		
Item	**Modelled annual revenue**	**% revenue**
Heat sales	£832k	39.4%
Coolth sales	£974K	46.1%
Service charge for new equipment	£90k	4.3%
EV chargers revenue	£145k	6.9%
CM & BM Power sales	£55k	2.6%
Elec Export	£14k	0.6%
Total annual scheme revenue (exc elec resales)	£2,110k	
Note: It is assumed that the Elec re-sales are essentially a cost pass through (mainly electricity expected to be supplied at cost to the Lumen Data centre) and therefore not included in the scheme revenues.		

This pattern of revenues suggests that:

- Policy changes that affect the revenues that the scheme can achieve from sales of heat and coolth are likely to be the most material influences on the overall viability and economic attractiveness of the scheme. These could include:
    - Policy changes that affect the relative prices of gas and electricity, including for example changes to the recovery of policy costs from electricity users.
    - Changes to the recovery of electricity policy costs which impact on the price of alternative sources of coolth (i.e. directly from electricity)
- Current expectations for revenue from EV charging and sales of power into either the capacity market or balancing market are expected to be a relatively minor proportion of overall scheme revenues – so policy changes affecting the scheme's ability to access these revenues or to increase them are a potential upside factor – but unlikely to be critical to the overall business case for the scheme.

5.2 Potential analysis of interaction of policy & scheme economics

We also suggest, based on our examination of the scheme financial modelling, that the GreenSCIES consortium consider testing or incorporating some of the following in their analysis of the scheme financial and economics case.

The assumptions about price the scheme can achieve for sales of Heat:

- The modelling includes generic sensitivity analysis of changes to Heat prices. It should be possible to run some more specific sensitivities quantifying the impact of potential changes to the recovery of policy levies (e.g. if electricity policy costs are partially shifted onto gas bills)? This could inform GreenSCIES risk management and policy advocacy.
- The consortium may wish to revisit the price assumptions used for heat sales to take account of recent gas price developments, and also to verify if the costs of boiler amortization and annual servicing (which would be required in the counterfactual gas heating case) have been taken account of in the modelling assumptions. If this cost has not so far been included, it would be worth adjusting the input assumptions for heat sales (ie include this in the

counterfactual gas heating case). This could push the assumed achievable sale price for heat a bit higher and improve overall scheme economics.

Assumptions about revenue from sales of flexibility

While the revenue expectations from sales of flexibility are much lower in the overall scheme NPV – they could still be an important source of upside for GreenSCIES. It may also be useful to gain insight from UKPN as to whether there are local network constraints and value that could be realized through forms of flexibility that GreenSCIES would be well-placed to provide.

Carbon Offsets

The Consortium may consider running a calculation of the £/tonne of carbon saved over the lifetime of the scheme – that is the capex contribution from the London Borough of Islington (LBI) carbon offset fund divided by total discounted carbon savings over the scheme lifetime. This could give GreenSCIES a good sense of whether there is any justification for a higher capital contribution to the scheme from the carbon offset fund. In doing the consortium should be aware that significant change has taken place in the guidance on carbon values to be used in policy appraisal, implying a higher value for carbon savings compared with previous guidance[51].

[51] https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation#introduction

Table 3: Policy change in the near and longer term, and impact on GreenSCIES

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Wholesale electricity market (WM)	The Govt has been implementing improvements to improve the functioning of the WM (some driven by the need to justify the CM to the European Commission). It is well recognized that much more flexibility is needed and that more granular price signals by time and location are therefore necessary. There exists concern over the issue of price cannibalization for renewables, the impact of interventions on WM prices and whether the WM is able to send adequate investment signals. The current direction of travel is to retain the CfD and CM schemes, implementing incremental improvements. See https://www.gov.uk/government/publications/great-britain-electricity-market-implementation-plan BSC modification P415 is seeking to extend the Virtual Lead Party (VLP) arrangements so that they allow customers to access the Wholesale Electricity Market through this route, independent of their supply arrangements, in a similar manner to the Balancing Mechanism and TERRE. Cost Benefit Analysis and impact assessment is being conducted – key issue is whether/how aggregators should pay compensation to suppliers for causing imbalance or energy sales losses. See https://www.elexon.co.uk/mod-proposal/p415/	The role of the WM in future is unclear, with uncertainty on how major power policies will evolve. The Government is unsure whether major market design reforms are necessary (i.e. replacing/reforming the Electricity Market Policy) but is gathering evidence through its Calls for Evidence. The Net Zero Market Reform assessment by ESO considers a wide range of reforms. The interventions are on a spectrum with central planning at one end and policy that enables a greater role for market on the other. For flexibility, some central planning type proposals include joint procurement of flexibility and firm capacity or long-term flexibility contracts. Demand-side flexibility faces considerable uncertainty regarding future price signals as support schemes and the CM impact WM prices, both at wholesale level and at retail market level due to allocation of costs (levies). Zonal and nodal pricing (locational marginal pricing) and centralized dispatch is also under consideration by Ofgem and NGESO.	How GreenSCIES is impacted depends on whether its technologies are eligible to participate in any schemes that exist. If not eligible, the business models must depend on WM prices that will likely be impacted by the interventions that they are excluded from. If locational value is introduced into wholesale prices through zonal or nodal prices, average WM prices will increase in London relative to national average, reflecting network congestion. Price volatility will depend on conditions within the zone or nodal market. Value in BM and TNUoS will reduce but flexibility and locational value will be more efficiently internalized in WM prices. This could improve business case for DER flexibility in London. Opportunities for locational arbitrage for EVs will depend on how granular zonal or nodal pricing is. How low down (voltage level) nodal markets can be implemented depends on DER growth and market liquidity, and monitoring/control capabilities within the network. Could initially implement at, for example, 132kV and extend to lower voltages over time as markets mature.

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Ancillary Services (AS)	NGESO is undertaking a wide range of reforms to its AS markets including: frequency response; reserve; thermal; reactive power; restoration; stability. General trend towards greater transparency, closer to real-time procurement, reducing carbon emissions. NGESO updates its Roadmap for the different markets (currently out to 2025) on annual basis: https://www.nationalgrideso.com/document/188666/download	Going beyond 2025, it could be expected that NGESO will continue to evolve its various markets to ensure system needs are met. AS procurement, however, could be impacted by wider market design reforms if introduced.	System needs will change with time as the power mix changes; markets will develop and mature with prices reflecting supply and demand.
Capacity Market (CM)	Govt published Call for Evidence on reform options for CM in Oct 2021 – no decision yet. Considering 'early actions' e.g. eligibility criteria for multi-year capacity agreements; split auctions; de-rating factors; non-delivery penalties. https://www.gov.uk/government/consultations/capacity-market-2021-call-for-evidence-on-early-action-to-align-with-net-zero	Full review due by 2024. Alternative Capacity Remuneration Mechanism (CRM) designs could be considered e.g. in its market design assessment, NGESO compares bespoke arrangements (strategic reserves), broad investment mechanism (e.g. obligation on suppliers), or no CM and wholesale prices only (p. 41): https://www.nationalgrideso.com/document/221776/download Energy Systems Catapult has also compared CRM options: https://es.catapult.org.uk/report/broad-model-for-a-capacity-remuneration-mechanism/	In the near term, Govt's focus is on improving CM to reduce carbon and increase reward for flexibility. If GreenSCIES' assets are flexible, firm and low carbon (e.g. EVs) and if they are eligible for the CM, revenues will likely increase. Post 2025, a CRM of some type is likely to be in place but could be a new model replacing the current CM model. If CM levies were allocated to consumers based on actual system stress conditions, and passed through by intermediaries (via smart tariffs - direct load control or self-control automation) it could encourage greater demand-side flexibility.

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Contracts for Difference (CfDs) Allocation of CfD costs/levies (and RO/FiTs)	Govt published Call for Evidence on reforms to CfD scheme in Dec 2020, and published outcome July 2021. CfD design changes likely to be considered for near-term auctions to help address price cannibalisation through greater exposure of generators to markets. Under existing arrangements, CfD costs projected to increase from £2.3bn in 2020 to £15bn in 2035 due to more qualifying generation, capacity targets and price cannibalisation increasing pay-outs to generators. Levies therefore expected to increase but Govt has committed to transfer some to gas over 10 years. Reforms to CfD scheme design (e.g. for AR5) could alleviate situation. BEIS Alternative Energy Market Programme exploring reform of policy cost allocation in order to encourage demand response (e.g. link to carbon intensity or share of renewables in power mix in real time.)	In CFE outcome/response, Govt 'recognise[s] any longer-term changes will need to be considered holistically as part of a wider approach to the electricity market'. E.g. in its market design assessment, NGESO compares bespoke arrangements (i.e. targeted procurement, Govt determining tech mix), inter low carbon tech competition (i.e. more tech neutral, either Govt auctions or mandate on suppliers), or broad-based mechanism (i.e. co-optimised procurement of capacity adequacy and low carbon generation) (p. 40); procurement of flexibility through long-term contracting is also being considered: https://www.nationalgrideso.com/document/221776/download	How GreenSCIES is impacted depends on whether its technologies are eligible to participate in any schemes that exist. For example: Can DER be aggregated? Are business models based on integrated resources eligible? Due to legacy long-term contracts under various schemes, levies will apply for the long term. Reforms to policy cost allocation could send consumers price signals for demand response and market design reforms will determine the extent to which levies will continue to accumulate.

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Carbon policy	CCC's 6th carbon budget published in December 2021. Recommended pathway - 78% reduction in UK emissions between 1990 and 2035 – brings forward UK's previous 80% target by nearly 15 years. BEIS/Govt commitment to decarbonise power by 2035 and 40GW offshore wind by 2030 among other tech targets. EU ETS and CfD auctions continue. Reforms to CfD design possible for AR5 following Call for Evidence. Carbon pricing signal incoherent/variable across economic sectors and energy vectors so moves to levelise are possible (see Govt commitment to policy cost reallocation above). BEIS aware of high carbon intensity of flexibility markets – regulation of carbon in ESO/DNO procurement possible. Lack of transparency for REGOs putting spotlight on need to better account for carbon.	It is certain that carbon mechanisms must evolve to achieve the Net Zero targets but how they will do so is not yet clear. For the power sector, given faster pace of decarbonisation, mechanisms are needed to complement the EU ETS. There is a debate about the extent to which the Government should procure the low carbon capacity, determining the volume requirements and tech mix. If it continues in this direction, there will likely be more effort to better coordinate procurement (optimal blend of capabilities for adequacy and system services) and to be inclusive and enable competition between resources. The alternative to Govt/ESO procurement, which would need to be designed to complement the EU ETS, is a more market-based approach, with carbon emissions reduction requirements/mandates applied to suppliers, with granular accounting of carbon and visibility for consumers. There will likely be efforts to better levelise carbon price signals across energy vectors in order to encourage vector switching. Phase out of high carbon assets/activities is happening and could continue.	Highly uncertain impact for GreenSCIES. If carbon regulatory drivers are applied downstream - to energy sold by suppliers/ intermediaries; to building owners – this could significantly drive demand for Net Zero integrated products/services and innovation. If the carbon regulation is applied upstream – with Government deciding generation capacity requirements, tech targets – risk that larger assets and particular technologies will be favoured over others and no driver for optimisation/integration. Tracking of carbon at the granular level, even if voluntary (through reformed REGO certification), could increase consumer demand for zero carbon DER and demand response linked to carbon not just prices.

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Balancing mechanism	In Dec 2021, NGESO announced its review of the BM due to high costs and concern over market power https://www.nationalgrideso.com/news/balancing-market-review-terms-reference	In ESO's Net Zero Market Reform (NZMR) assessment, nodal pricing is an option being considered. If adopted, energy and reserves are co-optimised through centralised dispatch, with no need for a BM. Slide 32 https://www.nationalgrideso.com/document/221776/download	While BM value has been increasing, actions are likely to be taken in the short term to contain costs. Zonal or nodal pricing would result in higher wholesale electricity prices for London area (compared to today). In a nodal market, value shifts from the BM and TNUoS into WM prices that all resources can access (unlike the BM). Creation of nodal markets, drives the need for local balancing services behind the node that GreenSCIES assets may be able to provide.
Imbalance Exposure	Imbalance prices are calculated based on a methodology and certain input assumptions, including the value of Lost Load (VOLL). To strengthen incentives for market participants to be in balance, the methodology and assumptions can be changed – this may be considered as part of the BM review. E.g. see https://www.elexon.co.uk/operations-settlement/balancing-and-settlement/imbalance-pricing/ and https://elexon-bsc-production-cdn.s3.eu-west-2.amazonaws.com/wp-content/uploads/2017/09/28160733/33_278_10_VoLL-Review-Process-Paper-v1.0.pdf	In ESO's NZMR assessment, nodal pricing is an option being considered. If adopted, energy and reserves are co-optimised and dispatched by the system operator, with no need for redispatching and a national BM. Slide 32 https://www.nationalgrideso.com/document/221776/download Behind nodes, however, balancing within the nodal market is necessary.	In the short-term, to help contain costs, action may be taken to strengthen incentives for market participants to self-balance, which may provide opportunities for GreenSCIES assets than can help BRPs/suppliers self-balance.

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
DNO procurement of flexibility and demand reduction and local energy/balancing markets (including P2P)	The current direction of travel, through RIIO-ED2, supports increased procurement of flexibility services by DNOs to reduce or remove the need for grid reinforcement.	Various models – including multi-vector – are being demonstrated or studied (e.g. ENA Open Networks; Prospering from the Energy Revolution (PFER) programme) and some of these will be evaluated in 2022/23. Trading platforms could be created for trading local energy services/products, with DNOs procuring flexibility through these platforms, competing with other flexibility users; this will make it possible to price optimize and maximise reward for GreenSCIES assets and system services they can provide. Ofgem has commissioned a major study on nodal pricing and NGESO includes nodal pricing in its NZMR options assessment; if implemented, this model would create local markets behind nodes that would require optimizing and local electricity balancing services. How DSO functions will be defined, split and coordinated between ESO (FSO), DNOs or any new entities continues to be debated across the policy community. Ofgem and BEIS have yet to indicate the direction of travel but are expected to do so in the next couple of years.	In future, GreenSCIES assets will be able to offer flexibility services to DNOs/DSOs. While the local network may not be currently constrained, this is likely to change with growth in DER. The size of revenues and how GreenSCIES might optimize its assets across multiple mechanisms rewarding flexibility is highly uncertain and will depend on how market design and governance arrangements are evolved over time.

Transmission network charges (residual and use of system)	Changes due to the Targeted Charging Review (TCR) are being implemented (see Table above). In its original Jun 2021 minded-to proposals on the Access and Forward-looking charges (AFLC) significant code review (SCR), Ofgem signalled that they were proposing to charge all users over 1MW TNUoS generation charges. Under current arrangements, small (<100 MW) distribution-connected generation (SDG), which face transmission charges (via their supplier) as inverse demand for their export during Triad or the demand tariff if they import during Triad. SDG charges are negative or 'capped' at zero, so generators do not face charges for export. Behind the meter generation (BTMG) also faces transmission charges (via their supplier) as inverse demand, with their output netting off demand on their sites. When exporting from their site, BTMG faces the same signal as SDG. In its January 2022 update on the Access and Forward-looking charges SCR minded-to proposals, Ofgem highlighted that they do NOT intend to direct changes to TNUoS (including the application of these charges to small distributed generators greater than 1MW) for April 2023 implementation via the Access SCR. However, Ofgem state that they still stand behind the principle that small generators should pay charges equivalent to larger generators where they have an equivalent impact on the network…which could be picked up via a different avenue (i.e. separate TNUoS reform programme). Ofgem are still assessing the responses to its TNUoS Call for Evidence (which closed for comments in November 2021) and have signalled they are still working out the best way forward.	Until Ofgem release their results on if they will be conducting reform of TNUoS charges, and what format/scope/timescales such a reform will have, it is difficult to comment on the future direction of TNUoS charging. However, TNUoS charges are a very controversial topic, with differing opinions based on generation size and location. There have been repeated calls for reform of transmission charging, particularly from Scottish interests. See: Electricity Grid (Review) Bill. Private Members' Bill (under the Ten Minute Rule) [sponsored by Alan Brown] which is seeking to require the Government and Ofgem to conduct and act on a review of the electricity transmission grid and associated charges, to include consideration of abolishing charge differentials based on geographic location. The Government's Scottish Affairs Committee also launched an inquiry on 'Renewable Energy in Scotland' highlighting concerns regarding transmission charging. The government response has been repeatedly to emphasize that, by law, transmission charging is a matter for Ofgem as the independent regulator.	How GreenSCIES will be affected will largely depend on what options for reform Ofgem sets out in its response to the TNUoS Call for Evidence. However, if Ofgem remain committed to expanding TNUoS charges to all users over 1MW, this could potentially lead to credits for any future assets above this threshold owing to the location of London. In its original minded-to proposals on AFLC, Ofgem signalled that generation under 1MW would continue to face the inverse of demand charges under the Embedded Export Tariff. If nodal pricing would be introduced, the forward-looking part of network charges (i.e. TNUoS, not the residual) would need to be removed from the network charge to avoid double-counting. This value is then reflected in wholesale energy prices that are more granular by time (every 30 minutes) and location (depending on number of nodes).

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Distribution Network Charges (residual and use of system)	At the end of 2021, Ofgem launched and closed a consultation outlining their plans to descope the wide-ranging review of Distribution Use of System (DuoS) charges from the Access and Forward-looking Charges Significant Code Review (SCR) and take the DuoS review forward under a dedicated SCR with a revised timescale. Ofgem highlighted that the shape of DuoS reform will depend on policy choices and development across Ofgem/Government/industry, such as: the extent to which locational flexibility is signalled through markets vs. charging or other mechanisms; the acceptable strength of signals for different user groups; visibility and availability of data across the energy system that enables greater innovation in planning and operating distribution networks. Indicated scope of DuoS review: - A review of the charging methodologies for Extra-High Voltage (EHV), as well as High Voltage/Low Voltage (HV/LV) - The balance between usage-based and capacity-based charges, as well as charges that could vary by time-of-use - Improvements to signals about how network costs and benefits vary by location - Improved predictability of charges for EHV users - The potential need for mitigating measures such as a basic charging threshold to protect small users (and vulnerable customers) from sharper charging signals	Ofgem signalled that the earliest possible date for a new DuoS implementation is 2025 (although given the delays of the current AFLC decision…this could easily be later). Ofgem seem focused on ensuring that any DuoS reform contains sufficient linkages with flexibility, and as part of the reform will likely need to update how DuoS works in practice in enabling and achieving the benefits of flexibility, sitting alongside other signals/mechanisms, as well as the linkages with Ofgem's wider full-chain flexibility work. Their choices on introducing greater locational granularity will likely depend on other wider reviews (e.g. NGESO's Net Zero Market Reform project, Ofgem's analysis of design options for nodal pricing etc.) DuoS reform work will likely also continue to open up the debate on the nature of charge design/cost allocation, particularly regarding the balance between usage-based and capacity-based charges.	The nature of the final outcome of DuoS is highly uncertain at this time. However, the final decisions will likely have a material impact on the value of flexibility at the local level, particularly given the fact that the TCR arguably undercut a lot of the existing value of flexibility. How ambitious Ofgem can be in the next few years will be limited by the readiness of the distribution networks in relation to progressing digitalization, sharing and managing data and monitoring assets and network performance etc. Ofgem/Govt is also concerned whether/how consumers and intermediaries will respond – consumer trials are helpful. Ideally a clear long term strategy is needed so that the next major change is on a clear pathway towards enduring Net Zero arrangements. Decisions on allocation of regulated network costs (and policy costs) will significantly impact the value of DER propositions for GreenSCIES.

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Network connection charges and access rights	Ofgem's minded-to proposals for the Access and Forward-looking Charges SCR (as of January 2022, with final decision March 2022): Distribution connection charging boundary: introduce 'shallower' connection charging boundary for generation (reinforcement costs only for the same voltage level of connection) and a 'shallow' connection charge for demand (removing the contribution for reinforcement completely for demand). Introduce High Cost Cap (HCC) for demand connections that are very high-cost (to protect DuoS customers from excessive contributions). - storage connections no longer treat import and export reinforcement separately, storage is considered in line with generation for the purpose of reinforcement contributions i.e. storage connections required to contribute to reinforcement works at their connection voltage according to their export capability and would NOT be exempted from reinforcement contributions if their import reinforcement works take precedence. Access rights (distribution level): - Levels of firmness: This would provide choices about the extent (in hours) to which a user's access to the network can be restricted and their eligibility for compensation if it is restricted. Ofgem also want to introduce end-dates for non-firm access arrangements. - Time-profiled access: This would provide choices other than continuous, year-round access rights (e.g. 'peak' or 'off-peak' access which could benefit certain users e.g. EV depot charging stations).	Ofgem has stated that, once its final decisions on Access and Forward-looking charges are made…they should be implemented by April 2023 (in line with the start of RIIO-ED2). At present, access rights are limited at distribution level compared to transmission level. In time, firm/greater access rights at distribution level would facilitate trading of network capacity. The level of monitoring and control at distribution level is not advanced enough yet to enable more sophisticated solutions. In constrained areas, DNOs are rolling out Active Network Management (ANM) solutions and may offer flexible network connections, with the possibility for the DNO to control the asset under constrained conditions, in exchange for lower connection charges. This can mean the asset may not be eligible to participate in other markets (e.g. BM), and this may limit total flex/service value the asset could potentially realise.	Ofgem's decisions, although not finalized, will likely result in cheaper connections for demand assets, and also a reduction in connection charges for generation assets (although any reinforcement costs at the same voltage level may still be significant). This in turn reduces the value of demand management solutions designed to avoid connection upgrades. Depending on the network conditions in the GreenSCIES location, if the DNO is facing significant reinforcement costs to install new assets, it may consider offering alternative connection agreements and introduce an ANM system. With growth in DER and increasing congestion at distribution level, the DNO will become more active and use tools at its disposal to operate and develop the network efficiently. Ofgem will need to keep evolving regulation over time as technologies and markets develop. One significant impact of these proposed changes is that whilst EV charging driven reinforcement work would face a 'shallow' connection charge, V2G driven reinforcement work would likely face the more expensive 'shallower' connection charge. This would apply if V2G is considered as and treated as a storage asset.

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Supplier hub and licensing	Despite previous reviews and consultations, no actions have been taken to reform the 'supplier hub' model. However, industry led action is slowly dismantling it e.g. P375 on asset-metering adopted; ESO's wider access to the balancing market initiative (VLP access); P415 and VLP access to wholesale energy market. The Govt issued a retail strategy in July 2021 and said reforms to supplier hub and supply license were still being considered.	In the longer term, reforms to the supplier hub and supply license framework seem inevitable as part of wider retail market reform. Govt launched a Call for Evidence on the latter that closed Jan 2022. A refresh of the retail market strategy can be expected in 2022 and this will likely include both short term measures to address the current energy price crisis but longer-term reforms too.	Reforms to the supplier hub concept and the supply license framework could open up new business model opportunities and greater scope for GreenSCIES.

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Energy efficiency policy	The Heat and Buildings Strategy signified a continued focus on R&D/innovation funding, coupled with gradual (2025 – 2035) tightening of regulations across tenures. This included several targets to improve energy efficiency: To upgrade all fuel poor homes to Energy Performance Certificate (EPC) band C by 2030 To upgrade as many homes as possible to EPC band C by 2035 (where practical, cost effective, and affordable); and To improve business energy efficiency by 20% by 2030 Significant focus on developing the market for technology (heat pump mainly) and EPC, but there is clear recognition of the need to deliver the solutions that consumers want to buy, make improvements to SAP and the importance of better co-ordination between national and local government. Market based mechanism for low carbon heat being consulted on, which would obligate fossil fuel boiler manufacturers to 'achieve heat pump sales in line with the trajectory of market growth needed to put us on a path for 2050 and the ambition to install 600,000 installations per year by 2028.'	Government could consider a policy strategy which is broadly technology-neutral, but which could vary across localities. UK will have to move away from gas boilers for home heating – unclear as yet on what will be the appropriate technology mix in the future. Heat pumps will not be the only solution, exploring options such as: - Hydrogen - Direct electric heating - District heat networks - CCUS & Bioenergy in future energy mix - Behavioural shift - Innovation in new and existing technologies The most appropriate mix of technologies must consider local characteristics including: - Building stock - Area density - Local energy network configurations On the market-based mechanism – policy attention may be better focused on introducing technology-neutral outcome-based drivers to the market for low carbon heating solutions for buildings.	Significant sentiment around local, place-based activity – Local Area Energy Planning could be one possible solution.

Policy change	Current changes underway or being formally considered	Potential longer-term change	Relevance for GreenSCIES
Heat Policy	Considering options to upgrade housing stock across various tenures over time throughout the next decade – subject to consultation. For example, EPC C: 2025 new homes, 2026 off gas grid, 'ambition of 2035' boiler ban – but could build upon softer approach using the Boiler Upgrade Scheme (BUS) so more a 'phase out' than an outright ban Heat and Buildings Strategy also indicated £3.9 billion of new funding announced, from 2022 – 2025, including: Social Housing Decarbonisation Fund (£800m) Home Upgrade Grant scheme (£950m) Boiler Upgrade Scheme (£450m) Heat Networks Transformation Programme (£338) Public Sector Decarbonisation Scheme (£1.425bn) Some positive signs on correcting pricing incentives and moving policy costs away from electricity, potentially important (as indicated in Net Zero Strategy - call for evidence expected soon) This would explore options to shift or rebalance policy levies (including legacy charges for policies such as feed-in tariffs, the Energy Company Obligation, Contracts for Difference, Renewables Obligation and the Warm Home Discount) over time from gas to electric.	Considering how industry can reduce reliance on subsidy and ultimately lower the barriers to the uptake of low carbon heating and cooling. On price incentives: could potentially consider policy levies moving into general taxation and / or embedding into an Emissions Trading Scheme (ETS) or direct carbon price to remove distortion (but this is politically tricky with high gas prices in retail market)	May be significant to GreenSCIES business case counterfactual. Given that the counterfactual is based on gas boilers, the proposed ban would inevitably make District Heat Networks a much more viable option in a policy future where new gas boilers for domestic heating are no longer an option.

6 Summary of Policy Blockers and Future Changes

This section brings together the current revenue streams from section 4 with the future policy development from section 5, into a single summary table. An accessibility status has also been included to provide an indication of how current policy is either facilitating on blocking each of the revenue streams.

SLES Revenue Stream	Accessibility Status	Notes on current policy blockers	Notes on future policy development
Load Shifting	Amber 🟡	MHHS (the lack of being a barrier) will be completed by October 2025.	MHHS is likely to strengthen incentives on suppliers to pass through to their customers underlying Time of Use differentials in the recovery of network charges and capacity market costs (i.e. TNUoS & DNUoS charges and the Capacity Market Supplier Charge all paid by suppliers). This may therefore provide GreenSCIES with opportunities to manage its own **cost base** by exploiting flexibility in its own electricity demand to load shift to favourable time of use tariff periods that may be offered in future by its electricity supplier.
Imbalance Exposure	Amber 🟡	High BM costs suggest incentives for BRPs to remain in balance not sufficiently strong. Providing imbalance services is possible via a supplier.	In the short-term, to help contain costs, action may be taken to strengthen incentives for market participants to self-balance, which may provide opportunities for GreenSCIES assets than can help BRPs/suppliers self-balance.
DNO procurement of flexibility and demand reduction	Amber 🟡	Whilst UKPN are not procuring flexibility services at the moment, policy is working in the direction of facilitating this where it is required.	The current direction of travel, through RIIO-ED2, supports increased procurement of flexibility services by DNOs to reduce or remove the need for grid reinforcement.
Self-consumption of PV energy	Green 🟢	Self-consuming PV to avoid import energy cost is fully doable.	None
Wholesale (SPOT) market trading	Amber 🟡	Currently only accessible via BRPs/Suppliers. However, GreenSCIES assets could respond if signals are passed through via smart tariffs.	If locational value is introduced into the WM, WM prices in London would increase (reflecting higher than average network congestion). Flexibility and locational value would be valued more within granular WM prices (with value shifting from BM and TNUoS charges) and a nodal market forced to optimise behind the node, benefiting DER flexibility in London.
Capacity Market	Amber 🟡	EV charging is not permitted in the CM, but heat pumps are. BEIS continue to seek	The CM will likely go through reform. Alternative Capacity Remuneration Mechanism (CRM) designs could be considered and will impact the

SLES Revenue Stream	Accessibility Status	Notes on current policy blockers	Notes on future policy development
		views how EV charging may contribute in the future.	demand-side differently depending on their design, whether resources are eligible to participate and impact on WM prices. If the allocation of CRM costs (levies) would be based on actual system stress conditions and passed through by intermediaries (via smart tariffs - direct load control or self-control automation) it could encourage greater demand-side flexibility.
Balancing Mechanism	Amber 🟡	Demand side assets can enter the BM via aggregation and VLPs. However, behind the meter assets are currently limited in how they participate.	Value in the BM has been increasing, but actions will be taken to contain these costs. The solution of zonal or nodal pricing increase wholesale prices in London, shifting value from the BM and TNUoS to the WM. This drives a need for local balancing services behind the node that GreenSCIES assets could provide.
Ancillary Services	Green 🟢	There are no policy challenges here. If the assets meet the technical requirements they can participate.	AS are evolving rapidly, reflecting the system needs and the technology available to meet them.
Network Connection Charges & Access Rights	Red 🔴	Network access is only currently normally offered at a fixed capacity, which blocks any value of a time-based connection capacity optimisation.	Ofgems current position (although not finalised) will likely result in cheaper connections for demand and generation assets. This in turn reduces the value of demand management solutions designed to avoid connection upgrades. Where DNOs face significant reinforcement costs, flexible connection agreements may be offered that GreenSCIES could use to reduce costs.
Network Charges	Amber 🟡	Opportunities to avoid network charges have recently been reduced.	If TNUoS charges are expanded to cover all users over 1MW, then this could potentially lead to credits for assets that are London based (due to negative local TNUoS charges). However, TNUoS charges would change if nodal pricing introduced as value shifts from TNUoS and BM to WM prices. Changes to DuoS charging are expected (although as yet unknown) and are likely to have a material impact on the value of flexibility at the local level, thus the value of DER propositions for GreenSCIES.
Inter-seasonal storage of heat using the aquifer	Green 🟢	No policy blockers. Value obtained by seasonal changes in power/heat prices.	None

SLES Revenue Stream	Accessibility Status	Notes on current policy blockers	Notes on future policy development
Peer to Peer trading	Red 🔴	Currently prevented by the supplier hub model.	Reforms to the supplier hub concept and the supply license framework could open up new business model opportunities and greater scope for GreenSCIES.
Heat Sales	Green 🟢	There are no policy blockers to heat sales per se. The current approach to policy cost recovery is however unfavourable for electricity users (GreenSCIES will be an electricity user) and favourable for retail gas usage (against which GreenSCIES heat sales must implicitly compete) which does not face a carbon price.	The policy environment for heat sales by heat networks is clearly developing, notably with the government appointment of Ofgem as Great Britain heat networks regulator to ensure consumers receive a fair price and reliable supply of heat, announced in December 2021. Clearly Ofgem's emerging regulatory policy could impact upon GreenSCIES. The Heat and Buildings Strategy confirmed that the government will look at options to shift or rebalance energy levies away from electricity to gas over this decade. A Fairness and Affordability Call for Evidence is expected with decisions in 2022. Future changes in policy cost recovery levies could improve the achievable price for heat sales. Although the current energy crisis is likely to slow the pace of moves to shift policy cost recovery towards gas customers.
Cooling Sales	Green 🟢	There are no policy blockers to this revenue stream	None

7 Recommendations

This section pulls together final recommendations for GreenSCIES to consider in developing its position on changes to the policy environment that impact upon its broad business model. These are summarised below:

- Sales of heat and coolth dominate expected scheme revenues, so policy changes that affect these are likely to be most material for the scheme economics and overall proposition:
    - Revenue from heat sales is dependent on the price which can be achieved, which is in turn a function of the cost of the competing alternative (heat from gas boilers).
    - The achievable price for heat sales therefore will be influenced by the future development of policy on carbon pricing of gas usage and/or policy cost recovery from gas users.
    - The consortium should therefore carefully consider its response to the forthcoming BEIS call for evidence on Fairness and Affordability. Clearly there is some appetite within government to address the bias in pricing between electricity and gas, but this will be conditioned by the current energy price crisis.
    - A move to recover policy costs partly from gas users would be most favourable to the raw economics of the GreenSCIES proposition, because it would act favourably to reduce operating costs and increase potential revenues. Funding policy costs through general taxation would not in itself improve the revenue potential for GreenSCIES but would reduce operating costs in respect of electricity.
    - More broadly the consortium may wish to consider developing a policy position on the longer-term development of policy incentives to promote adoption of low carbon heat technologies. This might include, for example, developing a policy position on how the UK Emissions Trading Scheme should be extended to cover emissions from all energy use in buildings. As an example of what this might entail, the ESC has previously developed policy thinking on these themes[52].
- The Consortium should in general advocate policy changes that increase revenue opportunities for the flexibility that it will be well placed to provide. This includes changes to the requirements for access to markets for flexibility, including the capacity market, balancing market, ESO-led ancillary services or through UKPN initiatives to procure flexibility at distribution level.
- As this paper demonstrates, this will require ongoing effort to monitor the emerging policy and regulatory environment, the detailed operational and technical requirements for accessing potential markets for flexibility, in order to build a fully robust picture of how GreenSCIES can maximise its revenue potential.
- The Consortium should also consider regular updates to its financial modelling to test the impact of emerging or proposed policy changes or to run sensitivities around these issues. This will help inform future understanding of where policy and regulatory change is most material.

[52] https://es.catapult.org.uk/insight/uk-ets-buildings-decarbonisation-part-3/

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