BURO HAPPOLD

NET ZERO TERRACE SLES

Digital Planning Interfaces

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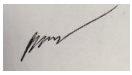
Digital planning interfaces document

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Glossary

Term	Definition
AI	Artificial Intelligence
API	Application Programming Interface
BEM	Building Energy Model
BH	Buro Happold
CEMS	Community Energy Management System
CRM	Customer Relationships Management
DERMS	Distributed Energy Resource Management System
DNO	Distribution Network Operator
DSO	Distribution System Operator
DT	Digital Twin
EMS	Energy Management Systems
EPC	Energy Performance Certificate
GDPR	General Data Protection Regulation
GIS	Geographic Information System
HEMS	Home Energy Management System
IMD	Index of Multiple Deprivation
LA	Local Authority
LAEP	Local Area Energy Plan
LDO	Local Development Organisation
LSOA	Lower Layer Super Output Area
MCA	Multi-Criteria Assessment
MPAN	Meter Point Administration Number
MVP	Minimum Viable Product
NESO	National Energy System Operator
NIA	Network Innovation Allowance
NZT	Net Zero Terrace
OS	Ordnance Survey
PSGA	Public Sector License Agreement
RESP	Regional Energy Strategic Planning
RIBA	Royal Institute of British Architects
SCADA	Supervisory Control and Data Acquisition
SIF	Strategic Innovation Fund
SLES	Smart Local Energy System
SP ENW	SP Electricity North West
TEM	Techno-Economic Model

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UK	United Kingdom
UKRI	UK Research and Innovation fund
UPRN	Unique Property Reference Number

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1 Introduction

The Net Zero Terrace (NZT) project aims to provide practical and affordable ways to cut carbon emissions for existing terraced properties in the United Kingdom (UK). The project brings together building fabric upgrades, communal heat networks, rooftop solar, and shared community energy systems to lower emissions and help tackle fuel poverty. Buro Happold has been appointed by SP Electricity North West (SP ENW) to support the development of the Smart Local Energy System (SLES) and digital planning solutions for the Network Innovation Allowance (NIA) project which supports the progression of NZT.

This report outlines the digital planning interfaces which are required for the NZT SLES and builds on outputs from NZT Strategic Innovation Fund (SIF) Discovery and Alpha stages as well as extracting relevant information from the recently completed UKRI Net Zero Terrace Pathfinders project. Digital planning will be explored in the sense of the technical item of extracting data, identifying suitable households and measuring flexibility requirements.

Digital planning sits at the heart of the design stages of identifying prospective clusters (groups of neighbouring terraced properties), obtaining data to improve the options selection criteria and multi-criteria assessment approach before feeding into a refined techno-economic model to establish the viability of schemes. Post installation the approach collects information on the system performance to refine future developments.

Incorporated into the planning flow is appraisal of the correct technical solutions for the community, affordability criteria, demographics that will inform user profiles and the capacity to deliver flexibility services.

1.1 Report structure

The remainder of this document outlines:

- **Foundational concepts:** establishing cluster definitions, ecosystem considerations, and a double pyramid approach.
- **Models and data flows:** Mapping different models against input and output data.
- **Digital planning interfaces:** Mapping of how stakeholders, processes and systems interact across the digital planning interface and link with the spatial and operational digital twins, as well as their functional roles, APIs, and data integration.
- **Digital interface data schema:** Proposed schema structure to ensure interoperability and efficient exchange of information.
- **Key findings and recommendations:** Proposed recommendations to consider for continued development of digital ecosystem.

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2 Foundational concepts

2.1 Cluster definition

To identify suitable properties for the NZT approach, households are considered as part of clusters. A cluster is defined as a group of terraced properties, typically ranging from a minimum of two rows of terraced properties to a maximum of 200 properties. A cluster can be defined as a group of properties connected to a feeder and depending on the nature of the cluster it may include all properties connected to a secondary substation, although this may not always be the case, as the natural clustering of properties also plays a role (e.g. not all streets align with an electrical boundary and may be connected across multiple feeders or substations). Each cluster will have a community system which may cross electrical boundaries but fits within a cluster; being typically defined by streets, houses and the people living in the area. The cluster formation process is dynamic in nature, capable of accommodating multiple potential scenarios given that no two streets will look the same and that there will be variability.

The overall framework is therefore designed to support informed decision-making by considering as many relevant factors as possible at an early stage through a Multi-Criteria Assessment (MCA) of different clusters, before progressing to more detailed analysis. This involves considering metrics such as building typology, floor area, garden space, potential routing for ambient loop, electrical considerations, energy vulnerability, funding opportunities, roof orientation, green space, and cluster size.

2.2 Ecosystem considerations

When planning clusters for NZT, it is important to take a system-wide perspective so that the approach integrates seamlessly with other strategic workstreams. This requires enabling four core capabilities:

1. **Extract data:** the likely mechanism is through a data shared environment, although APIs should also be explored.
2. **Hold and combine data:** bringing in fresh data and combining it with existing data and benchmarks.
3. **Undertake modelling and analysis:** enable project partners to undertake modelling and analysis within their own systems as well as within dedicated planning functions that are bespoke to Net Zero Terrace.
4. **Push data back:** feeding enhanced outputs back into shared platforms so that 3rd parties can update and apply their processes.

2.3 Double pyramid approach

In order to translate this ecosystem into a cohesive plan, a “double pyramid” approach is taken, as shown in Figure 2-1. The aim of the structure is to help bring together the operational and planning functions to cater for different stakeholder needs and ensure digital integration. This forms the digital spine by which the data architecture is designed.

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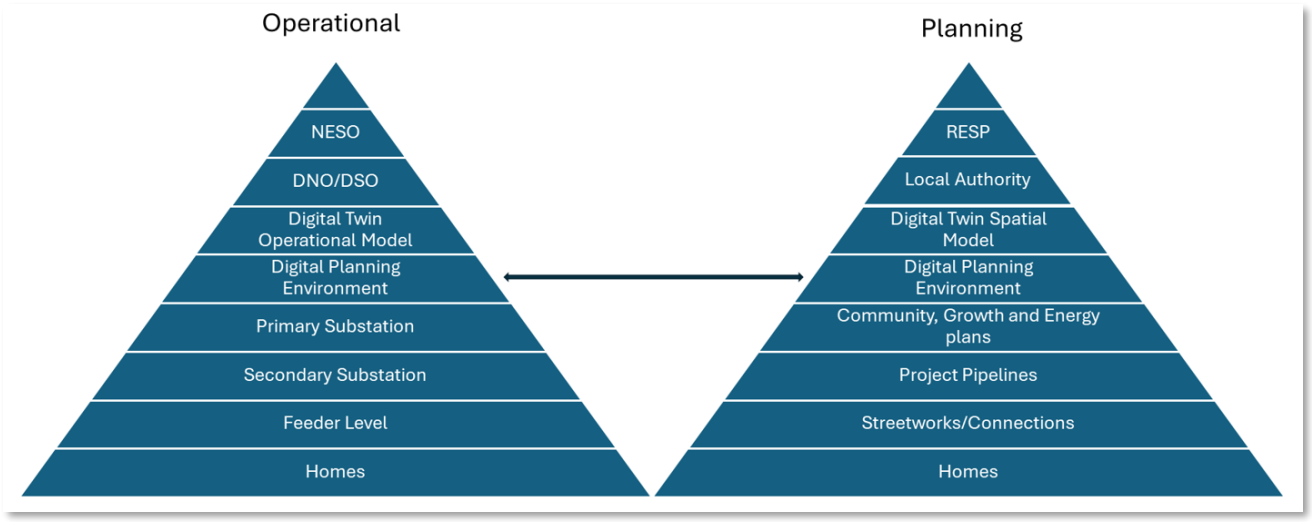


Figure 2-1: The double pyramids summarise the bottom-up to top-down alignment

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3 Models and data flows

The data architecture overlays the requirements from the double pyramid to the stages of modelling which are required for a NZT cluster. The approach is aligning data and broadly follows the Royal Institute of British Architects (RIBA) development stages[1]. Aligning NZT with these stages provides a recognised framework for progressing from early feasibility through to detailed design, implementation, and operation. Some models are required to be run several times as more detailed data is collected and as the study moves to more detailed design.

The planning "ecosystem" includes the following different items:

- **Regional screening module:** To establish regional context and determine where the viable clusters may be
- **Spatial planning module:** Discrete development of cluster boundaries
- **Retrofit module:** To establish retrofit requirements based on building archetype and available building data – also informed by the BEM.
- **Building Energy Model (BEM):** A model used to determine the specific solution tailored to the home based on a building physics approach
- **Techno-Economic Model (TEM):** A bespoke model developed to inform the process on techno-economic viability of clusters based on information collected during the planning flow and fed back into the evaluation process.
- **Home Energy Management System (HEMS), Community Energy Management System (CEMS):** In home system and community systems respectively, which will collect performance data and be the management system of resources during operation. The HEMS and CEMS may also be installed prior to the main installation to determine building and heating system performance which may be in conjunction with an in-home monitoring package.
- **Distribution System Operator (DSO)/ Distribution Network Operator (DNO) network planning and management:** DNO systems which are tailored to provide network data for a specific cluster location and then evaluate the need for reinforcement or flexibility.
- **Community app:** App which can be used by individual households to engage and provide data.

Figure 3-1 outlines the stages of screening, the input sources of data required and the output of the model.

[1] Royal Institute of British Architects (RIBA), RIBA: Plan of Work 2020 Overview. https://www.riba.org/media/syneeeto/2020ribaplanofworkoverviewpdf.pdf (accessed 1 September 2026).

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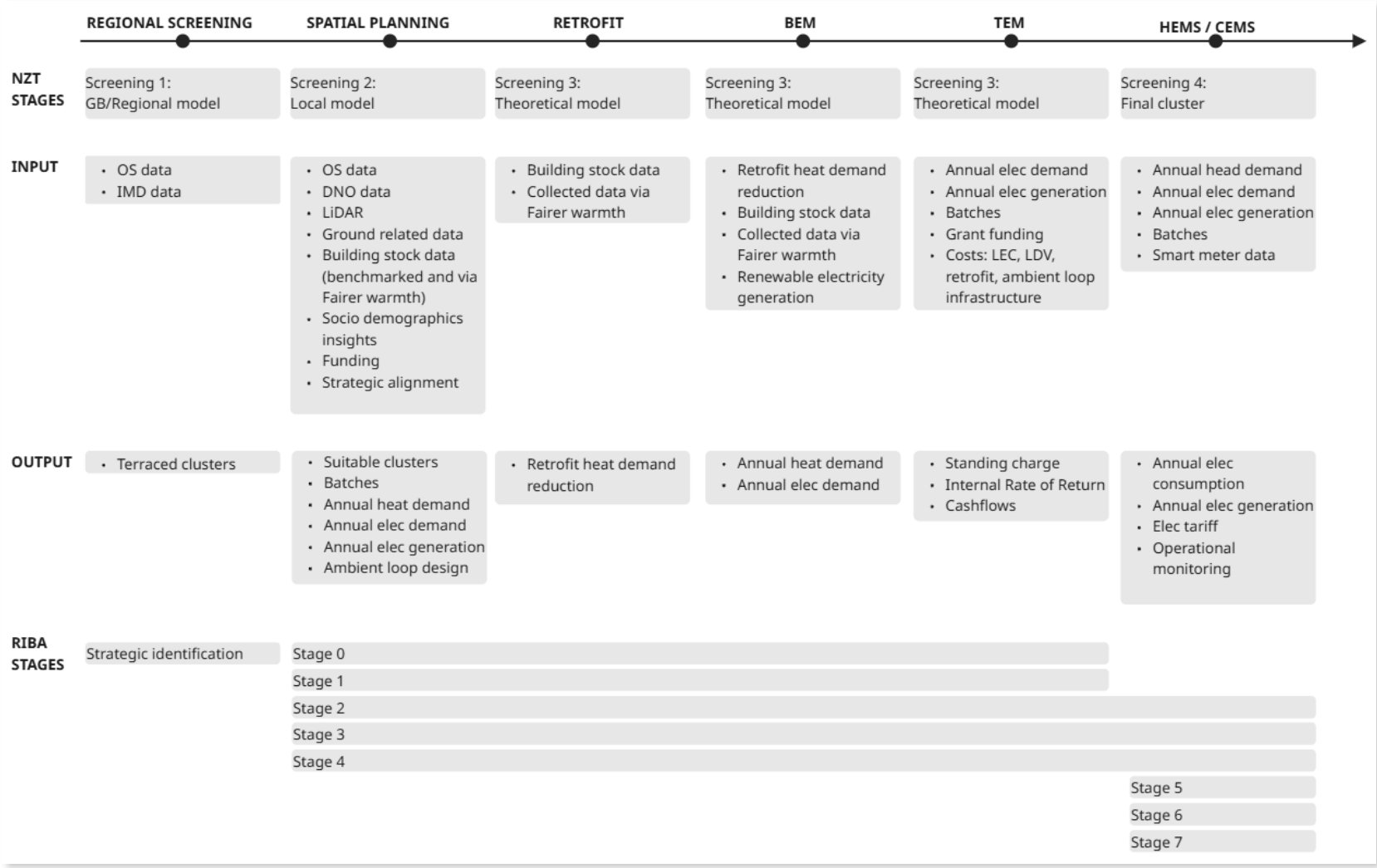


Figure 3-1: Mapping of models

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4 Digital planning interfaces

Understanding how stakeholders, processes and systems interact across the digital planning interface is critical to linking planning activities with the spatial and operational digital twins (DTs). The DTs relate back to the twin pyramid model where they represent both the spatial and operational context of each cluster. This interface operates as a hybrid integration environment, combining API-enabled systems, structured data exchange, and manual inputs.

Each stakeholder and system contributes to a continuous feedback ecosystem, where data flows into models and DTs and insights are returned to inform decisions, refine assumptions, and optimise delivery and operation.

This is shown in Figure 4-1and structured across four interacting layers:

- **Inputs:** Stakeholders that generate, supply, or act on data within the ecosystem, including residents, delivery partners, local authorities and infrastructure operators.
- **Digital planning interfaces:** The set of processes, models, and systems that transform stakeholder inputs into planning outputs, while enabling feedback between stakeholders, models, and systems.
- **Digital twins:** Spatial and operational environments where outputs are aggregated, visualised, and used to support decision making and ongoing system optimisation, digitally representing a cluster.
- **Users:** Stakeholders which have access to the digital twins, through tiered access.

The different elements of the planning environment are described in further detail below:

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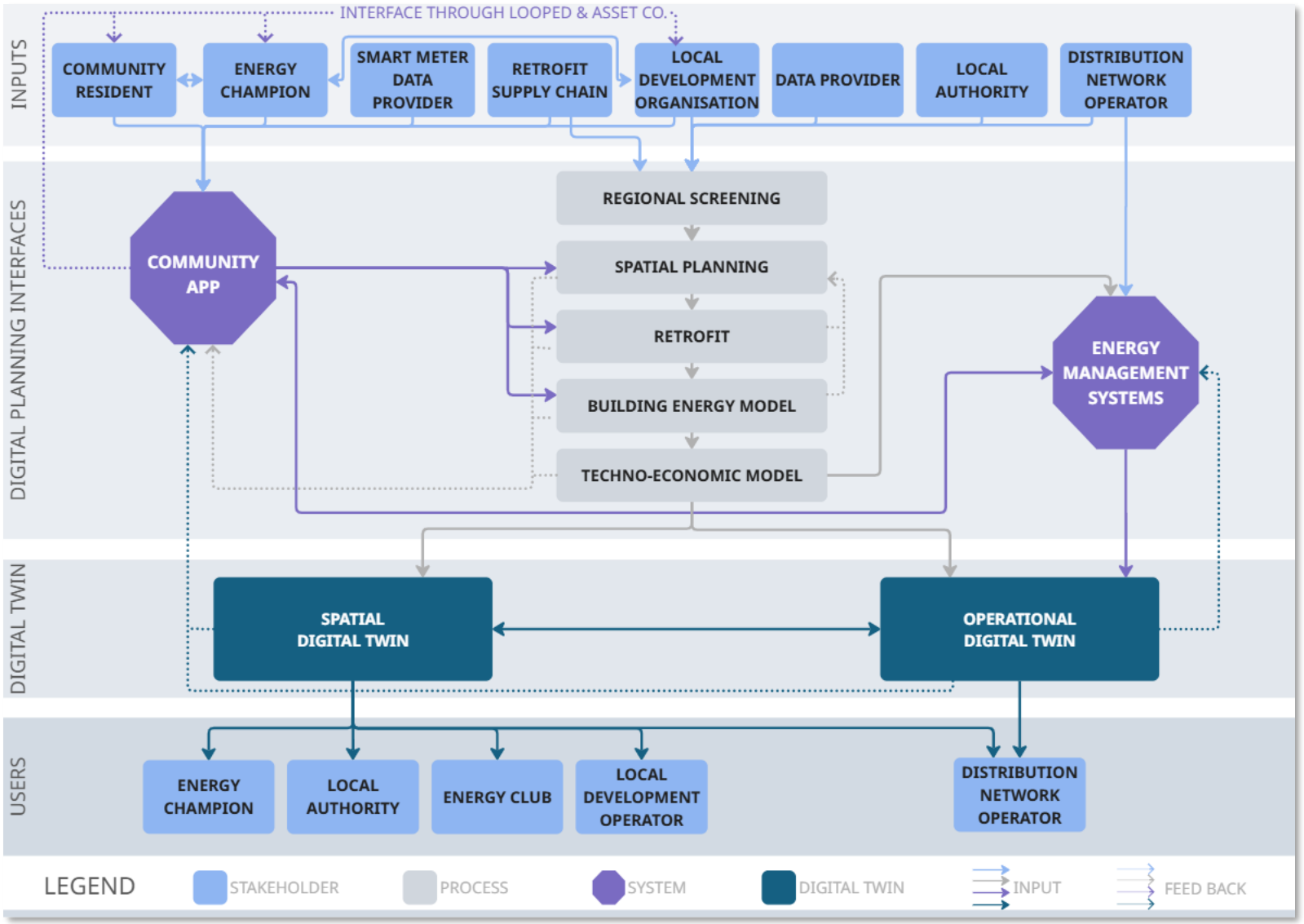


Figure 4-1: Digital planning interfaces

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4.1 Community residents

4.1.1 Functional role and interactions

Community residents are the primary source of lived experience data and the ultimate beneficiaries of interventions. Within the digital planning interface, residents interact primarily through the community app, acting both as providers and decision-making participants.

Residents provide:

- Property-level data related to building stock, existing heating system, and energy consumption.
- Socioeconomic data relevant to fuel poverty assessments.
- Feedback on retrofit options.

This input feeds into early-stage processes such as regional screening and spatial planning, helping to prioritise areas and increase data accuracy and confidence.

On a more informal level, residents share information to the energy champion who can gauge interest early in the process. The engagement between the community residents and the energy champion continues throughout the project.

Residents also receive outputs in form of:

- Personalised retrofit recommendations.
- Cost savings, carbon reduction projections.
- Consent requests.
- Tariff signalling and optimisation.

A key feature of this interface is bidirectional communication, where residents influence modelling assumptions while also receiving insights derived from digital twins.

Information is also received more informally from the energy champion.

4.1.2 API and data integration

Residents do not directly interact with APIs. Instead:

- The community app acts as an API gateway, making backend services available for others in the digital environment.
- Data is shared via secure API into modelling processes.
- Where relevant, outputs from models and digital twins are returned via the same API layer.

Residents are therefore indirect API participants, enabled through the app interface.

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4.2 Energy champion

4.2.1 Functional role and interactions

The energy champion acts as the primary 'human interface' between communities and the digital ecosystem. Their role is to maintain a visible, on-the-ground presence, and actively engage with community residents.

Information collected and shared includes:

- Level of resident interest and engagement.
- Early-stage insights on building characteristics.
- Initial feedback on needs, preferences, and constraints.

This information is fed into the community app and integrated into wider processes. It is particularly valuable at early stages of spatial planning where local insights can help shape more effective and targeted interventions. Information is also shared more informally with the Local Development Organisation (LDO), whose role is described in section 4.5.

The energy champion will also receive information back through the community app, including:

- Updates on project progress and planned interventions.
- Relevant insights or outputs from the digital tools to support engagement.

To further support community interaction, Energy Champions are granted tiered access to the spatial DT. While they don't have full visibility to all layers available to LA, they can interact with relevant visual outputs. This enables them to tailor engagement strategies and communicate key information more effectively with residents.

4.2.2 API and data integration

- Data is captured through the community app using a standardised format to ensure consistency and interoperability.
- Some information is shared informally with the LDO (as described in section 4.5), primarily through conversations that provide qualitative insights to support strategic decision-making, rather than through structured data transfer.
- All data integration must comply with General Data Protection Regulation (GDPR) requirements and account for any sensitive information.

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4.3 Smart meter data provider

4.3.1 Functional role and interactions

Smart meter data can be used to determine consumption and demand data at a high temporal resolution, forming a critical input to both planning and operational optimisation. This data enables a more accurate representation of actual energy usage, improving demand modelling and validation across the digital planning interface.

Key inputs include:

- Electricity and gas consumption data.
- Time series demand profiles, commonly half-hourly data.
- Meter Point Administration Number (MPAN) for meter level identification.

Aggregated data may also be available from the DNO directly. The data interfaces with the Energy Management System (EMS), as described in 4.10, by supporting real-time monitoring and optimisation. Through the EMS smart meter data is also further shared to the operational DT. The data can be extracted in more than one way either via SmartDCC interface to community or via a smart meter interface to the HEMS (if installed).

4.3.2 API and data integration

- Smart meter data is accessed via Smart DCC, or equivalent centralised services. There are also possibilities to use third-party providers or aggregators.
- Data is usually permission-based. Giving permission to access and use data is handled in the community app.
- API-based access is needed to share real time data, which is required for optimisation particularly in the EMS.
- Integration requires alignment with data privacy regulations such as GDPR, security and access controls.
- Data is granular and given the sensitive nature of the data, it requires strong consent frameworks, along with aggregation for wider use in planning (such as the spatial DT) and controlled access for operational use (such as for EMS and operational DT).

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4.4 Retrofit supply chain

4.4.1 Functional role and interactions

Retrofit supply chain includes all stakeholders across the retrofit and delivery supply chain, as well as assessors throughout the process, including retrofit assessors. This encompasses contractors, installers, assessors, and manufacturers. Retrofit assessors provide high granularity building level data, forming the backbone of accurate modelling. This goes beyond Energy Performance Certificate (EPC) data, incorporating detailed fabric, systems, and occupancy-related methodologies.

Key inputs include:

- Detailed construction characteristics.
- Heating and hot water systems.
- Air tightness.
- Observed retrofit constraints.
- Technology specification.

Retrofit supply chain data feeds into the community app and the processes.

4.4.2 API and data integration

Many organisations have their own standard procedures and platforms for gathering data. These platforms will need to integrate with the existing Fairer Warmth portal, that collects and records the data for NZT.

In some cases, data is shared in PDF format which presents different challenges to data which can be shared through an API. Allowing different systems for the retrofit assessor also present challenges in that data attributes collected may not follow the same naming convention or the same data may not be captured. This makes the process less streamlined and requires more cleansing and preprocessing of the data. This is currently conceptual and will be developed as the NZT matures.

Retrofit data is:

- Lodged and structured through retrofit systems.
- Maintained as validated auditable datasets that are aligned with PAS 2035: Retrofitting dwellings for improved energy efficiency[2], the UK standard which sets out best practice for design and delivery of energy efficiency retrofit measures to existing homes.

Within this architecture:

- Retrofit reports are uploaded by the retrofit assessor to the community app and digitised.
- The app acts as a primary gateway, pulling structured assessor data into the wider system.

This enables automated ingestion of standardised, granular retrofit data for consistent use across processes.

[2] PAS 2035: Retrofitting dwellings for improved energy efficiency. https://www.bsigroup.com/siteassets/pdf/en/insights-and-media/insights/brochures/pas_2035_2023.pdf (accessed 1 September 2026).

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4.5 Local Development Organisation (LDO)

4.5.1 Functional role and interactions

The LDO coordinates programme delivery and ties community engagement in the local clusters, supported by Looped. It is the entity that will engage with the community and install the NZT solution. Therefore, the LDO is well placed to begin engagement and collect community information. The LDO will design the system based on the cluster feasibility and design process and manage onward community engagement and data collection. In many ways the LDO is the client of the planning process in assessing viable cluster delivery.

Key interactions:

- Share community engagement local knowledge into cluster identification MCA, as described in section 2.1).
- Has a dedicated version of the community app. For information collection and community management.
- In some instances, Asset Co, the organisation which acts as the final decision maker for cluster progression, will act as a stage gate, for example deciding whether to proceed with deployment in a particular area. In these cases, information from the community app is shared with Looped which passes it to the Asset Co for decision-making. The outcome is then fed back to the LDO, who takes appropriate next steps.

4.5.2 API and data integration

Data is shared to the following:

- Community app, likely through a data collection page in the app. The app acts as a primary gateway, pulling structured assessor data into the wider system.
- Regional screening, the LDO provides structured feedback which feeds into MCA. Depending on the nature of feedback and input which is needed, this may be via batch uploads or more of a manual approach to inform decision making.

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4.6 Data provider (various)

4.6.1 Functional role and interactions

Data providers supply core datasets underpinning all processes. Whilst a significant proportion of data in the UK is open source, this section focuses on data with specific licensing requirements, or which must be purchased. This includes:

- Ordnance Survey (OS) data.
- Synthesised building stock data from data providers.

These inputs feed directly into regional screening and spatial planning.

Within this architecture, the planning engine is used to access and integrate datasets via centralised platforms such as the OS Data Hub, enabling consistent and scalable ingestion of national geospatial data. This includes collecting, cleansing and aggregating. DNO data flows will be developed in conjunction with the planning engine so any DNO can participate and access the process to provide DNO data and receive outputs.

4.6.2 API and data integration

Data providers represent one of the most digitally mature components of the ecosystem. Integration, however, can occur through multiple mechanisms, combining API services, automated downloads, and bulk data ingestion depending on the data provider.

- OS data (via OS Data Hub) can be accessed through API-enabled services or bulk download for local processing. In practice BH workflows typically involve downloading datasets from the Data Hub and ingesting them into internal systems, rather than relying on real-time API calls, which is not necessary for this type of data.
- Building stock will depend on data provider. Some data providers share data based on API configuration and others share data as a bulk download.
- OS data, or OS derived data (synthesised building stock data is in most instances) must be aggregated before sharing to remain compliant.
- Where OS data is not available through the OS Public Sector Geospatial Agreement (PSGA), BH can act as a third-party provider, and data can be purchased on an annual basis. Royalties will be incurred from OS and cost of overall data should be considered separate to project costing.

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4.7 Local Authority (LA)

4.7.1 Functional role and interactions

The Local Authority (LA) plays a central governance and coordination role, ensuring alignment with policy, existing plans, local constraints and opportunities (e.g. planning restrictions, funding limitations, conservation area requirements, and housing stock characteristics) and project pipelines.

Key functions include:

- Providing prioritisation based on current plans, funding mechanisms, and social and environmental criteria.
- Ensuring alignment with current plans and policy to enable work and ensure project implementation is possible.
- Approving and overseeing programmes to ensure alignment with local priorities.
- Acting on community data to enable delivery plans.

Key interactions:

- Inputs data into modelling process and receives outputs from regional and spatial planning, as well as interactive outputs within the spatial DT.
- Absorb data from the process into other planning and decision-making initiatives.
- Data ingested into the ecosystem, including policy inputs and planning datasets, is visualised alongside prioritised NZT clusters as they mature over time, enabling the LA to track progress, assess maturity, and influence decision-making.
- Related processes where data may be exchanged with the NZT process include Local Area Energy Plans (LAEPs), Regional Energy Strategic Planning (RESP) plans, Growth plans, Net Zero Neighbourhood initiatives, funding deployment (e.g. Warm Homes) and public and policy objectives

This creates a feedback loop, where LA priorities inform modelling outputs, which are then reviewed and refined through visualisation within the digital twin.

4.7.2 API and data integration

Data integration for LAs is typically of a mixed digital maturity, combining:

- Some datasets, such as Geographic Information System (GIS) layers, LAEP outputs, may be accessed via APIs or shared through batch downloads.
- Where granular or sensitive data is held, appropriate data-sharing agreements must be in place to ensure compliance with licensing, privacy, and data governance requirements. In such cases, data may need to be aggregated or anonymized before integration. Alternatively, data can be processed through a controlled ingestion layer to manage access and usage to the wider data ecosystem.
- Some inputs such as specific policy inputs and priority constraints are often provided in non-standard formats.
- To enable efficient integration, a structured input mechanism should be established. Examples of this include a standardised input template or defined schema for key policy and constraint fields.

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4.8 Distribution Network Operator (DNO)

4.8.1 Functional role and interactions

Integrating DNO data effectively is critical to the effectiveness of the digital planning interface, as it directly influences electrification pathways, infrastructure constraints, and system capacity considerations. The process can both inform the cluster planning based on network data and inform the DNO on network investment based on the planned deployment and capacity requirements.

Key inputs provided by the DNO, which feed into regional screening and downstream planning processes, include:

- Electrical network configuration and network topology.
- Identification of looped properties, plans for unlooping, and network arrangements
- Network capacity and headroom availability.
- Planned reinforcement and upgrade plans.
- Network model outputs and constraint assessments (e.g. forecast loading, thermal constraints, voltage constraints, and reinforcement requirements).
- Flexibility opportunities.

These inputs ensure that spatial planning and modelling outputs are realistic, deliverable, and aligned with network capability.

In addition, DNO data interfaces directly with Energy Management Systems (EMS), including both HEMS and CEMS for detailed property-level insights and community-wide insights, respectively. This data includes:

- Network constraints and dynamic modelling (including thermal and voltage constraints).
- Flexibility and demand response signals for optimisation, where services are available including curtailment requests, flexibility dispatch signals, and network constraint notifications.
- Any export limits for low-carbon technologies.
- Metering to show net energy flows through network assets.
- Upstream integration into Distributed Energy Resources Management System (DERMS) for wider regional network operation. DERMS is a technology system which is used to control and optimise the flow of electricity from Distributed Energy Resources (DERs) such as wind turbines and solar photovoltaic (PV) energy.

At a system level:

- Aggregated DNO data feeds into the spatial DT, enabling high-level planning and constraint mapping across geographic areas.
- More granular data feeds into the operational DT, supporting operational optimisation and in some instances real-time decision-making.

4.8.2 API and data integration

- The DNO may be able to share data through APIs in the future, but in the early stages of the project data will instead be shared thorough periodic batch downloads. Future API-based interfaces may support the exchange of

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network constraint, flexibility requirements and operational data. Where demand-side response, flexibility services, or automated control signals are implemented, consideration must be given to ensure alignment with OpenADR or equivalent industry standards.

- Given that some data may be shared at granular level with specific project partners consortium, but not all, appropriate data aggregation, access controls and data governance measures should be implemented to ensure that restricted data is protected.
- PowerFactory, an electrical network modelling and analysis software platform which is used by network operators and engineering consultants, supports real-time integration through APIs. An interface is being explored to co-plan using digital network data.

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4.9 Community app

4.9.1 Functional role and interactions

The community app is the primary user-facing data collection and engagement platform, acting as the central interface between community residents and retrofit assessors. The app also ingests information from smart meter data providers and LDO. The interface is explained in more detail in section 4.1-4.4. In summary, the app:

- Collects detailed resident input, allows retrofit assessors to upload information into the system, acts as a link and data controller for smart meter data and the link to the digital ecosystem.
- Acts as the CRM for collation and management of consumer data before aggregation, pseudonymisation and anonymisation into other processes.
- The community app interfaces with planning processes as well as EMS.
- Feedback loop from planning processes and the spatial and operational DTs, sharing relevant data back to be visualised for community residents.

4.9.2 API and data integration

Fully API-enabled system, acting as a Hub:

- User data APIs, including community residents, energy champions, and retrofit supply chain.
- Smart meter data provider API.
- Model query APIs.
- Feedback APIs.

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4.10 The Energy Management Systems (EMS)

The EMS is the generic term used for the overall energy management system which incorporates the home energy management system (HEMS) and community energy management systems (CEMS) and undertakes the operational aspects of the SLES in terms of control and monitoring functions.

The EMS will be used to collect and feed data into an analytics engine which will be used to assess the cluster performance and compare it to the planned performance (e.g. actual load profiles, flexibility delivered, retrofit performance). This is used to refine future planning interactions using Artificial Intelligence (AI) as a means of optimising planning data. Data breach considerations as well as consent must be integrated before using AI on restricted or sensitive data. In addition, elements of the EMS e.g. the HEMS may be deployed earlier than the full installation to begin collecting data to feed into the latter stages of design which will help better optimise the retrofit package, system sizing and expectations on heat performance and flexibility delivery.

4.10.1 Functional role and interactions

EMS, including both HEMS and CEMS operate at the interface between planning outputs and real-world operation. The EMS forms the operational spine of the digital ecosystem, characterised by high API maturity and real time data exchange. The CEMS may be provided via a Supervisory Control and Data Acquisition (SCADA) system, but this is to be confirmed during the CEMS development process.

Their primary role is to:

- Monitor and manage real-time energy consumption and generation.
- Control building-level and community-level systems.
- Enable flexibility and demand-side response, informed by network constraints and optimisation signals.

EMS receive key inputs from:

- Community app, where the key data relates to granular smart meter data.
- TEM.
- DNO data including
    - Time-varying flexibility or demand response signals (if provided).
    - Connection and export limits (if provided).

These inputs ensure that building and community operation is aligned with system-level optimisation and local network constraints.

4.10.2 API and data integration

EMS are normally among the most API-enabled components within the ecosystem, enabling real-time communication and control although other interfaces can be used between the HEMS and CEMS.

Real-time API integration is commonly used for:

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- Live energy modelling.
- Device control and automation.
- Demand response and flexibility participation.

System integration APIs connect with:

- Operational DT, providing continuous data streams for monitoring and optimisation
- Planning and modelling systems, enabling model validation and refinement
- DNO systems, in the early stages of the project, DNO data may be shared through periodic batch downloads. Future API-based interfaces may support the exchange of network constraints, flexibility requirements and operational data. Where demand-side response functionality, or automated control signals are enabled, consideration must be given to alignment with OpenADR or equivalent industry standards.

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4.11 Spatial Digital Twin (DT)

4.11.1 Functional role and interactions

The spatial DT provides a geographic, system-level representation of planning data, enabling visualisation, analysis, and decision making across LA areas. It is the primary environment for strategic planning and coordination, with the LA as the key user. Other users include the energy champion and LDO; all of which will have tiered access and use the Spatial DT to inform decision making and track progress. The spatial DT is planned to be developed over the next few years.

It should be noted that the intention is to develop the model which can be integrated with any third-party planning digital twin rather than a digital twin product in itself. This will feed digital information into third-party systems which enable a full representation of the cluster to be visualised. Collaboration with future platform providers is required to ensure input requirements are aligned.

Its core functions include:

- Aggregated outputs (e.g. summarised data from property level to cluster level) from regional screening, spatial planning, and TEM.
- Integrating datasets from LA plans and aggregated DNO data.
- Visualising priority areas, NZT cluster maturity and progress, infrastructure constraints and opportunities (e.g. alignment with planned work).

The spatial DT enables LAs to assess alignment between planning outputs from the spatial planning model (as shown in Figure 4-1), and policy objectives, track programme maturity and prioritisation across geographies, interrogate scenarios and test intervention strategies.

Interfaces related to the spatial DT:

- Receives aggregated data inputs from modelling processes and aggregated DNO datasets.
- In some instances, data is fed back through the community app if there are any changes or triggers for the community residents (e.g. availability of new funding schemes).

4.11.2 API and data integration

The spatial DT operates as an integration and visualisation layer, combining multiple data sources:

- API enabled interface with modelling processes.
- API enabled interface to operational DT.
- Exports GIS files in a suitable format for incorporation into other systems.

Data is typically aggregated to appropriate spatial scales and standardised into common schemas. Sensitive or restricted datasets are aggregated before visualisation and managed through access-controlled environments.

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4.12 Operational Digital Twin (DT)

4.12.1 Functional role and interactions

The operational DT provides dynamic, near real-time representation of system performance, linking planning outputs with real-world operation. It is the primary environment for visualising system optimisation and performance validation with the DNO being the key user, alongside EMS operators. The operational DT is planned to be developed over the next few years.

Its core functions include:

- Integrating real/near-real-time data from HEMS, CEMS and local energy assets.
- Monitoring of flexibility activation and response.
- Visualisation and interaction with synthetic networks (e.g. modelled representation of the network) at feeder level.
- Integrating local substation monitoring.

The operational DT supports validation of planning assumptions made in earlier stages, optimisation of system performance aligned with network constraints, monitoring of electrification impacts on the local network.

Interfaces related to the Operational DT:

- Receives granular EMS and DNO data.
- Feedback control and optimisation signals to the EMS systems.
- Interfaces with spatial DT, by passing on aggregated data for strategic insights and receiving strategic plans and constraints, and opportunities (e.g. funding availability, building stock characteristics, local development priorities, low-carbon deployment opportunities).

Given the granular outputs available in the operational DT, the main user is expected to be the DNO, supporting network planning, monitoring, and operational decision-making.

4.12.2 API and data integration

The operational DT is a highly API-dependent system, requiring continuous data exchange.

- Real-time API integration from EMS platform including live monitoring data and control and optimisation interfaces.
- Integration with DNO systems which can occur via batch updates.

Granular data requires strong privacy control as well as secure handling and access management. Alignment with DNO data sharing restrictions remains critical.

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5 Digital interface data schemas

Consistent data schemas underpin the digital planning interfaces, enabling streamlined processes and scalability across organisations. Establishing a clear standardised approach to data sharing is critical to ensure interoperability and efficient exchange of information.

A data schema defines:

- Which organisations need to share data.
- When data needs to be shared.
- What data needs to be shared.
- The required format of data.
- Data quality requirements.
- Licensing and data governance considerations.

A structured data schema has been developed to ensure consistency. This is particularly important because any enhanced data, which carries a higher level of confidence, must follow the same structure as the existing benchmarked data in order to effectively override or replace it. Table 5-1 shows the proposed template, where 'From' and 'To' refer to the interfaces illustrated in Figure 4-1. The schema is currently in draft form and subject to refinement.

Table 5-1: Proposed data schema with sample data

From	To	Data type	Attribute	Unique values	Data quality	Source	License / Data Sharing Agreement
DNO	*Regional screening*	*Discrete*	*uprn*	*-*	*-*	*SP ENW*	*Restricted at property level*
DNO	*Regional screening*	*Nominal*	*substation_id_name*	*-*	*-*	*SP ENW*	*Restricted at property level*
DNO	*Regional screening*	*Discrete*	*substation_id_code*	*-*	*-*	*SP ENW*	*Restricted at property level*
DNO	*Regional screening*	*Nominal*	*looped_property*	*yes; no; unknown*	*high; medium; low*	*SP ENW*	*Restricted at property level*

The schema includes the following fields:

- From.
- To.
- Data type
- Attribute
- Unique values.
- Data quality.
- Source.
- Licence / data sharing agreement.

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Figure 5-1 illustrates the classifications of data types, including quantitative (discrete and continuous) and qualitative (ordinal and nominal).

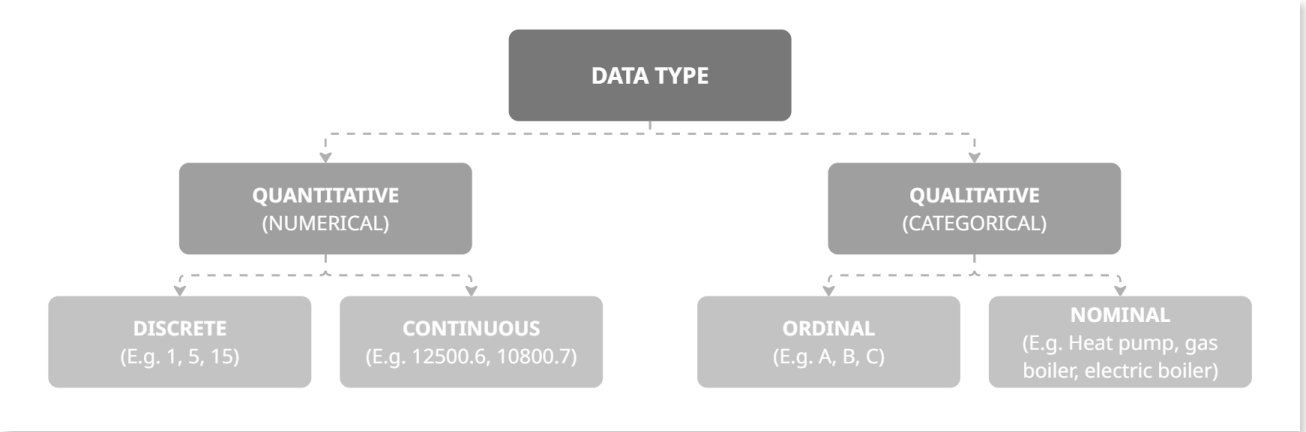


Figure 5-1: Data type mapping

To ensure that all datasets are spatially referenced, at least one of the following identifiers should be used for each datapoint:

- **Unique Property Reference Number (UPRN):** highest level of granularity for building stock. All information which is not General Data Protection Regulation (GDPR) sensitive and available at property level.
- **MPAN:** highest level of granularity for DNO data.
- **Postcode:** In some cases, data is aggregated to postcode.
- **Lower layer Super Output Area (LSOA):** Small geographical units used for statistical analysis and sharing of aggregated data, i.e. Census data which gives a picture of all people and households across England and Wales and Index of Multiple Deprivation (IMD) which is a relative measure of deprivation.
- **Cluster ID:** There may be some data which is not possible to provide as point data due to GDPR. Instead, a solution may be to provide an average for that specific cluster.
- **Secondary substation ID:** Data which the DNO can provide at secondary substation level.

It should be noted that the schemas will continue to evolve as the planning process is fully developed into the digital ecosystem.

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6 Recommendations and next steps

The digital planning ecosystem and key interfaces have been identified. The digital planning interface should be implemented as a hybrid ecosystem, supported by strong governance, standardised data schemas, and structured feedback loops. This approach enables integration across stakeholders with varying levels of digital maturity, whilst linking planning, delivery, and operation through a digital framework. Governance is addressed separately but any system needs to consider data security, processes for addressing breaches and data protection requirements.

Acknowledging the development is being undertaken under an innovation project, it is recognised that some of the integrated processes are either non-existing or not mature and will need development, testing and evaluation.

Key recommendations and next steps include:

- **Establish a robust data ingestion and standardised layer:** A centralised ingestion framework should be developed and implemented to standardise data across multiple formats including APIs, batch uploads and manual inputs. This should align with a defined data schema and include validation and quality assurance processes to ensure consistent high-confidence data across the ecosystem.
- **Prioritise DNO integration pathways:** Defining data sharing agreements, access levels, and aggregation requirements. Given the central role of DNO data it is key to define this early.
- **Strengthen data governance and security frameworks:** A clear governance framework to define data ownership, licensing, access rights and responsibilities across all stakeholders. This is particularly important for sensitive data, where aggregation, anonymisation and tiered access will be required to ensure that the digital ecosystem set-up is compliant with GDPR and infrastructure security requirements.
- **Standardise data inputs:** Structured templates and defined schemas should be developed to capture data input consistently from all stakeholders, to reduce preprocessing requirements and associated overheads. This is particularly relevant for non-standard data such as policy or programme constraints, where possible.
- **Maintain clear separation and linkage between digital twins:** A clear distinction should be maintained between the spatial DT, supporting aggregated and planning led decision-making, and the operational DT supporting real-time system optimisation. The interface between the two DTs is key, ensuring that operational insights inform strategic planning, and that strategic opportunities and constraints guide operational decision-making.
- **Plan for future API expansion, ensuring architecture is API-ready even where APIs don't exist yet:** The system architecture should be designed to be API-ready. This approach futureproofs the setup, allowing integration of future data services as they become available.
- **Clear data controller framework:** A defined data controller structure should be established, to clarify responsibilities for data collection, processing, storage and sharing across the digital ecosystem. This ties back to the governance structure
- **Integration of system modules:** The planning ecosystem relies on the integration of different modules such as the TEM, BEM, community app. Most of these have been developed to a point now where they need automation and integration to streamline the planning flow and automate it. Automation will mitigate risks associated with data leakage and errors.

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