Net Zero Terrace

Community Energy Management System Functional Specification Document

Network Innovation Allowance

Community Energy Management System (CEMS) Functional Specification Document

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Internal Use

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1. Purpose Context and Rationale

1.1 Purpose of this Document

The purpose of this document is to define, at a functional and system level, the role, responsibilities, boundaries, and interfaces of the Community Energy Management System (CEMS) within the Net Zero Terrace (NZT) Smart Local Energy System (SLES). It provides a specification to guide development, procurement, and integration as the project progresses from concept to implementation. By delineating the CEMS's responsibilities, this document establishes the technical requirements for a system that is scalable, resilient, and interoperable with the broader subsystems comprising the SLES.

1.2 Role of the Smart Local Energy Management System (SLES)

The SLES is a multi-layered system designed to decarbonise heat and power within the home, whilst promoting social equity. Within this structure, the CEMS provides coordination between high-level community strategies and home-level energy assets. It interfaces directly with the strategic directives of Fairer Share (FS) and distributes control signals to the Home Energy Management System (HEMS), which interprets these signals and manages the in-home assets to deliver the required energy response at the household level.

The work presented in this document has both drawn from and contributed to broader discussions on the SLES architecture. These iterative discussions have helped refine the architecture, while developing this specification has, in turn, highlighted ambiguities and areas for further clarification within the architecture. This document will also form the foundation of the CEMS Implementation Strategy, providing the specifications required to advance the CEMS from the conceptual architecture to a functional Minimum Viable Product (MVP).

1.2.1 High-Level Role of Subsystems

The current understanding of the SLES subsystems are as follows:

- **Fairer Share:** Acts as the high-level strategic 'brain' of the community energy scheme. It determines community-level scheduling and optimisation states to create maximum benefit for the community. It also runs value allocation algorithms that distribute energy costs and flexibility rewards based on household participation, vulnerability, and overall community system performance, ensuring households are treated fairly while maximising the community's overall financial and carbon savings. FS serves as the primary instructor, prioritising community-wide financial and carbon goals in line with these factors.

- **CEMS:** The central control and monitoring system. It ensures that home-level systems operate in a way that supports overall community objectives. CEMS collects household consumption data from the HEMS and aggregates it at the community level, generating a community profile by monitoring consumption patterns, analysing historical household data, and forecasting future energy use, exporting this data into a data storage system. It translates the high-level strategies from Fairer Share into actionable technical control signals for the HEMS units, performing simple calculations such as forecasting PV output.

- **Fairer Warmth (FW):** The platform that provides a user interface for household occupants to set comfort parameters, which the HEMS enforces to maintain household comfort levels. The platform also provides access to billing reports from Fairer Share and community-level statistics from the CEMS.

- **HEMS:** The operational controller of home-level energy assets. The HEMS manages the interface between the home-level assets and the CEMS, ensuring that community-level control signals do not violate household comfort or safety parameters. The HEMS completes simple optimisations at the in-home asset level to improve efficiency and reduce costs within the household.

- **Data Store:** A secure, centralised repository that stores aggregated telemetry and signal logs from the CEMS. It supplies the data needed for Fairer Share to perform audits, verify flexibility events, and calculate final bills.

2. Development of the CEMS Functional Specification

The Community Energy Management System (CEMS) functional specification was developed through an iterative process designed to define the system's precise role within the broader SLES architecture. Given the CEMS's position as the key control and monitoring intermediary of the other subsystems, the specification has been refined through workshops and whole-system evaluations. This approach ensures technical feasibility and maintains strict alignment with the overarching SLES objectives. The following section details the approaches and resources used in this development process.

2.1 Associated SLES Requirements

The foundational requirements for the CEMS were derived from a review of the overarching functional and technical requirements of the SLES, listed in BHD1.7 NIA Requirements - Functional and technical V3 (See Section 5). These high-level objectives were then translated into their CEMS-specific roles, to establish overarching CEMS responsibilities that map to the relevant SLES requirements.

Whilst the CEMS serves multiple roles, the SLES requirements were identified as a CEMS responsibility if they fulfilled the following primary criteria:

- **Community Level Aggregation:** Any requirement involving the aggregation of data across multiple households, or the ingestion of external sources (e.g. Distribution Network Operator (DNO) signals).

- **Coordinated Response:** Requirements necessitating the distribution of control signals across the home level management systems (HEMS).

Through workshopping sessions, the team established the functional boundaries of the system; identifying roles that reside outside the CEMS scope, and apportioning these to other subsystems, as outlined in Section 1.2.1 High-Level Role of Subsystems. Key exclusions include:

- **Household Level Control Logic:** The internal physical management of assets (e.g. maintaining thermal setpoints, comfort parameters), which is reserved for the HEMS.

- **Direct User Engagement:** All tenant facing scheduling, notifications, and interactive preferences are managed via the Fairer Warmth (FW) platform.

- **Strategic Optimisation and Community Resource Allocation:** Decisions regarding high-level market participation, the financial allocation of resources, and the strategic response to external signals are handled by the Fairer Share (FS) subsystem.

2.2 Architecture Control Flows

The refinement of the CEMS functions was further informed by the Architecture Control Flows, which identify the exchange of data and control commands between key subsystems from a systems-engineering perspective.

By mapping these bidirectional flows, the CEMS's role was distilled from a broad list of general requirements into a focused set of monitoring and coordination functions. Crucially, this exercise allowed for the identification of essential technical exchanges required to pass through the CEMS, such as the ingestion of household telemetry, the routing of strategic signals from Fairer Share, and the dispatch of operational commands to the HEMS network, ensuring that the CEMS facilitates interoperability between the subsystems.

Note that all SLES deliverables are iterative and may remain subject to periodic updates as the native functionality and development roadmaps of each integrated subsystem mature throughout the project lifecycle.

2.3 Functional Use Case Mapping

Following the synthesis of the SLES requirements, workshop outcomes, and architecture control flows, a verification of the current CEMS functions was performed to ensure a coherent, systems-level approach. This involved mapping the consolidated functions against the original Level 1 and Level 2 SLES Functional Use cases from BHD1.7 NIA Requirements - Functional and technical V3 (See Section 5), depicted in Figure 1, to confirm that all functions remain aligned with the SLES's overarching strategic goals.

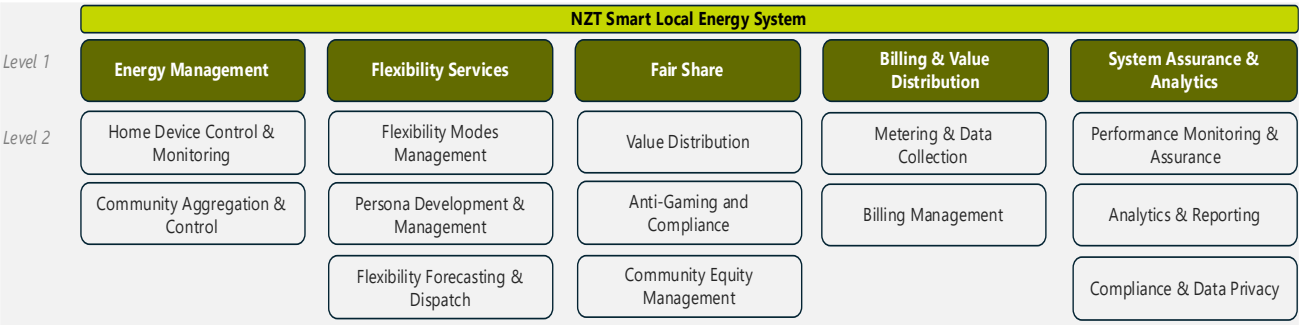


Figure 1 - Figure 1 SLES Functional Use Cases (developed by Buro Happold)

Building upon the Level 1 and Level 2 SLES frameworks, the relevant functional areas were expanded into a more granular Level 3. This stage provides a detailed breakdown of CEMS-specific technical functions, translating high-level system objectives into actionable, subsystem-level functional requirements for implementation.

This hierarchical structure ensures full traceability, allowing every technical feature developed for the CEMS to be mapped directly back to a primary SLES service. This provides an audit trail for system development, facilitating the verification of technical performance and ensuring that each function contributes to the broader SLES strategic goals.

2.3.1 SLES Functional Use Cases

The following high-level functions are taken from the overarching SLES Functional Requirements (Appendix A), representing the global objectives of the wider SLES ecosystem, as outlined in Table 1:

Table 1 - SLES Level 1 Functional Use Cases defined

Energy Management	Controls, monitors, and optimises energy use at home and community levels, ensuring comfort, efficiency, and resilience through smart device integration, and coordinates system operation.
Flexibility Services	Delivers dynamic energy flexibility and actively involves consumers and the community. This includes tailoring services to household needs and managing participation in flexibility events, while platforms like Fairer Warmth support engagement by enabling households to set personal preferences, better understand their participation, and view summaries of the benefits of engaging in flexibility services.
Fairer Share	Ensures equitable distribution of value and benefits across all households, maintaining fairness and transparency through algorithms, safeguards, and community equity mechanisms.
Billing & Value Distribution	Manages metering, billing, and financial transactions, supporting multi-tariff structures and integration with suppliers while ensuring accurate, transparent, and compliant processes.
System Assurance & Analytics	Monitors system health, performance, and compliance. Provides analytics and reporting for optimisation, supports continuous improvement, and ensures data privacy and regulatory alignment.

Table 2 highlights how the CEMS is expected to map to the Level 2 SLES Functional Use Cases.

Table 2 - Level 2 definitions of CEMS required responsibilities

Level 1	Level 2	Description of Function of the CEMS
Energy Management	*Home Device Control & Monitoring*	Serves as the primary interface between community-level requirements and home-level response. Monitors data from the HEMS in near real time and issues high-level control signals (e.g. requests to reduce energy consumption during peak periods), which are then interpreted and executed by the HEMS at the household level.
	Community Aggregation & Control	Aggregates individual HEMS data into a community level portfolio, enabling monitoring of overall energy consumption and performance. Transmits this aggregated information to a central data store for further processing and analysis. Translates community-level requirements from Fairer Share into distributed control signals for HEMS, enabling coordinated control strategies across multiple households.
Flexibility Services	*Flexibility Modes Management*	Receives defined community-level flexibility operating modes from Fairer Share, including requests for the community to increase or decrease energy consumption, and translates them into tailored control signals for HEMS, enabling switching between operating modes while respecting home-level user constraints enforced by each HEMS.
	Persona Development & Management	The CEMS receives high-level operating constraints from each HEMS and accounts for these when dispatching home-level control signals to meet community energy target states, however it does **not directly** develop or manage user personas. The CEMS also monitors user engagement with flexibility services, aggregates this into load profiles, and transmits the results to a central data store for Fairer Share to review; the CEMS therefore has an indirect role in accounting for user needs, but responsibility for meeting and managing personal needs resides within the HEMS.
	Flexibility Forecasting & Dispatch	Combines community load profiles with external data (e.g. weather) to support forecasting of available flexibility and transmits these forecasts to a central data store. Receives community-level flexibility requests from Fairer Share and translates them into home-level control signals for dispatch to the HEMS. Monitors the real-time execution of flexibility requests based on signals received from Fairer Share and corresponding responses from HEMS.

Fairer Share	*Value Distribution*	The CEMS communicates aggregated HEMS data and flexibility participation metrics to the central data store, enabling Fairer Share to review and allocate value to each home accordingly. However, it does **not directly** allocate or monitor value distribution; responsibility for this resides with Fairer Share.
	Anti-Gaming and Compliance	Monitors and analyses HEMS data to identify and flag behavioural inconsistencies, non-compliant activity, and potential artificial load shifting for downstream verification and review.
	Community Equity Management	The CEMS monitors and aggregates household participation patterns and transmits these metrics to the central data store, enabling Fairer Share to assess and calculate community equity. However, it does **not directly** manage community equity; responsibility for this resides with Fairer Share.
Billing & Value Distribution	*Metering & Data Collection*	Collects, validates, and processes metering data from HEMS, smart meters, and community assets, and transmits this data to the central data store. Ensures that metrics for each settlement period are complete, accurate, and prepared for downstream financial processing (in Fairer Share).
	Billing Management	The CEMS aggregates and supplies home-level and community-level load profiles that form the basis for billing calculations. However, it does **not directly** manage billing; responsibility for this resides with Fairer Share.
System Assurance & Analytics	*Performance Monitoring & Assurance*	Audits the feedback loop between a sent command and the actual HEMS response. Identifies underperforming assets or communication outages in real-time, initiating alerts or adjusting the community forecast accordingly.
	Analytics & Reporting	Records and monitors aggregated insights on energy usage, flexibility performance, financial outcomes, carbon impact, and community-level benefits. Transforms raw system data into high-level community performance metrics (e.g. total carbon saved, peak reduction, and community ROI), logging these in an auditable format. Generates and standardises aggregated metrics, events, and system logs to support downstream reporting, analytics, and external data sharing.
	Compliance & Data Privacy	Normalises and pseudonymises external datasets to support secure data processing and sharing. Monitors delivered system behaviour against DSO/feeder constraints and generates response datasets to support compliance monitoring, verification, and downstream analysis.

An additional layer of granularity, Level 3, was developed by the team and exists as a working document for future project phases. This can be seen as Table 3 in this document.

3 Functional Capabilities of the CEMS

The following section outlines the core functional capabilities required of the CEMS to meet the project's strategic goals. The primary purpose of defining these functionalities is to establish what the system must achieve at a functional level to ensure interoperability and performance, but without specifying the technical implementation required to deliver those functions.

3.1 Framework of Specification

The functional specification is organised in a clear format for developers and stakeholders to understand the system. The Functional Requirements table includes the following sections:

- **Function Title:** These are the main functions the CEMS must perform.
- **Associated SLES Requirements:** These are the SLES requirements that each individual function would be supporting.
- **MoSCoW Prioritisation:** To guide development and manage project scope, each feature is ranked using MoSCoW to determine their significance and relative importance when it comes to development:

- **Must have:** Essential features required for the first version (MVP)
- **Should have:** Important functions that add significant value but are not vital for initial deployment
- **Could have:** Desirable features that enhance the system but can be deferred if resources are constrained

Interacting System: This identifies the key interacting subsystem(s) within the CEMS function.

3.2 CEMS Functional Requirements Table

Table 3 - CEMS Functional Requirements (Level 3)

Level 1	Level 2	Level 3 ID	Function Title	Mapping CEMS Functions to Associated SLES Requirements	MoSCoW	Interacting System
Energy Management	Home Device Control & Monitoring	F1	Ingest & Monitor HEMS Level Operational and Metering Telemetry Data	R05, R07, R19, R20, R21, R53, R66, R67, R77	{m} Must-Have	HEMS
		F2	Handle HEMS Signal Acknowledgement	R51, R53	{m} Must-Have	HEMS
	Community Aggregation & Control	F3	Ingest & Normalise External System and Market Signals	R26, R39, R40, R41, R51	{m} Must-Have	Internal CEMS, DSO, NESO, Tariff Source
		F4	Aggregate Community Telemetry from HEMS	R05, R13, R21, R39, R41, R51, R62	{m} Must-Have	Internal CEMS
		F5	Generate Household Control Signals to Meet Community Targets	R08, R13, R26, R29, R42, R51	{m} Must-Have	Internal CEMS, HEMS
		F6	Transmit Household Control Signals to HEMS & Log	R08, R13, R18, R26, R35, R40, R41, R42, R51, R53, R77	{m} Must-Have	HEMS
Flexibility Services	Flexibility Modes Management	F7	Calculate Available Household and Community Flexibility Envelope	R13, R19, R20, R21, R39, R40	{m} Must-Have	Internal CEMS, HEMS
	Persona Development & Management	F8	Generate & Update Household Load Profiles	R04, R23, R61	{s} Should-Have	HEMS
	Flexibility Forecasting & Dispatch	F9	Ingest Weather and Irradiance Forecast Data	R08, R60	{m} Must-Have	Weather Data Provider
		F10	Calculate Household-Level Load Forecasts	R40, R51, R61	{m} Must-Have	Fairer Warmth, HEMS
		F11	Forecast Community Energy State & Required Dispatch	R08, R13, R19, R20, R26, R40, R60	{m} Must-Have	Internal CEMS, HEMS
Fairer Share	Value Distribution	F12	Monitor & Share Household Usage and Engagement Data to	R02, R05, R13, R21, R42, R43, R45	{m} Must-Have	HEMS, Fairer Share, Data Store

			Fairer Share (via data store) for Value Distribution			
	Anti-Gaming and Compliance	**F13**	**Monitor Community Behaviour & Flag Potentially Non-Compliant or Abnormal Activity**	R44, R45, R48	{m} Must-Have	HEMS, Internal CEMS
	Community Equity Management	**F14**	**Monitor & Share Household Participation and Flexibility Data for Community Equity Assessment**	R02, R21, R43, R45	{m} Must-Have	HEMS, Fairer Share, Data Store
Billing & Value Distribution	Metering & Data Collection	**F15**	**Compile and Transmit Metering Data for Settlement, Proof & Compliance Datasets**	R02, R05, R20, R21, R39, R41, R43	{m} Must-Have	Fairer Share, DSO
	Billing Management	**F16**	**Compile & Transmit Household and Community Load Profiles for Billing**	R02, R05, R21, R52	{m} Must-Have	Fairer Share, Data Store
System Assurance & Analytics	Performance Monitoring & Assurance	**F17**	**Community Level Health Monitoring & Maintenance Escalation**	R28, R51, R59	{s} Should-Have	HEMS, External Service/Governance Interface, Data Store
		F18	**Retry & Escalate Failed Control Signal Transmission**	R70	{m} Must-Have	HEMS
		F19	**Generate Benchmarking and Comparative Performance Metrics**	R62	{c} Could Have	Internal CEMS
		F20	**Monitor & Evaluate Forecast Performance**	R08, R19, R20, R26, R40, R60, R62	{m} Must-Have	Internal CEMS, Governance Interface, Data Store
		F21	**Monitor & Evaluate Flexibility Performance**	R41	{s} Should-Have	Internal CEMS, Data Store
		F22	**System Resilience & Recovery Coordination in the Event of Disconnection / Power Outage**	R51, R70	{s} Should-Have	Internal CEMS, HEMS
	Analytics & Reporting	**F23**	**Store Issued Signals & HEMS Responses**	R43, R51	{m} Must-Have	HEMS, Internal CEMS, Data Store
		F24	**Aggregate & Store Telemetry and Operational Data in Community Historian**	R02, R05, R07, R08, R19, R20, R21, R39, R41, R43, R62	{m} Must-Have	Internal CEMS, Data Store
	Compliance & Data Privacy	**F25**	**Normalise & Pseudonymise External Datasets**	R02, R21, R39, R41, R54, R65	{m} Must-Have	Internal CEMS
		F26	**Monitor Delivered System Behaviour Against DSO / Feeder Constraint & Generate Response Dataset**	R26, R39, R40, R41	{m} Must-Have	HEMS, Internal CEMS, DSO, NESO

4 Future Development

The system architecture is anticipated to evolve iteratively as our understanding of the subsystems and their capabilities matures. This section identifies the areas where further functional definitions are required, based on our current understanding of the CEMS, to facilitate the transition from the design phase to full operational deployment.

It should be noted that additional developments may arise during the system design iterations, and these will be continuously monitored. This section will inform the upcoming CEMS Implementation Strategy deliverable.

4.1 The Minimum Viable Product (MVP) Implementation

To achieve a functional MVP, the CEMS must transition from a theoretical design to a fully deployed operational system. This will require further consideration in the following areas:

- **Operational Reality**: The MVP of the CEMS must be capable of receiving control target states and dispatching corresponding control signals to the HEMS to implement the required actions.
- **Procurement**: The CEMS will need to be either constructed using an existing product, such as a cloud-based SCADA or aggregator platform, or it will need to be largely developed in-house if existing solutions do not meet the specific requirements of the CEMS.
- **Data Processing Boundaries**: For the MVP, it is currently assumed that most data processing will be handled by the Data Store and Fairer Share. The CEMS will perform basic checks, validation, timestamping, aggregation, and preliminary data analytics. Further clarification is needed regarding where data will be anonymised to comply with privacy and security standards.

4.2 Subsystem Interoperability

The interaction between the CEMS and its neighbouring subsystems must ensure reliable data and control flow while meeting security and scalability requirements.

A key consideration is whether Fairer Share will pull all data from the Data Store, rather than directly from the CEMS, in order to maintain an auditable trail. This approach would ensure that all financial calculations are based on recorded data, rather than live data in transit. It needs to be clarified whether this applies to all data or if exceptions will be made.

4.3 Assumed Functionality of the CEMS

It is assumed that the HEMS will handle asset optimisation, while Fairer Share will manage community-level target states. The boundaries of these roles will require further refinement as each subsystem is better understood, particularly to clarify the role of the CEMS function in coordinating between them.

5 Referenced Documents

Table 4 outlines a list of internal documentation associated to the CEMS functional specification stored within the NZT NIA Collaboration Area. Each document has been assigned a unique document ID to support reference, version control, and tracking. Where relevant, these documents may have been cited throughout this report. Any referenced documents have been provided on the external project portal or included within Appendices.

Table 4 - List of Key Internal Project Documents

Document Ref	Document Title	Description
BHD1.7	**NIA Requirements - Functional and technical V3**	Defines the high-level system requirements of the wider SLES architecture.

The key requirements table from BH D1.7 is included in the appendices of this document.

Appendices

A. NIA Requirements - Functional and technical V3 (BH D1.7)

Below, the SLES requirements table from BH D1.7 has been attached below.

Table 5 - List of SLES Functional Requirements

Functional Requirements		
Requirement Number	**Requirement Detail**	**MoSCoW Rating**
R01	The system shall automatically schedule heating (on a room-by-room basis) and hot water so that, by a user-specified time, the home reaches a user-defined comfort temperature and sufficient hot water is available, while optimising for the lowest available tariff and staying within user-set affordability limits.	Must Have
R02	The system shall calculate and distribute the value of community-generated renewable energy, low-tariff energy, and balancing/flexibility payments fairly across all participating households, in order to ensure transparent and auditable allocation.	Must Have
R03	The system shall allow residents to override the default thermal comfort settings based on lifestyle profiles, with clear notification that overriding may increase energy consumption and costs.	Must Have
R04	The system shall measure hot water cylinder levels and provide a user interface (via FW) for residents to set their desired hot water levels. It shall provide a set of default thermal comfort settings and lifestyle profiles, allowing residents to select or adjust profiles based on their needs.	Should Have
R05	The system shall submeter individual household consumption and aggregate bulk purchase generation, enabling accurate community billing and fair allocation of energy costs.	Must Have
R06	The system shall monitor indoor air quality and provide real-time feedback through an interface. When air quality falls below acceptable levels, it shall alert the user and recommend natural or mechanical ventilation. If all windows are closed, the system shall offer the option to activate mechanical ventilation to restore healthy conditions.	Will not have
R07	The system shall provide users with real-time and historical energy consumption data, including breakdowns by thermal and power service ites (ie: hot water, heating, small power) and time period, in order to support energy-saving behaviours.	Should Have
R08	The system shall maximise self-consumption from a control perspective, for benefit of community rather than household, of on-site solar generation by scheduling flexible loads (hot water cylinder, GSHP, battery) to coincide with periods of high solar output. This is subject to permission from the CEMS (which evaluates the community need)	Must Have
R10	The system shall allow users to set a threshold tariff value, so that specified appliances will only operate when the energy price is at or below the user-defined threshold.	Will not have
R11	The system shall allow users to set a deadline for appliance operation, ensuring the appliance completes its function before the specified time, while optimising to use the lowest available energy tariff.	Will not have
R12	The system shall provide bill management features that assure users their energy bills will remain within affordability limits, using low-cost energy where possible. Users should receive a paper bill if requested	Must Have
R13	The system shall prioritise rooftop solar as the primary generation source for household energy consumption.	Must Have
R15	The system shall provide a user-friendly interface for integrating and controlling smart appliances via HEMS switches or interfaces.	Will not have
R16	The system shall require installation of limit switches on doors and windows, generating alerts if they are left open and impact heating/cooling efficiency.	Could Have

R17	The system shall communicate with TRVs to enable room-level heating control.	Must Have
R18	The system shall enable authorised users or automated control logic to instruct and set the operational mode of the BESS	Should Have
R19	The system shall meter and record the electrical energy generated by the BESS and/or rooftop photovoltaic installations, providing real-time and historical data for energy management, billing, and reporting purposes, not supplied to user via fairer warmth	Should Have
R20	The system shall continuously meter and record the amount of electrical energy charged into the BESS, ensuring precise tracking for operational optimisation, billing, and system performance analysis.	Should Have
R21	The system shall submeter individual home consumption, flexibility provision, and generation, and apportion bill subsidies or use charges to provide a net bill to the community.	Must Have
R23	The system shall establish affordability criteria and match them against comfort requirements and energy consumption, providing user feedback and analytics.	Must Have
R24	The system shall communicate with smart sockets and outlets to enable scheduled switching on/off of appliances.	Will not have
R26	The system shall couple generation with demand in voltage-restricted areas to minimise curtailment from inverters.	Could Have
R27	The system shall support operation for a defined time period in the event that the homeowner WiFi fails (assuming homeowner WiFi is utilised for HEMS communications), ensuring all core HEMS functions are available in the instance of a WiFi failure.	Should Have
R28	The system shall monitor the heat pump, hot water cylinder, battery and inverter and anomalies and alert the relevant personnel to trigger maintainance activities.	Should Have
R29	The system shall automatically shift operation of flexible appliances to off-peak hours to support grid stability and reduce strain.	Will not have
R31	The system shall provide personalised energy tips based on real-time data to help users optimise energy consumption.	Could Have
R32	The system shall identify and minimise vampire loads from devices in standby, prompting users or using smart plugs to cut power.	Will not have
R33	The system shall provide predictive billing and prepayment options for users accustomed to pre-payment meters.	Could Have
R34	The system shall allow users to schedule holiday periods when they are away from home, adjusting energy usage accordingly.	Could Have
R35	The system shall communicate with smart appliance interfaces, outlets, and solar inverters to perform high-energy functions when solar production is high. (Over and above the functions described in the current Must Have applicance interfacing to be considered as a demand management process for controlling devices to consume when instructed by HEMS)	Will not have
R39	The system shall manage voltage constraints on the local network as set by the DSO, including inhibiting generation when necessary and optimising demand to mitigate voltage rise or export during voltage drop. A metering system at the CEMS level shall monitor overall generation and demand to verify compliance with voltage limits. The architecture shall include mechanisms for DSO payment for voltage management services.	Must Have
R40	The system shall implement thermal control in areas where thermal capacity is limited by the DSO, managing load within firm constraints set at feeder, secondary, or primary substation levels. The CEMS shall determine and monitor these constraints, and the system shall optimise heating loads and diversity without compromising user comfort.	Must Have
R41	The system shall respond to national balancing signals from the NESO, enabling participation in balancing markets and providing revenue streams to consumers. The system shall support submetering to measure flexibility delivered and enable payments to households or via the CEMS for balancing services, including “turn down” demand events with metered proof.	Must Have

R42	The system shall optimise energy consumption and storage based on a prioritisation stack: (1) home comfort, (2) community savings, and (3) storage (hot water, then battery). Tariff response shall prioritise on-roof PV, followed by local community energy managed by PPA via CEMS, and then agile tariffs. The system shall allocate energy to heating, hot water, and storage according to this stack.	Must Have
R43	The system architecture shall include provisions for receiving payments from the DSO for voltage management services and from NESO for national balancing services, ensuring transparent and auditable allocation to participating households.	Must Have
R44	The system shall be scalable, ethical, fair, resilient, value-driven, accessible, and compliant with all relevant regulations, standards, and policies.	Must Have
R45	The system shall ensure equity and value for all community members, calculating value delivered and distributing it fairly at all system levels, regardless of individual asset ownership or usage patterns.	Must Have
R46	The system architecture shall be flexible to accommodate changes in commercial and distribution models, supporting multiple energy market structures and futureproofing for evolving requirements.	Should Have
R48	The system shall implement anti-gaming mechanisms, using analytics and user pattern recognition to prevent manipulation of the Fair Share system for individual benefit at the expense of the community.	Should Have
R49	The system shall develop and maintain persona-based profiles for each household, adapting services and comfort parameters to changing occupant needs, behaviours, and community transitions.	Should Have
R50	The HEMS shall maintain a local historian to store metering and operational data during CEMS connection loss, transferring data upon reconnection to ensure continuity and resilience.	Should Have
R51	The system shall optimise community diversity by controlling heat pumps and other flexible loads to reduce peak demand, support black start recovery, and enhance aggregated flexibility within DSO constraints.	Should Have
R52	The billing system shall support multiple billing options, including standing charges for net zero asset recovery, energy supplier charges, and local energy tariffs, and shall be compatible with smart metering.	Must Have
R53	The system shall integrate to enable two-way communication, real-time data collection, and efficient energy management at all levels.	Should Have
R54	All analytics and data collection shall comply with GDPR and privacy regulations, with clear privacy notices and permissions for data use at home, community, and regional levels.	Must Have
R56	The system shall ensure cyber security, protecting user data and system operations from unauthorised access, cyber threats, and data breaches, in compliance with relevant standards.	Must Have
R57	The system hardware and software shall be CE approved, meeting all relevant safety and regulatory standards for installation and operation in homes.	Must Have
R58	The system shall use an open architecture, enabling integration with third-party systems for data exchange, control, and monitoring, and avoiding proprietary “black box” solutions.	Must Have
R59	The system shall provide robust service and support, including software upgrades, fault finding, warranty provision, and user helpdesk access.	Must Have
R60	The system shall integrate weather data to optimise battery storage and rooftop PV operation, improving energy management and cost efficiency.	Could Have
R61	The system shall support building physics models to analyse heat flows, temperature gradients, and building performance, providing actionable insights for energy management.	Will not have
R62	The system shall provide an aggregating platform to develop insights and analyse performance across multiple HEMS units, supporting benchmarking and optimisation.	Could Have

R65	Data generated by HEMS, CEMS, and all associated devices must not be owned by any corporate entity. Ownership always remains with the community or individual end-users. Users must be able to access, correct, and request deletion of their data at any time. No corporate entity may claim, store, or process data beyond what is strictly necessary for system operation, and only with explicit community/user consent.	Must Have
R66	All device integration and communication within the home and with the HEMS must follow local-polling or local-push IoT classification, as defined by the Home Assistant community. No reliance on cloud or external services for core functions	Must Have
R67	The system must communicate via either MQTT or REST API. CEMS to third-party platforms must use REST API. All APIs must use secure authentication (OAuth 2.0, API keys) and encrypted transport (TLS 1.2+).	Must Have
R69	The system must support local autonomous operation if internet or CEMS connectivity is lost. In case of communication failure, the system must default to a safe, energy-efficient mode that maintains occupant comfort and safety. Manual override must be available for critical functions.	Must Have
R70	Critical system components must have redundancy or backup options where feasible. The system should target >99% availability for core functions. Automatic recovery procedures must be defined for power or network outages.	Will not have
R74	The system and all connected devices must support secure, authenticated over-the-air (OTA) updates. Safe rollback procedures must be available in case of update failure.	Must Have
R75	Devices must be installed in secure locations and be tamper-resistant. Regular physical inspections must be part of maintenance.	Must Have
R76	All user interfaces (including apps, web portals, and physical controls) must be accessible to users with disabilities. Interfaces must conform to the Web Content Accessibility Guidelines (WCAG) 2.2 AA level or higher.	Must Have
R77	The ability to integrate for monitoring and issuing control instructions to the following devices without significant driver development (noting that some development for the specific equipment selected in the test facility may be required in the first instance): Ground source heat pump, Domestic Solar invertor, Domestic Battery storage system, Smart hot water tank	Must Have