GreenSync

CATAPULT Energy Systems

FEASIBILITY STUDY

LCT Connect

Automatic Asset Registration Programme
Net Zero Innovation Portfolio -
Flexibility Innovation Programme

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Contents

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Glossary

AAR ..... Automatic Asset Registration
ACL ..... Access Control list
AEMO ..... Australian Energy Market Operator
API ..... Application Programming Interface
ARENA ..... Australian Renewables Energy Agency
ASHP ..... Air Source Heat Pump
BEIS ..... The Department for Business, Energy and Industrial Strategy
BESS ..... Battery Energy Storage System
BUS ..... Boiler Upgrade Scheme
BYOD ..... Bring Your Own Device
CAR ..... Central Asset Register
CHP ..... Combined Heat and Power
CIM ..... Common Information Model
CNI ..... Critical National Infrastructure
DBP ..... Data Best Practice guidance
DCC ..... Data Communications Company
DER ..... Distributed Energy Resources
deX ..... Decentralised Energy Exchange
DG ..... Distributed Generation
DNO ..... Distribution Network Operator
DoC ..... Digitalisation of Connections
DRS ..... Domestic Recharging Scheme
DSO ..... Distribution System Operator
DSRSP ..... Demand Side Response Service Provider
DPIA ..... Data Protection Impact Assessment
ECR ..... Embedded Capacity Register
EDiT ..... Energy Digitalisation Taskforce
ENA ..... Energy Networks Association
ESA ..... Energy Smart Appliances
ESC ..... Energy Systems Catapult
ESOO ..... Electricity Statement of Opportunities
EV ..... Electric Vehicle
EVHS ..... Electric Vehicle Homecharge Scheme
FES ..... Future Energy Scenarios
FTE ..... Full Time Equivalent
FiT ..... Feed in Tariff
GCP ..... Google's Cloud Platform
HMRC ..... His Majesty's Revenue and Customs
IAO ..... Information Asset Owner
IUK ..... Innovate UK
LCT ..... Low Carbon Technology
MCS ..... Microgeneration Certification Scheme
NCSC ..... National Cyber Security Centre
NEM ..... National Electricity Market
NGESO ..... National Grid Electricity System Operator
NME ..... Network Modelling Environments
MPAN ..... Meter Point Administration Number
NUAR ..... National Underground Asset Register
NZIP ..... Net Zero Innovation s Portfolio
OCR ..... Optical Character Recognition
OEM ..... Original Equipment Manufacturer
OFGEM ..... Office of Gas and Electricity Markets
OZEV ..... Office for Zero Emissions Vehicles
PAS ..... Publicly Available Specification
PKI ..... Public Key Infrastructure
PV ..... PhotoVoltaic
RBACS ..... Role Based Access Controls
REC ..... Retail Energy Code
REGEX ..... Regular Expression
RHI ..... Renewable Heat Incentive
SCADA ..... Supervisory Control and Data Acquisition
SCEA ..... Small-Scale Energy Asset
SEC ..... Smart Energy Code
SEG ..... Smart Export Guarantee
SMETS ..... Smart Metering Equipment Technical Specification
SMI ..... Smart Metering Inventory
SO ..... System Operator
SoLR ..... Supplier of Last Resort
SPaR ..... Security, Privacy and Resilience
SSES ..... Smart Secure Electricity System
SW ..... Software
TLS ..... Transport Layer Security
TRL ..... Technology Readiness Level
V2G ..... Vehicle to Grid
VAS ..... Value-Add Service
VES ..... Virtual Energy System

1. Executive summary

This feasibility report is the culmination of the LCT Connect project team's Phase One findings for the Automatic Asset Registration (AAR) Programme[1]. The report includes a thorough analysis of the current energy landscape and the pressing need for a digitalised energy system in Great Britain (GB). These drivers substantially informed the approach we have taken to our solution which is detailed in this report. Underpinned by our deep understanding of the policy, regulatory and technology requirements, the solution proposed is best placed to deliver an efficient, scalable and secure AAR and Central Asset Register (CAR) for low carbon technologies (LCTs) in GB.

The transition to a net zero energy system, and the associated uptake of LCTs, is transforming the energy landscape in GB. These circumstances are presenting the industry with myriad opportunities as well as several challenges.

Such challenges include that the uptake of LCTs is rapidly accelerating but at present there is a distinct and increasing lack of visibility of these energy assets. Whilst registration with network companies is a legal requirement for some assets, it is understood that roughly 40% or less of new small-scale energy assets are currently being registered and hence visible to the networks. Many of those responsible for registering assets (e.g., consumers and installers) are unaware of their responsibilities, leading to complex and multiple registration processes. Where assets are notified, registration issues persist as the data is collected and held by multiple systems that do not speak to each other, resulting in incomplete datasets. The accelerating rate of asset installation also presents a very real system problem for the network. This rapid uptake of LCTs is forecast to continue and will require the associated increasing volume of assets to be carefully managed to ensure system stability and supply is maintained.

In developing our solution, we have built on the previous efforts of industry, the energy regulator Ofgem, and UK government to digitalise the energy sector and create a viable route for asset registration. By building on previous endeavours to solve

[1] https://www.gov.uk/government/publications/automatic-asset-registration-aar-programme

asset registration in the energy sector, and leveraging the international experience of our project team, we have developed a comprehensive solution for GB. The LCT Connect project will successfully deliver the required capabilities to digitalise LCT registration and to develop a CAR that can securely collect and share data about registered energy assets. Furthermore, we have also created a realistic plan to enable scaled domestic flexibility capability to be deployed in GB.

To ensure the LCT Connect solution would meet the needs and benefit the greatest number of users, we consulted repeatedly with a wide cross section of the industry. This engagement provided us with a number of valuable insights and a deep understanding of both the needs and challenges associated with digitalising the energy system. Our solution is based on findings from this exercise along with substantial input from several subject matter experts (SME) in the LCT Connect project team that have extensive experience in the field.

We have designed the LCT Connect solution around five core use cases:

Visibility	Gives users visibility of low carbon technologies that are connected to the network.
Standardisation	The creation and maintenance of common data and API standards across the flexibility value chain will reduce costs and complexity for all actors (DSRSPs, OEMs, retailers etc). An integrated AAR and CAR solves the standardisation since the formats can be coordinated through the secure cloud bridges architecture and the final data stored within CAR will utilise best practice in standardisation, supporting interoperability across assets and service providers.
Planning	The registry of assets to support the planning of local network and infrastructure upgrades, including charge points, battery storage and solar. It can also be used to develop smart local energy systems which optimally utilise low carbon technologies and renewable energies.
New business models	Visibility and control of energy consuming or generating assets in consumers' homes will allow retailers and aggregators to offer more tailored services, such as Heat as a Service, improved billing and, more attractive tariffs connected to demand side response, or innovative financing models for low carbon tech assets. Additionally, visibility of other (possibly local) assets on the register may allow consumers to pull together more effectively and into new community business models.
Change of service/retailer	A key benefit of LCT Connect is the ability to use the CAR to communicate with Assets. This provides an important "value-add" of the proposed solution enabling seamless changes of service and retailer.

To better understand what is technically feasible and viable, we assessed best practices in asset registration and compliance in other markets where GreenSync's platform, the Decentralised Energy Exchange (deX) has been piloted and/or is already in commercial use. By leveraging the deX product that has already been deployed in Australia, the LCT Connect project will build on the significant investment and several years effort in product development to date and enable at a minimum, 36 months of acceleration of the AAR and CAR deployment in GB.

Previous implementations and approaches in GB are closely tied with the flexibility proposition, and there is considerable overlap between specific asset registration for the purposes of having a single source record of assets on the network for visibility and capacity planning, and flexibility services which have primarily focussed on smart assets eligible for such services. The scope of the LCT Connect project is tied to the registration of domestic and small non-domestic assets but has a value-add proposition for data services and enabling telemetry information to pass between market participants.

Based on this we have developed an approach where AAR and a CAR create value by focussing on the following key components.

Universal registration, connectivity, and interoperability

Our technology is compatible with all major global electric vehicle (EV), solar photovoltaics (PV) and heat pump original equipment manufacturers (OEMs) application programming interfaces (APIs), third party registers and communications pathways. It has been designed and built to transition from static to dynamic data provision for network operators, retailers and Demand Side Response Service Providers (DSRSPs). These attributes collectively provide a streamlined digital registration pathway that enables the secure collection and exchange of accurate data in near-real time.

Single system of record with verified asset data

The LCT Connect solution has been designed to act as a single system of record based on verified installer data, which can be validated with key industry data sources to enhance accuracy. This ensures that all parties have a common understanding of asset information, and can have confidence in the source and accuracy of that information. This mitigates the challenges associated with relying on manual data input from installers or customers, that has repeatedly been proven to be incomplete and inaccurate.

Minimal cost, greatest value

Minimising the cost to implement and operate the end-to-end AAR/CAR solution at scale were key considerations and we have designed a solution that ensures that benefits are maximised for relevant market players, OEMs, installers and consumers at the lowest cost.

Scalable, adaptable and persistently accurate

The LCT Connect solution has been designed from the outset to scale in line with LCT adoption rates and can be adapted to either a distributed or centralised operating model. Furthermore, with the capability to collect dynamic LCT data and support key market processes from registration, change of tenancy, change of retailer or decommissioning, the CAR will remain persistently accurate and therefore useful for all market participants.

Further development and enhancement of the deX platform, as detailed in this report, for LCT Connect and based on the principles outlined above will benefit all market participants and will seamlessly link with other already established attempts to register LCTs in GB.

The Benefits

Automatic Asset Registration that benefits multiple actors

Figure 1: Benefits of the LCT Connect solution

Specific benefits of the LCT Connect solution for individual participants and users include:

- **Customers** – allows customer choice and future proof for investment.
- **Installers** – provides a simple process to meet emerging compliance requirements.
- **OEMs** – enables least cost compliance and VPP access and avoidance of redundancy.
- **Networks** – delivers a consistent approach to registration, visibility and control to meet planning and operational requirements.
- **Retailers enables** - Bring Your Own Device (BYOD) Flexibility Services offers at scale and allows customer registration and optionality participating in flex and trading platforms.

The LCT Connect solution that will be delivered in Phase Two consists of four key components:

1. Automated Asset Registration module is a software module with the capability to interact with the users registering a new or existing asset and/or applying for a change of ownership or technical parameters of an already registered asset. The AAR module will also be responsible for validation of the asset registration for which it will fetch dynamic asset information through deX. Once validation is completed and registration is confirmed, the AAR module will create an entry in the CAR.
2. Central Asset Register module is a "System of Record" module that will act as an intelligent data repository for all relevant data of a registered LCT. The CAR will not only receive entry creation requests from the AAR but will also, through the capabilities of deX, regularly monitor any changes or updates to registered assets and trigger updates to the CAR registry.
3. LCT Value-Add Services module is built on top of the capabilities required for successful automation of the AAR and CAR processes, and provides the option for innovators to easily build-out their own applications utilising LCT Connect data and services.
4. The deX engine is a well-proven and stress tested engine. It provides a toolbox of processes and integration points with the vast majority of existing OEMs and is fundamental and foundational to the successful and rapid uptake of the AAR/CAR.

As a consortium of key industry partners, including GreenSync, Energy Systems Catapult (ESC) and the Data Communications Company (the DCC), we are excited at the prospect of demonstrating these capabilities in Phase Two. For the 'Technology Development' phase, we intend to deliver an AAR and CAR implementation based on GreenSync's deX platform. This will be done in collaboration with a wide cross section of key project partners and their systems to test

the different use cases and flows as detailed in this report. This work will not only further validate the use cases but will, through engagement with various stakeholders, create an awareness of what is technically feasible and commercially meaningful to implement as part of pilot testing during the third phase of the project. Furthermore, the third phase will focus on solution resilience and scale.

GB is far from being the only jurisdiction looking at how to deal with LCT registration and compliance. Internationally, as small-scale energy assets become smarter and more internet connected, policymakers, regulators and network operators around the world are also recognising the need for a more digitised energy system in order to truly unlock the benefits of decarbonisation and decentralisation. Australia is at the forefront of this transition and in particular is experiencing a rapid uptake of solar PV. In that country the deX platform has been in operation for over two years and has already been stress tested at scale. As well as providing a state-wide LCT registration function with an average 3,000 systems being registered each month as at December 2022, deX is also a vital tool providing a critical service to ensure system stability and security of supply is maintained during periods of minimal operational demand (see Section 2.4 for more information). The energy landscape is quickly shifting and fast becoming increasingly connected and complex. The need for such a mandated emergency service shows the urgency of acting 'yesterday' in order to cope with the technological and customer behaviour changes already underway in the energy sector.

This AAR innovation competition sits alongside several other government-backed innovation projects and policy initiatives. Of relevance to the AAR project is the Smart Meter Energy Data Repository (SMDR) competition, Interoperable Demand-Side Response (IDSR) competition, and the overarching Smart and Secure Electricity System (SSES) policy programme. We consider that AAR, in the model proposed through LCT Connect, is a key enabler of the future electricity system and will be complementary to these other key initiatives:

- **Smart Meter Energy Data Repository** – currently at the feasibility stage, this project seeks to establish the technical and commercial feasibility of a smart meter energy data repository. As set out in this report, smart meter data could help to identify existing deployments of LCT assets and validate information within the CAR. Therefore, LCT Connect could be a 'user' of any future Smart Meter Energy Data Repository. The DCC are participating as part of this innovation project to help assess the technical feasibility of proposed solutions in context with existing legacy technology, as well as exploring the potential for other data streams such as smart meter 'system' data to be incorporated into the repository.

- **Interoperable Demand Side Response** – government has identified that interoperability will be key to supporting consumer confidence in investing in LCT assets, and to avoid potential consumer harm from lock-in to poor value offerings. The CAR would support interoperability by giving competing providers a single source of truth about the assets deployed in given locations, without the consumer needing to provide detailed technical specifications each time they want to switch. GreenSync is a partner in the DSR ready project led by GEO.

- **Smart and Secure Electricity System Programme** – the model for LCT Connect presented in this report is consistent with and supports the SSES policy programme, which seeks to ensure the uptake of smart electricity appliances is underpinned by appropriate security, data privacy, interoperability and consumer protection. CAR and AAR support these outcomes by providing a central view of the technology deployed across GB, enabling monitoring and enforcement in the event of product

recalls or other concerns relating to standards. Additionally, dynamic data held within the CAR could be interoperable with and enable proposals for anomaly detection of load controlling commands.

We believe the LCT Connect solution as described further in this report not only addresses the AAR/CAR needs but also allows for future extensions that can support energy market development when integrating LCTs. As we view the establishment of AAR/CAR in GB as urgent, we recommend that Phase Two of the project is not only used for technical development and demonstration, but also for defining and agreeing the regulatory framework under which the LCT Connect can operate, providing the benefits to the wider energy market as detailed in this report.

2. The LCT Connect solution

The LCT Connect solution is the delivery of an integrated, scalable, digital first solution that enables small-scale energy assets (SCEA) to be securely and automatically registered and data about those assets and their performance to be passed between market participants. LCT Connect is made up of two key components, Automatic Asset Registration (AAR) and a Central Asset Register (CAR). The solution will be achieved by adapting and extending the already proven capabilities of GreenSync's digital deX platform to the UK context with due consideration given to the relevant regulatory, technical and legislative requirements.

The overall goal of the solution is to ensure a seamless end-to-end process for registering new assets and enabling access to relevant dynamic data for market participants who have the appropriate permissions. This is achieved through the implementation of software integrations or "bridges" between LCT Connect and OEM management platforms, which enable the secure exchange of information required for registration. By using existing deX bridge architecture and technology, the LCT Connect solution can provide coverage of the required OEMs at significantly reduced time and cost.

Assets in scope of this innovation activity include all small-scale domestic and small business energy assets that are currently required to be registered, including solar PV, heat pumps, small EV charge points and home battery storage.

- For **'connect and notify'** connections (Power Generating Modules with a capacity of 16A per phase or less, connected at low voltages, and single-phase load and generation up to 60A), the solution will automatically register the asset to a Central Asset Register upon installation.
- For **'apply to connect'** connections (Power Generating Modules with a capacity of more than 16A per phase and single-phase load and generation above 60A) the solution will automatically confirm registration once the asset has been installed, provided prior approval has been obtained.

The solution will seamlessly integrate with existing equipment and services that installers already use on site, minimising duplication and/or the need for additional work for installers when registering assets. This includes collection of the Meter Point Administration Number (MPAN) from the Digital Communications Company's (DCC) Smart Metering Inventory (SMI) and data from OEM systems directly into the CAR.

Once an asset is registered, the LCT Connect solution can enable additional value-add services including real time telemetry and control services. These services can be made available to authenticated and authorised users of the LCT solution, with representation of the relevant consent from the asset owner in the system.

The real time telemetry streaming service provides a mechanism for consumers to receive real time asset state information with a relatively short retention period. This data can be used for a variety of purposes by both the DSRSPs and DNOs - the decision about how telemetry data is used and retained is delegated to the consumers. To minimise unnecessary data collection (in line with BEIS data privacy objectives within the SSES programme), telemetry for

specific measurement points is only collected and provided where there is a contracted requirement for that telemetry.

While the LCT Connect solution provides a mechanism for representation of consent for control services, the implementation of control services is out of scope for this program.

2.1. The benefits of an integrated solution

The LCT Connect project team has undertaken a detailed analysis across policy, regulation, business model, technical requirements and use case specific outcomes to address the challenge of registering assets using a whole systems approach. The output of that detailed analysis is found throughout this document and is also reflected in the approach of the LCT Connect solution itself.

The solution, as noted in Figure 2 in Section 2.2 below, is a complete end-to-end approach in the lifecycle of registering relevant asset data. By integrating stakeholders' needs into the technical and governance approach of the solution we believe that we have set out a proposal that solves many critical problems for OEMs, installers, Distribution Network Operators (DNOs) and enables these parties to interact with LCTs more efficiently and consistently.

Further benefits of the platform are demonstrated in the reference case in Section 2.4.

2.2. Solution architecture

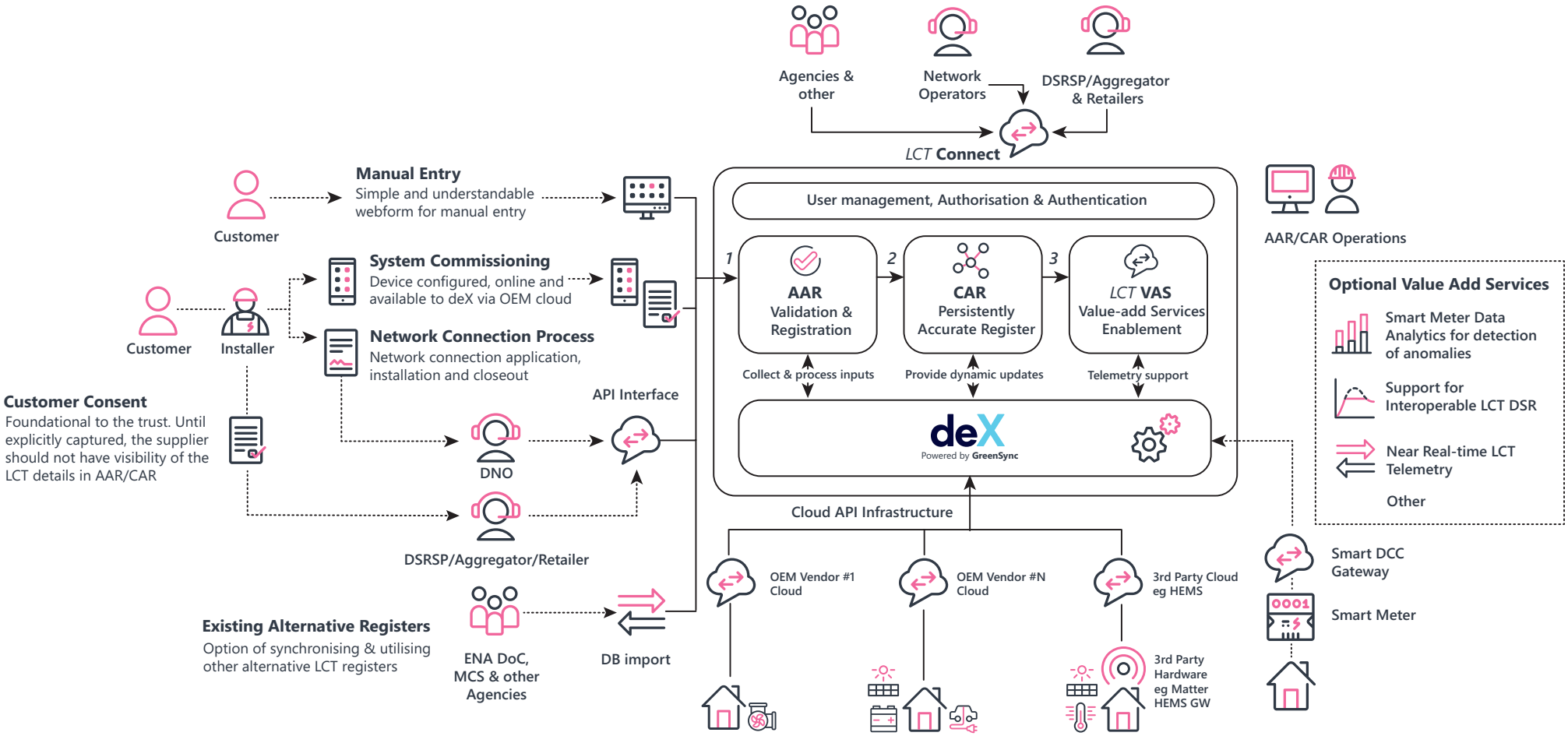


Figure 2: Conceptual architectural diagram of the LCT Connect solution

As depicted in Figure 2 above, GreenSync's deX platform will be utilised to expedite the implementation of AAR/CAR. deX provides an existing toolbox of processes and technologies with many OEMs, which is fundamental to the successful delivery of the LCT Connect solution and rapid realisation of the AAR/ CAR outcomes.

The solution is designed around three core data flows:

- **Registration Workflow:** as data is collected from various inputs (manual entry, autogenerated system commissioning report, third party registration), the existence, uniqueness and details of the asset are validated within the OEM's system which triggers the next steps.
- **CAR Entry Creation Workflow:** Following the collection of validated details from OEM systems, these details stored in the CAR as the system of record. The entry will be made with all necessary data as well as permissions for accessing the data. Successful entry in CAR with a verified end-to-end connection to the registered asset allows for value-add services to be enabled for an asset.
- **Value-add Service Enablement Workflow:** with end-to-end connectivity verified, and uniquely identified and registered assets, providing access to static and dynamic data, LCT Connect authorised and authenticated users can request additional services. Within this project, the operation of near real time telemetry services will be demonstrated.

Details on the test cases that will be executed in the project are provided in Section 5.1.

2.3. Detailed description of the solution

The following sections provide a detailed description of the AAR and CAR solutions proposed in LCT Connect. Both are closely coupled with the activities and outputs from AAR triggering and feeding information into CAR.

The technology solution comprises of several functional modular components that interact with each other and provide access to third parties through APIs. This approach to system design provides a mechanism for actors to connect and interact with other actors to achieve desired outcomes while providing flexibility and optionality. The solution enables multiple standards to be used, reflecting the nascent nature of standards across different LCT asset types and OEMs and is therefore scalable with the market.

As new parties arrive in the market (whether they be OEMs or DSRSPs), they will be able to connect to the central solution through integrations or secure cloud bridges with deX. As they will have their own users, systems and applications, they will be able to customise and present their own bespoke user interactions (system owners, and DSRSP users).

2.3.1. Automatic Asset Registration

The AAR is required to dovetail into several existing industry processes, some of which are currently in various stages of digitalisation. Asset registration will be aligned with these existing industry processes, the expected use of the data and primary use cases identified though this Phase One research. The AAR aims to complement and unify these processes, and comprises three key interactions.

1. Data Collection
2. Asset Nomination
3. Asset Registration/Asset Validation

The execution of step three will trigger actions that result in subsequent activities in the CAR (described in Section 2.3.2).

The first activity in the asset registration workflow is Data Collection. The AAR will accept inputs from customers, installers, and potentially devices themselves at the point at which they are commissioned. Those inputs fit into the following main categories:

- Demographic data: postcode, etc.
- Connection information: MPAN
- Asset information: ratings, capacities etc.
- Permissions/consent and contract information.

Project partner the DCC maintains a large asset register referred to as a Smart Metering Inventory (SMI) which will be leveraged to validate the MPAN. Other information will be validated from other sources, such as the asset information from OEMs directly, or the type test register.

One of the key learnings from GreenSync's international experience is that the installer experience is critical to the overall successful operation of the solution and automation is a fundamental key to realising this success. Without a great installer experience, there is significant risk of a low installer utilisation rate and/or poor-quality data input. Similarly, insights from installer apps in the UK indicated that installers require the right engagement and incentive to ensure assets are registered accurately and meaningfully.

Consequently, as much as possible, installer activities and interactions will be designed in line with the following principles:

- **Minimisation of manual input** – If an asset can provide details on its own capabilities, the installer should not have to enter that. Where possible the systems should collect and utilise data that is already stored. For example, utilising DCC's SMI as a data repository of data for validation of input from installers.
- **Responsive and transparent feedback** – If something goes wrong, installers should be notified as quickly as possible, and be provided with feedback on what went wrong and what action(s) to take.
- **Minimisation of duplication** - Installers should not have to input data multiple times.
- **Validation of inputs** – Data input validation should be applied where possible to mitigate risks associated with installer errors/omissions.

As a request to register a new asset is made to AAR as an Asset Nomination. This is a critical step in the process, as at this point there is no guarantee of end-to-end connectivity and asset details are yet to be verified.

The creation of an Asset Nomination triggers an Asset Validation workflow, in which the asset's existence is verified within the OEM platform in near real time[3]. It should be noted that internet connectivity is not always available on location, and so the option to complete registration at a later stage also needs to be available. The two outcomes of the Asset Validation step are:

- Success – Asset has been validated; asset details have been verified.
- Failure – The asset could not be validated. In this instance, feedback would be provided back to the individual that has input the data, with possible actions required to resolve.

The versatility of the AAR platform allows the registration process to enable varying levels of automation. Alongside offering registration from installer input through a third-party system or application, there will also be a mechanism for assets to be registered automatically at the point of commissioning through an integration between an OEM's system and an AAR API. Further use cases such as Supplier of Last Resort (SoLR) arrangements and de-registration are discussed later in Section 3.

[3] If there is no connectivity at that time, then asset details can be collected, and asset validation can be performed at a later point.

This registration process will be complemented by collaborating with and linking to other platforms and datasets such as the ENA DoC (Energy Networks Association's Digitalisation of Connections future system) platform (once developed). This will allow for data to be validated and updated, ensuring that all authorised parties have the most accurate and consistent picture of an asset's capabilities. In addition, the AAR can potentially integrate with the existing ENA registers of approved technology models to further support validation. Third party integration will also be possible, enabling certification schemes such as MCS and Flexiorb to generate far higher rates of certification by building key elements of their process into the AAR workflow.

2.3.2. Central Asset Register

The CAR acts as a system of record for assets that have been registered through the AAR. The CAR is required to store data on a wide variety of hardware types, and potentially broader data about the full system installation in the case of combined heat and power (CHP), PV, and/or battery storage. Following on from the interactions of systems via the AAR module, there are two key activities that take place in CAR:

- Asset Registration: Asset Linkage
- Permission Management

On successful validation Asset Linkage is performed, and the asset details are recorded in the CAR. A critical detail of this activity is that the asset is created as single unique entity within the CAR. This means that as and when other parties want to interact with the asset (in line with demonstrated consent), they are interacting with the same asset entity within the system. This ensures that duplicate asset records are not created when a second party attempts to register the same asset. In addition to the creation of validated asset details, the CAR will also record details on what and how parties will interact with assets via Permission Management. This is a core aspect of the LCT Connect solution, as users of the CAR will only have access to information for which they are authorised. Specifically, parties will only be able to interact with assets where they have demonstrated consent and only for purposes agreed to by the asset owner. Collected consents are retained and are made available for periodic audit.

This approach ensures that permissions are broad enough to enable implementation of the customer's desired use case whilst ensuring privacy and security of personal data. Our overview of potential regulatory and organisational options for this solution propose that the cyber security and privacy requirements could be governed by the Smart Energy Code (SEC).

The CAR is designed around the following principles that are core for all aspects of the LCT Connect platform:

- **Scalability:** The CAR will be scaled to support the expected volume of LCT devices.
- **Performance:** The CAR solution will enable timely access to the data stored therein and remain performant to expected rate of data access requests.
- **Validation and enabling interoperability:** The data stored in CAR is reliable and can be linked to, and be utilised by, other data and operations.
- **Security:** The CAR system and data are secured in all aspects, in line with industry best practices and approaches. This includes access and system security.

The CAR will be a cloud deployed system, which when coupled with the bridge architecture model, will mean that the LCT Connect platform is already enabled for **scaling** of data storage and data access components. Although cloud services readily facilitate increases in processing and storage capabilities according to the needs of the platform, using the twelve-factor app methodology[4]. In the highest projection scenarios for domestic LCTs GB could see up to 12 million heat pumps, 16 million EV

chargers, 2.5 GW of battery storage and 21 GW of solar PV s deployed by 2035[5],[6] made available on request.

It is understood that a wide range of parties will be interested in the data held in the platform. Balancing **performance** of access to data that is of value while maintaining compliance with data privacy and potentially critical national infrastructure (CNI) obligations will require varying levels of access to be made available to different entities. Additionally, the open data triage process will need to be applied for all open datasets that are made available, as per the Energy Data Best Practice[7] (DBP) guidance. The registration process adopted for the AAR is the first step to ensuring protection of sensitive information and that access is only available where there is lawful basis, including consent from the asset owner. Consumer protections are vital to ensure households have clear information about any offerings based on using their assets, including any drawbacks or negative implications. The platform approach to access and permissions management are discussed further in Section 2.3.1.

Ensuring **interoperability** with other data sources, such as the type test register, heat pump, EV charger databases, or the Embedded Capacity Register (ECR) which are all maintained by the ENA, the MCS and other industry databases is a key requirement for the CAR. Distribution Network Operators (DNOs), network planners, installers, DSRSPs, and innovators alike will benefit most from a solution that allows them to easily build an accurate picture of all major assets that are connected. This also requires a rigorous validation process for the data which begins with the AAR (see Section 2.3.1 above). This functionality lays the foundation for utilisation of these assets in operational or value-add services such as flexibility and telemetry services.

The CAR will promote innovation within the sector by creating a single source of truth for asset data, providing insights into new and retrofit LCT trends and availability of potential capacity for provision of flexibility services. Critically, the LCT Connect solution does not impinge on the business models of established flexibility providers – it provides them with an alternative mechanism for retrieving information on, and interacting with, those assets for flexibility services and supports full interoperability.

2.3.3. LCT value-add services

With deX, the LCT Connect solution can go above and beyond the AAR programme requirements by allowing the exchange of static and dynamic data between LCTs and LCT Connect users, providing individual and/or aggregated LCT asset data, triggered through sets of LCT Connect enabled data services.

With the foundational technology that enables messages to be sent to and received from remote devices, a range of telemetry and control services can be enabled for provision to third parties.

While the core of the LCT Connect solution relates to the capabilities made available through the AAR and CAR, the solution design will ensure that there is a clear pathway for these value-add services in the future. As the solution provides the technology for many parties to provide services to many parties requesting services, the barriers and costs for asset acquisition and participation are significantly reduced. As with the AAR and CAR, a permission management solution is fundamental to ensure that customers assets are only providing services where there is an explicit agreement to do so and will ensure that each asset is only providing services or participating with one DSRSP at a time, in line with expectations emergent from PAS1878 and the SSES policy direction.

A good example of a value-add data service is the provision of near real time telemetry. While this relates to a data passthrough rate of tens of messages per second, testing has

[4] https://12factor.net/
[5] https://www.nationalgrideso.com/future-energy/future-energy-scenarios
[6] https://evenergytaskforce.com/charging-the-future/
[7] https://www.ofgem.gov.uk/sites/default/files/2021-11/Data_Best_Practice_Guidance_v1.pdf

been undertaken and demonstrated that 100,000 simulated devices can be controlled in a similar timeframe already as per today (hundreds of messages per second). GreenSync has assessed what is required for the system and platform to scale to millions of devices and is confident the required throughput will be achieved well ahead of when it is required.

Near real time telemetry streaming service by deX

- Designed to be a near real time telemetry streaming service with a relatively short retention period. The decision about which telemetry data is collected and retained is delegated to the consumers of the stream.
- Telemetry is to be made available only to parties that have established an agreement with a provider of telemetry and valid customer consent.
- To minimise unnecessary data collection, telemetry for specific points is only collected and provided where there is a contracted requirement for that telemetry.

In Australia, deX's near real time control capabilities is being utilised today to provide critical system security services in the states of South Australia and Western Australia. Just recently, because of severe weather conditions in South Australia, from 13/11/2022 to 19/11/2022, the system demand dropped below the system Minimum Demand Threshold on six of the seven intervening days. GreenSync's deX platform was utilised to send out curtailment controls and receive confirmation of response from a fleet of approximately 16k residential LCTs. These commands were executed in under 10 minutes and provided approximately a third of the 400MW requested each day by AEMO as part of their emergency generation curtailment response.

2.3.4. Limitations of the solution

For the LCT Connect to be meaningful, LCTs must be internet connected. To provide a pathway for network operators to manage the volumes of LCTs expected to be installed on the network, this should be mandated as soon as practicable. The LCT Connect solution would both benefit from this and would then be able to check compliance against the obligation of being internet connected.

2.3.5. Out of scope

To ensure compliance when registering assets on the platform, either policy and/or regulatory based methods will be required. For example, one mechanism for ensuring registration compliance could be having registration of the assets with DNO's on the LCT Connect platform as a condition on OEM warrantees. While the requirements and approaches to achieve a high compliance rate will be explored through the project, and recommendations will be made, decisions on the regulatory approach and mechanisms to achieve target compliance rates are out of scope.

The LCT Connect solution will not perform any of the following activities or functions, and therefore, these will not be included in Phase Two and Phase Three of this project.

LCT Connect module	Description
AAR, CAR	Creating a new flexibility marketplace including: Participant registration; Tender creation and publication; Bid submission; Bid assessment; Service requests; Settlement calculation; Payment advice generation.
LCT VALUE-ADD SERVICES	Establishing direct relationships with end consumer – End customers have existing relationships with a variety of entities (DNOs, retailers, OEMs) already. Rather than introduce another system and organisation to interact with the end customer, LCT Connect will complement and leverage those existing relationships to achieve the desired outcomes.
AAR	While the LCT Connect solution provides a mechanism for representation of consent for control services, the implementation of control services is out of scope for this program. The technology for provision of control services exists today, and can be readily enabled in future projects.

Table 1: Out of scope

2.4. Reference case – deX in Australia

Australia is experiencing a rapid and accelerating uptake of LCTs, and in particular the widespread adoption of distributed solar photovoltaics (PV) as shown in Figure 3 below. In its annual Electricity Statement of Opportunities (ESOO) report released in August 2022[8], the Australian Energy Market Operator (AEMO) noted "production from distributed PV is estimated to supply approximately 23% of the residential sector's overall underlying consumption in 2021-22. Over three million homes have distributed PV generating to meet their own demand and at times exporting electricity to the grid. By 2031-32, this is expected to reach to approximately 46-53% of the residential sector's overall consumption, or approximately 4 million to 4.5 million homes, depending on scenario".

As households and businesses supply more of their own energy from distributed PV and storage, they will draw less electricity from the grid. This has significant implications for electricity networks, market dynamics and the wider industry. As this penetration from distributed PV continues to accelerate, AEMO forecasts that all National Electricity Market (NEM) mainland regions will experience minimum operational demand – the lowest level of demand from the grid – in the daytime during the next five years.

[8] https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/nem-electricity-statement-of-opportunities-esoo

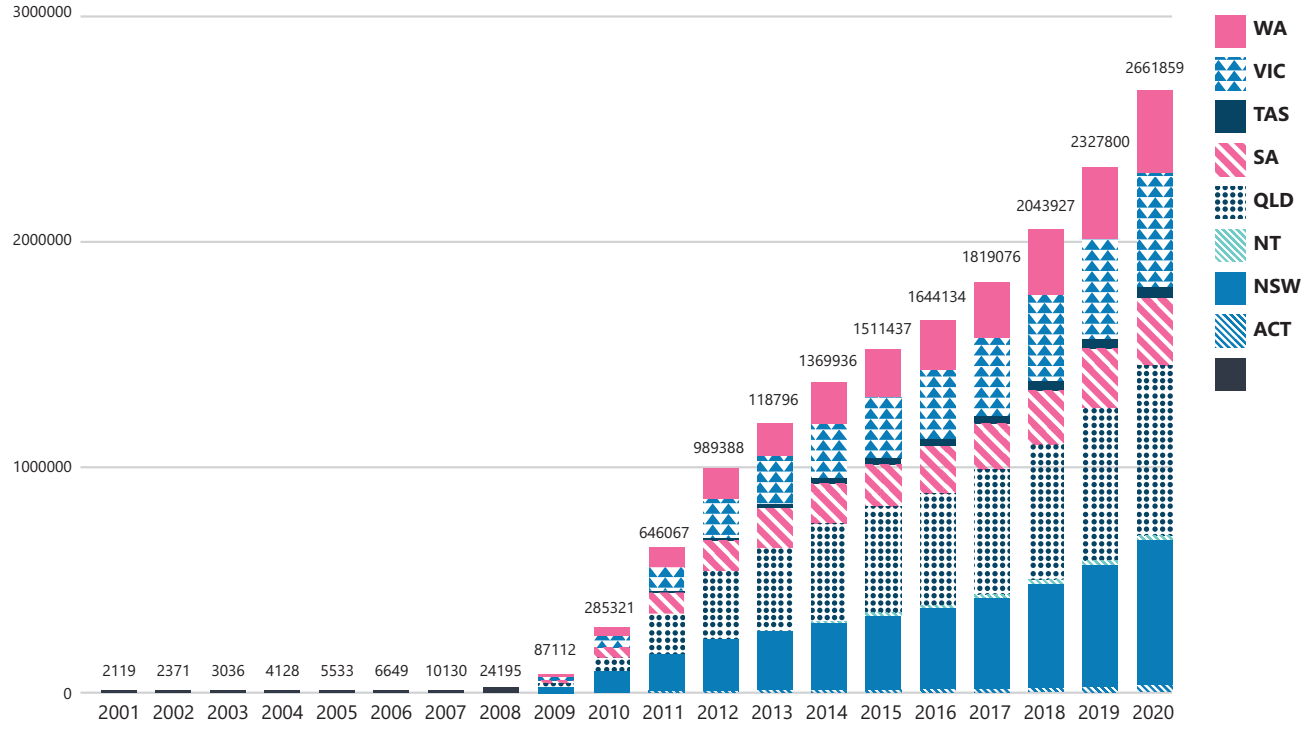


Figure 3: Cumulative count of solar PV installations (small-scale) - Australia[9]

South Australia is at the forefront of this transition. Since 2016-17, the contribution of rooftop PV at the time of maximum underlying demand has almost tripled in the State. In 2020-21, distributed PV generated 2,173 GWh (estimated) and met up to 83% of underlying demand at times. Over the next decade generation from distributed PV is forecast to more than double to 4,974 GWh[10].

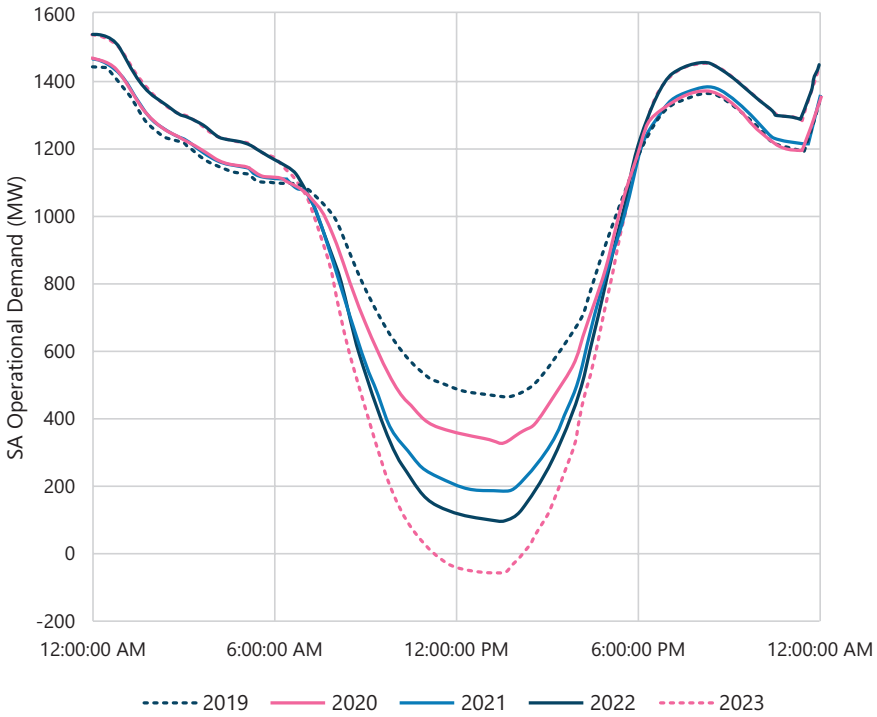


Figure 4: South Australia operational demand forecast (MW)[11]

[9] Clean Energy Regulator, Small Scale Installations 2021
[10] https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/south-australian-advisory-functions
[11] AEMO Minimum demand operational thresholds in SA, 2020.

In response to the risks presented by forecast minimum operational demand as shown in Figure 4 above, in 2020 the government of South Australia passed the Smarter Homes Regulations[12]. These are a series of new technical standards and requirements for smaller generating systems in the State to ensure system stability and security of supply is maintained.

The Smarter Homes Regulations came into effect on Monday 28th September 2020. The regulations require all customers installing or upgrading solar systems in South Australia to appoint a 'Relevant Agent' who is responsible for remotely disconnecting and reconnecting the system during State electricity security emergencies. Similar regulations were implemented in Western Australia in 2022 and other Australian states are expected to follow in the near future.

Since the introduction of the regulations, deX has been appointed Relevant Agent for 160MW across two Australian states and has developed API integrations with seven international OEM brands representing more than 95% of the small inverter OEM market share. Over this same period of time deX has significantly scaled, progressing from an average of 100 registrations per week in early 2021 to 730 today and growing, and a total of 30,000 registered systems in November 2022. Learnings from the initial deX integrations helped to significantly reduce the software development and integration time required with subsequent OEMS. This cut the average coding and testing time per integration from three months to one month with defined best practices and standard processes to accompany new technology providers.

As the Relevant Agent, deX must provide the advanced communications capabilities to control the entire fleet of solar systems on command in order to meet the remote disconnection/reconnection compliance requirements.

Since the regulations were introduced, they have needed to be actioned seven times. By far the largest of these events was on Saturday 12th November 2022 when a transmission tower on the interconnector between the Australian states of Victoria and South Australia was brought down in an extreme weather event. This resulted in South Australia being electrically islanded from the rest of the country until the tower was repaired and reinstated one week later. These conditions precipitated the AEMO and distribution network operator SA Power Networks needing to issue curtailment of distributed PV instructions in order to maintain system security on six of the seven intervening days.

Approximately 400MW of solar curtailment was activated each day. The deX platform, via its integrations with seven OEMs, delivered almost a third of this curtailment through API control. Further curtailment was enabled via supervisory control and data acquisition (SCADA) or 'call and drop' from large scale solar farms, with SA Power Networks needing to resort to Enhanced Voltage Management to 'shake' additional legacy uncontrolled systems offline.

Because of the volume of LCTs registered in deX, the platform was able to provide a significant proportion of the required curtailment. This is a clear and direct validation of the case for LCT registration. It is self-evident that the larger the volume of registered LCTs, the greater the orchestration that can be provided from their collective capacity.

In addition to the API curtailment and control via deX, SA Power Networks also deployed their Enhanced Voltage Management scheme. This scheme involves intentionally raising the network voltage significantly above the network's standard limit (253 V), to force the disconnection of solar PV via overvoltage protection mechanisms. While effective, this approach is also associated with undesirable consequences, including increased power consumption of certain loads, degradation of equipment life and in some cases equipment failure.

[12] https://www.energymining.sa.gov.au/industry/modern-energy/solar-batteries-and-smarter-homes/regulatory-changes-for-smarter-homes

The Enhanced Voltage Management solution in South Australia has been described by many in the industry as “brutal”. The overall lack of proactive planning has had negative impacts on all customers and required the deployment of an unsustainable solution in Enhanced Voltage Management to the problem. Had the AEMO and Government of South Australia acted sooner to register and gain control of PV systems upfront, the use of Enhanced Voltage Management could have been avoided and a more considered and sustainable approach implemented.

3. Use cases

In this study, "use case" is used to describe the fundamental need the system must perform, which is then broken down to a set of more detailed requirements.

A wide variety of use cases were initially considered, then narrowed down to the most valuable. These included the shortlist below, which were not prioritised. Many of these use cases did come up again during the research, such as demand supply control - which was noted to be a use case that **should not** be enabled for the DNOs in the GB context.

- Improving business case for installation of LCTs
- CNI visibility
- Demand supply control
- Research
- Fault detection
- Fraud detection
- Targeted assistance
- Installer performance
- Emergency services planning
- Validating LCT assets are compliant for use in GB

Other investigations into LCTs visibility were also used to inform and supplement the use cases developed by the project team. This includes the LCT use cases from the ENAs open networks project[13], which developed a list of 14 uses cases and corresponding users as shown in Figure 5 below. These are primarily electricity network use cases and so our use cases expand upon these whilst distilling and condensing the ENA use cases.

As the energy system evolves and increased volumes of LCTs connect to the distribution network, having visibility of assets becomes increasingly important. We believe that the LCT visibility use case will impact multiple stakeholders including OEMs, energy retailers, DSRSPs, aggregators, and network operators, as well as government and regulators. The description of the needs identified for each of these key stakeholders is outlined below.

4. Use Cases Definition

The Product team has identified fourteen use cases that will benefit from enhanced operational DER visibility and monitoring and has classified them in five main categories, as shown in Table 1. The use cases captures all prospective DER-DNO/ESO interactions (service or activity) that will make use of data applicable to the PoC. The use cases that stem from sharing of DER data between the DNO and ESO are not in scope of this product.

Table 1: Use Cases Definition

Use Cases Definition		
Category		**Use Case**
DER providing service to DNO only	1	Flexible Connections dispatch (ANM)
	2	Flexibility Service dispatch
DER providing service to ESO only	3	Ancillary and Balancing services
	4	System Restoration (Black Start)
	5	Capacity Mechanism Planning
DER providing services to a DNO and ESO	6	Whole system coordination (resolving conflicts of services)
All DER - Improvement of existing processes	7	Improved System Resilience
	8	Improved real-time Network Operation
	9	Improved Outage Planning (DNO)/Network Access Planning(ESO) processes
	11	Improved Demand forecasting processes
	12	Real-time DSO Data transparency
	13	DER compliance with relevant standards
Market Facilitation (Non-DSO services)	14	Facilitation of new Markets (e.g. peer-to-peer)

Figure 5: ENA use cases for DER services

[13] https://www.energynetworks.org/assets/images/ON21-WS1B-P6%20Operational%20DER%20Visibility%20Use%20Cases%20and%20Volumes%20(30%20Jul%202021).pdf

#	Stakeholder	Description of stakeholder need
1	**Network Operators**	Low visibility, in particular of assets that could have a significant impact at scale such as EVs and heat pumps, means there is uncertainty around the amount of current and planned network headroom on the distribution network. There is an opportunity to use comprehensive asset register data to improve asset investment, flexibility and planning decisions.
2	**DSRSP and aggregators**	DSRSP and aggregators may require visibility of assets within LCT Connect, particularly as they acquire new customers reducing barrier to entry for customer switching if all assets are on one platform.
3	**Ofgem and BEIS**	For government, and regulators, the need is to help inform and support policy decisions and directions. The geographical deployment and trends of LCT devices connecting is a significant enabler towards a Net Zero energy and heating system. Data services can provide compliance monitoring capabilities.
4	**Original Equipment Manufacturers**	For OEMs, a simple and unified process for engaging with DSRSPs reduces their overheads and streamlined connections processes increases uptake of technology deployment.
5	**Emergency services, such as fire and rescue services**	Open access to asset location to identify the location of domestic LCTs that could pose a potential risk to public health.
6	**Innovators**	Develop new and existing business models and products using the asset register data
7	**Local Authorities**	Responsible for local area energy planning, having visibility of LCT assets will help inform these plans.
8	**Finance Providers**	As providers of green financing, having visibility of when LCTs have actually been installed allows them to validate their green products are delivering the expected results.

Table 2: Summary of stakeholder needs

The final five core use cases are defined as:

1. Visibility
2. Planning
3. Standardisation
4. New Business models
5. Change of service/retailer

Each of these use cases is described in detail in the following sections below.

3.1. Use case one: LCT visibility

The LCT visibility use case outlines how LCT Connect solutions will give users visibility of low carbon technologies that are connected to the network. This is one of the most important use cases for the platform as it will enable users to see what assets are being connected (such as solar PV, heat pumps, batteries, and EV), when they are connecting and allow better planning and management of the resources and network.

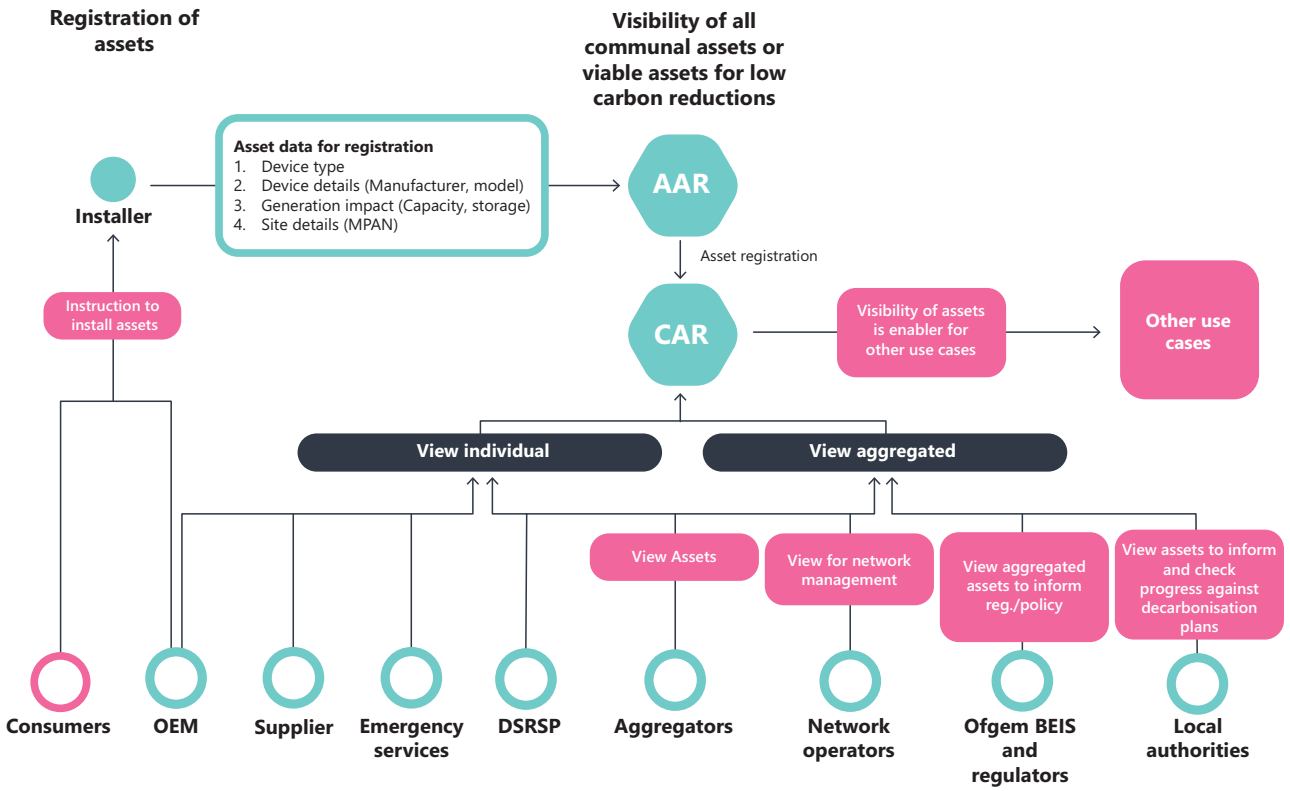


Figure 6: Data flow for the LCT case study. It shows the interactions of the individual stakeholders (circles) with the AAR and CAR platforms.

To aid the development of the solution, use case data flow diagrams were produced for each use case. The LCT visibility data flow is shown Figure 6. Not all data flows will be included in this report and many of the pertinent data flows are included in the above diagram.

The LCT visibility use case will engage a particularly wide range of users including network operators, consumers, DSRSPs, aggregators, government and regulators, OEM and other support services. We anticipate that across these use cases, each of the stakeholder will need visibility of assets on an individual, and aggregated basis across specific geographies. Importantly, there will need to be a user access authentication layer and consent mechanisms for assessing different users' ability to view different LCTs within the tool. Different users will require different data as stored in the CAR solution.

- **Network operators** - Network operators are the primary stakeholders for this use case and will likely to want to see aggregated assets across an area which will support their network reinforcement and wider planning (See next use case).
- **Consumers** - Ability to log in and see their assets performance, or status of registration.
- **DSRSP and aggregators** could use this data for visibility of assets in each region, enabling targeted flexibility solutions.
- **Local authorities** could benefit from greater visibility of installed low carbon technologies to inform their local area energy plans and understand how they are performing against their decarbonisation goals.
- **Ofgem, BEIS and other governmental organisations** can view number of assets to inform the policy intervention or potential investment initiatives based on uptake of assets in particular areas of geographies, demographics or similar.
- **OEM** – Tracking the spread of installed assets enables a better understanding of the uptake of technologies across the country.

- **Users benefiting from wider support services** - Enabling visibility of asset locations for emergency services/ vulnerability support services. Provides visibility of asset information in context with PSR (or equivalent and wider data sets, self-disconnection data, weather etc.

The users and this use case will require a view of numerous datasets including the following static variables.

- Meter Point Administration Number (MPAN)
- Postcode and address (perhaps also geographical location although this can be inferred)
- Network connection point
- Date of installation
- Asset type
- Rated capacity of asset, voltage, current, power, etc.
- Rated export/import (where applicable)
- Current flexibility service provider (where applicable)
- Distribution network operator for the connected network.

Not all this information will be available to all stakeholders and permissions will be determined by an authentication process in the access to ensure privacy and security.

3.2. Use case two: Planning

This use case considers the registry of assets to support the planning of local network and infrastructure upgrades, including charge points, battery storage and solar. It can also be used to develop smart local energy systems which optimally utilise low carbon technologies and renewable energies.

The uptake of low carbon technologies is accelerating with up to 12 million heat pumps, 16 million EV chargers, 2.5 GW of battery storage and 21 GW solar PV potentially deployed by 2035, thus visibility of the network will enable appropriate planning and anticipation for network reinforcement and other solutions. Further to this, the types of assets on the network can highlight the need for further targeted upgrades and installations, as well as inform flexibility decisions.

The visibility and planning use cases are interconnected in that improved planning is enabled by better visibility of assets and their locations. For this reason, stakeholders are similar and are for this use case as follows:

- **Network operators** are primary users for this use case. They can use it to understand what areas of the networks are at, or will be close to, the headroom thresholds on their networks and thus which areas need interventions. They will do this by extracting the LCTs for an area (or perhaps the entire network depending on the study). These can then be fed into network modelling environments (NME) which can model their potential impact through power flow analysis and other tests.
- **DSRSP and Aggregators** will only indirectly use this data for this use case, although may be able to anticipate areas of headroom as well as where they may get best utilisation (if an area will need flexibility services for example).
- **Ofgem, BEIS and other governmental organisations** may be able to see assets across the UK, so can also validate the planning needs across DNOs as well areas of potential (more PV possible, under-utilisation of HPs). This can drive incentives and focussed initiatives to help uptakes of LCTs and distributed generation (DG). They can also identify the future needs of the DNOs and what programmes they may need to develop to support them.
- **OEM/Installer** do not have a direct application in this use case, but they can organise their demands by anticipating the future planning required. This can help ensure that there is sufficient supply for important LCT uptake. They may also be able to infer what areas geographically to focus which product.
- **Customers** are also not directly involved in this use case, although they may profit

from incentive driven planning e.g., import tariff for PV.

This use case will require the same static data as captured for the visibility use case, but planning will also benefit from the following dynamic variables:

- State of charge/discharge (for storage assets)
- Energy telemetry data (current, voltage, real power, reactive power, etc.)
- Mode or state
- Energy usage of the device

Data access will only be available for organisations/individuals with appropriate consent and may include flexibility providers who have signed a contract with the households to utilise their asset in a service such as DSR. Permissions will be determined by appropriate authentication layer in the AAR/ CAR platform. Where the LCT Connect solution is regulated, BEIS or Ofgem may want to make provision in regulation to ensure that use cases such as this are realised and expected.

3.3. Use case three: Standardisation

An AAR/CAR solution with standardised registration can remove significant overhead and remove barriers to adoption amongst installers. The creation and maintenance of common data and API standards across the flexibility value chain will reduce costs and complexity for all actors (DSRSPs, OEMs, retailers etc).
Incompatible standards are a major roadblock to meeting Net Zero targets, requiring coordination across a whole host of actors. An integrated AAR and CAR solves standardisation since the formats can be coordinated through the secure cloud bridges architecture. In other words, even if each OEMs utilises slightly different formats the final data stored within CAR will utilise best practice in standardisation, supporting interoperability across assets and service providers.

3.4. Use case four: New business models

Visibility and control of energy consuming or generating assets in consumers' homes will allow retailers and aggregators to offer more tailored services, such as Heat as a Service, improved billing and, more attractive tariffs connected to demand side response, or innovative financing models for low carbon tech assets. Additionally, visibility of other (possibly local) assets on the register may allow consumers to pull together more effectively and into new community business models.

Enabling retailers and DSRSPs to have visibility of energy consuming and generating assets within households allows them to offer more tailored services and tariffs. This unlocks the potential for improved revenue generation which can then be shared between consumer and retailer.
Visibility of assets across multiple asset owners allows for those owners to band together and provide services which may not be accessible to single asset owners at smaller scale.

The business models can be categorised into two areas determined by whether they are new services offerings for consumers with LCTs, or to enable solutions for consumers using communally available assets.

The proactive service offering will mainly benefit:

- **DSRSPs, Retailers and Aggregators** have visibility of energy assets via the CAR. This gives them the ability to offer tailored services to individual customers based on how their load and generation profile is expected to be as well as services around load control.
- **Customers** benefit from a more specific offering to get the most out of their assets, optimising for cost, carbon or preferences. They could also participate in emerging local energy markets.

There will be also secondary benefits for **Network operators** who can benefit from grid services if tailored offerings to customers contain these.

The use of communal assets will also benefit the same stakeholders but with different services, namely:

- **Customers** benefit from visibility of other energy assets. This allows them to pull together and plan for new business models as well as establishing peer to peer contracts.
- **DSRSP and Aggregators** will be the vehicle through which revenue generation or cost offset will be realised for the customers.

Again, there will be secondary benefits but this now extends to the OEM and installers:

- **Network operators** can benefit where communities consider their impact on grid capacity in their business models.
- **OEM/Installer** can benefit from interacting with potential community business models and providing assets to support these.

These service offerings will require:

- MPAN
- Location of Asset
- Type of Asset
- Capacity of asset (import/export/storage capacity)

3.5. Use case five: Change of service provider

A key benefit of LCT Connect, is the ability to use the CAR to communicate with Assets. This provides an important "value-add" of the proposed solution enabling seamless changes of service and retailer. There are three main sub use cases this enables:

- Onboarding new customers OR change of service provider (Shown in Figure 7).
- Customer leaving property and leaving LCTs behind.
- Customer moves to new property with the LCT asset.

The CAR solution enables new consumers at a property to be quickly onboarded and this is useful when a user appropriates the EV charger or other assets within the property. It also facilitates integration with commercial business models and a smooth transition to utilise the asset without delays.

This is primarily a use case for the consumers or their representative instructing the service that they intend to switch to a new DSRSP. The CAR should then be updated automatically by a request to switch service provider.

The data to enable a change-of-service provider is relatively minimal and will only require MPAN number, asset location, type of asset and a consent for the switch itself. Consent can be managed for this by the gaining DSRSP notifying LCT Connect in this particular use case. New contracts from consumers with their existing service providers may change the date at which the consent elapses, and would require the consent date expiry to be updated by the platform based on a signal from the DSRSP. In the longer term, an equivalent to the SoLR process may be required as DSRSPs fall out of the market. While wider governance will have to be developed by policy colleagues at BEIS and Ofgem, the technical solution for ensuring continuity for consumers may well be required to be enabled by the LCT Connect proposition. This is an extension of the change of service use case.

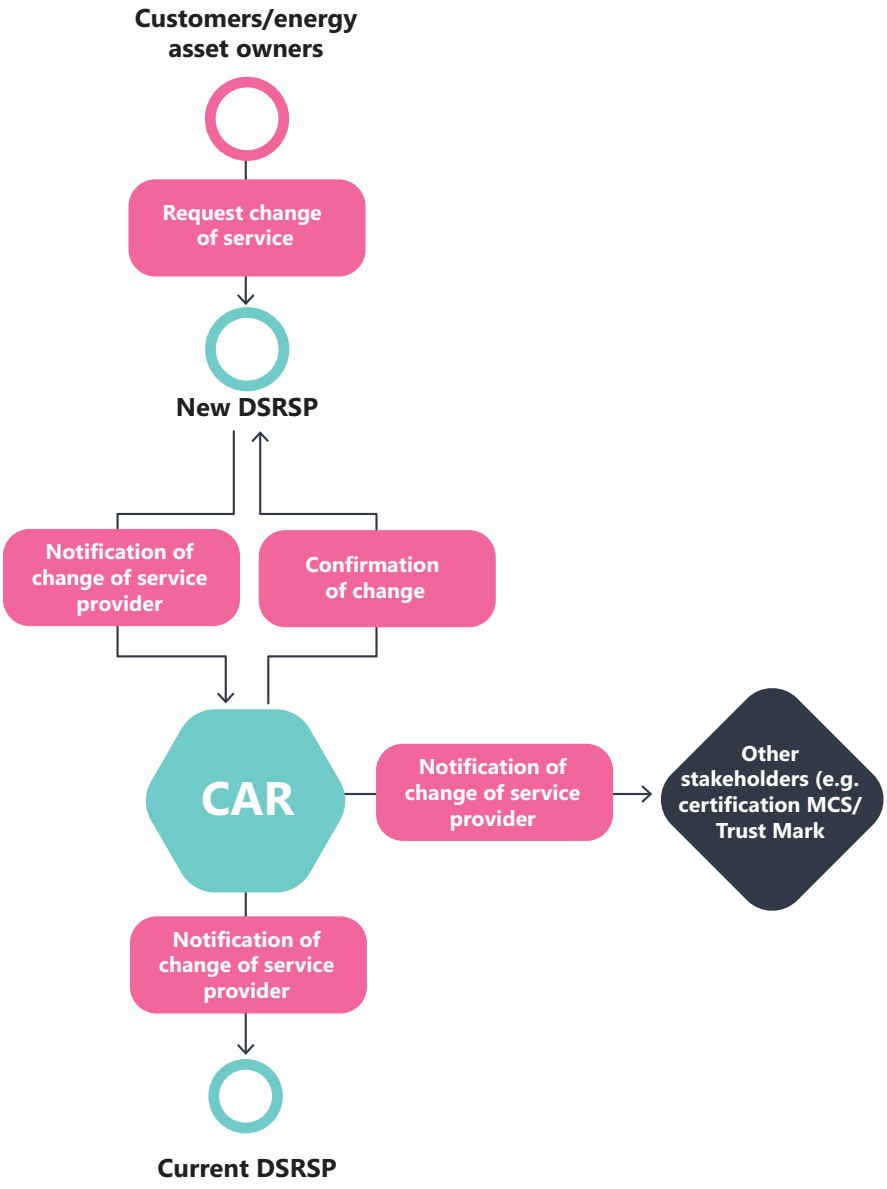


Figure 7: New customer change of service use case

4. Route to market

To identify the most likely route to market, a review of the regulatory landscape was first conducted. This included an investigation into other projects or services with similar functions to LCT Connect.

4.1. Regulatory landscape

Along with the physical infrastructure being developed to facilitate the energy transition, building the digital infrastructure enabling the creation, capture, storage, dissemination, and utilisation of data across the sector continues. The development of device specifications, such as PAS1878[14] (Publicly Available Specification) and PAS1879[15], licence conditions for networks in making data "Presumed Open"[16] and the development of work such as the AAR competition all demonstrate a step change in the role of data and digitalisation in the sector. The next phase of the transition, in parallel with the rapid uptake in EVs, the building of large amounts of offshore wind infrastructure and the shift to heat pumps, may well be defined by the building of **digital critical national infrastructure** in the energy sector.

These enabling infrastructure projects, such as the AAR competition or the Smart Meter Energy Data Repository[17] represent some of the least regrets proposals taken forward by the government. The foundational data that these projects will create and manage will enable a variety of positive use cases that may give direct or indirect benefit to consumers and the energy industry more broadly. Other digital infrastructure projects, such as the recommendation for a consumer consent dashboard[18] from the Energy Digitalisation Taskforce (EDiT) represent some action being taken to ensure that consumers can, with confidence, ensure they, or their retailers/flex providers, can access and utilise data on their behalf with appropriate controls in place. We understand that the Retail Energy Code (REC)[19] organisation is developing a proof-of-concept consumer consent mechanism with the intention of further developing and possibly operating it as a public good for the retail sector.

Not all enabling digital infrastructure is currently within the government's scope, with Open Energy[20] having gone through a similar competition structure to the AAR competition but has subsequently not been translated into industry requirements. Market based adoption of this solution has been increasing over time. Energy Systems Catapult expect that Open Energy may have a significant role to play in relation to data sharing, access, and visibility across the energy value chain. It may, upon hitting a critical mass of organisations utilising it, be brought into the regulated sphere. Each of these projects will have a material impact on the AAR and therefore require the project to remain cognisant of their progress and outcomes.

In addition, the government has recently issued a consultation titled "Delivering a smart and secure electricity system: the interoperability and cyber security of energy smart appliances and remote load control", referred to as SSES[21]. The consultation sets out to:

1. require all organisations capable of remotely controlling large electrical loads (greater than 300MW in aggregate) to comply with the Network and Information System Regulations, using the Cyber Assessment Framework;

[14] https://www.bsigroup.com/en-GB/about-bsi/uk-national-standards-body/about-standards/Innovation/energy-smart-appliances-programme/pas-1878/
[15] https://www.bsigroup.com/en-GB/about-bsi/uk-national-standards-body/about-standards/Innovation/energy-smart-appliances-programme/pas-1879/
[16] https://www.ofgem.gov.uk/publications/decision-data-best-practice-guidance-and-digitalisation-strategy-and-action-plan-guidance
[17] https://www.gov.uk/government/publications/smart-meter-energy-data-repository-programme
[18] https://es.catapult.org.uk/report/delivering-a-digitalised-energy-system/
[19] https://www.retailenergycode.co.uk/
[20] https://openenergy.org.uk/
[21] https://www.gov.uk/government/consultations/delivering-a-smart-and-secure-electricity-system-the-interoperability-and-cyber-security-of-energy-smart-appliances-and-remote-load-control

2. require energy retailers to make time-of-use-tariff data openly available in a common format, accessible over the internet;
3. ensure that larger domestic-scale energy smart appliances (ESAs), including electric vehicle (EV) charge points, batteries, and heating appliances (such as heat pumps) are interoperable with demand side response service providers, using ESA standards;
4. require smart heating appliances and batteries to meet cyber security and grid stability requirements, similar to those already in train for EV charge points;
5. require electric heating appliances with the greatest flexibility potential (namely heat pumps, storage heaters and heat batteries) to have smart functionality;
6. establish a proportionate and flexible licensing framework for organisations providing demand side response to domestic and small non-domestic consumers.

While the requirements of the LCT Connect proposition and the AAR competition do not require enabling flexibility, the utilisation of LCT Connect would allow a messaging network to be created that would enable flexibility. The consultation above, particularly points 3, 4 and 6, create opportunities for the development of the LCT Connect proposition in meeting the outcomes of the government's flexibility work.

- Point 3 aligns well with the deX OEM/ Vendor approach to interoperability and linkages with PAS standards.
- Using deX, compliance mechanisms can be built into the processes of the platform to enable point 4.
- Point 6 can be enabled, with BEIS preferred licensing route discussing the implementation of logic based, data driven rules for licensees within the new regime for flex providers.

The SSES consultation, in addition to the contents set out in Table 3 below, creates a list of infrastructure projects and use cases that have been considered by the project team as it developed the proposition for LCT Connect. This should be in alignment with BEIS expectations for the competition, as well as value-add opportunities.

Project	Organisation(s)	Funding mechanism	Scope	Expected outcome (speculative)	LCT Connect Alignment
Smart Meter Data Repository	TBC	NZIP (BEIS)	Create a single access point for smart meter (demand) data	Some sort of data portal is built if feasibility study and proof of concept is successful, but regulatory and legislative enabling changes for access lag significantly behind implementation.	Consideration will be taken to understand how data from both services could be joined and utilised by third parties.
Open Energy	Icebreaker One	Previously BEIS/IUK. Now self-funded	Reduce legal and technical barriers to data sharing. Consistent approach.	Continued adoption by industry. Critical threshold of parties using it at some point in the next 24 months creates momentum for regulation.	Longer term ambitions of the platform may use Open Energy as the mechanism for "Shared" aggregated data.
Consumer Consent Dashboard	Retail Energy Code (REC), or any other industry partner	REC	Consumers' single point of consent.	Too early to say.	Depending on the outcome of this work, bringing the LCT Connect consent mechanism to use this solution wouldn't likely be a large technical challenge.
National Underground Asset Register (NUAR)	Geospatial Commission (Cabinet Office)	Treasury	Streamline data sharing between owners of underground assets and those who dig up the ground.	This will be a "simple" database of assets and their locations with appropriate geospatial interoperability. Linkages of approach to this would be beneficial to LCT Connect.	Limited scope for interaction between two datasets, however ensuring geospatial data lines up between would be beneficial to wider society. Consider in roadmap how this can be enabled.
Digital Spine	TBC	NZIP (BEIS)	Study assessing technical feasibility and policy implications of the energy system 'digital spine' concept, as proposed in EDiT.	A common API and data formatting schema will be designed to surface "identified critical data assets" in a consistent way. If feasibility successful, live project unlikely deploying anything that can be used until at least mid-2024.	Like Open Energy comment. Depends on what market design solution is broadly implemented.

Table 3: Relevant digital infrastructure building/ projects (not inclusive of AAR competition

4.2. Market size

To understand the scale of opportunity available for the AAR/ CAR and its further capabilities for enabling asset control, an assessment of the deployment of existing low carbon technologies at domestic scale was undertaken. The following technologies were investigated:

- Heat pumps
- Solar photovoltaics (PV)
- Battery energy storage systems (BESS)
- Electric vehicle (EV) chargers

Alongside the current view, the potential future levels of uptake have been considered. This has been aligned with the National Grid's Future Energy Scenarios (FES) for heat pumps, solar PVs and BESS. The FES describe four different potential futures scenarios which make assumptions as to the decarbonisation journey of GB. For EV chargers, the Electric Vehicles Energy Taskforce projections were used.

Although the study focussed on these four LCTs, there are many technologies (and variants on the four above) which would derive value from being integrated into the LCT Connect platform including, but not limited to, home energy management systems, direct electric or immersion heaters, heat batteries and smart plugs.

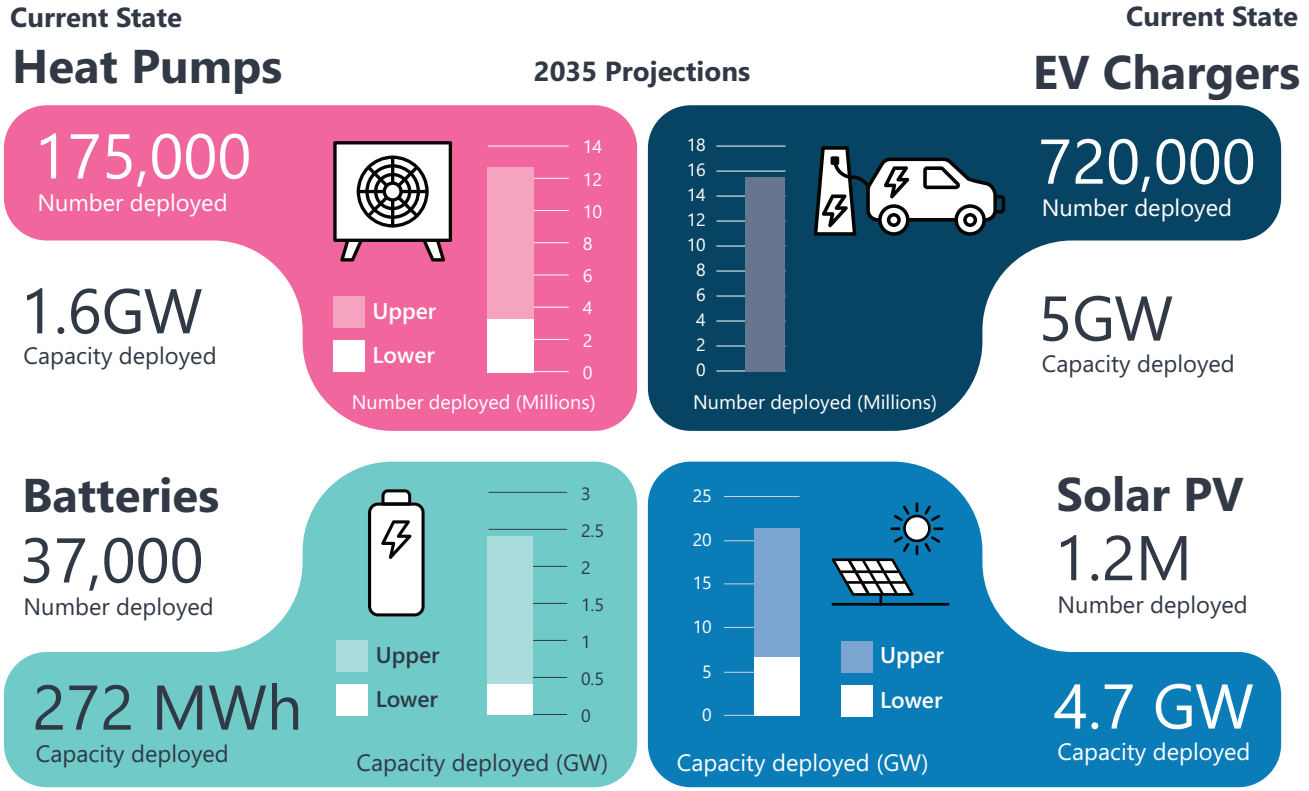


Figure 8: Overview of current and 2035 deployment of domestic LCTs across the UK

4.2.1. Regulatory context and trends

Heat Pumps

The renewable heat incentive (RHI) was replaced by the boiler upgrade scheme (BUS) in May 2022 going from a payment per unit of heat consumed to an upfront grant to offset the high the capital expenditure associated with heat pumps[22],[23]. Running costs of heat pumps are similar to that of a gas boiler but with a much higher capital expenditure (ASHP 2022 average £11k, G/WSHP 2022 average £17.5k), even factoring in the BUS[24],[25]. Despite this lack of financial incentive, 29,500 heat pumps were installed in homes in 2021. With the UK government targeting 600,000 installations per year[26],

[22] https://www.ofgem.gov.uk/environmental-and-social-schemes/domestic-renewable-heat-incentive-domestic-rhi
[23] https://www.gov.uk/guidance/check-if-you-may-be-eligible-for-the-boiler-upgrade-scheme-from-april-2022
[24] https://www.ofgem.gov.uk/publications/price-cap-increase-ps693-april
[25] https://www.recc.org.uk/pdf/performance-data-research-focused.pdf
[26] https://www.nationalgrideso.com/document/263951/download

given appropriate regulatory change, it is expected that this rate of installation will increase alongside the developing maturity of the supply chain. Octopus Energy are such an organisation pioneering an approach to rapidly roll out heat pumps across the UK quoting as low as £3,000[27] for a standard installation These are targeted at easy to treat homes with the intention of cutting carbon quickly across the UK's residential heat demand and to learn from these "low hanging fruit" buildings. These learnings would subsequently be applied to circumstances where the electrification of heat is more difficult.

Solar Photovoltaics

The feed in tariff was a scheme which paid owners of renewable generation technologies for the energy they generated. The scheme was launched in 2010 starting with very generous payments in early years and reducing over time until the scheme finally finished in 2019[28]. Correspondingly, 2010-2016 saw significant uptake with installations tailing off before the closure of the scheme. Associated with recent energy price volatility, uptake has increased in the last couple of years with 112,000 installations in 2022 up to November.[29]

Battery Energy Storage Systems (BESS)

The UK domestic BESS market has been emerging since around 2015 and despite not having been supported by any direct government incentives has been growing steadily. Domestic BESS is generally installed alongside solar PV arrays (40% of PV installed with BESS alongsid[30]) to maximise the benefits of utilising generated electricity behind the meter. This is encouraged by the fact that BESS, when installed by itself, has the standard VAT of 20% applied which drops to a reduced rate of 5% when installed alongside solar. As technology costs decrease and value in flexibility markets emerge, it is expected that installations will continue to rise over time.

Electric Vehicle Chargers

The installation of EV chargers has been supported by the EV chargepoint grant (previously known as the Electric Vehicle Homecharge Scheme) which was introduced in 2014 and closed to homeowners in March 2022. The grant application statistics show that up to June 2021 160,000 domestic EV chargers were installed[31]. Apart from this source, there is very little data available for deployment of domestic chargers. As the grant is time limited and there were 820,000 EVs on the road by Q1 2022, it is assumed that this is an incomplete source of data. Statistics based assumptions (related to number of homes with off-street parking, multiple EVs sharing a charger, etc.) were made in the Electric Vehicle Energy Taskforce report to estimate 720,000 EV chargers deployed by 2022. With the EV chargepoint grant being phased out, it is likely that many domestic chargers will be installed without being registered and therefore visibility of assets and the benefits those bring will be lost. These circumstances further strengthen the need for an LCT Connect solution. Additionally, The Electric Vehicles (Smart Charge Points) Regulations 2021[32] which came into force in June 2022 sets requirements on the registration of sale, electricity supplier interoperability and smart functionality which LCT Connect could provide a solution for. Vehicle-2-Grid (V2G) chargers are still in their infancy, ~£3,700 more[33] than smart monodirectional chargers. When technology costs reduce enough for the economic case to be viable for asset owners, greater demand side response potential through LCT Connect is anticipated by using the EV as a high capacity (typically ~40kWh[34]) battery accessed through the V2G charger.

Driving the installation of EV chargers are the sales of EVs themselves. The cost and disruption associated with installing an EV charger is minimal when compared to that of the vehicle itself. EV salary sacrifice schemes

[27] https://octopus.energy/get-a-heat-pump/
[28] https://energysavingtrust.org.uk/grants-and-loans/feed-in-tariff/
[29] https://datadashboard.mcscertified.com/
[30] https://api.solarpowereurope.org/uploads/4721_SPE_BESS_report_08_mr_fae9b5f56b.pdf
[31] https://www.gov.uk/government/statistics/electric-vehicle-charging-device-grant-scheme-statistics-january-2022/electric-vehicle-charging-device-grant-scheme-statistics-january-2022
[32] https://www.legislation.gov.uk/uksi/2021/1467/contents/made
[33] https://www.ofgem.gov.uk/publications/case-study-uk-electric-vehicle-grid-v2g-charging
[34] https://www.eonenergy.com/electric-vehicle-charging/costs-and-benefits/battery-capacity-and-lifespan.html

are now being introduced[35] and will provide a mechanism to help with the uptake of EVs and their associated chargers.

In the context of the UK's Net Zero target and historic installations, it can be seen that there is a strong and growing need for the LCT Connect platform. The case to bring it in as soon as possible is strong, as every installation that isn't drawn in through the AAR process, is likely to be more difficult to bring in retrospectively.

4.3. Organisational structure for the solution

Based on insight from previous projects, this section sets out some recommended actions to take forward when considering an LCT Connect implementation in the GB market. The underlying assumption of this work is that the implementation of CAR and AAR solutions integrated functions, and therefore require some sort of coordinated cost recovery mechanism under one organisation. Given this feasibility study sets out an **integrated solution** for AAR/ CAR, both the organisational structure, and the cost recovery mechanisms should be considered as a whole system solution. Given wider regulatory objectives of protecting consumers, supporting decarbonisation and improving the energy system we believe that this integrated solution works towards these objectives within timescales that will accelerate GB's transition to Net Zero.

The project has identified two ways the LCT Connect solution can be brought forward into the GB market. The first, is for GreenSync to run the solution in a similar manner to their implementation in the Australian market, i.e., run as a for profit organisation providing the technology and service enabling LCTs to achieve compliance with latest Australian Standards, fulfilling Relevant Agent Remote disconnection and reconnection requirements as well as dynamic export limitation[36]. As the notion of a Relevant Agent[37] is not present nor possibly needed in GB, an alternative route can be identified, where the AAR/ CAR operator is a regulated function, possibly under the SEC. With this option one could see the DCC, or some other regulated entity, having a service contract in place to operate the proposed technical solution for the GB market.

Sections below set out our position, which has been influenced by our research and engagement with the industry, most prominently in discussions with the ENA LCT steering group held on Nov 16th, where representatives showed a strong preference for the AAR/CAR functions to be regulated. Networks when we engaged with them also noted a unanimous preference that the functions should not be something the DNOs were to maintain and operate.

[35] https://www.zap-map.com/electric-vehicles/ev-salary-sacrifice/

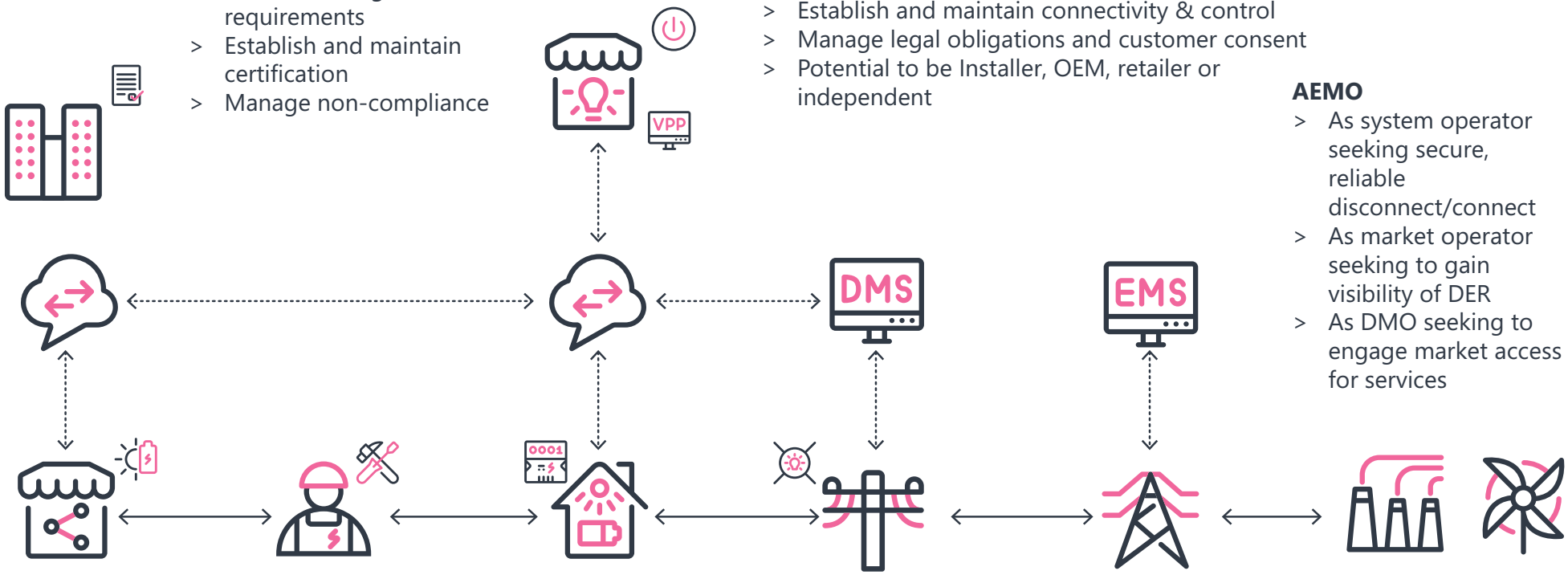
[36] Every new or upgraded exporting generation system from Sept. 2022 must have a Relevant Agent and be capable of being remotely disconnected and reconnected by the Relevant Agent. From July 2023, under SA Government Dynamic Export Limits, all exporting generation systems need to comply with the Office of Technical Regulator's remote updating methods and export limiting methods guidelines.

[37] The Relevant Agent is a party who has been authorised and/or appointed by the owner or operator of the prescribed electricity generating plant by written authorisation to manage the above requirement on their behalf. The Relevant Agent framework has been designed to enable the Australian Energy Market Operator (AEMO) and State Government to reduce the risk of major blackouts, under certain rare circumstances, by monitoring and maintaining safe levels of solar PV generation.

Office of the Technical Regulator (OTR)
> Provide rules/guidelines for requirements
> Establish and maintain certification
> Manage non-compliance

Agent/VPP Operator
> Provide remote connect/disconnect capability service to SAPN, AEMO, SA Minister
> Establish and maintain connectivity & control
> Manage legal obligations and customer consent
> Potential to be Installer, OEM, retailer or independent

AEMO
> As system operator seeking secure, reliable disconnect/connect
> As market operator seeking to gain visibility of DER
> As DMO seeking to engage market access for services



Tech Vendor
> Req. for compliance
> Installer standards
> Device ID validation

Installer
> Req. for connection
> Customer interface
> Consent/Device ID collection/ submission

Customer
> Obligation for connection
> Benefit from simplicity/value add

SAPN
> As DSO seeking greater visibility
> As DSO seeking to implement Dynamic Export Limits

Figure 9: Australian cost recovery journey example

4.3.1. Clear organisational framework

Any organisation who manages the LCT Connect solution on behalf of the sector should have a clear legal/regulatory framework for doing so. This would still need to be the case for a for profit solution, given the need to effectively incentivise installers and other organisations to engage with the service. Given our understanding of existing codes and licenses, we could envisage, that in a directly regulated scenario, the DCC taking on the role of operator of the LCT Connect solution, with modifications of the SEC and REC (and potentially the DCC Licence) possible to enable that to occur. The DCC Licence provides certainty that services are resilient to any financial difficulties, with robust contingency plans in place.

The DCC have developed security processes and systems which are deployed by hundreds of organisations, underpin thousands of device combinations and billions of message transactions. Similarly, their finance operations and processes facilitate complex cost recovery across multiple industry programmes and customers (energy retailers, other DCC users). Re-using mature technology and capabilities that have already been paid for will deliver further financial savings for the industry and consumers. This approach would reduce the need to create new entities and regulatory instruments to enable the solution to be embedded in the industry. Given the technical specifications of the solution as discussed later, we expect that whoever is running the service will need to be party to the SEC, which is estimated to be easily an 18-month process to complete.

An alternative to the DCC operator could be using a wholly code-based model where there is an obligation on a code body to procure the AAR/ CAR service on behalf of code parties. This would mirror the SSES consultation that proposed either the licensing DCC to provide services or placing it solely within a code.

In the instance where the LCT Connect solution is not embedded in regulation in some capacity, other mechanisms for ensuring compliance will be required. Otherwise, there is material risk that without some sort of regulatory obligation to comply with the service, value opportunities will not be realised. Similarly, statutory, or financial mechanisms to ensure installer compliance with the service may be required in addition to the convenience of a tech led solution.

4.3.2. Cost recovery mechanisms

Previous attempts at bringing a solution to market have consistently been fraught with financial challenges. Given the GB energy landscape is broadly a tightly regulated space, with specific provisions for monopoly services to have clearly defined roles, objectives, SLAs and cost recovery routes, a clear pathway will be required to develop as part of a Phase Two of any implementation plan for the functions being built as part of the AAR solution.

Funding mechanisms will need to be resolved for the following:

- Automatic Asset Registration (AAR),
- Central Asset Register (CAR), and
- (possibly) LCT Value-Add Services.

There are a few options for funding in the GB energy system. The overall proposed scope of the cost recovery should be sourced by a combination of OEMs, DNOs and DSRSPs, with additional scope for use case cost recovery for other activities. GreenSync's experience in Australia and the work conducted through this feasibility identified that those who extract market value or other in-kind benefits from the proposed solution should have some route to pay for the service. Given the use cases developed and feedback received from stakeholders, the following sections sets out the options for funding routes in more detail, with Table 4 and Table 5 below laying out our aggregate view on cost recovery. For clarity, Table 4 "regulated system" is an in-theory future state

where there are regulatory requirements for the company type to engage with the service.

This regulated cost recovery route works with the software solution (LCT Connect) being managed within an existing regulated entity such as the DCC, with GreenSync as technology provider. Alternatively, Table 5 shows where GreenSync could operate the service as a for profit service in the sector without the direct oversight specific regulatory requirements would bring, like their implementation in Australia.

GreenSync has commercial service agreements in place with many DNOs, retailers and global inverter OEMs in the Australian market for the provision of registration, visibility, and control services for DER. These broadly fall into two categories: - mandatory compliance services- discretionary flexibility services.

Compliance services have initially driven the scaling of registration of LCTs in the Australian market due to the critical system risks posed by the uptake of rooftop solar. However, with these core 'emergency backstop' measures in place, looking forward it is expected that discretionary flexibility services (including customer optimisation and market-driven flexibility services) will see the greatest utilisation of the deX Platform over time. We anticipate that the UK's more mature market structures for flexibility services will see rapid utilisation of LCTs registered via AAR by DNOs, retailers and DSRSPs, providing a pathway to cost recovery. Where the AAR is enabling compliance services, a pathway also exists to recovery costs via global OEMs in a comparable manner to Australia.

Funding route	AAR	CAR	VAS
Requirements set on OEMs			
Requirements on Installers			
Recovery via DNOs			
Recovery via DSRSPs			
Recovery via Retailers			
Use Case Cost Recovery			

Table 4: Options for funding for each component. Traffic light system indicates assessment on current willingness to pay in a regulated system.

Funding route	AAR	CAR	VAS
Requirements set on OEMs			
Requirements on Installers			
Recovery via DNOs			
Recovery via DSRSPs			
Recovery via Retailers			
Use Case Cost Recovery			

Table 5: Options for funding for each component. Traffic light system indicates assessment on current willingness to pay in a free market system.

Within the context of what is displayed on Table 4 and Table 5, as well as the preceding paragraph, we believe that while a free-market proposition is viable as demonstrated by deX's implementation in other worldwide jurisdictions, there is a strong preference from market players to see this solution to be tied into some sort of policy or regulatory mechanism. The following sections discuss how each market participant set out in the table may interact with the cost recovery.

4.3.2.1. Requirements set on OEMs

Recovering costs directly from manufacturers is a potential funding route, through a levy or tax scheme that can be implemented by HMRC or BEIS on smart devices. In addition to the costs associated with adopting PAS 1878 embedded into the device costs, additional levies on device sales would likely directly correlate to consumers lower uptake of smart devices. If this option were to be taken, a cost benefit against the negative impacts to consumer uptake should be undertaken by BEIS. Our engagements with OEMs suggest they may only consider the registration of the asset solution to be a fair cost stack for their business to take on. This would limit the ability to raise revenue from OEMs. Depending on implementation could create uneven distribution of financing to the AAR solution if it were example tied to units sold. This route also then ties the funding directly to the performance of the LCT market in GB.

On balance however, the costs of managing and registering assets should be recovered at point of sale as they may never participate in flex markets (with opportunities to generate revenue via that route therefore lost). There is work to be done to determine how much this should cost and what proportion of the overall cost of the entire LCT Connect solution this should be.

Where the solution is not regulated, commercial arrangements would be fostered between GreenSync and the OEMs directly for the services that can be provided.

4.3.2.2. Requirements on installers

Installers are going to be the initial point of interface between a device and the LCT Connect solution. Working on behalf of a customer, an installer will interface with the AAR using an installation pathway which interlocks with existing industry practices such as the network connection process. Some, but not all, of these installation pathways incur a cost that is to be paid to the DNO to facilitate the LCT to be connected. In either a market driven or regulated space, this pathway could be used to enable a value flow between installer and the LCT Connect platform, via the DNO's existing financial flows for connection as an intermediary. Of note, companies such as EV-Comply have created subscription-based models for installers to help reduce the burden of paperwork in completing certain types of LCT installations in the GB market. Given our proposed partnership with EV-Comply in Phase Two, investigation into using this value flow to recover costs for the LCT Connect solution could also be utilised.

Broadly, installers noted that reducing their administrative burden to comply with existing and future regulations is a service they would and do pay for, so tying part of the LCT Connect value proposition into that approach would be beneficial.

4.3.2.3. Cost recovery via DNOs

Costs could be applied to DNOs for the facilitation of flexibility systems, particularly as each of the CAR, and AAR components would be core data assets to be utilised by the DNOs. For example, the flexibility market provisions that are enabled by the solution serve the network as direct enabler of network constraint and management. Given the current emerging landscape for flexibility is focussing on price signal responsiveness, consumer choice and targeting reduced costs and emissions for consumers, it is unlikely that a DNO centred provision for domestic

flexibility would be the preferred market response overall. However, the DNOs, and wider users of the energy system are going to be the primary beneficiaries of the flexibility provided. Either in a regulated or free market system approach, DNOs are likely to be paying a portion of the LCT Connect solutions costs, which would pass some costs across all energy consumers, regardless of their ownership of LCTs. Given LCTs are likely to be a critical component of our future energy sector, the argument can be made that this could be primarily a network borne cost regardless of if networks are mandated to pay for it or not.

Networks flexibility primarily revolves around five flexibility market types, not all of which domestic flexibility will be able to respond to, due to technical limitations, geographical constraints, and other factors. With the ED2 final determinations due in December 2022, the window for the creation of a regulated type of cost recovery in the immediate future has passed. It could however be considered via the data and digitalisation reopeners due in year three of the ED2 price control, January 2026[38], or earlier if Ofgem consider "There has been a material shift in the roles and responsibilities of the licensee due to a change in legislation, licences, or industry codes, and as a result there is a requirement for the licensee to provide new, or significantly altered, digital or data services". If a route to regulated cost recovery was decided upon, it appears likely that the DNOs would be the obvious route – though, in the interim the LCT Connect programme is confident that DNOs have a willingness to pay for the service as noted in Table 4 and Table 5.

4.3.2.4. Cost recovery via DSRSPs

The SSES consultation proposes that DSRSPs will be licenced by Ofgem in future, introducing a new set of regulations. This will provide a greenfield opportunity to insert regulation to recover costs for both the AAR and CAR solutions, in addition to any LCT Value-Add services they benefit from. As DSRSPs, these providers will require a low cost, reliable and consistent mechanism to interact with devices directly, to send commands and receive telemetry data. While some established participants will have their own solution working, a new marketplace can be enabled by utilising the CAR. From a whole market perspective, enabling a new approach to gain insight via LCT Connect would reduce risk of vendor lock in by those organisations with embedded solutions, and allow other market participants opportunity to gain customers from existing companies, making customers less "sticky" and promoting a competitive market.

Therefore, socialising costs, possibly by market share across licensees, may be a useful way to ensure continued operation of the system and that larger players in effect pay to help smaller players enter the market, acting as one mechanism against monopolistic positions developing. Using an approach, the SEC takes could be prudent here, where it sets costs by charging its users by number of messages set across the network, or by market share. As the SSES programme develops, maintaining close ties and developing a proposition for the proposed LCT Connect solution should enable government to enable a market for DSRSPs.

Where the solution is not regulated, commercial arrangements would be fostered between GreenSync and DSRSPs directly for the services that can be provided. We would consider these most likely to fall into the 'value-add' element of the "LCT Value-Add services" provision as set out in Table 4 and Table 5.

[38] https://www.ofgem.gov.uk/sites/default/files/2022-06/RIIO-ED2%20Draft%20Determinations%20Core%20Methodology.pdf

4.3.2.5. Cost recovery via retailers

Like the route described above for DSRSPs, this option facilitates a cost recovery using the supplier licence conditions (SLCs) that point to them being required to follow the SEC. This means that if cost recovery mechanisms were included in the SEC, changes to SLCs may not be required. Given that not all retailers may become DSRSPs, nor use the flexibility provisions of their customers devices, there may be some pushback in industry from using this mechanism. However, given the retailer is the point of contact for consumers engaging in this industry, it isn't out with the realm of possibility that retailers would accept paying for part of the provision of these services if they can integrate with the provision on behalf of their customers.

Those retailers may prefer to use existing legal frameworks of the SLCs, in addition to existing code governance mechanisms to reduce legal overhead. Where the solution is not regulated, commercial arrangements would be fostered between GreenSync and retailers directly for the services that can be provided.

4.3.2.6. Cost recovery for value-add services

Outside the boundaries of regulated cost recovery activities there will be wider use cases, such as use of data by fire services, private enterprises, or other regulated parties of the energy sector. It's proposed that beyond the core use cases and cost recovery methods proposed, allowances are made for additional products and services to be built by the overall solution provider, financed in part by the regulated cost stack, and supplemented by a use case driven pricing model. Though it should be noted some services may be deemed a public good and therefore costs are socialised across the service to facilitate that (fire services being an example of users needing access who should not necessarily have to pay).

Monetising value-add services can drive iterative development of the capabilities of the organisation(s) managing the services. Like examples above, this would comprise of a core business model for GreenSync in the event of progressing without a regulated cost recovery route.

4.4. Deployment

The deployment of LCT Connect can be looked at from several perspectives based on the desired outcomes of the solution. These are outlined below.

4.4.1. Key considerations

To deploy the LCT Connect solution in the GB market the following steps will be required:

- A contract with a **cloud service provider** will be needed to allow for the application and the data to be hosted. This will be an effective base from which to scale up as the original data requirement can be small to start with and increase as more assets come into the LCT Connect platform. The choice of provider must align with privacy and cyber security requirements.
- **OEMs** will need to be onboarded before any automatic registration can occur which allows for the asset data to be verified:
    - This should be as broad a sweep as possible of OEMs if this is a regulated requirement to use LCT Connect. However, there will be a need for this to be an on-going integration process since OEMs will come and go across the lifecycle of LCT Connect.
    - Through GreenSync's experience in Australia, it is understood that it is critical to LCT Connect's success to have OEMs onboarded. Also, the value to OEMs for onboarding is small, the initial integration should be offered as a free service to ensure as much uptake from OEMs as possible. The cost for integration can then be recovered through other

value-add services such flexibility through LCT data and control. A premium membership can then be offered to OEMs for access to realise greater value from data allowing, for example, improved customer profiling.

- **Installers** would need to be onboarded as a key part of delivering LCT since they are the likeliest stakeholder to perform the asset registration role.

4.4.2. Realising value

Contracts with stakeholders who have an interest in the data of new assets being installed (AAR functionality) will need to be established. This could include **accreditation bodies, grant providers and network and system operators.**

Additional contracts with stakeholders interested in the asset data for existing installed assets captured by LCT Connect (CAR functionality) will need to be established. This could include **DSRSPs, network and system operators, local authorities, installers and OEMs, retailers and aggregators, accreditation bodies and financial providers**.

4.4.3. Capturing existing assets

A decision must be made around whether existing assets which are already installed will be captured by LCT Connect. There will be value here in consolidating existing asset registers as current sources are disparate. There will be additional value in having these existing assets integrated into LCT Connect from the opportunity to enable those assets to benefit from the LCT Connect solution and passing of telemetry data across the platform. However, this will not be the same automatic process which would be facilitated by the AAR process and is unlikely to ever achieve the same level of accuracy as new assets connecting to the service. Through the process of desk-based research, stakeholder engagement and existing knowledge, several sources to populate the LCT register with existing and registered assets have been identified. Table 6 gives an assessment to their appropriateness for different LCTs.

	Heat Pumps	EV Chargers	Solar PV	Batteries	Comments
MCS Installation Database					Most comprehensive database of heat pumps and solar PV with capacities, location and equipment model data available. Up to 50kW for electricity generating systems and 45kW for heat generating systems (or up to 70kW for multiple heat products in one system). Battery storage installation data has started to be captured as well.
DNO Asset Databases					DNOs will hold information as to what assets are installed on their networks. However, notification rates are known to be incomplete (~40%) of installed assets.
EPC Register					EPC register will hold information around what technologies are installed at properties. The focus of EPCs is energy cost with information on heating, hot water, ventilation and lighting currently being captured.
Social Housing Decarbonisation Fund					Focus is on low carbon heating. However, some PV may be captured when a part of an appropriate fabric first approach[39].
Energy Company Obligations					Focus is on low carbon heating and insulation measures as well as microgeneration[40].
OZEV funded grant schemes					Electric Vehicle Homecharge Scheme (EVHS) and Domestic Recharging Scheme (DRS) database will hold applications for EV charger grants. However, this is a time limited grant and therefore will not be exhaustive.
Smart Meter Data Analysis					First pass to establish whether properties are exporting through smart meter data will uncover any generation which is not yet registered. Furthermore, detailed analysis and disaggregation of data could yield insights into more greater understanding of assets and use profiles (Source: the DCC).
OEMs' databases					OEMs will find value in owning a database of their installed assets. However, through conversations with stakeholders, we understand that the presence and completeness of these varies widely between OEMs.

Table 6: Potential sources for registering existing assets into LCT Connect

[39] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1114571/shdf-wave-2.1-competition-guidance.pdf
[40] https://www.ofgem.gov.uk/publications/eco3-measures-table

5. Future phases overview - implementing and piloting the solution

In accordance with the BEIS AAR/CAR programme, the technical implementation of the solution will be undertaken in Phase Two and intense real-world pilot testing in Phase Three. In order to deliver the pilot, ESC's Living Lab test facility and LCTs will be utilised. The Living Lab[41] with over 1,500 connected homes across England, Scotland and Wales has been established to design, market-test and launch innovative products such as AAR/ CAR. The Living Lab will enable us to effectively run near real-world testing of the AAR/ CAR solution in Phase Two, providing valuable insights for Phase Three as well as how AAR/ CAR will be perceived by the consumers who participate in this trial.

We are certain the commercial viability of LCT Connect can be assessed throughout the operation of this demonstrator and challenges addressed by improving system resilience before deploying at a nationwide level. We will, throughout both project phases, run extensive tests (from cyber penetration to stress and performance testing) to ensure the expected level of functionality is achieved and collect industry feedback to refine the processes and implementation of AAR/ CAR.

We intend to establish an 'Industry and Project Partner Panel (I&3P)' advisory group, comprised of industry leaders actively engaged in the LCT Connect Phases Two and Three and representatives from relevant governmental organisations. As the project goes life, we plan to keep the panel open and extend the offer for participation to other interested relevant parties.

The panel will have a standing mandate from the LCT Connect Steering Committee to advise on matters of technical, regulatory and operational significance for the successful implementation of AAR/CAR. It will enable open discussion and the multilateral exchange of information on the most relevant topics for AAR/CAR implementation in the UK market, including regulation and policy matters, core technical capabilities, organisation and oversight. This will allow us to engage early with energy market key decision makers and stay abreast of the latest policy changes that may impact AAR/CAR future deployment.

5.1. Test case approach

The solution will be deployed as a dedicated instance on a UK cloud infrastructure (Google Cloud Services) and tested according to a test protocol specified and defined during Phase Two.

As Phase Two is limited in time and resources, two test iterations focused on eight core test cases (indicated in Figure 10 and explained in detail below) will be scheduled for AAR and CAR with the possibility for all project partners to be present, witnessing the tests. The goal of these tests is to support the validation of the designed and developed solution in Phase Two, allowing for the early identification and resolution of potential issues, and provide enough time for documenting results and findings in preparation for Phase Three real-world testing.

In order to test the AAR/ CAR processes with as realistic as possible scenarios, we will test LCTs located in OEM labs and utilise real customer installed LCTs in ESC's Living Lab. The Living Lab today features 164 homes with Heat Pumps, 287 homes with Solar PV and 370 homes with both an EV and a charger. Phase Two will target homes with installed and connected LCTs of the participating OEMs.

[41] https://es.catapult.org.uk/tools-and-labs/living-lab/

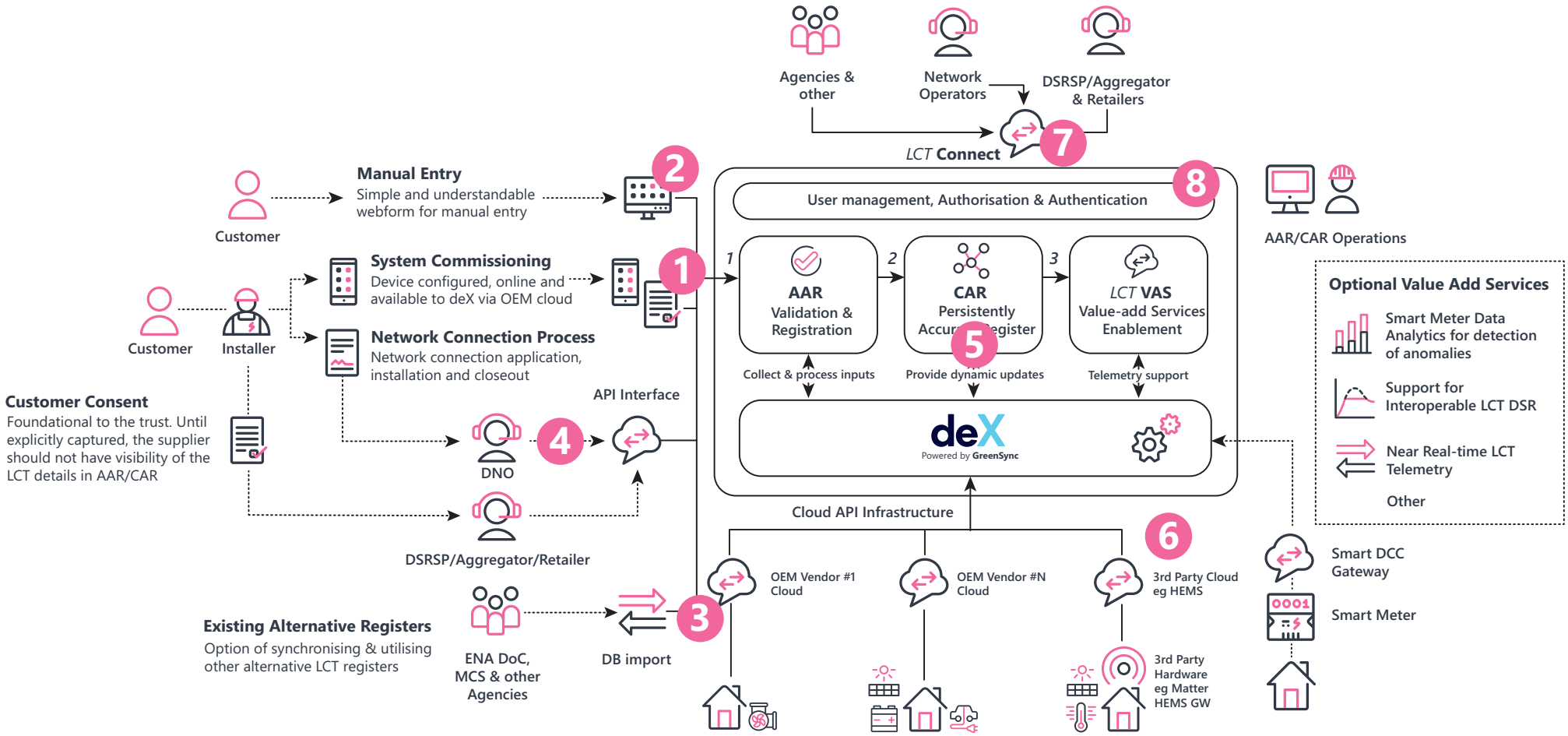


Figure 10: Eight corner test cases for Phase Two

Following is an overview of the proposed test cases as depicted in Figure 10.

1 Registration of an LCT

The test case will show how the end-to-end registration of a newly installed LCT, incl. collection, exchange and validation of both 'static' and 'dynamic' asset data. This covers two sub-test cases:

- New asset installed at an unknown MPAN; and
- Registration of a new LCT with a Customer/MPAN that has one or more LCTs already registered.

2 Registration of an existing, already installed LCT

The test case will show how also assets that have already been installed and possibly are not internet/OEM connected can be registered and classified with AAR/CAR.

3 Registration of an existing, already installed LCT - Other register import

The test case will demonstrate that assets already registered in alternative registers can be registered within the CAR via AAR.

4 Interaction with existing registers – data reconciliation

The test case will demonstrate how other existing registers can benefit from AAR/CAR 'dynamic' data. For this test case, UKPN will integrate to the AAR system to retrieve details on systems.

5 Change of registered LCT asset

The test case will demonstrate how CAR can be kept up to date with respect to three key scenarios:

- Change of ownership (Registered owner/Customer moves, selling the property including one or more registered LCTs);
- Change of LCT asset (Change or upgrade of a registered LCT asset); and
- Decommissioning of an LCT asset.

6 Registration of an asset through a HEMS system

The test case will demonstrate how a HEMS system can be used to trigger an automatic asset registration. GEO's latest Matter-based HEMS system will be utilised.

7 Enabling value-add services

The test case will demonstrate the platform's ability to deliver the performance and quality of telemetry needed to support local flexibility markets as well as the use of CAR data for other LCT technology research and analysis projects.

8 Authorisation, authentication and user data management

Data privacy and cyber security of the AAR/CAR is paramount. The test case will demonstrate GDPR rules are followed with regards to data privacy and cyber security. There is no sequence diagram for this test case as this functionality is implicit within and demonstrated through other test cases.

6. Conclusion

The energy landscape in GB is undergoing a digital transformation and the rapid uptake of smart LCT assets are significantly contributing to the changes underway. Every day that passes without an AAR or CAR solution embedded into installer practices and industry data flows is an opportunity missed for LCT assets to be used to their fullest in GB. Even at the most pessimistic LCT penetration rates; the AAR and CAR are critical to proactively managing the transition to net zero in a coordinated and orderly manner.

We are certain the implementation of the LCT Connect solution is technically feasible and are extremely confident in its future success. With a firm view on the GB context and the implementation pathways that are described in this document, as well as the well-established operation of deX in Australia, we see no foundational challenge that cannot be overcome by regulatory and policy changes alongside the LCT Connect proposition. In short, the solution is already proven to scale. Some changes are required, and Table 7 below sets out the recommendations and opportunities that are needed to either to be actioned or considered as the market for flexibility develops in GB in order to derive the full set of benefits the LCT Connect solution is able to provide.

A core question that needs to be resolved by BEIS and Ofgem, is through which route does an AAR/ CAR solution enter the market? For several reasons, such as cyber security, critical national infrastructure, technology implementation and others, this consortium is of the view that a regulated solution is preferred. While the cost recovery routes may not currently be completely clear, with further work required from colleagues in government on how to fairly recover costs associated with consumer benefits, the probability of building a solution that works for all stakeholders is high and we are confident that this will minimise the cost burden on consumers, regardless of the cost recovery route.

Further, having reviewed and discussed this proposition with other market participants, we are confident that the LCT Connect proposition is not reinventing the wheel, and will offer commercial, academic, and non-commercial benefits to a wide variety of stakeholders who will use data from the platform. This could either be as a trusted partner and permission-based user of LCT Connect, or a user of open data. Ultimately, the dynamic data the platform holds will enable users who have authorised and authenticated access to enter the market and develop new value for consumers.

It is our view that we have developed a complete and compelling solution for AAR and a CAR that provides the quickest and most secure pathway to realising a digital energy system and Net Zero targets. Furthermore, the LCT Connect solution will be delivered in a coordinated, standardised, low cost and scalable manner – ensuring the maximum benefits are delivered for all users.

With view of the plans set out for Phases Two and Three, along with the considerations and recommendations set out by this Phase One Feasibility Study, the deemed probability of success for the proposed solution is high. The mandating of the national AAR/ CAR solution through legislation or regulation would increase the probability. Our view is that the single biggest contributor to the long-term success of any asset registration solution, including LCT Connect, would be a provision that all LCT assets are required to be internet connected as set out in ID 2 within Table 7.

6.1. Recommendations and opportunities

For the solution to work at scale, the following recommendations need to be considered which have been identified thought the consultation and research of this Feasibility Study.

ID	Recommendation/Opportunity	Section of report	Action required from who?
1	Implement a compliance programme that monitors the outcomes of the SSES work using the tech stack and data from LCT Connect.	N/A	Of note for the SSES team at BEIS and policy support colleagues at Ofgem.
2	Internet connectivity of DSR devices will be critical to enabling a full registration process to work, as well as to enable new flexibility products and services to be deployed in GB.	2.3.4	BEIS to consider what levers it can use to ensure this. SSES team should be sighted.
3	The LCT Connect solution, in the long term, could enable a switching service between DSRSP providers with the data held and collected. Thought is needed by BEIS policy colleagues if this service is something that GB should be implementing.	3.5	BEIS to consider (SSES team in particular).
4	Some level of compliance is needed to get the AAR solution to work and scale. An obligation on installers may be the best route.	2.3.4	BEIS, Installers and OEMs to review what could be an industry led or policy first mechanism.
5	OEM warrantees should be tied into registration of the assets with DNO's/on the LCT Connect platform.	2.3.4	BEIS, DNOs and OEMs to review what could be an industry led or policy first mechanism.
6	Authorisation by default.	N/A	Require OEMs to obtain authorisation at the time of installation. Could be managed through same lever described in ID 8.
7	Don't delay. The longer the initiative is postponed the greater the number of assets that will be missed/lost.	N/A	deX as a working platform in Australia will help speed up the development and deployment at scale.

ID	Recommendation/Opportunity	Section of report	Action required from who?
8	Where possible, implement mandatory data fields, validation and requirements to engage.	N/A	Utilising levers granted in the energy bill could provide the requirement for OEMs to participate in the solution. Powers to create licenses can be used to mandate DSRSP's, too, if there were a good reason.
9	The DCC could be the operator of the LCT Connect solution – and use the SEC to provide appropriate governance.	4.3.1	DCC/Ofgem/BEIS teams to discuss. Smart Meter and Digitalisation teams in both DCC/Ofgem, as well as SSES team at BEIS will need visibility of conversations.
10	Australian market development experience suggests that benchmarking installers with data promotes higher quality installations. Consider implementing in GB.	N/A	BEIS to consider.
11	Explore options for securely sharing an open data set of aggregated asset data for use by innovators and researchers.	N/A	LCT Connect operator when in build/ rollout phases.
12	Hold structured knowledge sharing to foster focus and decision-making with the wider energy market space.	5	Phase Two proposal should have a structured knowledge sharing focus with relevant industry bodies. LCT Connect project proposes a I&3P to achieve this.
13	Continue conversation on the SSES consultation with BEIS/ Ofgem to identify overlap/ opportunities.	N/A	Awarded Phase Two project to work with SSES policy team during future phases. Share concepts to help BEIS/Ofgem on cybersecurity to extend/adapt the scope to help support the digital spine or other relevant initiatives.
14	A SoLR equivalent provision may be required for DSRSPs. Policy development works should consider LCT Connect as a potential enabler of that.	2.3.1 and 3.5	SSES policy team at BEIS.

Table 7: Recommendations and opportunities

6.2. A solution delivering substantial benefits to the UK energy market

The LCT Connect Feasibility Study sets out across the whole document a series of benefits. For the avoidance of doubt, an aggregated list of those benefits has been provided. These are not provided in a particular merit order and is a non-exhaustive view of all the benefits LCT Connect would provide to stakeholders.

ID	Benefit Type	Specific	Primary Benefit to whom	Secondary Benefits to whom
1	Data Availability	Permission based access to data that previously has not been available, such as providing essential data to fire services.	DNO's	Fire Service, DSRSP's, Local Authorities
2	Data Availability	Aggregated open data available for wider purposes.	Anyone	Anyone
3	Market Operation	New market propositions can be developed on top of the data services that LCT Connect can provide. Lowering barriers to market entry for DSRSP's.	Innovators	Consumers
4	Market Operation	Creating the ability for consumers to change service more easily between LCT providers.	Consumers	Innovators
5	Energy System	Supporting planning of DNO's as they develop the necessary physical and digital infrastructure to support the rollout of LCT assets.	DNO's	Consumers
6	Market Operation	The ability to use the CAR to communicate with assets, enabling telemetry data and change of status information to be updated.	DSRSP's	Consumers
7	LCT Uptake	Providing a simpler process to meet obligations of installers providing information to relevant organisations.	Installers	Regulators
8	Market Operation	Enabling a least cost compliance and VPP access (rather than a many to many relationships with DSRSPs and retailers).	OEM's	Consumers
9	Energy System	Delivering a consistent approach to registration, visibility, and control to meet planning and operational requirements.	DNOs	Local Authorities and other planning bodies
10	Market Operation	BYOD Flexibility Services offers at scale and allows customer registration and optionality participating in flexibility and trading platforms.	Retailers/ DSRSP's	Consumers

Table 8: Overview of benefits

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