Project	Net Zero Terrace SIF Alpha
Subject	System Planning Approach
Deliverables	M5 D7 System Planning Approach
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1	Description of system planning approach	AD/CF	27.3.2024	PP

Contents

GLOSSARY

BH	Buro Happold Ltd
CEE	Centre for Energy Equality
CEMS	Community Energy Management System
DESNZ	Department for Energy and Net Zero
DFES	Distributed Future Energy Scenarios
DNO	Distribution Network Operator
DSO	Distribution System Operator
EPC	Energy Performance Certificate
ENWL	Electricity North West Limited
GB	Great Britain
GSHP	Ground Source Heat Pump
HEMS	Home Energy Management System
IMD	Indices of Multiple Deprivation
LSOA	System Lower Super Output Area
NZT	Net Zero Terrace
NZPV	Net-present value
PV	Photo-Voltaic
RVE	Rossendale Valley Energy
SIF	Strategic Innovation Fund
SPV	Special Purpose Vehicle
TEM	Techno-Economic Model
TOID	Topographic Identifier
UPRN	Unique Property Reference Number

1 Introduction

Buro Happold has been appointed by Electricity North West Limited (ENWL) to create the planning approach for Net Zero Terrace Streets (NZT) as part of SIF Alpha. This report outlines the system planning approach, which is of the core components of the service solution to identify and deploy community clusters with the NZT solution.

1.1 Strategic Need

Due to spatial constraints for small, terraced properties, the current decarbonisation pathway (the counterfactual) relies on installing electric boilers for heating in these properties. Whilst easy to install they incur several issues, primarily high bills for consumers and high impact (demand) on the electricity network. The alternative is to use highly efficient ground source heating via ambient loops. However. there is currently no planning framework in place to support terraced properties to transition by installing heat pump. This requires a community-based solution which relies on ambient closed loops to deliver heat to multiple homes and multiple homes to connect at the same time. In the instances where communities are keen to implement such solutions there is a myriad of issues to overcome to make the solution viable; from a technical, financial, and electrical infrastructure perspective. This is exacerbated by the planning by the Distribution Network Operations (DNO) and community being carried out in silo.

Co-planning between the community, deployment of heat infrastructure (assumed to be by an Special Purpose Vehicle or SPV) and the DNO would seem to offer many advantages over business as usual in unlocking the potential for communities and network customers in individual homes to benefit from such a solution.

1.2 Benefits

Net Zero Terrace planning approach explores a novel innovative way of providing smart energy solutions to communities. By considering the constraint and benefits from a spatial and technical planning, community engagement and electrical infrastructure planning, the planning for Net Zero Terrace is cohesive and ensures that all aspects are covered. Figure 1-1 illustrates the Net Zero Terrace Streets (NZT) planning approach and highlights the synergy of the method.

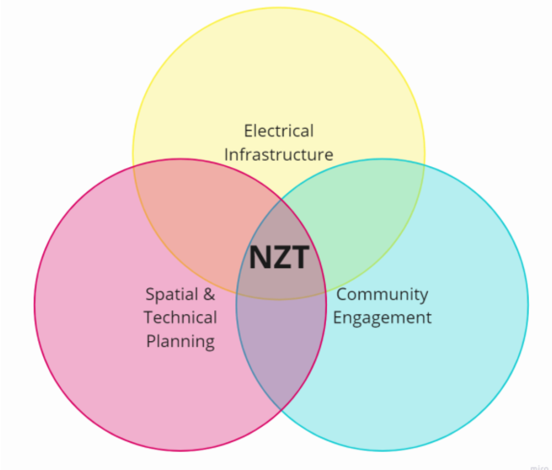

Figure 1-1 Venn Diagram for Net Zero Terrace

As part of the planning approach, the three streams that make up the Venn diagram form the framework of the 'three-swim-lane approach'. Traditional approaches to planning do not consider the integration of all three streams of information nor information exchange between these three streams. Local Area Energy Planning (LAEP) promotes the integration of stakeholders co-planning to identify opportunities to accelerate decarbonisation and deliver consumer value. This approach adopts the same principles and recognises that currently LAEPs tend to miss out communities such as those we are targeting and do not go into the detail needed to develop viable pipeline and create demand at the 'street level'. However, by adopting the same principles we can tailor an approach which unlocks these otherwise stranded communities:

There are significant benefits for all parties with this co-planning approach. Key benefits are listed below:

- Carbon savings – *the acceleration of transitioning homes onto affordable electric heating will save over 2 tons of carbon dioxide per home per year*.
- Reduced overheads – *this is key to the successful deployment of low carbon systems. By reducing the burden placed on organisations to strategise, engage, and find consumers, create demand and provide infrastructure solutions as and when required, we reduce operational overheads which are normally recovered off the consumer.*
- Reduced bills – *reduced cost of deployment and overhead will be reduced, which ultimately reduces the bills and providing solutions which integrate local renewables and appraise property efficiency requirements, they can be reduced further.*
- Timings and actions – *by co-planning, all parties know where to go, when to go and how to go. This is imperative for creating more detailed designs, as it makes it clear where each item or task fits in as part of the bigger picture*.
- Flexibility provision – *flexibility can be provided through the DSO network services or via the Smart Local Energy System. Which one is used requires planning and a decision making process to select the most appropriate option. There are significant potential benefits in leveraging the in-built flexibility provided behind the meter and from community solutions that can mitigate network reinforcement at low cost to both the consumer and the networks. Not only does flexibility mean that there is a possibility to reach communities which otherwise would not be able to decarbonise now, due to constraints on the network, but it also means that the DNO can capture learning of how flexibility will work on scale to apply elsewhere.*

2 Methodology

2.1 Co-Planning Need

As highlighted in the introduction, Figure 2-1 illustrates the co-planning venn diagram. In order to successfully implement NZT the following streams need to be brought together:

- Electrical infrastructure data
- Spatial and technical planning data
- Community engagement data

Only by recognising all three and their reliance on each other will the planning be successful.

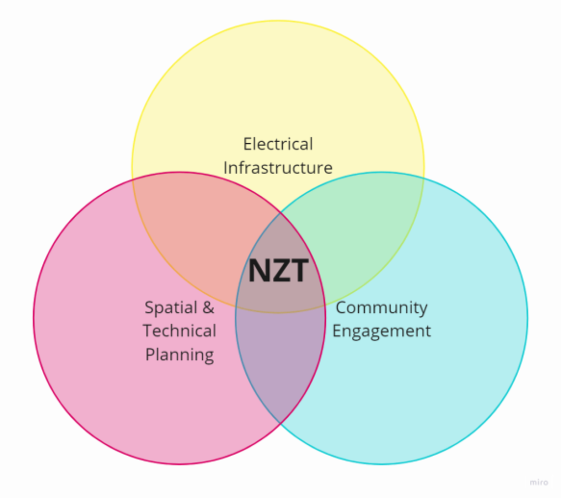

Figure 2-1 Co-Planning venn diagram

2.2 Planning Methodology

The planning methodology for the Special Purpose Vehicle (SPV) consists of multiple stages, all of which consider the electrical infrastructure, spatial and technical planning, and community engagement. Figure 2-2 shows the planning flow:

- GB/Regional model – *allows regional strategising and quick identification of opportunities for deployment. Data captures all properties and transformers in the region and provides output of small, terraced properties.*
- Local model – *allows more detailed planning analysis with consideration to multiple datasets, including local feeder data. This is relevant to provide a more in-depth analysis on the captured clusters from the regional model. Clusters are further refined.*
- Theoretical model – *technical information provided at this feasibility stage, including the energy model, techno-economic model and DNO flexibility. Light touch community engagement is also included at this stage.*
- Final clusters – *final step before deployment, allowing for sample surveys and detailed community engagement.*
- Deployment – *installation and drilling, reinforcement where required and continued community pitching.*
- Post deployment – *live integration of data into digital twin, from DNO, equipment and the community, meaning that new data is created at this step.*

The data and overall learnings from the setup of a NZT community are fed back into the model, thus improving any future NZT communities.

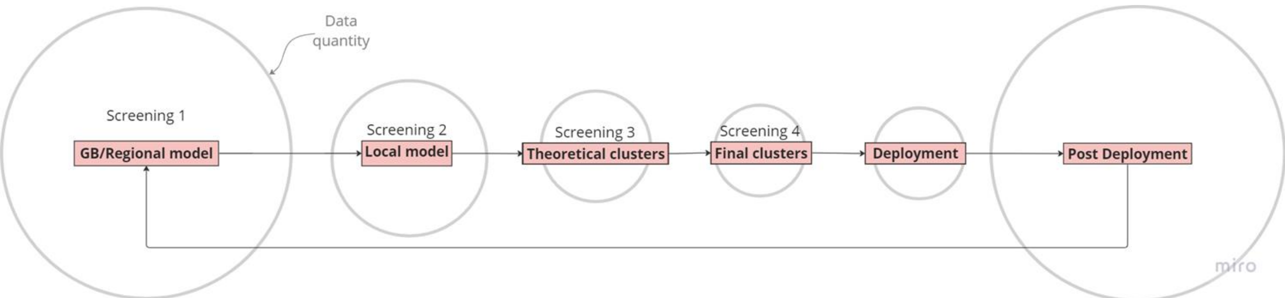

Figure 2-2 Planning Methodology

Note how the steps in Figure 2-2 all have a corresponding circle indicating data quantity. The data quantity for the GB/regional model, which have data for all properties and substations in the region or in GB is drastically reduced for the local model where only small, terraced properties are carried forward. The data quantity is slightly reduced for the theoretical clusters, final clusters, and deployment, aligning to the refinement of the clusters. Post deployment, however, the data quantity goes up again. This relates to the collection of live data, which helps to inform the system. Whilst the data quantity may go down for some of the steps, this does not mean the processing is easier as we need to begin to cross-reference data in the most accurate way to support the emerging aspects of scheme design and deployment. Collected community data will feed in as part of this cross-referencing process.

It is worth highlighting that this overarching planning methodology considers all steps and may be accessed at different points in the process depending on the maturity of the deployment model at that particular locality. For example, there may be instances where the community is mature and engaged irrespective of the planning identifying them as a suitable NZT community. In these instances, it is likely that the community will join directly at *Local model* or *Theoretical cluster*. There may, however, be key checks needed at early stages to ensure that the data and analysis on the network and building stock in earlier stages are captured to ensure a streamlined approach.

The three swim lane methodology is shown in Figure 2-3; considering the planning methodology skeleton as shown in Figure 2-2 and the DNO planning, community planning and building stock planning as shown in the Venn diagram in Figure 2-1. Note that these steps will be broken down over the next pages and that this image, solely is for illustrative purposes.

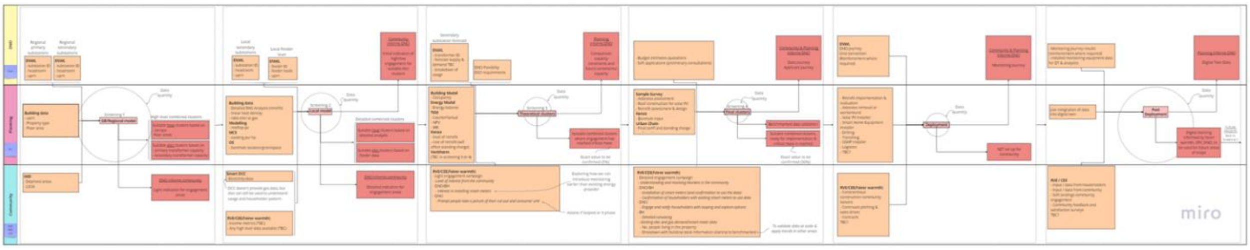

Figure 2-3 Three-swim-lane planning methodology

2.3 High Level Cluster Identification

As part of the planning, clusters are identified. These clusters consider both the heat used in the homes and the electrical constraint. The hierarchy of how these clusters set up are shown in Figure 2-4.

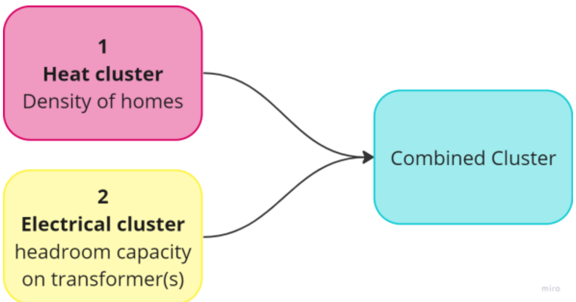

Figure 2-4 High level cluster identification

The clusters are defined in the following order:

1. heat cluster – *this relates to the density of suitable homes in an area. At the initial stages this is primarily defined by smaller terraced properties. A cluster is group of multiple homes that meet the criteria for deployment at a commercially viable scale.*
2. electrical clusters *a group of LV connections (of heat pumps) within a defined electrical boundary e.g. a distribution transformer.*

The overlap of the heat cluster and electrical cluster defines the community, or combined, cluster.

2.4 Step-by-Step Planning

Figure 2-5 Swim Lane methodology step 1 and 2 shows the first two steps of the swim-lane methodology: the *GB/Regional Model* and the *Local Model*. These are described below.

2.4.1 GB/Regional Model

The *GB/Regional model* provides a 'broad-brush' screening of the data sufficient to strategise at the regional level as to where clusters may be deployed and/or where network interventions may be required to accommodate clusters. The data captures all properties and transformers at a regional level, allowing for a high-level understanding of where there are clusters suitable for NZT deployment. As part of this early check initial transformer checks and flagging for looping on the electrical network is included. Open-source data which highlights deprived areas is overlayed on top of the electrical and building stock data.

The output from the *GB/Regional model* is high-level, combined clusters considering primary and secondary transformer level as well as small, terraced properties. The community planning is informed by the output from the DNO, providing a light indication for potential engagement areas.

2.4.2 Local Model

Since only small, terraced properties are carried forward to the Local model, there is a significant reduction in data but an increase in granularity. A more detailed planning analysis is carried out, with consideration to local feeder data.

The local model focuses on establishing a defined local boundary that can be informed by community, local authority or DNO. This entails identifying buildings and clustering them within the boundary area, assigning the electrical boundaries and overlaying any community information to inform the selection of cluster.

To ensure that the *Local model* is effective, for cluster selection a

Further detail to the Local plan and the flow within this step is detailed in the deployment plan, which is shown in Figure 2-9.

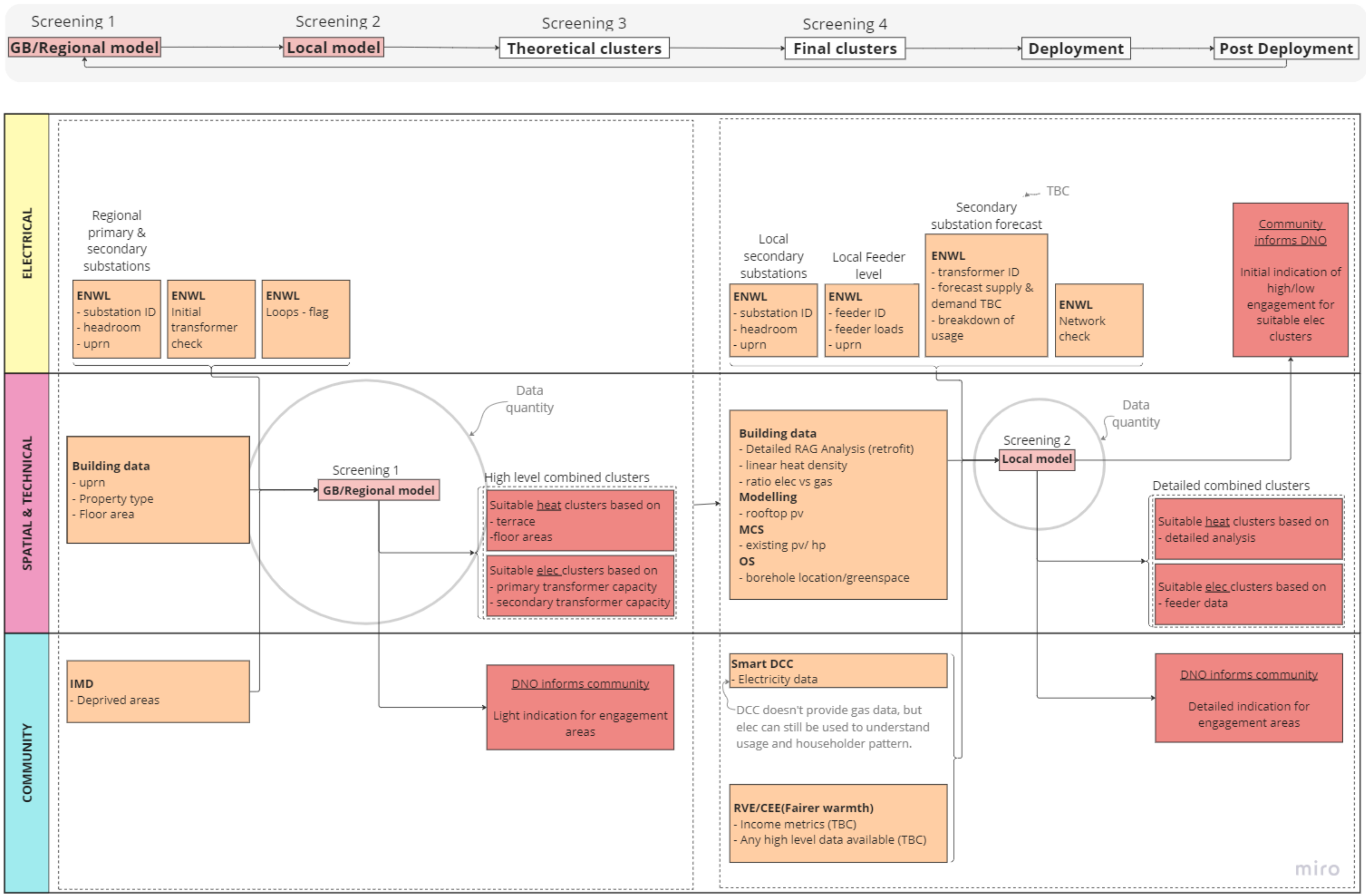

Figure 2-5 Swim Lane methodology step 1 and 2

Figure 2-6 shows the third and fourth step of the three-swim-lane methodology: the *Theoretical Clusters* and the *Final Clusters*. These are described below.

2.4.3 Theoretical clusters

The detailed heat clusters from the *Local model* feed into the *Theoretical clusters.* This stage corresponds to a pre-feasibility or feasibility stage where the building model, energy model, and techno-economic model are considered. High-level input from Kensa and sample building surveys are also included as part of this stage as well as DNO flexibility and DSO requirements.

Light touch community engagement is key for this step to understand the maturity of the community and how engaged they are. There is an interest to explore how we can increase interest in installing smart meters as this will inform the modelling in two ways:

- support the modelling of the electrical network
- support in capturing areas with high fuel poverty

To further validate the network data and to help assess if the property is looped or 3 phase, there is a benefit in prompting people to photograph their cut-out and consumer units. This will support the DNOs modelling and therefore reduce potential blockers and delays that may first be captured much later otherwise.

2.4.4 Final Clusters

The final cluster bridges the gap between a theoretical cluster and one that is ready for deployment. As such, this step entails conducting sample surveys, and get detailed information from Kensa and Urban chain. If loops have been detected, a loop service need to be carried out. If there are any issues flagged, this cause delays.

Detailed community engagement is integral for this step, with focus to understand and resolve any blockers in the community and how engaged they are. Following on from the initial engagement as part of the *Theoretical clusters* related to smart meter installation, where level of interest is captured, the *Final clusters* look at installing the smart meters. As part of this step, confirmation to use the householders smart meter data is also included.

Collection of community data will also serve a role in validating the benchmarked building stock data, such as historic electricity and gas demand data, number of people living in the property and existing loft conversion in property. To validate the building fabric a drop-down with items that align to the benchmarked data will be useful to include.

The refined and agreed criteria to select clusters includes:

1. infrastructure alignment with DNO and heat system
2. validating cluster size as being commercially viable
3. validating electrical infrastructure choices to enable cluster deployment
4. determining service offering (retrofit, flexibility service, number of connections, minimum needed for deployment, street works requirements and planning, solar PV etc).

All of these listed items must be considered as part of the four screenings (*GB/Regional model*, *Local model*, *Theoretical cluster* and *Final clusters*) and the output of the *Final clusters* should therefore already have all steps listed above captured. However, it is worth noting that if mature community groups have joined directly at step at *Local model* or *Theoretical cluster* it is important to cross-reference with this criteria list before progressing to deployment.

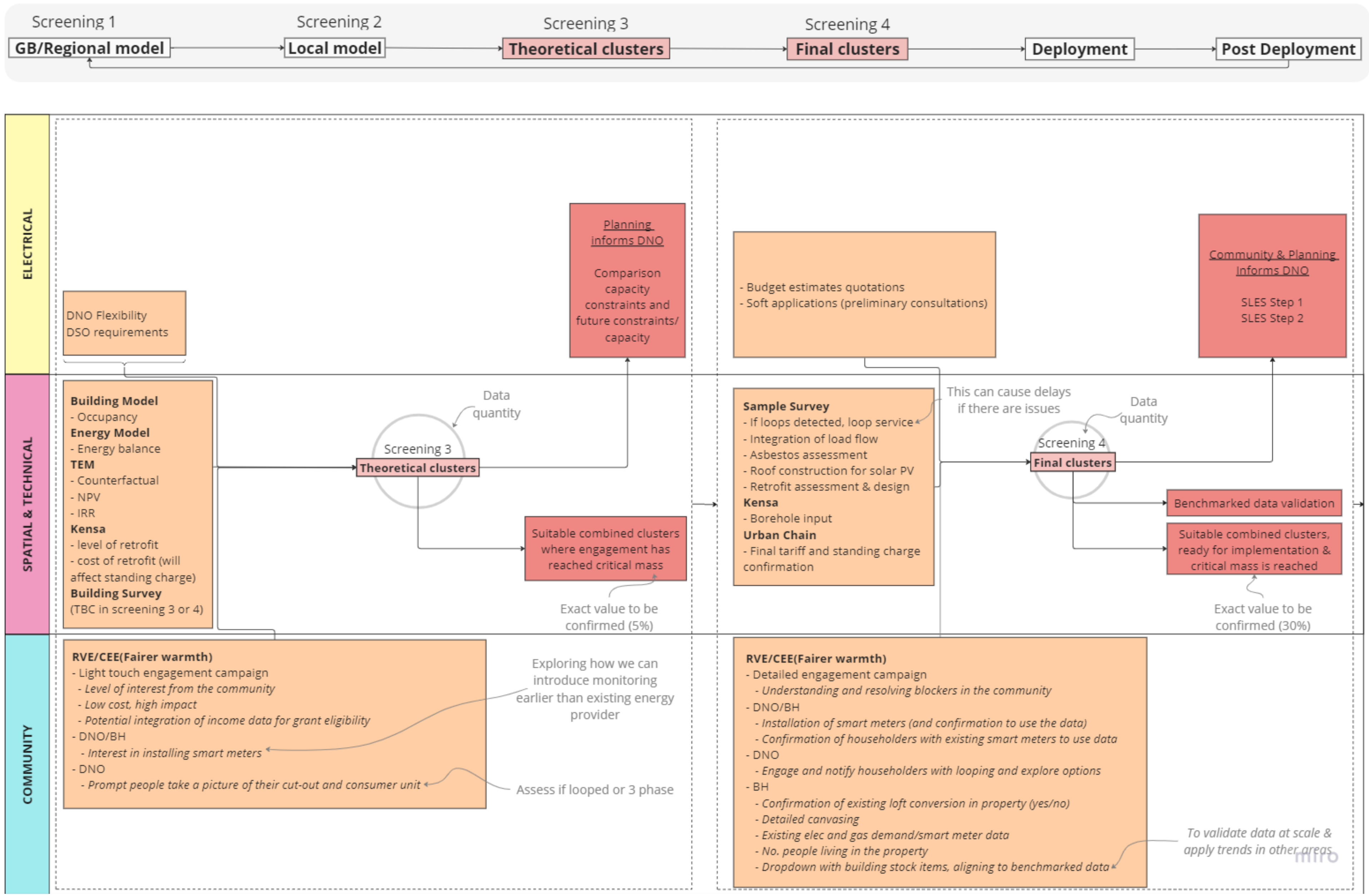

Figure 2-6 Swim Lane methodology step 3 and 4

Figure 2-7 shows the two final steps of the three-swim-lane methodology: *Deployment* and *Post Deployment*. These are described below.

2.4.5 Deployment

The *Deployment* captures the implementation of NZT including grid connection and reinforcement, where required, retrofit implementation & evaluation (inc. ventilation), asbestos removal or potential workarounds, solar PV installation, smart home equipment installation, drilling, trenching and installation of ambient loop. Other relevant logistics are also captured as part of this stage. The community is informed about progress as part of the installation and will get updates accordingly.

The output of the *Deployment* is a community set up under NZT.

2.4.6 Post Deployment

The final step captures *Post deployment*. Live data through various streams is integrated in into a digital twin. This includes data from the community though fairer warmth, SPV, DNO, home energy management system (HEMS) and community energy management system (CEMS).

The digital learnings will be used for future areas of scope, and as such the *Deployment* loops back to *GB/Regional Screening*.

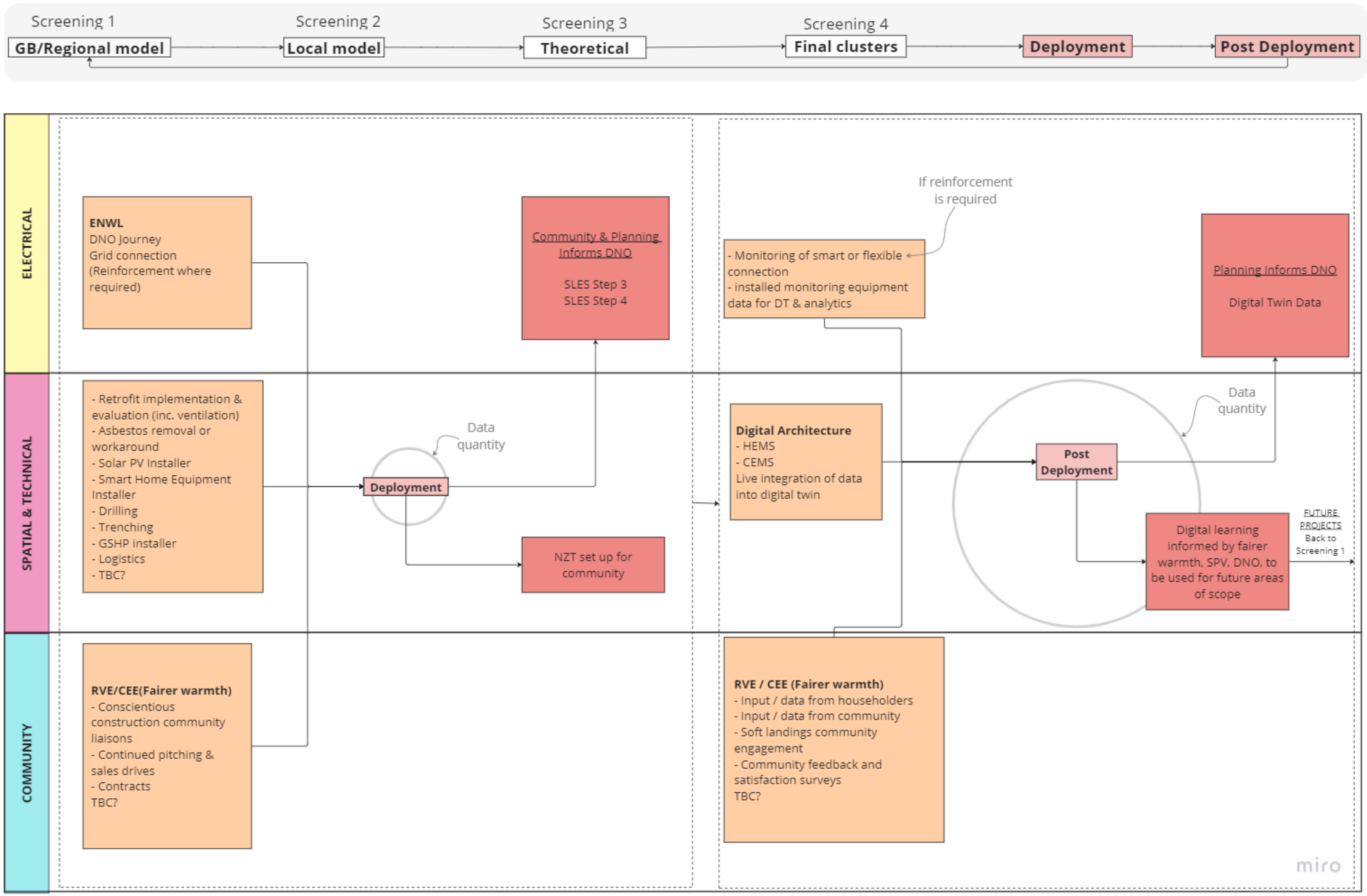

Figure 2-7 Swim Lane Methodology step 5 and 6

2.5 Deployment Planning

The process for the digital planning forms part of the local model, as shown in Figure 2-8.

Figure 2-8 Deployment planning as part of high-level flow

The flow for the digital planning is shown in Figure 2-9.

As part of the flow there are a number of sub-areas which are followed by a Red Amber Green (RAG) analysis. These are:

- Property selection – *analysing benchmarked data at property level*
- Area selection – *analysing two tiered linear heat density and fuel poverty/socio-economic impact*
- Space availability - *Proximity to greenspace/ carparking space. Identify at least one space that's suitable for boreholes*

At this stage the clusters are defined and go through a generation analysis and an electrical infrastructure analysis. These are carried out in parallel

- Generation analysis
    - screening 1 – *modelling possible generation of wind, solar (ground mounted and rooftop) and cross-referencing with the threshold for what's required to make area suitable (MW)*
    - screening 2 – *exploring flexibility opportunities and additional measures that may be required if the required threshold isn't met. Generation constraints and future constraints/ upgrades will also be considered to ensure that solution is in line with the DNOs equipment ratings and peak generation, reinforcement plan and pipeline of generation connections.*
- Electrical Infrastructure analysis
    - DNO Analysis at transformer level – *Capacity constraints and future constraints/ capacity is analysed based on primary and secondary substation information, in line with DNO equipment ratings and peak demands, primary and secondary substation forecasting and reinforcement plans. Based on outputs each substation is categorised through a RAG analysis. As part of the 'Theoretical cluster' a comparison of cost for reinforcements compared to setting up a flexible community system will be completed. For this step to be carried out the capital expenditure (CAPEX), which is why it's not part of the 'Local model'. There is no output from the analysis which need to feed into any other steps as part of the 'Local model'.*
    - DNO feeder cable analysis – *electrical infrastructure/ cable constraints and flexibility capabilities is assessed for the properties with sufficient capacity/ some flexibility are then assessed at individual property level.*
- Suitable clusters – *following this detailed analysis, the potential clusters are linked to Fairer warmth and the community engagement. The suitable clusters are also brought forward to the next step; the 'Theoretical cluster', where more detailed analysis is carried out.*

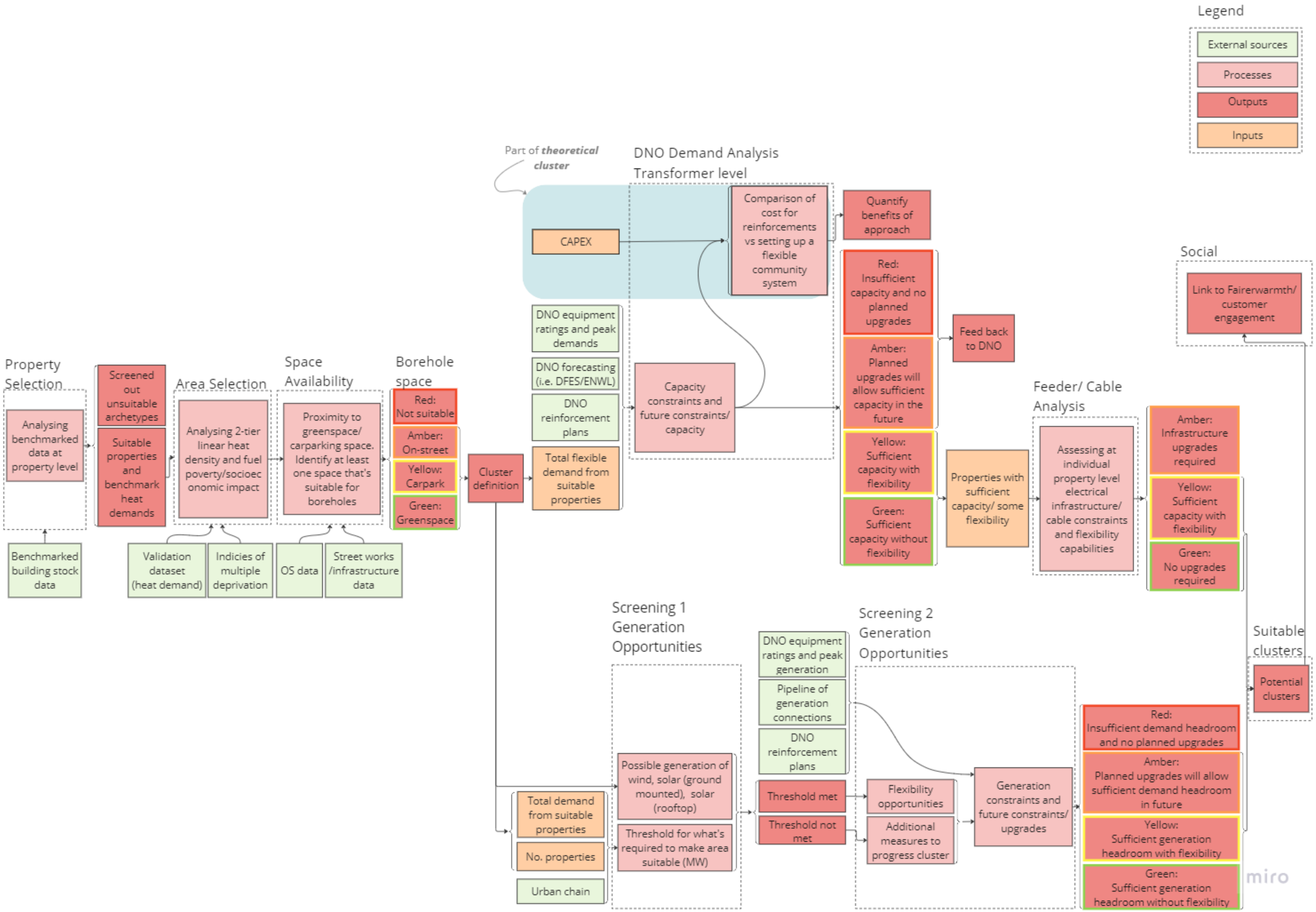

Figure 2-9 Deployment planning flow

3 Data Strategy

3.1 Overview

In preparation for beta, the data strategy has been outlined with the vision that the next phase will be using a common source of truth between stakeholders. There is significant value and benefits a 'digital eco system' as it allows multiple stakeholders to plan together and have confidence in using the same data. The real potential lays in bringing localised data into the planning process to improve the quality, which has knock on benefits, including far more accurate infrastructure sizing, reduced cost and overheads for deployment and better support and engagement with local community representatives.

To meet this vision of a 'digital eco system' which will allow for strategic targeting and phasing of clusters for NZT, multiple data sets from multiple stakeholders are required. To begin to execute the planning approach, as detailed in the section above, the following data sets have been received an analysed.

- DNO data – *ENWL is has open-source data available which we used for the modelling. In addition, we were able to use more granular data which was provided directly by ENWL.*
- Community data - *Indices of Multiple Deprivation is available open-source and provides good insights to which areas in the country that are deprived. In beta, data collected from the community will be integrated to improve granularity with a local context.*
- Building stock data – *we were able to utilise parity data under license from Rossendale Borough Council as a source of data more enhanced than EPC data.*

This is not a complete list of the data required to deploy NZT and additional data sets required will be explored in subsequent phases. The below sections will discuss in more detail the data sets received, any data issues and actions for the next phase.

3.2 Data Granularity

When combining multiple streams of information, understanding data correlation and alignment is a benefit as well as identifying gaps.

The following levels of granularity are considered:

- Unique Property Reference Number (UPRN) – *this is the most granular dataset. Building stock data and other data sets pertaining specifically to each individual property are provided at this level*
- Lower Layer Super Output Area (LSOA) – *most open-source data provide information at this level*
- Transformer level – *electrical boundary which must be considered to understand which properties that are connected to which transformers, particularly at a high-level analysis.*

Frequently, there is a discrepancy between the statistical boundaries at LSOA level and the electrical boundaries at transformer level. For example, the properties connected to one transformer may cross multiple LSOA boundaries, as shown in Figure 3-1. For this reason, it is important to have data at UPRN level to ensure accurate aggregation to transformer level. This is important to ensure sufficient head room on the transformers.

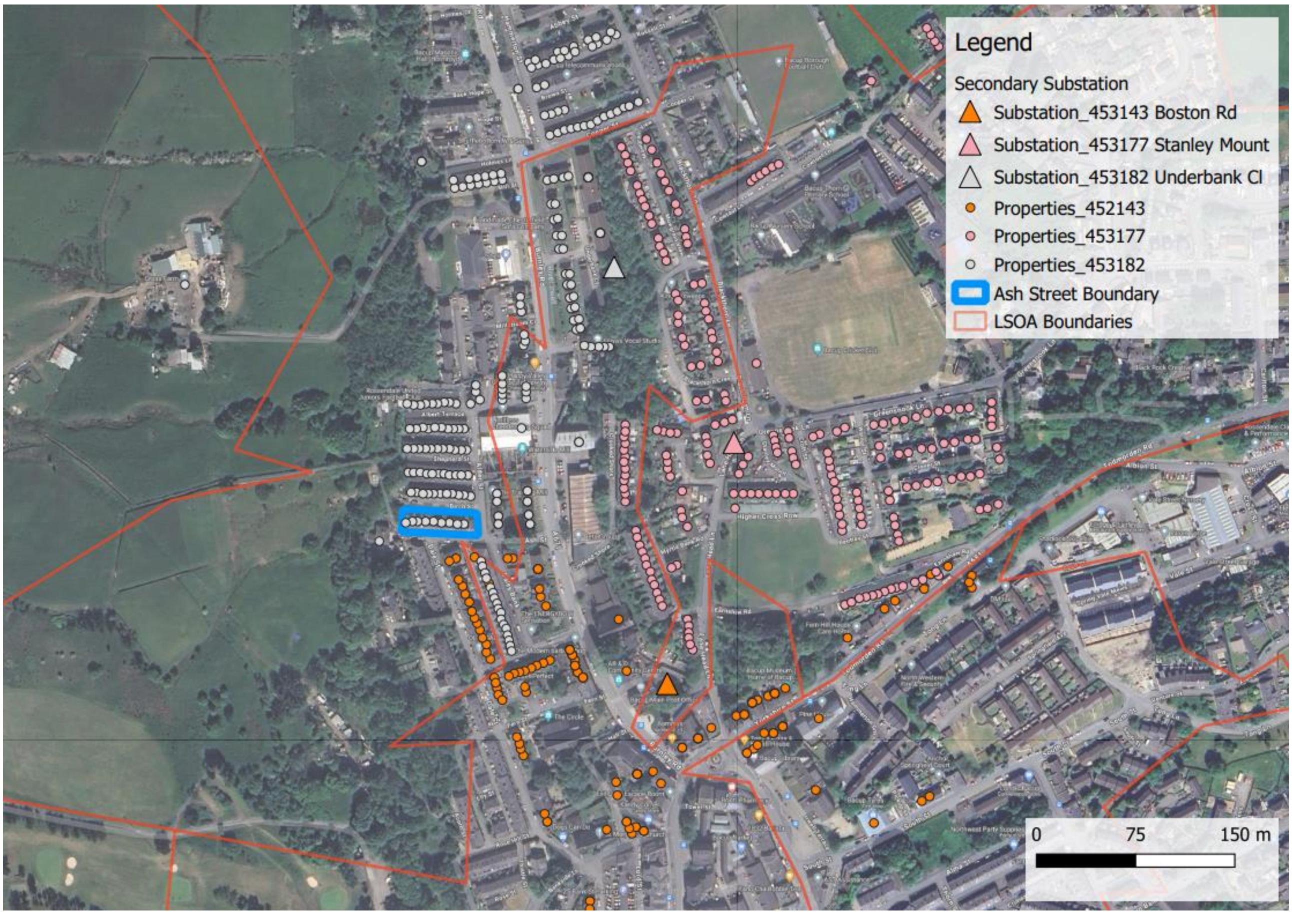

Figure 3-1

3.3 DNO Data

Weekly meetings were held between ENWL and Buro Happold. Strong progress was made in the meetings and ENWL agreed the exchange of DNO data into the planning process which allows the use of a common source of the truth. Agreement of data is often a long process with multiple delays. It is therefore a significant advantage to the projects subsequent phases that an agreement already is in place under alpha with regional data at a granular level.

3.3.1 Data Received

To identify the electrical clusters and the available headroom to deploy NZT, both open-source DNO data and data received directly from ENWL was used.

ENWL provided a list of UPRNs and they're associated low voltage transformers. Matching this with the benchmarked building data provided by parity provided the spatial geometry for the UPRNs and allowed the data to be visualised. The parity data, in conjunction with the DNO data, was also used to determine the number of terraced properties connected to each transformer. Open source ENWL data was used to determine the available headroom at the secondary substations.

Figure 3-2 shows which properties are fed by which transformers. This was modelled by matching UPRNs to transformer IDs. By mapping the properties to their respective transformers, the number of properties connected at each transformer can be determined, and benchmark data can be used to estimate to loads associated with installing a heat pump at the properties and the generation capacity. Combining this data with the estimated headroom of the transformers allows identification of electrical clusters with sufficient capacity to deploy the Net Zero terrace scheme, without intervention. The data can also be used to help inform the level of flexibility and upgrades required where sufficient headroom is not available.

Figure 3-2 Properties mapped to secondary substations

Combing the data provided by ENWL with the open-source data and the Parity data allowed for the transformer summary as shown in Figure 3-2. Shown is the total number of properties connected to each transformer, and the number of terraced properties connected to the transformer. This information could be used in the planning process to target transformer clusters where many terraced properties are connected – maximising the number of households that could benefit from the net zero terraced scheme. Also include in the transformer summary is the available headroom. This information will be used in the planning process to identify areas where there is sufficient capacity to deploy NZT and identify areas where flexibility or reinforcement will be required.

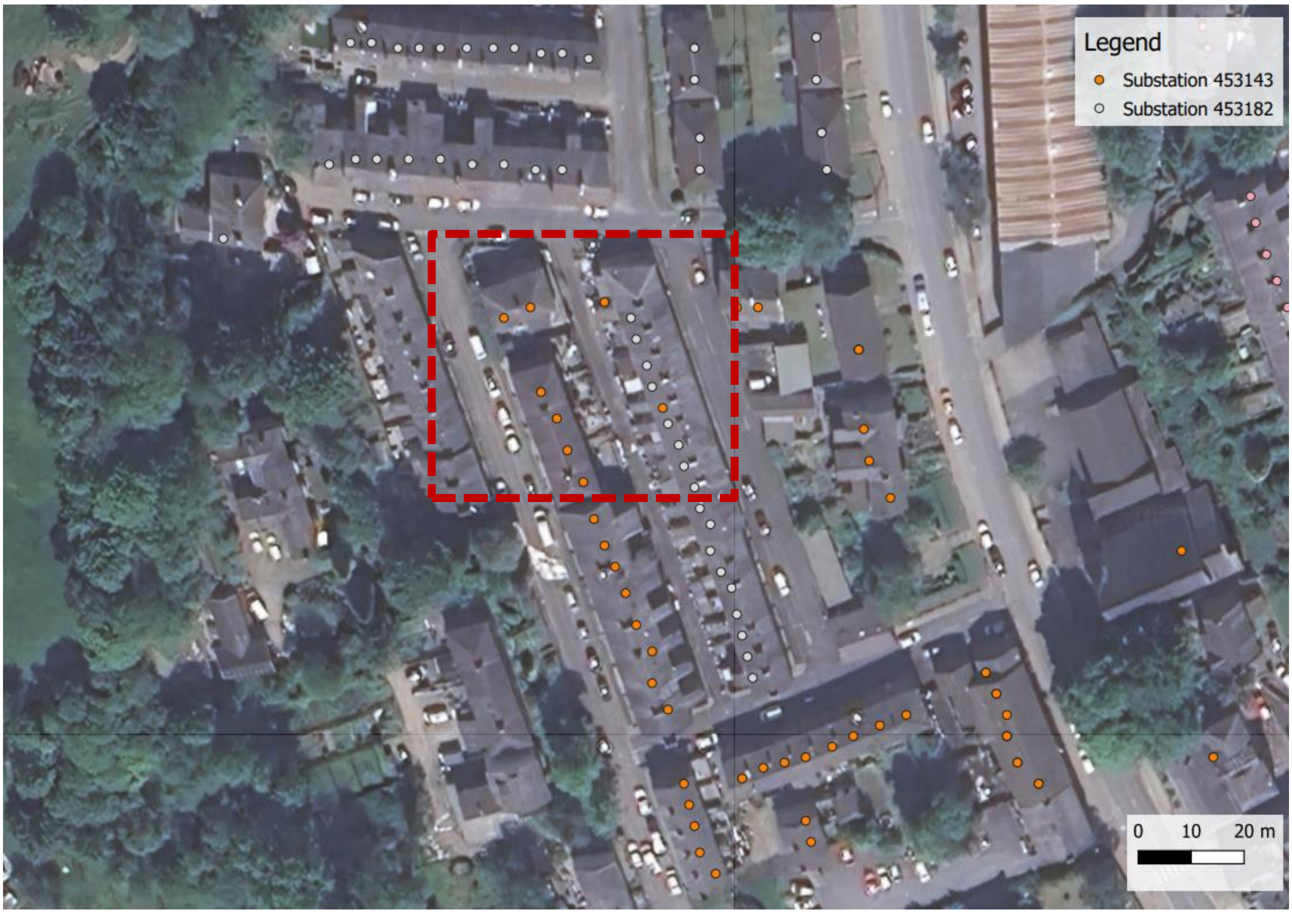

Figure 3-3 Properties tagged with their corresponding transformer

Figure 3-3 demonstrates the importance of including DNO data in the early planning stages. Highlighted is a street of terraced homes fed by two different transformers. Despite the properties proximity to each other they would lie in different electrical clusters. This is important to identify as different transformers will have different constraints and NZT may not be deployable to all households on a street due to the electrical infrastructure constraints. A community engagement strategy could hinge on this differentiation as the 'energy community' engagement strategy needs to understand where and when heat pumps could be installed. In addition, any active network management interface may be separately deployed via different substations.

Table 3-1 Transformer Summary

	Total Properties Connected	Terraced Properties Connected	Percentage Terraced properties	Capacity	Load	Headroom
453143 BOSTON RD	136	78	57%	533.33kVA	37.9kVA	495.433kVA
453177 STANLEY MOUNT	210	137	65%	500kVA	36.33kVA	463.67kVA
453182 UNDERBANK CL	221	169	76%	500kVA	40.29kVA	459.71kVA

3.3.2 Low Voltage Data

To model the capacity available more accurately at property level and to determine individual property suitability for the deployment of NZT more granular low voltage data will be required. ENWL have provided LV data in the form of shapefiles and initial analysis has been conducted to establish the quality of the data.

Figure 3-4 Low Voltage Shapefile provide by ENWL

Figure 3-4 show to location of the service points and LV conductors provided by ENWL. To model the capacity available at each property information on the cable length, size and construction is required. To establish the property level capacity for an entire cluster index homes would be modelled. This could include modelling the properties closest and furthest away from the substation for each property archetype. This could then be used to provide insight into the property level capacity available for an entire cluster.

The data provided by ENWL contains cable size however, cables that appear to be connected offer differ in size and it is not clear why this would be the case. In theory, the cable lengths could be measured using the shapefile provided however, the lines representing the LV conductors are often found to be split into multiple parts which would make measuring the cable length to an individual property difficult and time consuming. It is also unclear whether to LV cables provided feed directly into the properties as there are no cables feeding into the service point.

To further establish the electrical infrastructure within an area an area schematic should be referred to. Once reviewed the additional data required by ENWL to estimate the capacity at property level can be established. Work should also be conducted to confirm the cable size defined in the model. It should be noted that while with additional data sets from ENWL the capacity on the cables and the transformer can be identified the capacity of the household distribution board an breaker size cannot be identified. This means that although modelling results may show capacity at an individual property the household distribution board and breaker may not have capacity. However, consumer unit upgrades are not difficult and costs are low when compared to the deployment.

3.4 Community Data - Indices of Deprivation

Understanding the community is vital for a successful NZT approach, and this includes fuel poverty, engagement, any blockers, and the communities needs and priorities. For alpha, open-source data has been used. However, there is significant value in integrating more granular community data in subsequent phases.

Figure 3-5 highlights the Indices of multiple deprivation (IMD) for Rossendale. IMD is provided at LSOA level and is an open-source dataset which provides a measure of relative deprivation across each of the constituent nations in UK. 1 indicates areas which more deprived and 10 indicates areas which are less deprived. Since the dataset is available across all of England, Wales and Scotland and IMD could be used in the planning approach to identify and target areas which are more likely to be fuel poor and could benefit from the Net Zero Terrace scheme.

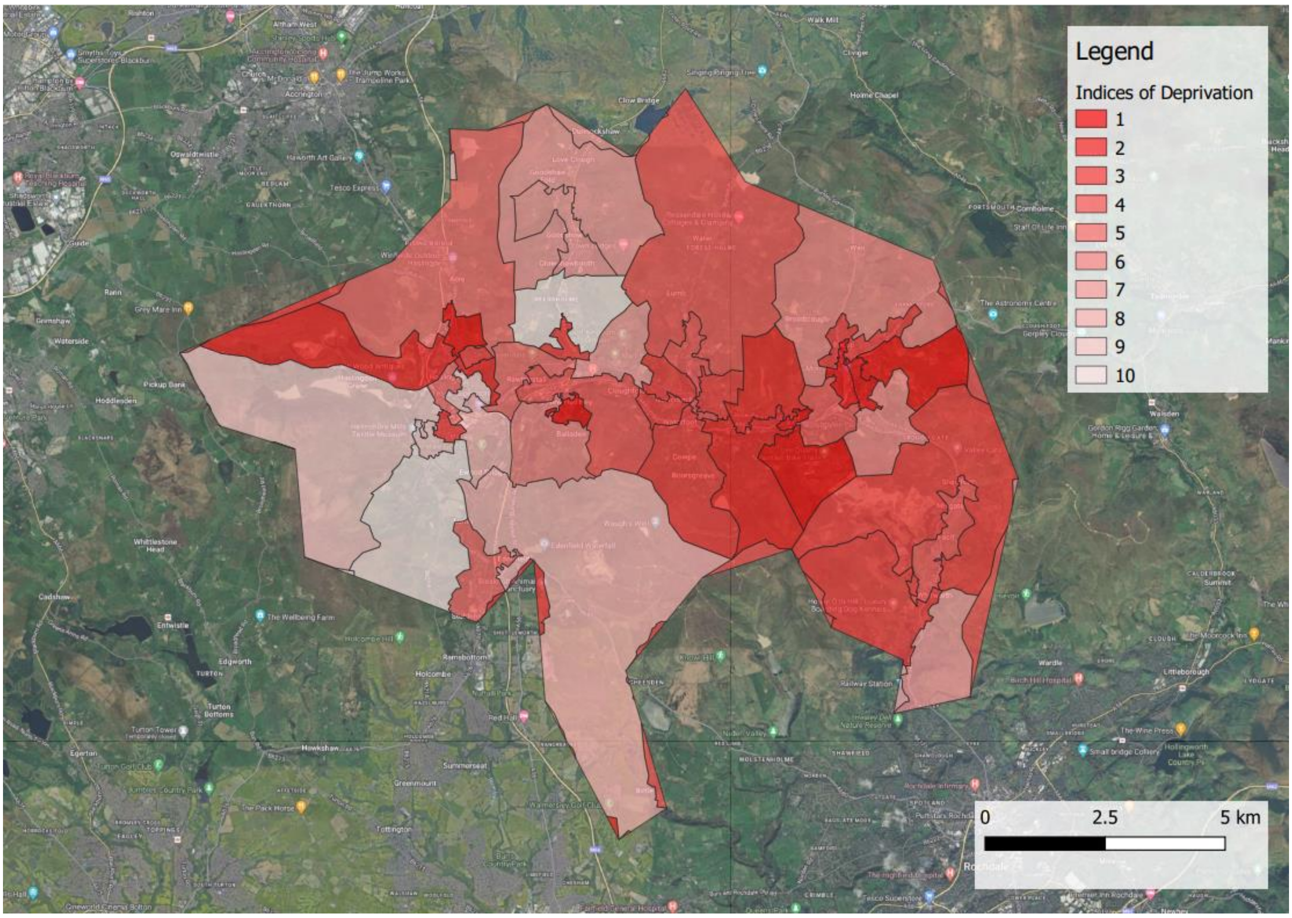

Figure 3-5 Rossendale Indices of Deprivation

Figure 3-6 highlights the properties mapped to secondary substation overlayed with IMD. Street A (target area) is in a relatively deprived area with IMD 3. However, note how other properties on the same transformer are in an area with IMD 1, which is the most deprived in the countries. Using IMD in conjunction with community groups and others who have strong knowledge of local context targeting can be improved.

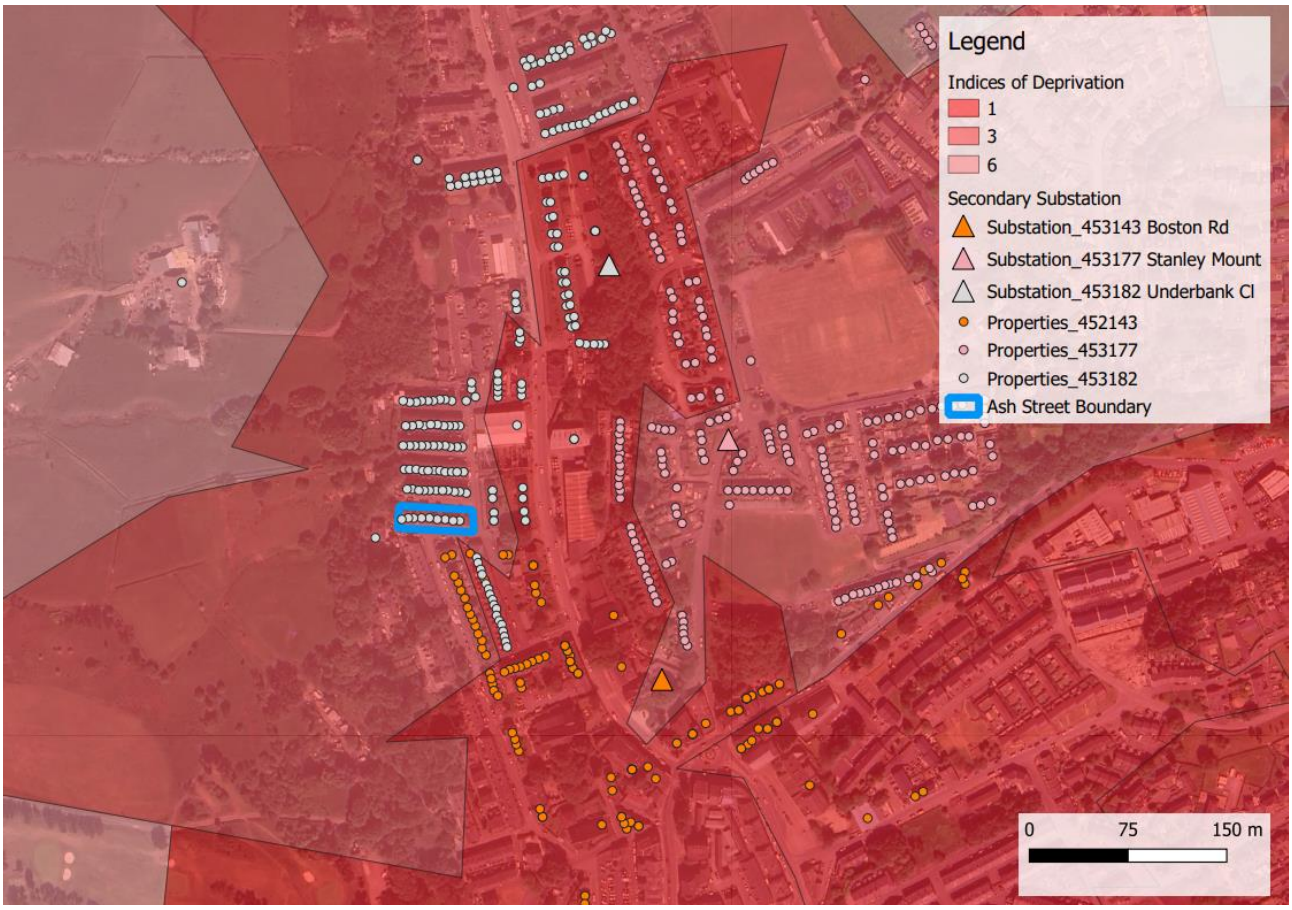

Figure 3-6 Properties mapped to secondary substation overlayed with indices of multiple deprivation

3.5 Building Stock data

The decarbonisation of the building stock, specifically heat, is often the single greatest challenge for an urban area. As such, building stock information is important for cluster identification and infrastructure sizing. Understanding what data that currently is available and what approach is working well, as well as limitations and weaknesses will help inform what analytical methodology that will be most suitable to bring forward.

For validation of the benchmarked demand, domestic data exists at postcode and LSOA and aligns well with regional and national analysis.

3.5.1 Data Fields

Improved data exists for the domestic building stock (e.g. more EPCs and finer resolution summary data to enhance models). As the volume of domestic properties will be very large a prioritisation of key fields is needed. For the initial screening the following data fields will be required:

- Standard geographic identifier – *e.g. UPRN, TOID and location*
- Property type – *e.g. terraced, detached, flat*
- Total floor area

This design note focuses on the initial screening with a large-scale context and associated issues. However, for completeness, the following fields will be considered in later stages of the screening.

- Property age
- Property tenure
- Main heating system – *ensure this includes communal systems as a separate option*
- Main fuel type
- Wall type – *ideally with level of insulation, e.g. solid brick or cavity*
- Wall insulation – *indication of wall insulation, e.g. filled cavity, internal or external wall insulation*
- Loft insulation – *roof type may also be useful but not vital*
- Glazing type

- Energy demand (annual) – *ideally split by space heat, domestic hot water and small power but not required. For Parity this was inferred via energy bill split i.e. consumption ratio.*
- Current EPC rating
- Potential EPC rating
- EPC lookup code – *if available*
- Current CO2 emissions
- Heritage status – *listed building or in a conservation area*

These are based on the likely level of information available, ideally specific U-values would be available but this is not considered a viable ask given the base data.

Domestic data at property level suffer from data sharing issues. Our experience on previous projects in dealing with multiple partners and displaying data at several tiers through a digital interface is that there need to be sufficient time in place to set up data sharing agreements. Reaching an agreement can take months, and it is crucial for the next stages of the project that this already is considered. Displaying point data can be a significant GDPR issue for domestic properties.

3.5.2 House Deployment Readiness

An EPC score can provide a measure for defining household readiness. An EPC score provides a score for the properties energy efficiency with A being the most efficient and G being the least. A higher scoring can indicate a reduced heat loss from households which could therefore result in a reduced heat demand. This could provide an indication into which households achieve a sufficient standard of energy efficiency to install a heat pump, and which households require upgrades to improve efficiency. It has been assumed that properties with energy efficiency rating of A, B or C can install a heat pump with very little to no energy efficiency upgrades (this will be explored further in beta). Properties with EPC scores of D or below are likely to require moderate retrofit upgrades to reach a sufficient level of energy efficiency to install a heat pump.

Figure 3-7 shows a comparison of the EPC scores found across all the terraced homes in Rossendale, as defined in the parity data. It can be seen that the majority of homes have EPCs of D with the number of homes reducing towards each boundary.

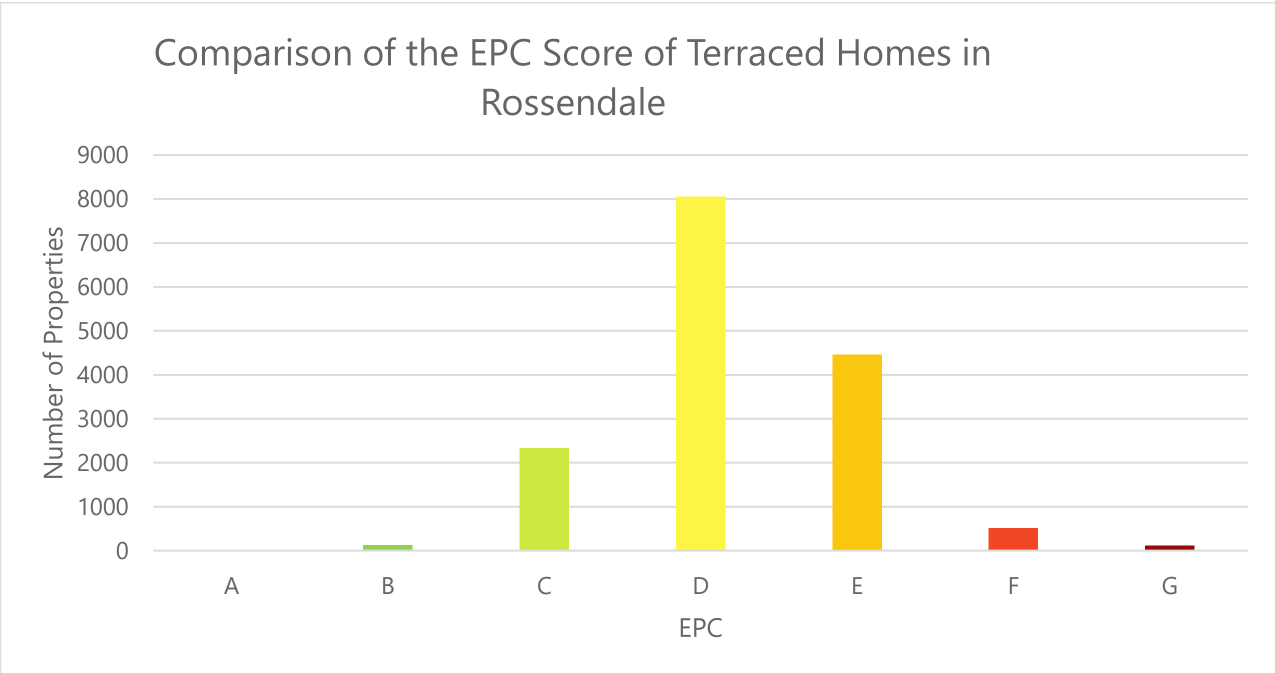

Figure 3-7 Comparison of the EPC scores found across terraced homes in Rossendale

Figure 3-8 provides an example of how the different EPCs are distributed across Rossendale. A significant number of EPC D and EPC properties are observed across the sample area.

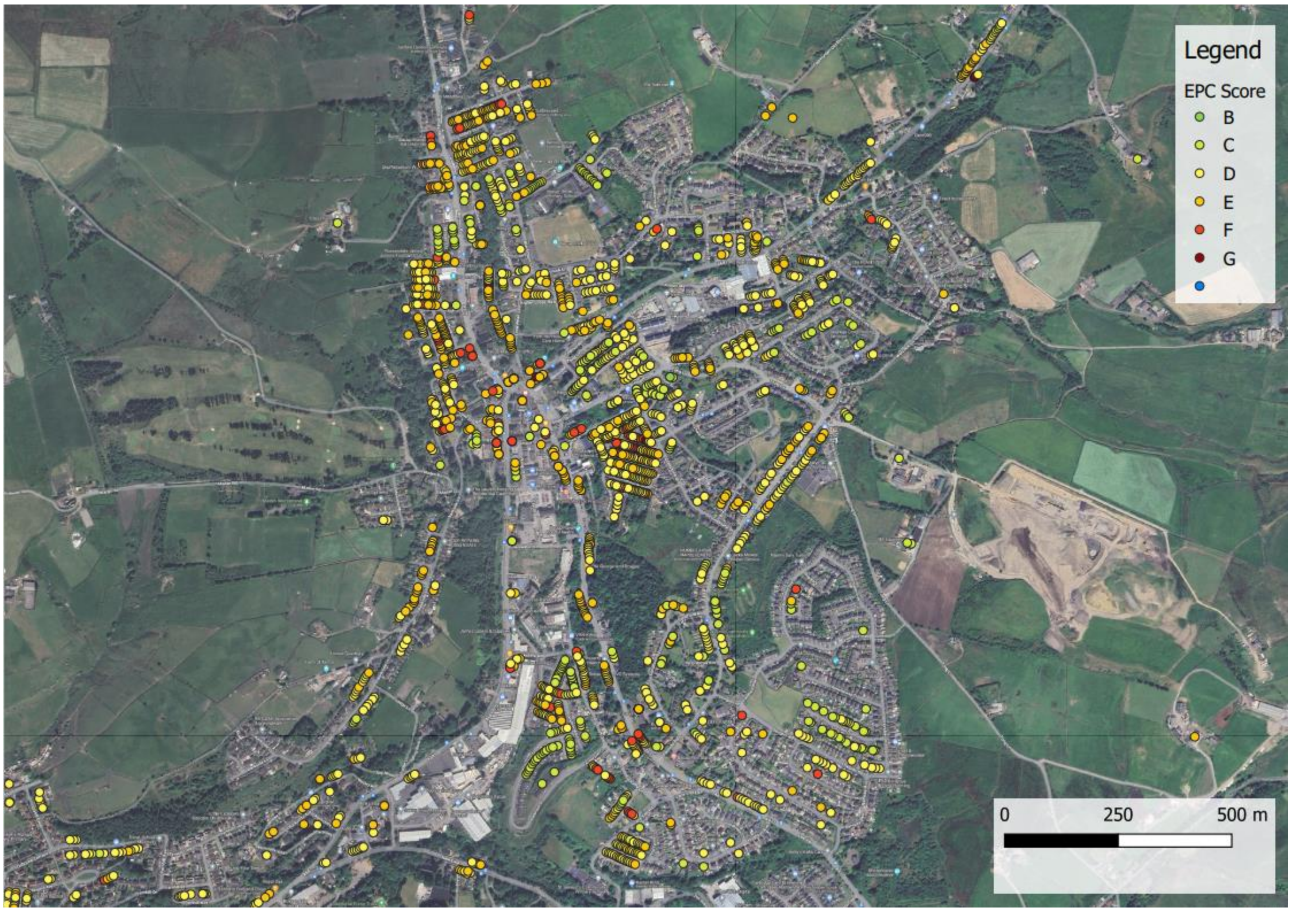

Figure 3-8 Example of the EPC scores found in terraced homes across Rossendale

The above figures suggest that the majority of properties in Rossendale do not meet a sufficient standard of energy efficiency to install a heat pump in their current state (based on the assumption EPC D or below). Only 15.8% of the properties in Rossendale could currently be fitted with a heat pump if an EPC score is used to indicate readiness. This suggests that substantial levels of retrofits are required across Rossendale to deploy the NZT scheme. However, it must be noted that an EPC is just one measure and other factors should be considered when defining a household's readiness for NZT deployment. Additional measures, such as building surveys, could be used to improve confidence in the definition of household readiness.

3.5.3 Retrofit Analysis

An analysis was performed on building stock data to estimate the SAP score required through retrofitting, to ensure that a 6kW heat pump can meet the house's energy demands. This was performed by taking an assessment of the current energy demands (calculated through stock data and building physics concepts).

This analysis found that a cut-off of 7500kWh/yr space-heating is required for the retrofit. Table 3-2 highlights the corresponding SAP scores at each house size to meet the space-heating requirement.

Table 3-2 SAP score at retrofit per floor area

Total floor area (m^2)	SAP score at retrofit
>124	81-83
74-124	74-76
61-74	69-71
50-61	67-69
<50	57-59

The summary statistics of all terraced households requiring retrofitting is show below. Please note the maximum annual space heating (kWh/m^2) does not necessarily correlate to the maximum annual space heating (kWh)

Table 3-3 Summary statistics - terraces requiring retrofit, Rossendale

	Floor area (m2)	Space heating per area ((kWh/m2)/yr)	Space heating (kWh/yr)	Space heating + hot water (kWh/yr)	Heat loss coefficient (W/°C)	SAP score
Mean	88	181	16066	21906	348	54.8
Min	11	32	1567	2672	58	-9.1
Q1	61	155	10017	14188	221	50.1
Q2	69	183	13451	19285	294	56.0
Q3	109	206	19916	26826	434	60.9
Max	489	377	83288	146997	1674	81.4

3.5.4 Data Issues

Issues are highlighted in the context of domestic data with focus on how this data will be used for scaling the NZT methodology to a regional or potentially GB level.

Figure 3-9Figure 3-9 shows the OS building outlines with the terraced properties, as defined in the parity data, shown in yellow. From an initial visual assessment, terraced properties are not accurately recorded in the benchmarked data. The visualisation highlights the inaccuracies found within the benchmarked data. Current data sets even under licence can only do so much. There are techniques to improve and cross correlate different data to improve accuracy which will be explored under Beta. Below are some examples of issues:

- Commercial units highlighted as a terrace property
- Semi-detached properties marked as terraced properties
- Terraced properties not being recorded (particularly issues with end of terraces being marked as semi-detached properties)

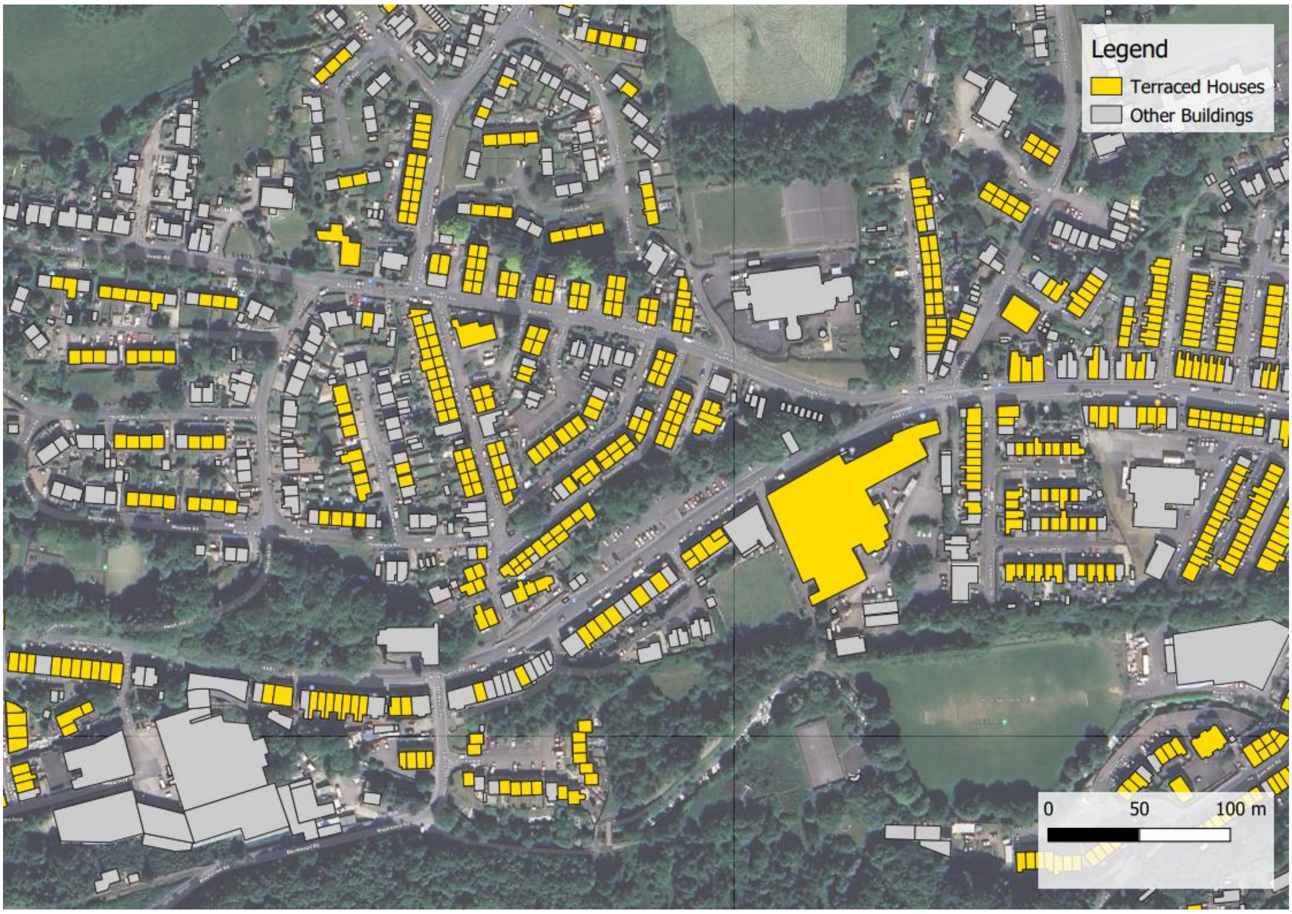

Figure 3-9 Properties defined as terrace by Parity

These inaccuracies in the data are seen across the entirety of Rossendale and result in inaccuracies which provide a reduced level of confidence with any modelling done with the data. For example, the discrepancy between actual terraced homes and modelled terraced homes becomes an issue when looking at how many terraced properties are connected to which substation and associated headroom. This problem is twofold:

- Terraced properties being labelled as another property type: *By not capturing all terraced properties, there is a risk that when estimating the additional load and generation associated with the deployment of the NZT scheme the total headroom required to deploy the scheme at a transformer cluster is underestimated. This may result in targeting and engaging clusters where there is not sufficient headroom and large infrastructure upgrades would be required to deploy the scheme and.*
- Other property types being labelled terraced properties: *By overestimating the number of terraced properties connected to a single transformer, load and generation associated with the scheme could be overestimated. This could result in the identification of some transformer clusters as unsuitable due to the assumption that there is insufficient headroom, however, as the number of terraced homes has been overestimated this may not be the case.*

For the example shown in Figure 3-9 manual visual checks were used to establish the inaccuracy of the data however, it is not possible to do this at scale.

Figure 3-10 highlights properties in Bacup that are marked as terraced properties in the dataset. It can be assumed that the accuracy for properties with existing EPC will be higher than those that have been infilled by parity. However, it is worth noting that there are several instances where the data is incorrectly infilled by the EPC assessor. For example, several terraced homes are filled in as semi-detached and vice versa. This creates issues in the modelling, as it means that the number of terraced homes in an area as displayed by Parity does not correspond with the number of terraced homes that exist in the area. The data providers reliance on EPC can therefore cause issues if no additional validation is included and must be considered when using the data.

Figure 3-10 Data origin for terraced properties

Figure 3-11 illustrates the split between the heating technologies used for the terraced properties in Bacup. Note how one area have a good split between gas and electric. Targeting this combination could be beneficial in fuel poor areas, as properties on direct electric can get a reduced bill by buying in to the NZT approach.

Figure 3-11 Current heating technology for terraced properties

3.5.5 Data Validation

Further data sets are required to validate the building stock data and to identify any issues with the data. The necessary data sets to validate the building stock data will be explored further and defined in the Beta phase. During Alpha limited data validation has been carried out.

The planning approach has looked to identify and target properties currently heated by mains gas or electricity. Figure 3-12 shows how this data has been validated using the Postcode level gas statistics: 2021[1], published by the Department for Energy Security and Net Zero (DESNZ). This validation has compared the number of domestic properties with gas as the main fuel type, as defined in the parity data, and with the number of gas meters, as defined by DESNZ, at postcode level. This has been used to determine the level of confidence when identifying the main fuel type of a property.

As shown in Figure 3-12 it was found that for 50% of the postcodes the number of properties with gas as the heating type, as defined by parity, and the number of gas meters defined by DESNZ was consistent. For the vast majority of postcodes the difference in the number of properties with gas was less than 20%. This provides a good level of confidence in the parity data for identify properties heated by gas.

[1] https://www.gov.uk/government/statistics/postcode-level-gas-statistics-2021-experimental

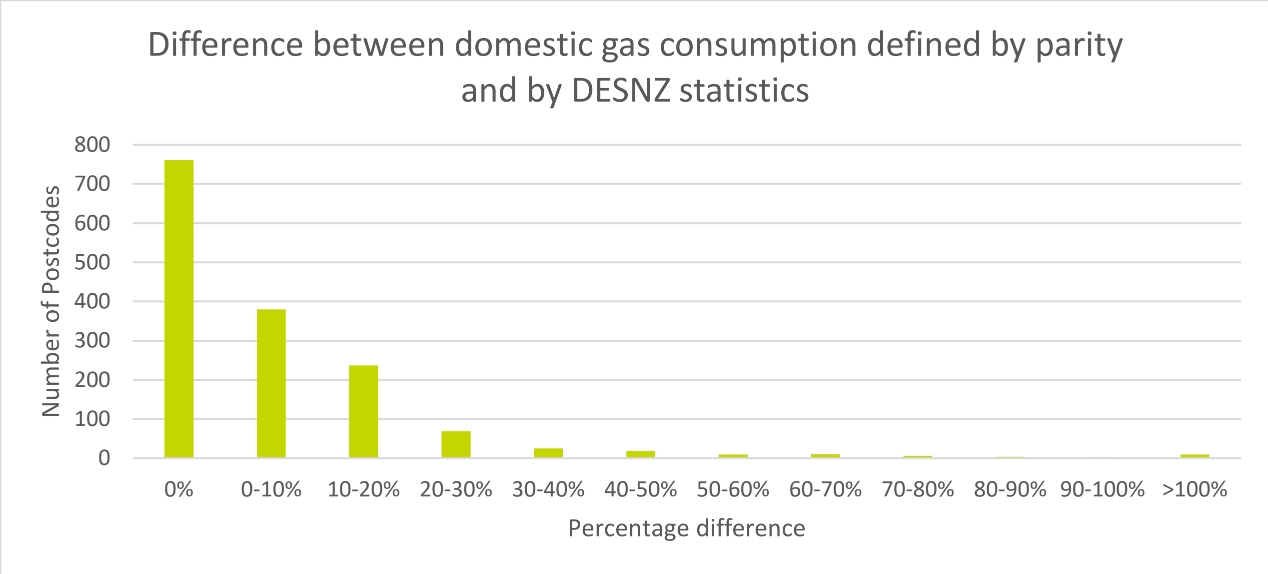

Figure 3-12 Validation of building stock data fuel type

Postcode level gas statistics were not available where the number of gas meters for a postcode was less than 5 or the top 2 highest consuming meters accounted for more than 90% of the consumption. For Rossendale, over 30% of the postcodes were not include in the gas statistics. For the postcodes which were not included, it was found that in only 8% of cases were there 5 or more properties in the parity data with gas as the main heating type. This further improves confidence in the parity data and for identify gas heated properties.

3.6 Renewable Energy

3.6.1 Large Scale Renewable Assessment

A high-level assessment has been conducted across the borough of Rossendale to screen for suitable sites for large scale renewable deployment. Large scale renewable site could provide an investment opportunity for the community energy companies and the exports could be used to reduce consumer bills. When considering locations suitable for large scale wind numerous environmental and external factors have been considered. Sites with hard constraints meaning, sites where renewable development would not be suitable were screened out, and remaining were the sites where large scale renewables could potential be deployed. The hard screening criteria's for the sites were:

- Land use – *e.g. buildings, roads and rail, trees, playing fields, development site*
- Topography – *tend to screen out high slope angles and undertake shading analysis*
- Agriculture land grade (exclude 1 and 2), grades 4 and 5 are used as a positive soft weighting
- Environnemental contraints – *SSSIs, RAMSAR etc.*
- Historic constraints – *e.g. battlefields, parks and gardens*
- Screening out of areas uses ~30 datasets
- Hard screening factors are adapted for wind

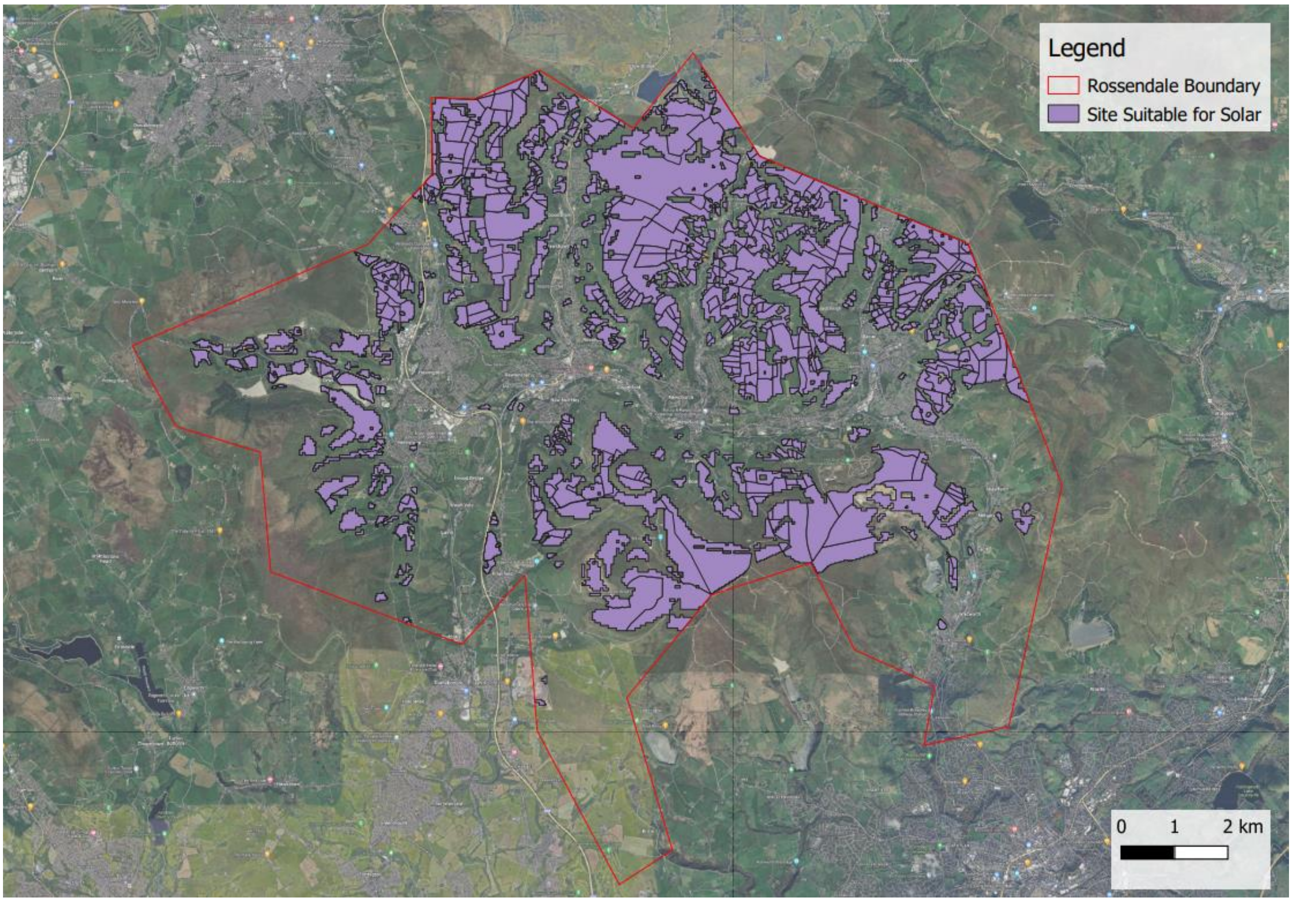

Figure 3-13 Suitable location of Ground Mounted Solar Sites Exceeding 500kWp

Figure 3-13 shows to sites suitable for ground mounted solar deployment where installed capacity could exceed 500kWp. Many of the suitable sites are concentrated to the north of the borough however, reasonable opportunity for development exists throughout most of the borough. Limited opportunity for solar development is seen in the south and southeast of the borough. The availability of large-scale renewables could influence the clusters selected for deployment as the opportunity to private from the site to nearby NZT homes could reduce bills for the community. It should be noted that while the above sites have been identified as potentially suitable for solar development a more in-depth study would be required to confirm suitability. The ownership of the land identified as suitable has also not been considered and this could impact the lands availability for development.

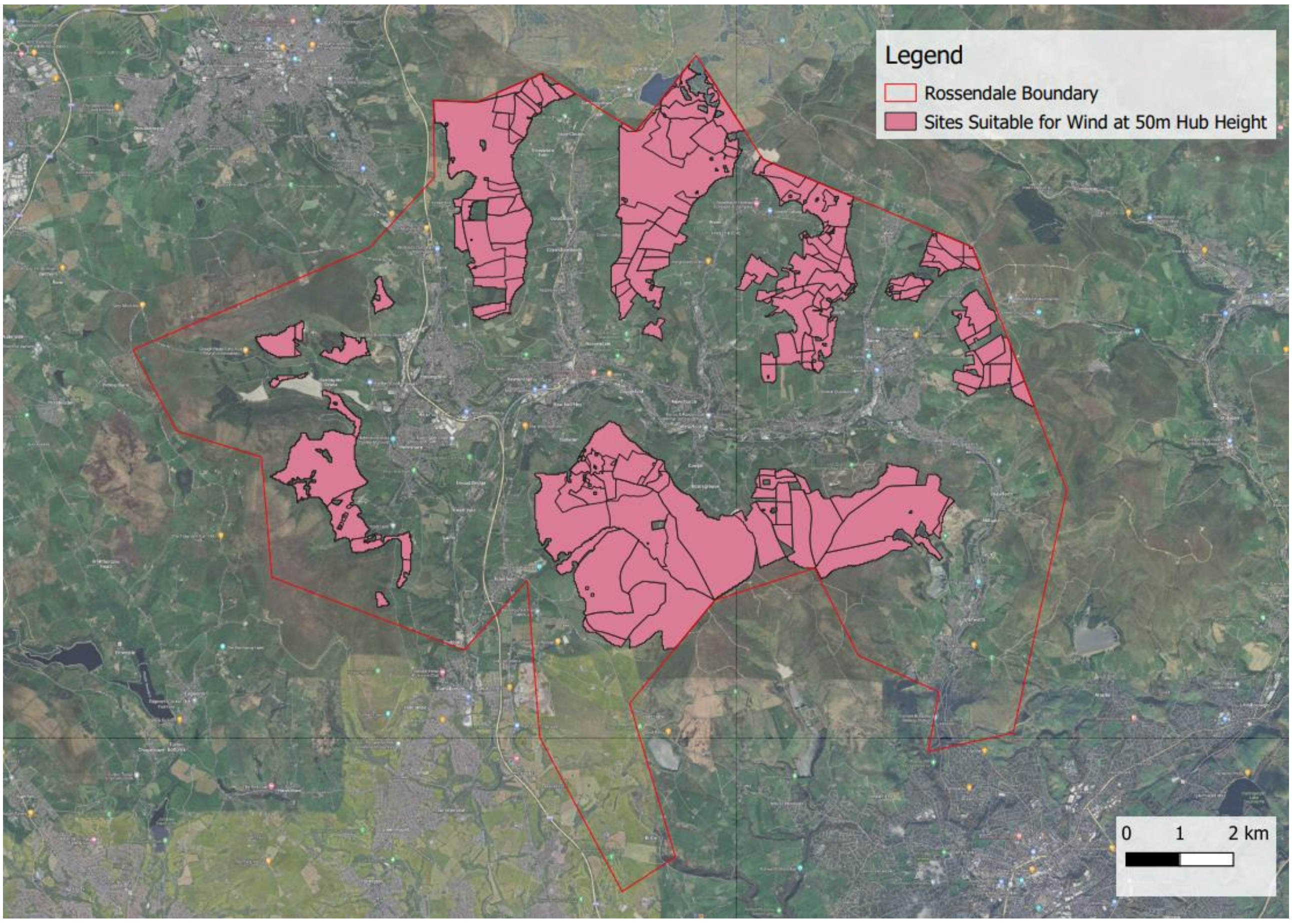

Figure 3-14 Suitable Location of Wind Generation with a Hub Height of 50m

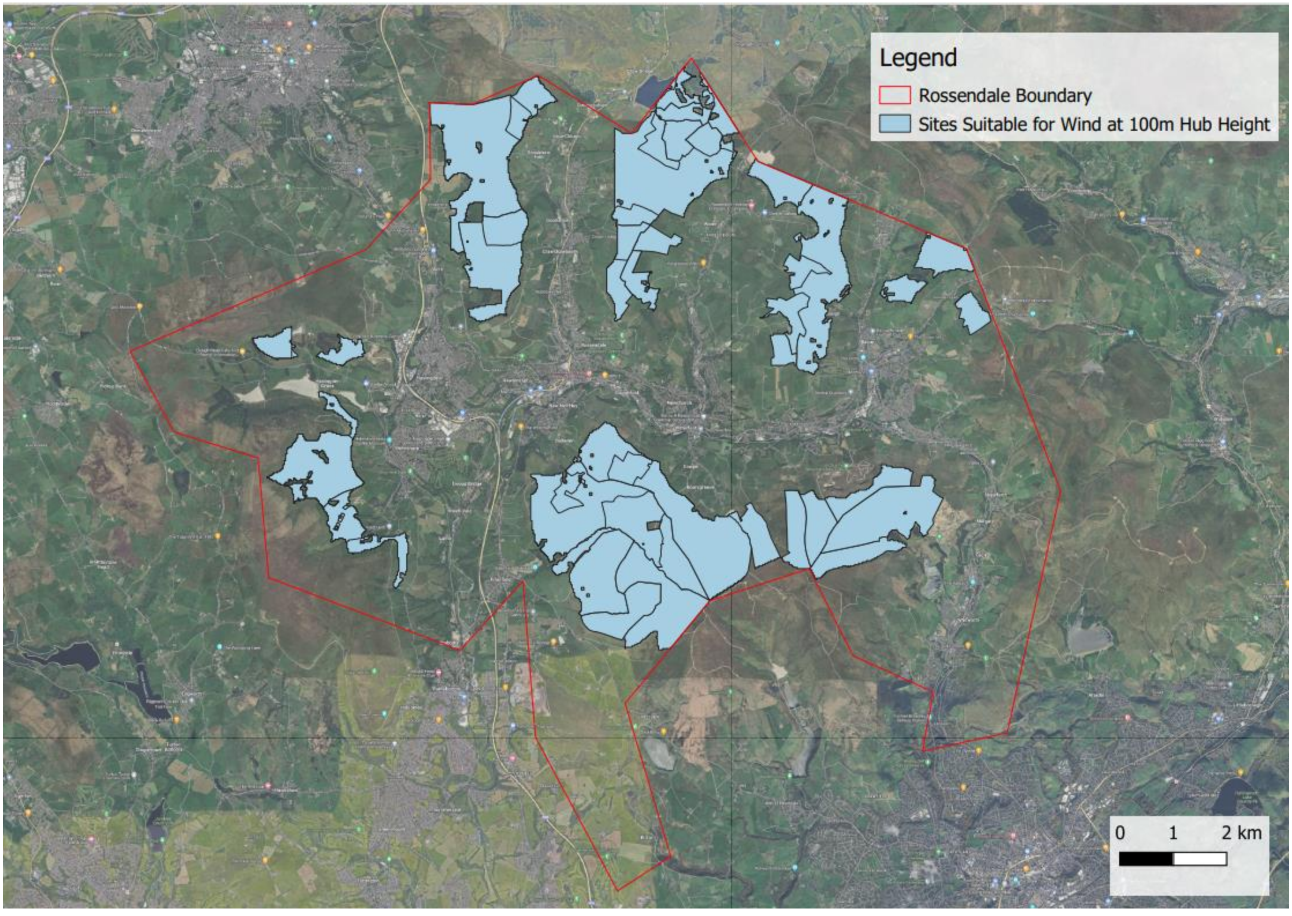

Figure 3-15 Suitable Location of Wind sites with a hub height of 100m

Figure 3-14 and Figure 3-15 demonstrated the potential for wind generation development at a hub height of 50m and 100m across the borough of Rossendale. Wind generation provides significantly less opportunity for development when compared with solar, however, the site identified could be expected to allow for increased generation capacity. Several opportunities for wind generation development is present in the North and centre of the region. The proximity of the suitable sites to terraced home cluster should be explored to assess the suitability for private wire imports. This could improve a cluster suitability if there is any opportunity to further reduce energy bills.

3.6.2 Solar PV for Street A

A more in-depth solar PV assessment was carried out for solely Street A using PVsyst. Figure 3-16 show 3D and 2D (birds-eye) views for two solar PV options that were modelled across the terraced street. The following options are considered:

- Option 1 – *solar PV installed across the entire length of rooftop on the street*
- Option 2 – *property ownership boundaries are respected between the properties, leading to the gaps shown between the arrays.*

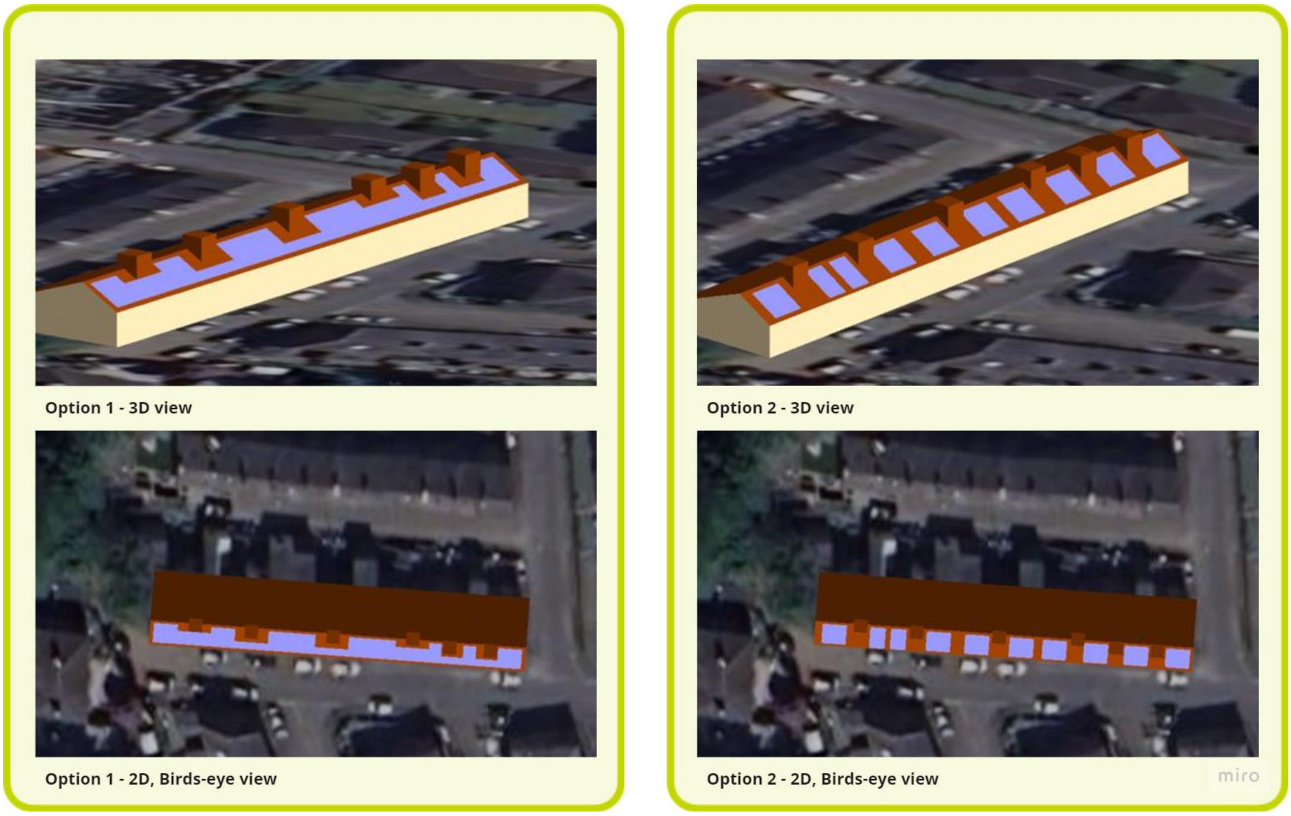

Figure 3-16 Solar PV on Street A: Option 1 and 2

A nominal peak capacity of 28kWp and 22.4kWp were calculated/estimated for option 1 and 2 respectively. Consequently, this results in a 20% reduction in capacity when respecting the building ownership boundaries. It must also be noted that these values are based on an exemplar 400Wp solar panel from a reputable manufacturer and that these nominal capacities may vary depending on the panel used.

4 Actions for Beta

The work completed under alpha highlights the need and the benefits of a co-planning approach. There are a several actions that are required, which are detailed in this section.

4.1 Data Validation and Inclusion

During alpha some work has been done to validate the data sets used. However, during Beta methods for effectively validating data sets need to be found. Validating property type could be done through insurance or census data, and LiDAR data could be used to validate property size.

There is a huge value to validate provide insights both to the building stock and for the DNO with data collected as part of the community engagement. For example, insights such as loft conversion and information related to looping can play a key role in improving accuracy of relevant retrofit offer and a reduce potential delays. During beta the inclusion of indices of deprivation and other social parameters, such as fuel poverty, should be considered. This could influence the targeted clusters as NZT looks to reduce fuel poverty across the UK through offering an affordable low carbon solution.

As part of the data validation there are other datasets that would be relevant to include, such as data provided by MCS and Smart DCC. MCS data will provide insights into which properties that already have low carbon technologies installed, which is useful for understanding the integration of modelling and provides insights for sizing of equipment in the local area. It is worth noting that from a fuel poverty perspective that this is not the most relevant dataset. Smart DCC data, however, have a clear link to fuel poverty and exploring the integration of their datasets in next Beta will be valuable.

4.2 DNO Data

The data provided ENWL under the alpha phase has allowed for identification of the electrical clusters by mapping properties to their corresponding transformers. During the beta stage more in depth analysis should be carried out to establish the most suitable electrical cluster based on infrastructure capacity. Initial modelling should look to identify the expected load associated with the deployment NZT at each of the properties and aggregated this up to transformer level. Here the identification of transformer where sufficient capacity exists to deploy NZT will be possible. Integrating the load information with forecasting and the distributed future energy scenarios will provide insight into whether any capacity constraints are expected in the future. Where it is identified that there is not sufficient capacity for the deployment of NZT options for flexibility should be explored. Where deployment is still not possible with flexibility work could be done on identifying the feasibility of infrastructure upgrades. The inclusion of LV data will allow for more accurate modelling at property level. During beta work will be done to establish the remaining data sets required to model LV level capacity and a modelling methodology will be developed to identify capacity at scale.

4.3 Renewable Assessment

During NZT Alpha a high-level large scale renewable assessment has been carried out. For Beta the benefit of having large scale generation opportunities close to targeted clusters should be identified and its place in the planning approach more clearly defined. Interlinking this with the energy model and TEM work packages would allow for modelling of the energy consumption expected for off-site renewables and the economic feasibility could be assessed.

4.4 Digital Platform

The use of a digital twin could provide an interactive platform for multiple parties to consolidate and visualise data. For example, all maps and graphs in this design note could be available to click through and overlay, as part of the digital twin. This will significantly improve the sharing of data and analysis between partners, which will support in gap identification and co-planning. Integrating live network data and load flow into our digital platform combined with data collected from the community highlights the benefit of the common source of truth. It could also improve consumer engagement, by introducing gamification and interaction with the data in an engaging environment.