WILLESDEN GRID SUPPLY POINT: STRATEGIC DEVELOPMENT PLAN

Our network serving communities across West London

Draft for consultation

07/2025

Scottish & Southern Electricity Networks

CONTENTS

1. EXECUTIVE SUMMARY

SSEN is taking a strategic approach in the development of its distribution networks. This will help to enable the net zero transition at a local level to the homes, businesses, and communities we serve. Our Strategic Development Plans (SDPs) take the feedback we have received from stakeholders on their future energy needs to 2050 and translate these requirements into strategic spatial plans for the future distribution network needs. This helps us transparently present our future conceptual plans and facilitate discussion with local authorities and other stakeholders. The overall methodology and how it fits into our wider strategic planning process is presented in the Strategic Development Plan methodology.

The focus area of this SDP is that supplied by Willesden Grid Supply Point (GSP) in West London, shown below.

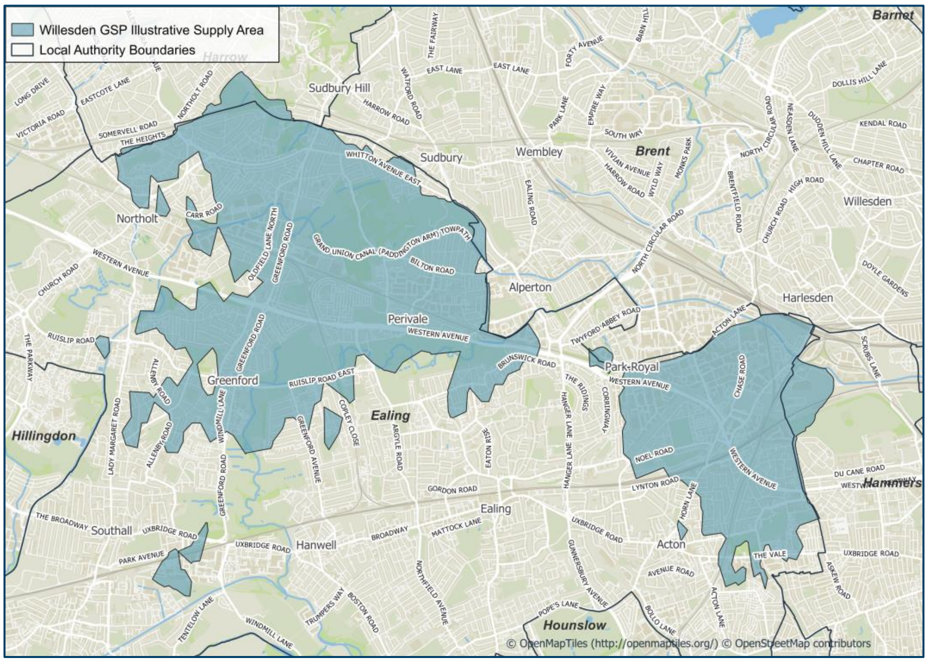


Figure 1 Area of focus for this SDP.

This report documents the stakeholder led plans that are driving net zero and growth in the local area, the resulting electricity demands, and the network needs arising from this. Plans across Ealing and the Old Oak Common and Park Royal development corporation (OPDC) have been considered in preparation of this plan. Some reinforcement work has been triggered in this area through the Distribution Network Options Assessment (DNOA) process.

This SDP utilises the Distribution Future Energy Scenarios (DFES) to understand the pathways to a 2050 network that can support net zero and growth in the local economy. Recommendations from this report outline the initial steps that we believe should be taken on that pathway to develop the network in an efficient and stakeholder-led way.

2. INTRODUCTION

The aim of this report is to demonstrate how local, regional, and national targets link with other stakeholder views in the area to provide a robust evidence base for load growth out to 2050 across the Willesden Grid Supply Point (GSP) area. A GSP is an interface point with the national transmission system where SSEN then take power to local homes and businesses within a geographic area. Context for the area this represents is shown above in Figure 1. This report was produced in alignment with SSEN's Strategic Development Plan methodology.[1] The methodology report outlines the process that we follow in the rollout of our Strategic Development Plans and should be referred to alongside this report.

To identify the future requirements of the electricity network, SSEN commission Regen to produce the annual Distribution Future Energy Scenarios (DFES). The DFES analysis is based on the National Energy System Operator (NESO) Future Energy Scenarios (FES) while accounting for more granular stakeholder insights from agencies such as local authorities and new demand and generation connection applications. The DFES provides a forward-looking view of how demand and generation may evolve under four different scenarios as we move towards the national 2050 net zero target, these scenarios are shown below in Figure 2.

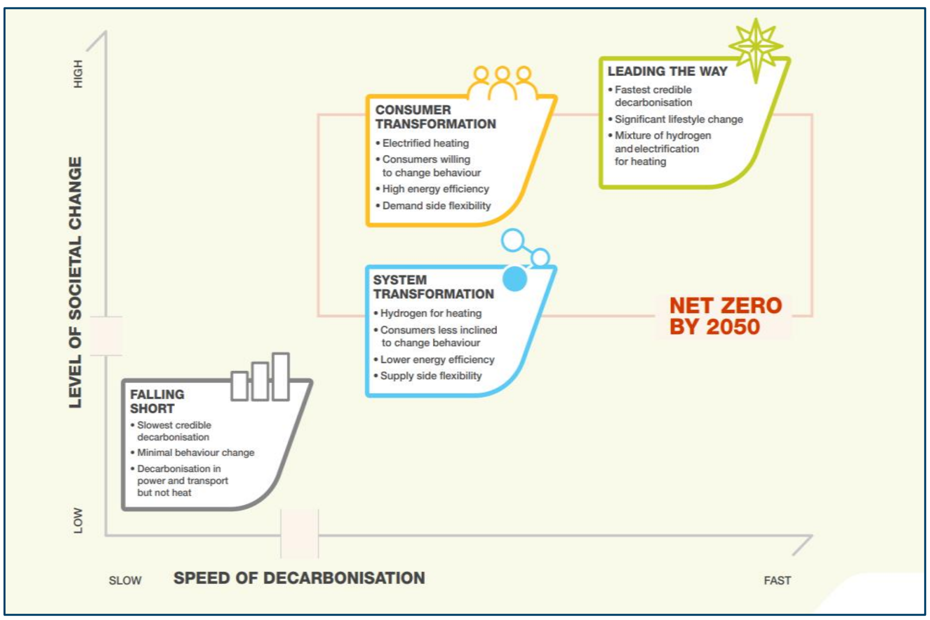


Figure 2 DFES 2023 Scenarios

Using the DFES, power system analysis has been carried out to identify the future system needs of the electricity network. These needs are summarised by highlighting the year the need is identified under each of the four scenarios, and the projected 2050 load. Here, system needs are identified through power system analysis using the DFES 2023 Consumer Transformation scenario in alignment with evidence gathered in preparation of the SSEN ED2 business plan. We also model across the other three scenarios to understand when these needs arise and what demand projections should be planned for in the event each of these scenarios is realised.
The DNOA process will provide more detailed optioneering for each of these reinforcements, improving stakeholder visibility of the strategic planning process. Opportunities for procurement of flexibility will also be highlighted in the DNOA, to cultivate the flexibility markets, and to align with SSEN's flexibility strategy.

1 Strategic Development Plan Methodology - January 2025

3. STAKEHOLDER ENGAGEMENT AND WHOLE SYSTEM CONSIDERATIONS

3.1. Local Authorities and Local Area Energy Planning

The main local authority that is supplied by Willesden GSP is Ealing as shown in Figure 3. The development plans for these local authorities will have a significant impact on the potential future electricity load growth on SSEN's distribution network. As such, it is vital for SSEN to engage with these plans when carrying out strategic network investment.

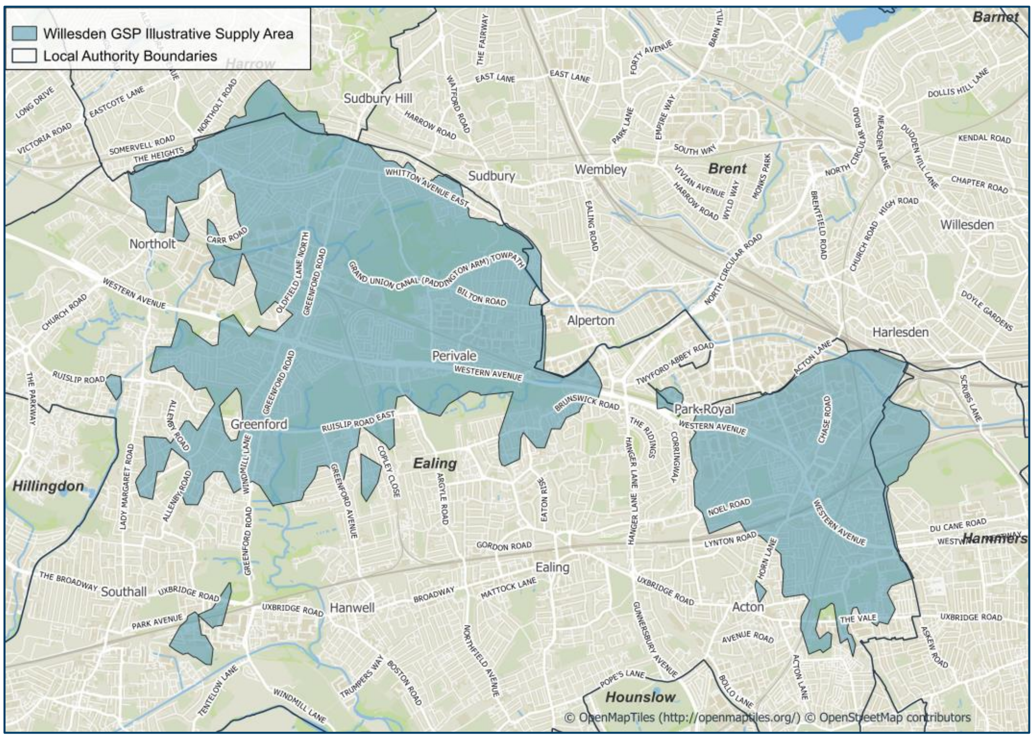


Figure 3 Area of focus for this SDP.

3.1.1. Ealing

Over the past decade (2011 to 2021) the population of Ealing increased by 8.5% to approximately 367,1004.[2] The borough is strategically placed with Heathrow Airport to the West and the new High Speed 2 (HS2) terminus at Old Oak Common opening in 2030 to the North-East of the borough. Five new Elizabeth Line stations opened across the borough in 2022 in addition to the existing underground and mainline stations.

Ealing council have published multiple action plans and strategies highlighting their net zero ambitions, including their target to become carbon neutral by 2050.[3]

---

2 Census 2021, January 2023, How life has changed in Ealing: Census 2021.

3 Ealing Council, January 2021, Climate and Ecological Emergency Strategy

3.1.2. Old Oak and Park Royal Development Corporation

The Old Oak and Park Royal Development Corporation (OPDC) is a Mayoral Development Corporation (MDC), established by the Mayor of London to secure the regeneration of the Old Oak opportunity area, spanning land in three boroughs – Ealing, Brent and Hammersmith & Fulham. The area includes Park Royal industrial estate, the Old Oak development area around the new High Speed 2 Old Oak Common station and protected land at Wormwood scrubs.[4]

SSEN have supported the development of the Local Area Energy Plan (LAEP) for the area by sharing network data. Outputs from the LAEP have informed the DFES projections to inform long-term strategic planning of the distribution network in the area.

3.1.3. Specific whole system considerations

As a densely populated urban area, the focus area of this report is well suited to district heating. We are already aware of some projects in the area that are progressing this (for example OPDC). Where the energy source for these district heat networks is electrified, there is clearly a requirement on electricity networks. However, we should also understand the use of other energy vectors in this sector. If these alternatives are developed further, we will not observe as much of a significant increase in capacity requirement on the distribution network arising from decarbonisation of heat in the area.

Engagement with neighbouring local authorities and published LAEPs have given some insight into this and will continue to influence our forecasts.

3.1.4. Transmission interactions

We are working with NGET on their longer-term West London strategy. The strategy is in very early stages of development and is centred around a review of NGET's existing 275kV network which may result in potential upgrades to and/or reconfiguration of connected substations including Willesden GSP.

NGET currently own and operate Acton Lane 22kV BSP. This site currently has no scheduled work for reinforcement, but its continued operation will be reviewed and incorporated as part of NGETs West London strategy in coordination with SSEN. SSEN's strategy is to migrate from non-standard voltage systems such as 22kV. To move away from the legacy 22kV network SSEN have begun work (during ED2) to move distribution owned downstream assets to be supplied through the local distribution network or Willesden GSP at 66kV. This work will need to continue throughout ED3 to remove dependence on the 22kV network in the area.

3.1.5. Flexibility Considerations

Flexibility services

SSEN procures Flexibility Services from owners, operators, or aggregators of Distributed Energy Resources (DERs) or Consumer Energy Resources (CERs), which can be generators, storage, or demand assets. These services are needed in areas of the network which have capacity constraints at particular times or under certain circumstances. SSEN purchases Flexibility Services from all types of providers (e.g. domestic or commercial). Information on the process for procurement and how to participate are published on the Flexibility Services website and information on real time decision making on which providers are dispatched can be found in the Operational Decision-Making document.[5,6]

---

4 Old Oak and Park Royal Development Corporation (OPDC) | London City Hall

5 SSEN, Flexibility Services Procurement (Flexibility Services Procurement - SSEN)

6 SSEN, 02/2024, Operational Decision Making (ODM), SSEN Operational Decision Making ODM

SSEN regularly recruits new Flexibility Services providers and increases the procured Flexibility Services with the latest bidding round for long term requirements held in May 2025 and recruitment through the Mini-Competition process in April 2025.[2]

Areas across Willesden GSP where flexibility has been procured is shown below in Figure 4. This map shows all Flexibility Services procured, which covers requirements beyond those identified for managing the deferral of reinforcement.

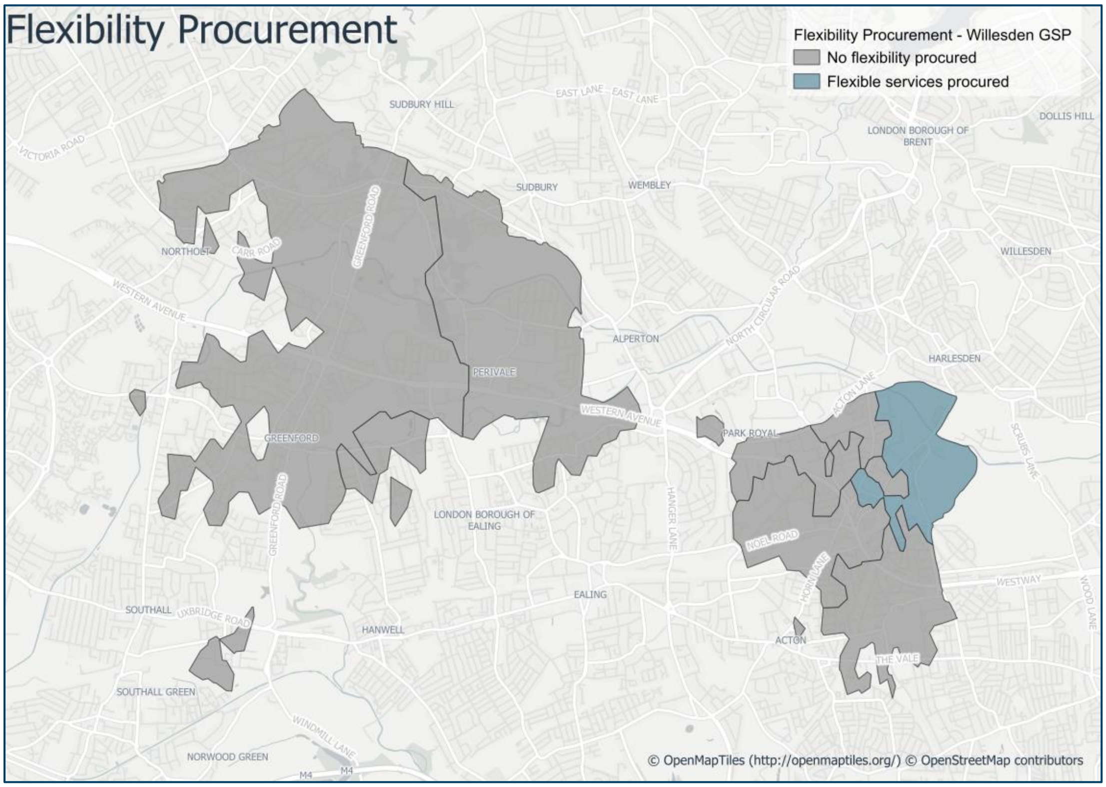


Figure 4 Flexibility procurement across Willesden GSP

4. EXISTING NETWORK INFRASTRUCTURE

4.1. Willesden Grid Supply Point Context

The Willesden GSP network is made up of 66kV, 22kV, 11kV, 6.6kV and LV circuits. It supplies a predominantly urban area in West London. In total, the GSP serves approximately 36,600 customers. Table 1 shows the values for the GSP, and the primary substations supplied by the GSP. The peak maximum demand refers to the peak at each individual substation which may not be at a coincident time as the others (meaning we would not expect the values for all primary substations to sum to that at the GSP). In some cases, other third parties are connected at Extra-High Voltage, meaning that the sum of primary substations peak demands will not sum to the value for the relevant upstream Bulk Supply Point (BSP) or Grid Supply Point (GSP).

Substation Name	Site Type	Number of Customers Served (approximate)	2023/24 Substation Maximum demand in MVA (Season)
Willesden	Grid Supply Point	36,600	124.13
Acton Lane	Bulk Supply Point	12,400	33.27
Canal Bank 11kV	Primary Substation	1,700	30.78
Greenford	Primary Substation	17,700	30.89
Perivale	Primary Substation	7,700	16.73
Wesley Avenue	Primary Substation	New Primary Substation	-
Canal Bank 6.6kV	Primary Substation	1,700	4.36
Goldsmiths	Primary Substation	6,100	8.44
Leamington Park	Primary Substation	3,700	5.90
Park Royal	Primary Substation	1,000	8.70

Table 1 Customer number breakdown and substation peak demand readings (2023-2024)

4.2. Current Network Topology

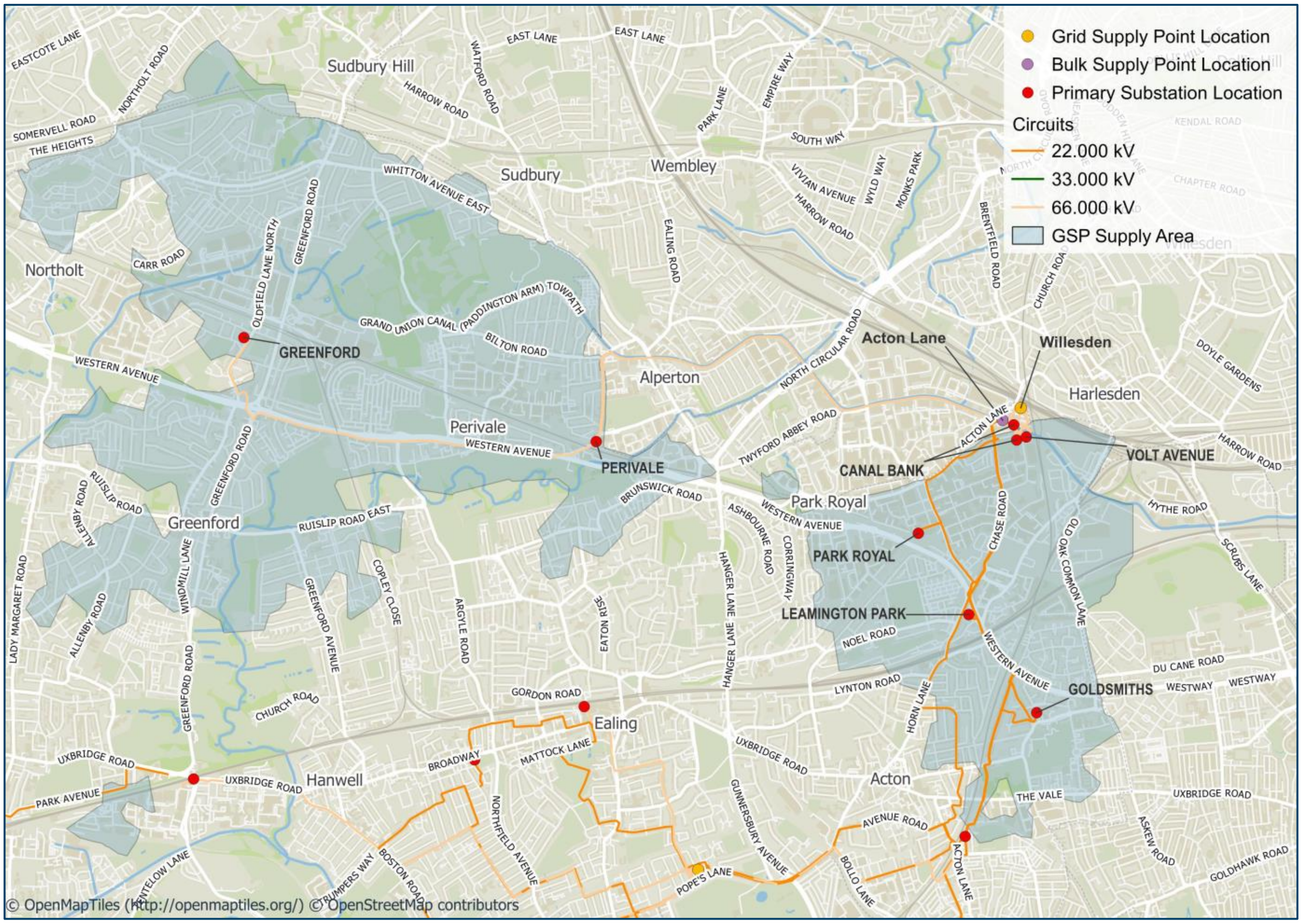


Figure 5 Geographic Information System view of Willesden electricity network.

4.3. Current Network Schematic

The existing network at Willesden GSP is shown below in Figure 6.

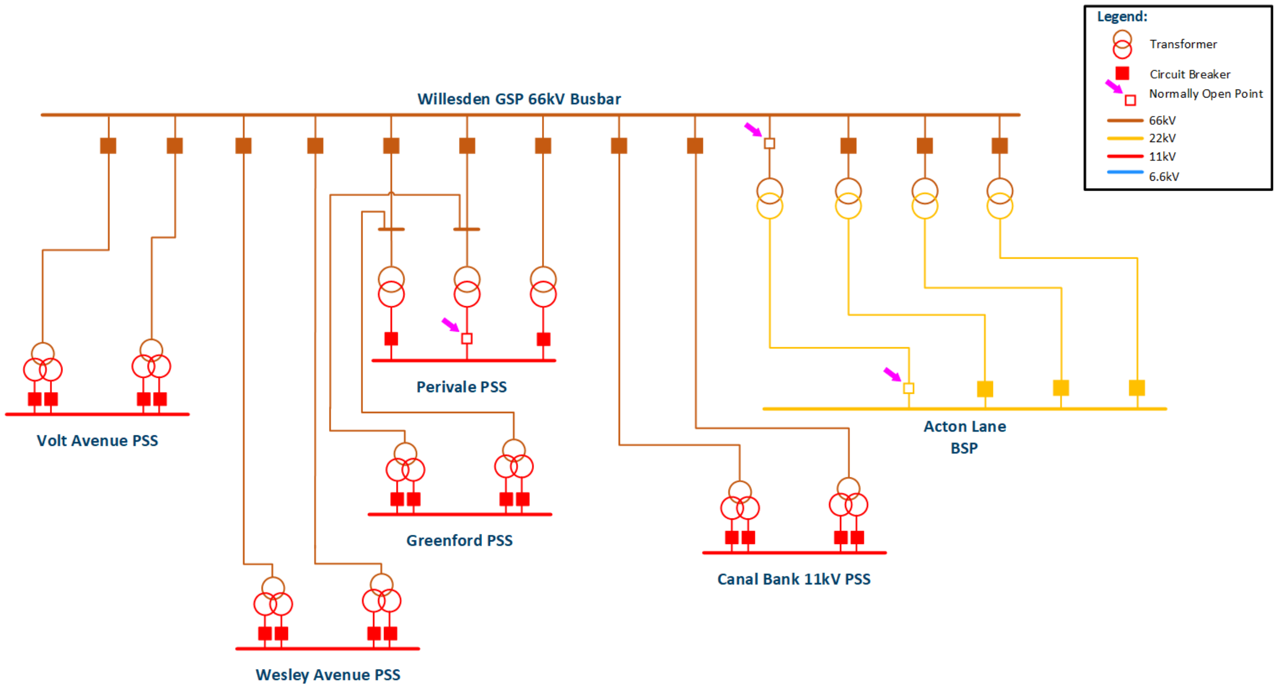


Figure 6 Existing network supplied by Willesden GSP

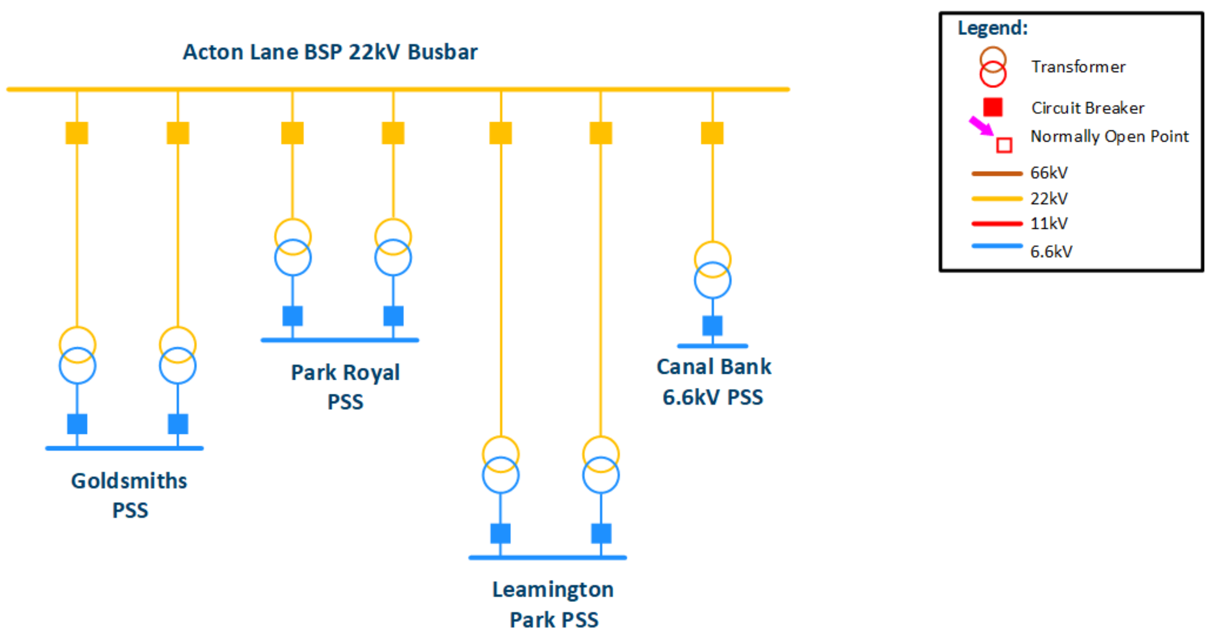


Figure 7 Existing network supplied by Acton Lane BSP

5. FUTURE ELECTRICITY LOAD AT WILLESDEN GSP

The following section details load growth across the technologies projected in the Distribution Future Energy Scenarios. There are important notes on the values presented here:

- These projections relate to the GSP supply area highlighted in Figure 3 and are not directly aligned to a particular local authority.
- Where MW values are presented in this section, they represent total installed capacity. When conducting network studies these values are appropriately diversified to represent the coincident maximum demand of the entire system rather than the total sum of all demands.

For consistency with the analysis undertaken, the insights presented here are from the DFES 2023 analysis. Results for the DFES 2024 analysis are presented in appendix A. DFES 2024 will be used in the ensuing detailed optioneering through the DNOA process.

5.1. Distributed Energy Resource

5.1.1. DFES Projections

Generation

The Willesden GSP supplies an urban area of West London (as shown above in Figure 3). As the area is mostly urban built environment, there is limited opportunity for large scale generation projects. However, as shown below in Figure 8, we still see some uptake in Solar PV across the area with up to 35MW installed by 2050 under the Consumer Transformation scenario. A significant proportion of the projected generation results from small-scale rooftop Solar PV (<10kW), seizing the opportunity for domestic rooftop solar across the area.

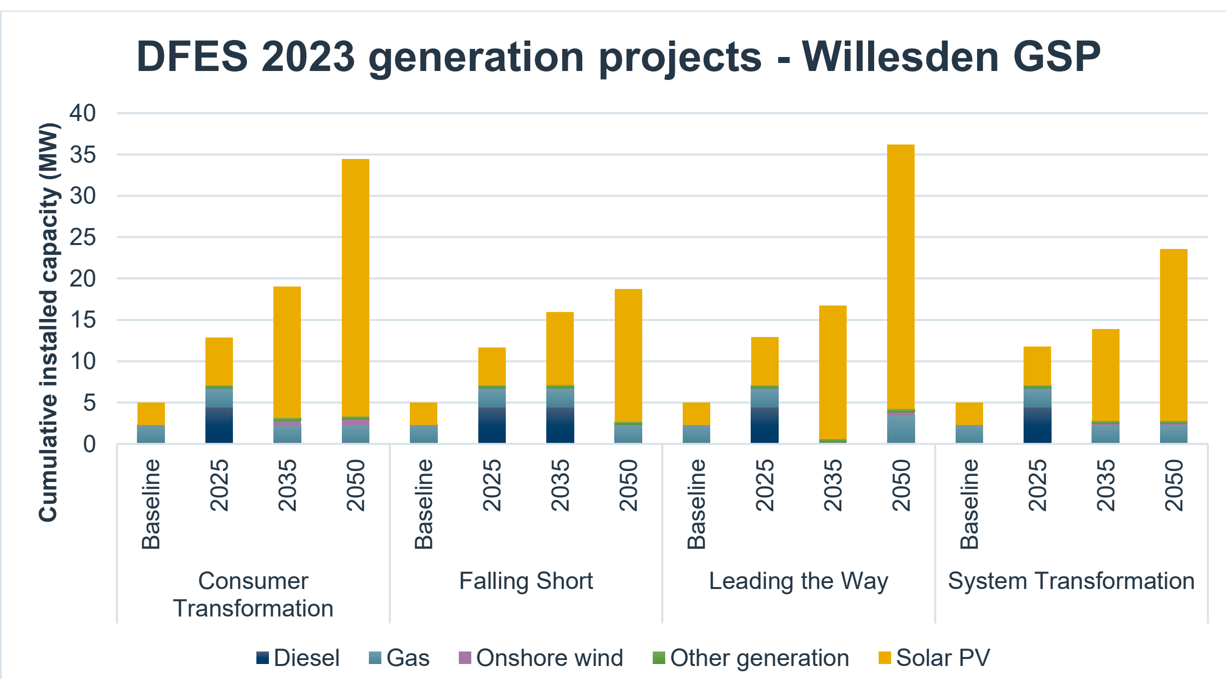


Figure 8 Projected cumulative distributed generation capacity Willesden GSP (MW). *Source: SSEN DFES 2023*

Storage

To accompany the generation projected in the DFES 2023, we also see the development of some Battery Storage across the area. Under the Consumer Transformation scenario, this equates to 9MW of domestic storage and 4MW of battery storage at high energy user sites connected by 2050. There are no large-scale batteries for generation co-location or standalone grid services projected to connect at Willesden GSP.

5.2. Transport Electrification

5.2.1. DFES Projections

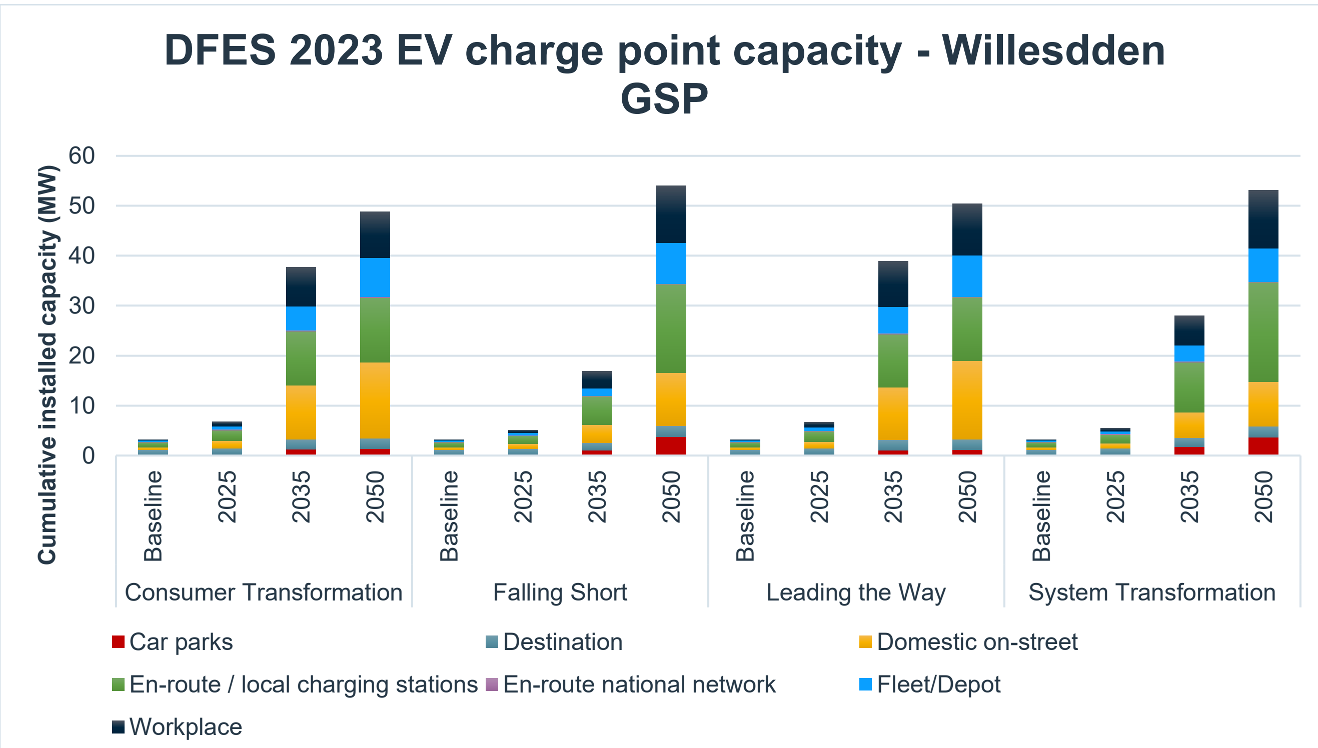


Figure 9 Projected EV charge point capacity across Willesden GSP. *Source: SSEN DFES 2023*

Figure 9 shows the distribution of projected EV charge point capacity across a range of sub-technologies with Workplace, En-route / local charging stations, Fleet/Depot, and Domestic on-street chargers being the most significant contributors. On top of the sub-technologies covered above, there are also approximately 24,000 domestic off-street chargers that are also projected to connect across the area by 2050 (under the Consumer Transformation scenario). The total number of electric vehicles (cars and Light Goods Vehicles (LGVs)) across the study area is estimated to reach approximately 40,000 vehicles by 2050 under the Consumer Transformation scenario.

5.3. Electrification of heat

The pathway to heat decarbonisation is more uncertain, and as a result we currently see a wide range of credible scenarios. Following the decision by DESNZ on the role of hydrogen for heating in 2026, there will be a clearer view of the impact of heating on the electricity network.[7] This decision will allow both electricity and gas networks to better understand future requirements, and plan to these accordingly. Further to this, engagement has made it clear to us that there are aspirations for the development of heat networks across the West London area. Viable sites have been identified through the West London Local Area Energy Plan (LAEP) and are emerging through the Department for Energy Security and Net Zero (DESNZ) national heat network zoning. Currently, the presence of heat networks is considered through the DFES analysis using heat network project pipelines[8] in the near term and DESNZ opportunity areas for district heating networks in the longer term.[9] This is aligned to targets for heat networks to serve 20% of domestic heating by 2050. The impact this has on DFES projections is a decrease in the number of standalone heat pumps projected in areas where there is likely to be development of heat networks.

5.3.1. DFES Projections

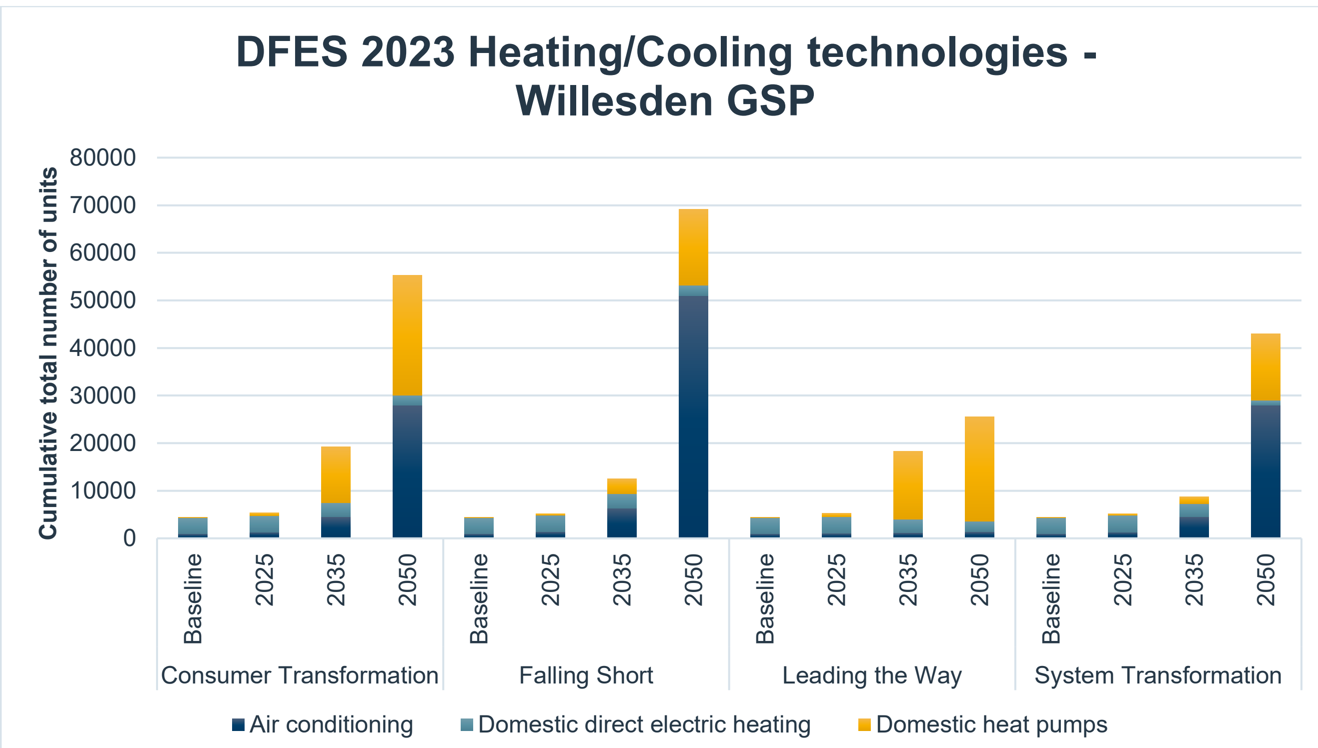


Figure 10 Projected number of heating/cooling technologies across Willesden GSP. *Source: SSEN DFES 2023*

Under all four scenarios, we see a significant increase in the number of heating/cooling units. The increase in the number of domestic heat pumps is expected to increase to approximately 25,000 under the Consumer Transformation scenario. There is also a notable increase in the number of air conditioning units which varies

7 Decarbonising home heating - Committee of Public Accounts

8 Heat networks pipelines - GOV.UK

9 Opportunity areas for district heating networks in the UK: second National Comprehensive Assessment - GOV.UK

significantly across the different scenarios. It is important to study the impact of this as this will drive electricity demand in the summer where, due to higher ambient temperatures, assets such as circuits and transformers will have lower ratings.

5.4. New building developments

Through engagement with local authorities, we have developed an understanding of new development across our licence areas. This has allowed us to gauge an insight into future electricity demand for new developments ahead of a formal connection application. Below we investigate the developments across the study area for this SDP.

5.4.1. DFES Projections

Through the DFES process SSEN have been made aware of a large amount of new office and school & college floorspace contributing to a total of over 84,000m^2 of new floorspace in the study area. Alongside non-domestic new developments, there is also an anticipated 7,000 new homes projected to be built ahead of 2050 (under the Consumer Transformation scenario).

5.5. Commercial and industrial electrification

There is a significant commercial and industrial electrification in the area. This is predominantly driven by the Old Oak and Park Royal opportunity area. As this development is on the boundary between SSEN and UKPN's licence areas, the projected electrical demand will be split across UKPN and SSEN's distribution networks. Information from the Local Area Energy Plan has fed through the DFES process, with the projections included in the numbers listed above in section 5.4.1. It should be noted that this new development will have large electrical demands that new infrastructure will be required to support. This is explored further in section 8.

6. WORK IN PROGRESS

Network interventions can be caused by a variety of different drivers. Examples of common drivers are load-related growth, specific customer connections, and asset health. Across Willesden GSP these drivers have already triggered network interventions that have now progressed to detailed design and delivery. For this report, these works are assumed to be complete, with any resulting increase in capacity considered to be released. Summary of existing works is tabulated below:

ID (Schematic Reference)	Substation	Description	Driver	Forecast completion	Fully resolves strategic needs to 2050?
1	Perivale 66kV busbar and Park Royal Primary substation (PSS)	Installation of a 66kV busbar at the Perivale primary substation site. Install two new 66/11-6.6kV transformers. Connect Greenford and Perivale primary substations to the new 66kV busbar at Perivale.	DNOA Process	2029	No
2	Development of Wesley Avenue PSS (reinforcement of Canal Bank 6.6kV PSS)	Installation of two 66kV circuits from Willesden GSP to new Wesley Avenue site and install two 66/11kV transformers. Installation of a new 11kV switchboard at Wesley Avenue. Decommission and remove from site the existing 22/6.6kV transformers and the 6.6kV switchboard.	Primary Reinforcement	2026	N/A
3	Acton Lane to Leamington Park 22kV circuit.	Reinforcement of one section of the 22kV circuits from Acton Lane to Leamington Park PSS.	Customer Connection	2025	No
4	Leamington Park PSS HV network uprate from 6.6kV to 11kV	Installation of two new 22/11kV transformers to replace the old 22/6.6kV units. Uprate the downstream HV network from 6.6kV to 11kV.	Primary Reinforcement	2026	No

Table 2 Works already triggered through customer connections and the DNOA process.

Where the above works are marked as not providing sufficient capacity for 2050 peak demands, it is important to note that this relates to the individual primary substation's firm capacity. When considering the further works identified in this report, the holistic plans aim to provide capacity across the GSP for 2050 based on current projections.

Alongside these asset solutions being deployed, flexibility solutions are also being used to release additional capacity.

1.1. Network Schematic (following completion of above works)

The network schematic below in Figure 11 shows the 66kV network with changes highlighted and referenced to the table above.

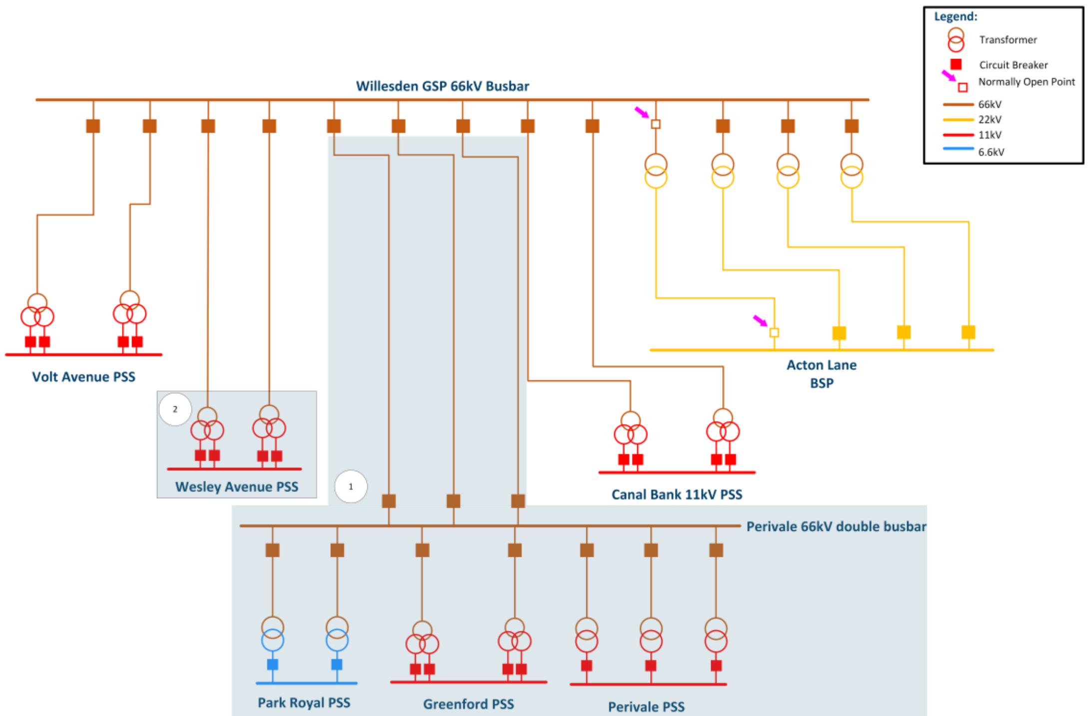


Figure 11 Willesden 66kV Network schematic following completion of triggered works.

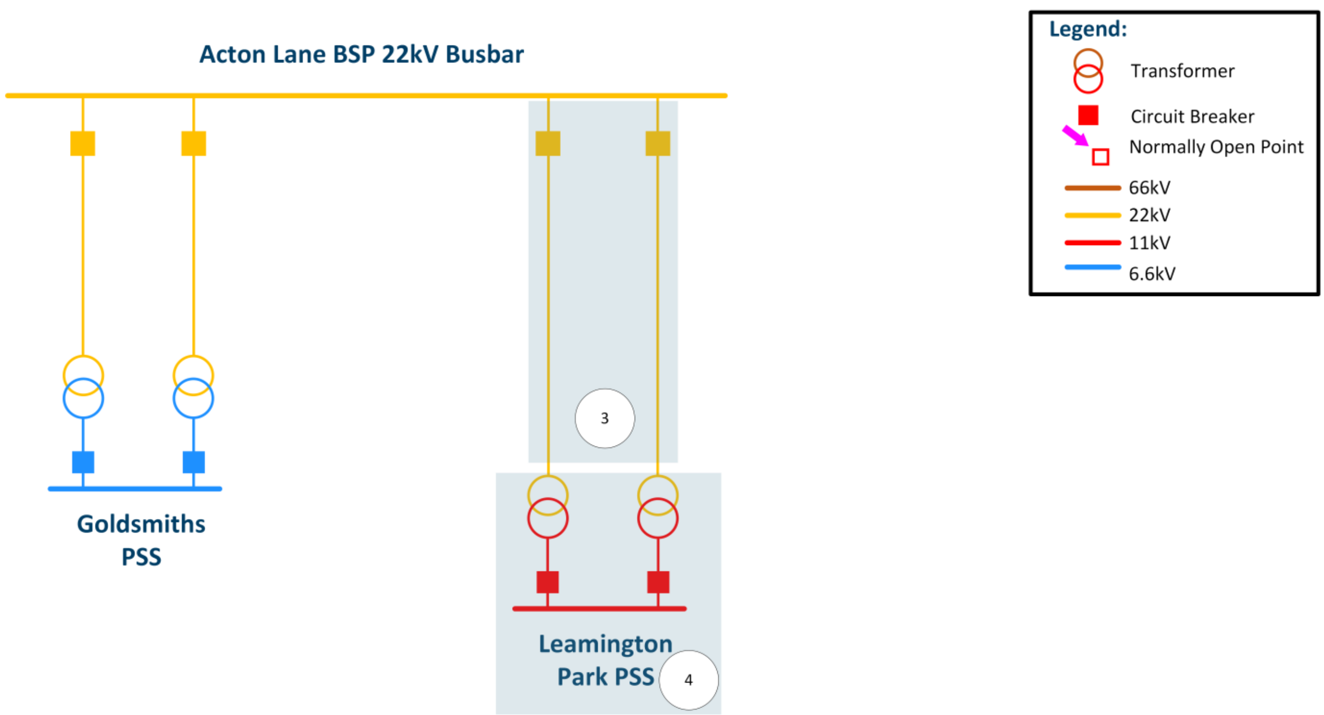


Figure 12 Acton Lane BSP downstream network schematic following completion of triggered works.

7. SPATIAL PLAN OF FUTURE NEEDS

7.1. Extra High Voltage / High Voltage spatial plans

The EHV/HV spatial plan shown below in Figure 13 shows the projected headroom or capacity shortfall due to demand increases at primary substations across the Willesden SDP study area. Darker blue shades indicate that there is a projected capacity shortfall whereas lighter blue shades indicate that there is headroom capacity based on current projections. EHV/HV spatial plans for the other DFES scenarios are presented in appendix B.

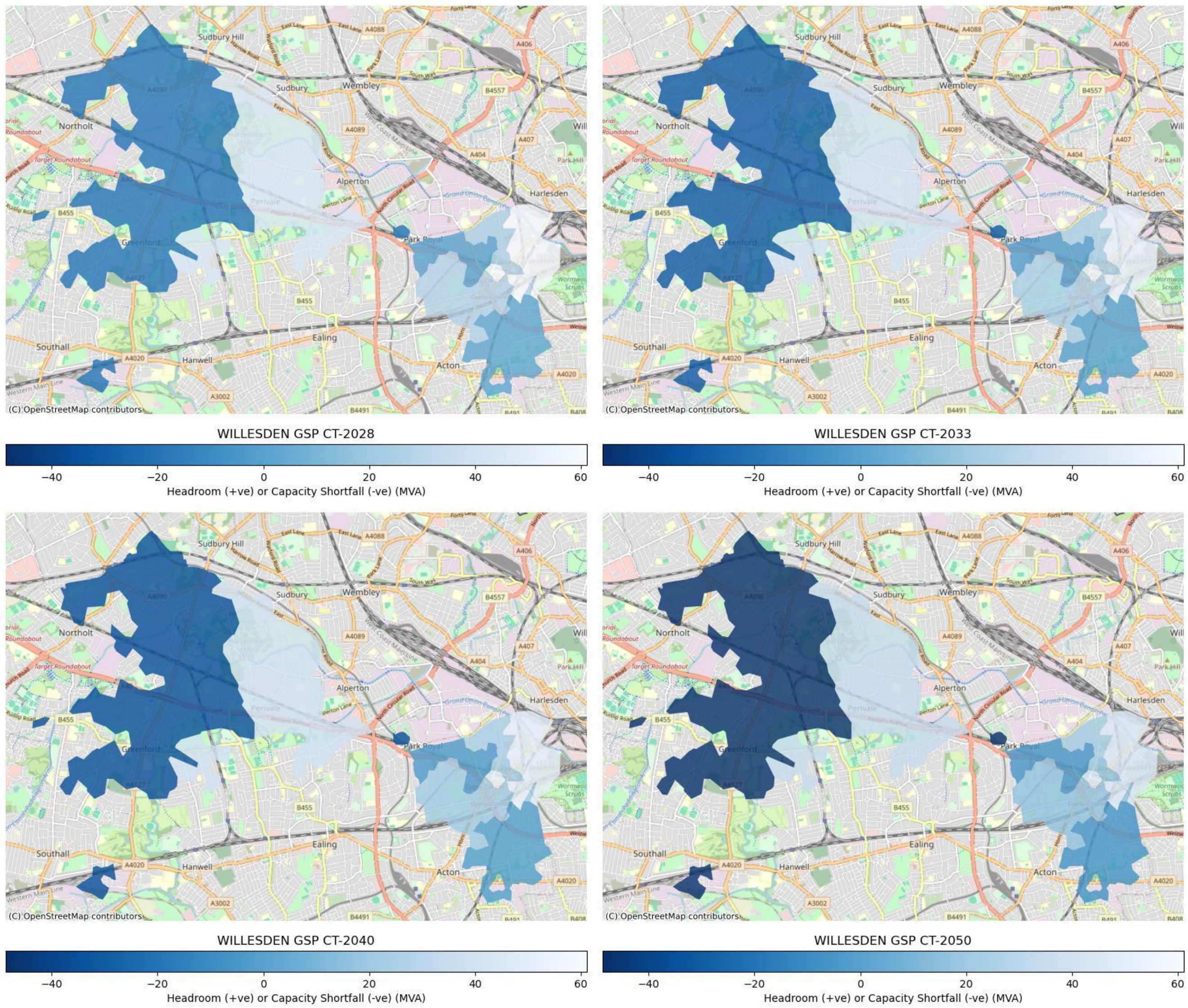


Figure 13 Willesden GSP - EHV/HV Spatial Plans - Consumer Transformation

7.2. HV/LV spatial plans

The HV/LV spatial plans shown below in Figure 14 show the point locations of secondary transformers supplied by Willesden GSP. The points are colourised based on the projected percentage loading with red meaning higher percentage loading and green being lower percentage loading. The HV/LV spatial plans for the other DFES scenarios are available in appendix C.

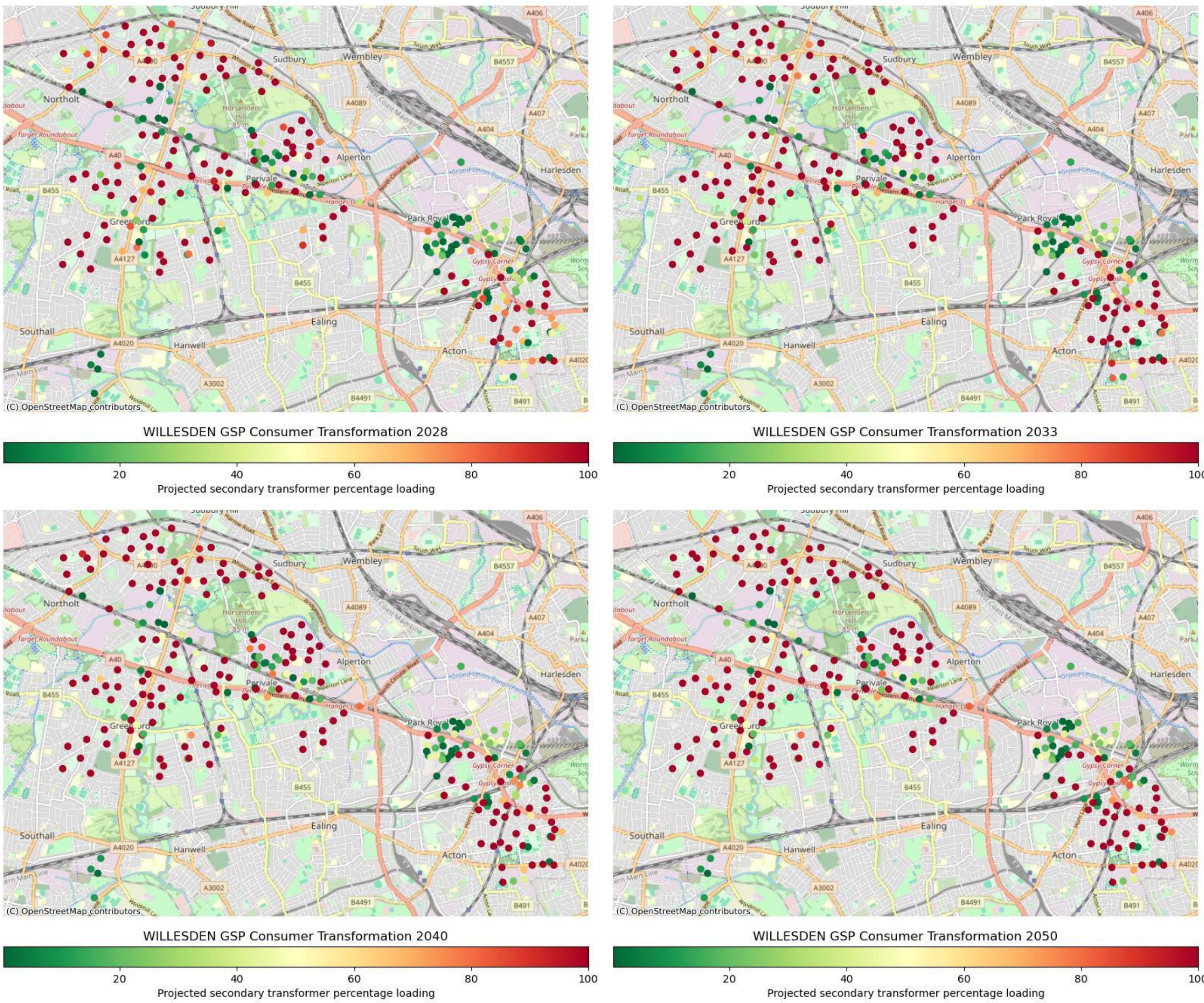


Figure 14 Willesden GSP - HV/LV Spatial Plans - Consumer Transformation

8. SPECIFIC SYSTEM NEEDS AND OPTIONS TO RESOLVE

8.1. Overall dependencies, risks, and mitigations

There are a number of overarching risks to the delivery of our strategic plan. Below we list these alongside proposed mitigating actions. We will work with stakeholders to develop these mitigating actions further.

Dependency: Delivery of the currently triggered work that is required to enable some of the solutions proposed in the following sections.
Risks: Alternative options are required to be progressed if earlier work prevents proposed options progressing.
Mitigation: Annual update of this Strategic Development Plan will capture updated delivery timelines and propose alternative solutions as appropriate.

Dependency: Capability of the EHV network to connect future large demand users (large new developments and data centres)
Risks: Large capacity on HV networks made available through proposed work but with limited options for large demand users to connect at EHV.
Mitigation: Perivale 66kV double busbar provides the opportunity for potential new 66kV connections. Note this is also subject to transmission capacity at Willesden GSP.

8.2. Future EHV System Needs to 2033

The following table details the near-term to medium-term distribution network system needs that have been identified through power system analysis. While asset solutions are described in the table below it is important to note that the use of flexibility will be evaluated for all schemes to ensure the best possible solution is progressed. For the projects shown in Table 3 we recommend that these are progressed through the DNOA process so that there is sufficient time for solutions to be designed and delivered.

ID	Location of proposed intervention	CT Year	ST Year	LW Year	FS Year	Network State	Proposed option(s) to resolve
1	22kV Circuits from Acton Lane BSP to Leamington Park PSS	Ahead of 2030	Ahead of 2030	Ahead of 2030	Ahead of 2030	N-1	A small section of this 22kV circuit is being uprated currently, as detailed in section 6.Later we see a projected constraint on the full length of the 22kV circuits, options to resolve could be: • Opportunities for load transfers through the 6.6kV network are limited due to the decommissioning of Canal Bank 6.6kV and the fact that Goldsmiths is approaching capacity. • As a legacy voltage level, significant investment in the 22kV network is not aligned with SSEN's long-term strategy. It is proposed that flexibility should be utilised for reinforcement deferral until 2029/2030. At this stage new 66/11kV transformers could be installed with new 66kV circuits to be installed to an upstream 66kV

ID	Location of proposed intervention	CT Year	ST Year	LW Year	FS Year	Network State	Proposed option(s) to resolve
							busbar. This could be either the Perivale 66kV double busbar or alternatively, a scheme to install a 66kV double busbar at Southfield Road PSS (Ealing GSP) would allow transfer of Leamington Park PSS to Southfield Road PSS. Option to shift to Southfield Road would not bring forward the work highlighted in ID 3.
2	Goldsmiths 22/6.6kV Primary Transformers	Ahead of 2030	Ahead of 2030	Ahead of 2030	Ahead of 2030	N-1	To resolve the projected constraint on the primary transformers, options to resolve could be: • Reinforcement of the two existing transformers with higher rated 22/11kV units, requiring uprating of the downstream 6.6kV network. This would align with SSEN's strategy to remove legacy HV voltage levels. However, there would still be some dependence on Acton Lane and the 22kV network. • Transfer Goldsmiths PSS to the new Perivale 66kV busbar. Reinforcement of the two existing transformers with higher rated 66/11-6.6kV units, and new 66kV circuits from Perivale to Goldsmiths. This would align with SSEN's strategy to remove legacy voltage levels (both 6.6kV and 22kV) and allow for Park Royal to also be uprated to 11kV. However, this would also bring forward the dates of work between Willesden and Perivale to ensure security of supply standards are maintained. • Alternatively, to prevent construction of long 66kV circuits to Perivale, the work introduced in ID1 to install a 66kV double busbar at Southfield Road PSS. With installation of higher rated 66/11-6.6kV transformers as written above would allow for subsequent uprating of the 11kV network.
3	66kV circuit from Willesden to Perivale double busbar	2030-2033	2041-2050	2030-2033	2041-2050	N-1	The 66kV circuits between Willesden and Perivale are projected to be overloaded within the ED3 price control period. Another consideration is that demand growth in the late 2030s will mean that this group demand will require restoration of a proportion of the group demand within 3 hours under a second circuit outage. To resolve this constraint, potential options could be: • Reinforcement of the existing circuits to the maximum rated 66kV circuits will release capacity and would contribute towards SSEN's target of removing oil filled cables (requires new cable routes) – requirement for further reinforcement or addition of new assets will be dependent on whether the transfer of additional primary substations to the Perivale 66kV busbar is progressed.

ID	Location of proposed intervention	CT Year	ST Year	LW Year	FS Year	Network State	Proposed option(s) to resolve
							• Installation of an additional circuit is dependent on the availability of CBs at Willesden GSP. If this option is progressed, then it may require significant rearrangement of existing network infrastructure.
4	Canal Bank 66/11kV Primary Transformers	2030-2033	2030-2033	2030-2033	2030-2033	N-1	The current site at Canal Bank 11kV PSS has previously been identified as not suitable for installation of higher rated 66/11kV transformers. As a result, there is limited potential to increase capacity at this site. Instead, it is suggested that the projected load here is connected at neighbouring primary substations. Wesley Avenue PSS is a suitable candidate for this in the near-term.
5	Greenford 66/11kV Primary Transformers	2030-2033	2034-2040	2030-2033	2034-2040	N-1	To resolve this projected capacity requirement at Greenford PSS: • Reinforcement of the two existing transformers to 80MVA units would provide sufficient transformer capacity at Greenford PSS to satisfy the current projected demands at the site until beyond 2050. • Subject to the possibility of site expansion, an additional 60MVA transformer could be added to the site. This would also provide sufficient transformer capacity at the site and may release up to an additional 40MVA of firm capacity subject to which circuit works detailed in the next row are progressed.
6	66kV circuit from Perivale 66kV double busbar to Greenford PSS	2030-2033	2034-2040	2034-2040	2034-2040	N-1	Reinforcement of the 66kV circuits from Perivale to Greenford PSS will release the additional transformer capacity that could be released following completion of one of the reinforcement options in the row above. Potential circuit works could include: • Reinforcement of the two existing circuits to an equivalent rating of the firm capacity of new transformers at the site. This option would align better with the installation of two 80MVA transformers. • Alternatively, an additional 66kV circuit may be constructed from Perivale to Greenford. This would allow the full capacity of a third transformer to be released and provide a level of N-2 security.
7	Leamington Park 22/11kV Primary Transformers	2030-2033	2034-2040	2030-2033	2034-2040	N-1	As introduced earlier (ID1), it is proposed that the constraint on the supply circuits is deferred to the same year that this need is projected to arise as this will allow installation of higher rated 66/11kV units. Allowing for connection to the 66kV double busbar being delivered at Perivale, or a similar 66kV double busbar solution, that couple be progressed at the

ID	Location of proposed intervention	CT Year	ST Year	LW Year	FS Year	Network State	Proposed option(s) to resolve
							Southfield Road PSS site. Alternatively, if the new primary transformers at Goldsmiths PSS are sized sufficiently (40MVA units), then connecting new load at Goldsmiths in the near term could defer or even mitigate the requirement for additional reinforcement at Leamington Park PSS. This would be desirable as the primary transformers were only recently added to the site so have a lower health risk.

Table 3 Summary of system needs identified in this strategy through to 2033 along with indicative solutions.

8.3. Future EHV System Needs to 2040

ID	Location of proposed intervention	CT Year	ST Year	LW Year	FS Year	Network State	Proposed option(s) to resolve
8	22kV Circuits from Acton Lane BSP to Goldsmiths PSS	2034 - 2040	2034 - 2040	2034 - 2040	2034 - 2040	N-1	Reinforcement of the existing circuits from Acton Lane BSP to Goldsmiths PSS will release the full capacity of the transformers proposed to be installed at the site in section 8.2. This would require overlay of approximately 6km of 22kV circuit. If the solution to move Goldsmiths PSS to connect to the Perivale 66kV double busbar or an equivalent at Southfield Road is progressed earlier, then 66kV circuits will have been installed and will likely mitigate the need for reinforcement of the 22kV circuits identified here. Geographically, Goldsmiths is much closer to the Southfield Road site, this may result in it being the lower cost option.

Table 4 Summary of system needs identified in this strategy through to 2040 along with indicative solutions.

8.4. Future EHV System Needs to 2050

ID	Location of proposed intervention	CT Year	ST Year	LW Year	FS Year	Network State	Proposed option(s) to resolve
9	66kV circuit from Willesden to Canal Bank 11kV PSS	2041 - 2050	2041 - 2050	-	2041 - 2050	N-1	As mentioned earlier, previous investigation has shown that expansion of the Canal Bank 11kV PSS has been shown to not be viable. As the transformers become the capacity limiting factor at an earlier date, it is not proposed to carry out any reinforcement of the 66kV circuits from Willesden to Canal Bank 11kV PSS. Instead, it is suggested that load growth in the area initially connects to Wesley Avenue PSS and then in the longer term, to Leamington Park PSS/Goldsmiths PSS where we have suggested reinforcement.

Table 5 Summary of system needs identified in this strategy through to 2050 along with indicative solutions.

8.5. Future requirements of the High Voltage and Low Voltage Networks

Our HV/LV spatial plans have shown that there is no clear pattern to future demands on these lower voltage networks. We are therefore planning on a forecast volume basis, and this section provides further context on this work for both the Willesden GSP high voltage and low voltage network needs to 2050.

8.5.1. High Voltage Networks

Voltage rationalisation

There is ongoing work to remove non-standard voltage levels across the SSEN distribution network. Across Willesden GSP, this has been progressed through the uprating of the 6.6kV network of Leamington Park PSS to 11kV and the decommissioning of Canal Bank 6.6kV PSS. Once this work is complete, the only remaining 6.6kV network under Willesden GSP will be that supplied from Goldsmiths PSS and Park Royal PSS. Considering the age of this network and the limited remaining area of 6.6kV network downstream of Willesden GSP, it is not desirable to continue operation of the 6.6kV network.

As explored in sections 8.2-8.4, there is a significant amount of EHV work required to ensure that primary transformers have the capability to operate at 11kV. If the timelines followed above are followed this will result in the EHV network being capable to supply 11kV networks before the end of ED3 (2033). The remaining work on the HV network to enable operation at 11kV should be progressed throughout the ED3 period (from 2028 to 2033). This may require reinforcement of existing 6.6kV circuits and secondary transformers. Following this strategy would relieve Willesden GSP of legacy 22kV and 6.6kV networks by 2033. Scoping the schemes required to uprate the 6.6kV network to 11kV forms a key recommendation of this report. Due to the large amount of Paper Insulated Corrugated Aluminium Sheath (PICAS) cable and Paper Insulated Lead Sheath (PILC) cable, the amount of HV reinforcement could be significant. Appropriate cost benefit analysis tools used in the Distribution Network Options Assessment (DNOA) process will evaluate options and ensure the most efficient solution is progressed.

This would achieve SSEN's strategy for removal of the 6.6kV network at Willesden GSP, increase resilience, and release capacity on the HV network.

HV Capacity needs

As well as the EHV system needs identified in sections 8.2 to 8.4, increased penetration of low carbon technologies (LCTs) connecting to the distribution network will result in system needs on the High Voltage (HV) and Low Voltage (LV) networks. To provide a view on the impact of these technologies on the distribution network here we have used the load model that is produced by SSEN's Data and Analytics team.[10]

The load model is a machine learning product which estimates a half-hourly annual demand profile for each household based on a series of demographic, geographic and heating type factors. This enables us to estimate capacity on the electricity network while protecting individual customers data privacy by using modelled data. These views are then aggregated up the network hierarchy based on the combinations of customers associated with each asset. This view is supplemented with the DFES to highlight the projected impact of LCTs on the network.

For the 9 primary substations supplied by Willesden GSP, the percentage of secondary substations where projected peak loading exceeds the nameplate rating of the secondary transformer was taken from the load

10 SSEN Open Data Portal, 2023, SSEN Secondary Transformer – Asset Capacity and Low Carbon Technology Growth.

model data. Figure 15 demonstrates how this percentage changes under each DFES scenario from now to 2050.

To satisfy these requirements a variety of solutions will need to be investigated. It is likely that a combination of flexibility and asset replacement will be employed to resolve the projected HV system needs. It is important to note that for HV needs, flexibility is likely to be provided through Distributed Energy Resources (DER), Consumer Energy Resources (CER), and domestic/commercial Demand Side Response (DSR). One of the challenges associated with procuring flexibility to High Voltage and Low Voltage system needs is that only a small number of customers can provide a flexibility service due to the requirement to be supplied by a specific secondary transformer. As the role of aggregators develops, we may see a shift in the potential for flexibility in an area. Where the magnitude of an overload is too large for flexibility to be feasible, addition of new assets or asset replacement will be necessary.

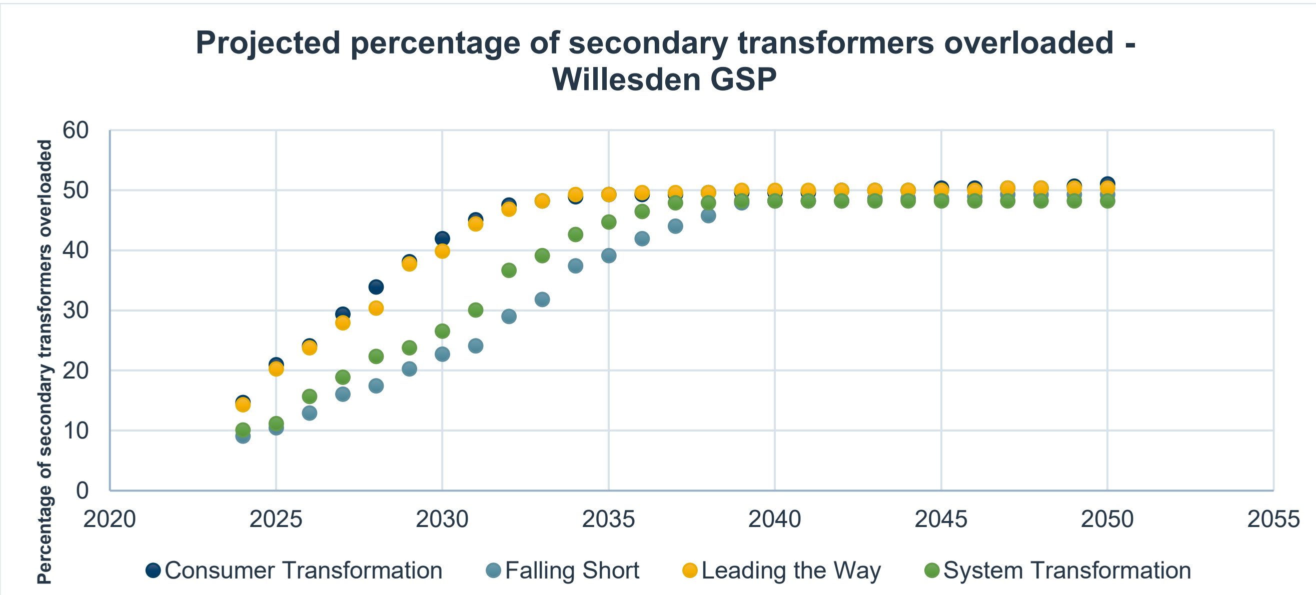


Figure 15 Willesden GSP Projected secondary transformer loading. *Source: SSEN Load Model*

Considering the Just Transition in HV development

SSEN are building on the findings from the Vulnerability Future Energy Scenarios (VFES). This innovation project investigated how the use of new foresighting techniques, along with data analytics and expert validation could be used to identify and forecast consumers in vulnerable situations as we move toward net zero. Use of the outputs from the VFES enable SSEN to develop the network in a way that truly accounts for the levels of vulnerability their customers in different locations face.

One of the outputs from this innovation project was the report produced by the Smith Institute.[11] This work groups Lower Layer Super Output Areas (LSOAs)[12] that share similar drivers of vulnerability. The groupings were informed by mathematical analysis of demographic data and of SSEN's priority service register, using machine learning to model the complex relationships that exist between the two. The resulting group numbers and descriptions are shown in Table 6.

---

11 VFES Machine Learning Discovery of Vulnerability Signatures Report, Smith Institute, 08/11/2022, (NIA SSEN 0063: VFES – Vulnerability Future Energy Scenarios | SSEN Innovation)

12 Lower layer Super Output Areas (LSOAs) (Statistical geographies - Office for National Statistics)

Group Number & Level of Vulnerability	Description of Group
1 – Very high	Driven up by higher levels of poor health and disability/mental health benefit claimants, reduced by smaller household sizes.
2 – High	Driven up by larger household sizes, reduced by lower elderly population levels.
3 – High	Driven up by larger elderly population levels, reduced by lower levels of disability and mental health benefit claimants.
4 – Slightly higher than average	Driven up by larger elder population levels and moderately higher provision of care, reduced by smaller household sizes.
5 – Slightly lower than average	Driven down by lower elderly population levels and larger levels of ethnic diversity, increased by higher household sizes and greater provision of care.
6 – Low	Driven down by lower level of bad health and disability/mental health benefit claimants, increased by moderate elderly population levels and household sizes.
7 – Very low	Driven down by substantially lower elderly population levels, less provision of care and a higher level of households in private rented dwellings.

Table 6 VFES groupings

As shown in Figure 16, there is only one small cluster of Lower-layer Super Output Areas (LSOAs) that are class 1 meaning they have been identified as very high vulnerability. This is located to the south of the Willesden GSP study area. There are secondary transformers that are located within this area that are projected to be overloaded in 2028. These secondary transformers should be prioritised for load related reinforcement as it will reduce the likelihood of asset failure for load reasons and increase network resilience in these areas. By doing so, supporting customers who may be more vulnerable.

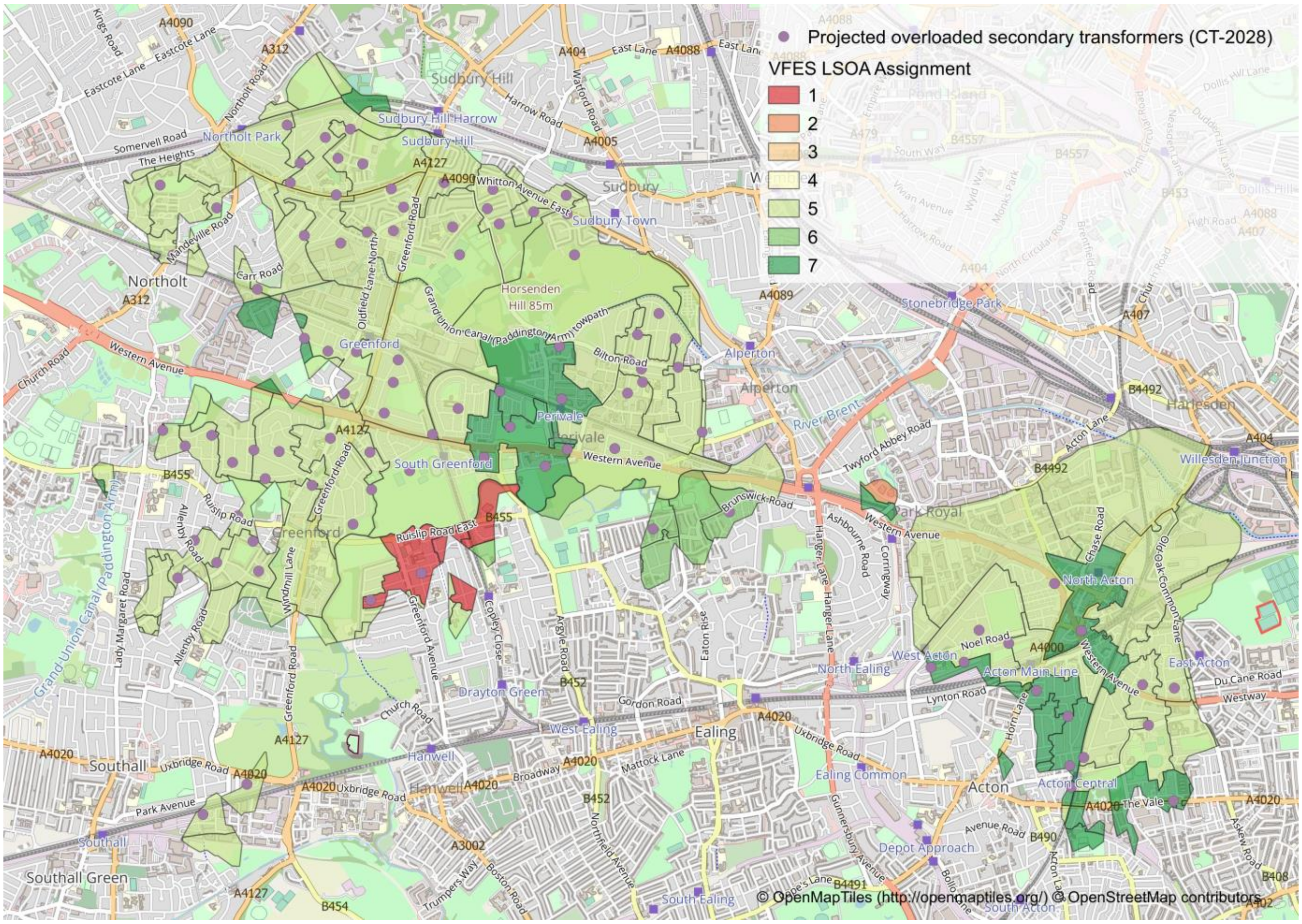


Figure 16 Willesden GSP area VFES output with secondary transformer overlay.

8.5.2. Low Voltage Networks

Drivers for interventions in low voltage networks may be either capacity related or be driven by voltage requirements. We are progressing options to resolve both of these drivers. From a network perspective the solution typically involves upgrading the number of LV feeders to split/ balance the load and improve voltage or to install another substation at the remote end of the LV network to balance load and improve voltage. In both instances, flexibility at a local level, especially voltage management products linked to battery export and embedded generation such as solar is likely to be required alongside traditional reinforcement.

We are leveraging recent innovation work through Project LEO (Local Energy Oxfordshire) and My Electric Avenue to inform this strategy. Enhanced network visibility through Smart meter data analytics and low-cost substation feeder monitoring is also necessary to enable appropriate dispatch of services and network reconfiguration.

Capacity driven needs – Thermal constraints tend to materialise in the sections of cable leading to the substation (transformer) where multiple customer loads join together. We are modelling requirements out to 2050 leveraging low voltage monitoring and metering equipment combined with analytical techniques. This will demonstrate how the magnitude of the system need of the LV network across Willesden changes across scenarios and years out to 2050.

Voltage driven needs – Generally, connection of Low Carbon Technology and large loads such as heat pumps is limited by voltage constraints before thermal constraints when located more than around 150m from the local secondary transformer. Increased loading on our low voltage networks can reduce the voltages to consumer premises. This is a non-liner relationship and as such requires more complex analysis. We are currently undertaking analysis to better understand the extent of this future need.

Initial analysis indicates that 17% of low voltage feeders may need intervention by 2035 and 21% by 2050 under the CT scenario as shown in Figure 17. The need is unlikely to be triggered until 2028 onwards. However, due to the timeline to grow our workforce, with jointing training typically taking 4 years to be fully competent, it is necessary to start recruitment and initiate programmes ahead of need to be able to deliver the required volumes from 2028 onwards.

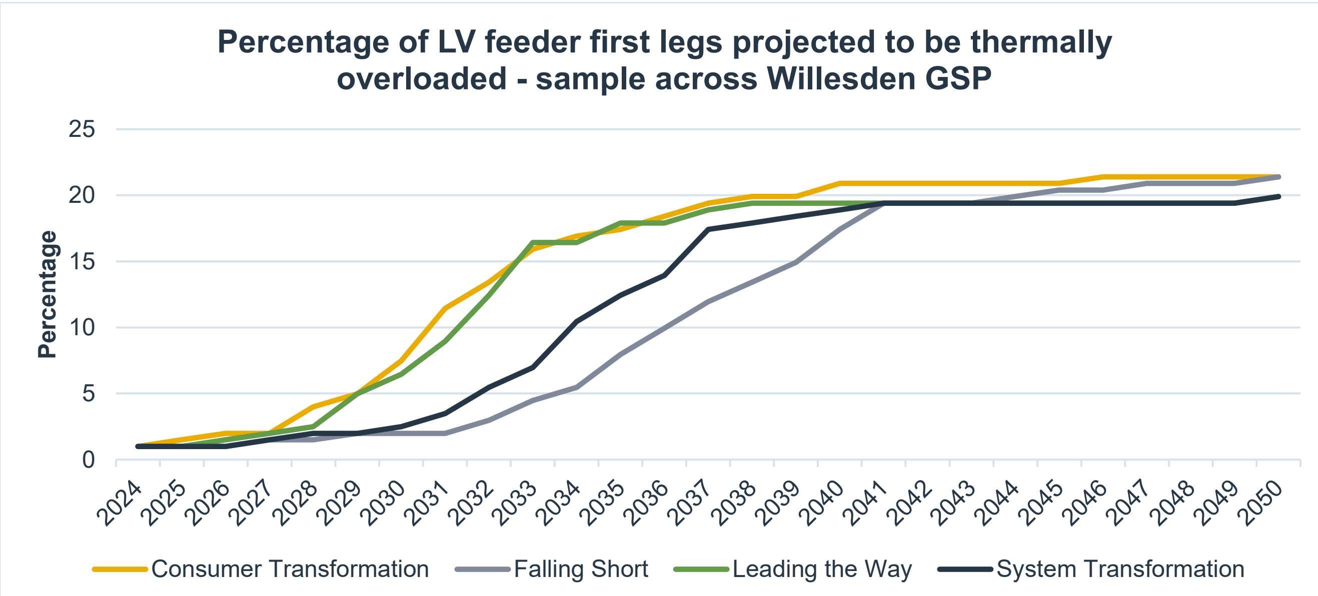


Figure 17 Percentage of LV feeders projected to be overloaded under Willesden GSP

9. RECOMMENDATIONS

The review of stakeholder engagement and the SSEN 2023 DFES analysis provides a robust evidence base for load growth across Willesden GSP group in both the near and longer term. Drivers for load growth across Willesden GSP arise from multiple sectors and technologies. These drivers impact not only our EHV network but will drive system needs across all voltage levels.

The findings from this report have provided evidence for 4 key recommendations:

1. System needs that have been identified to arise in the near-term should be progressed through the DNOA process to develop a more in-depth solution. It should be noted that some of these needs will likely be grouped where a holistic solution is appropriate. For this SDP, this includes:
    a. 22kV Circuits from Acton Lane BSP to Leamington Park PSS.
        i. May require installation of a 66kV double busbar at Southfield Road PSS (Ealing GSP), connecting Leamington Park PSS at 66kV to allow for 66/11kV transformers to be installed. This removes the dependency on the Acton Lane 22kV network.
    b. Goldsmiths 22/6.6kV Primary Transformers
        i. Similar to point a.i. the opportunity to transfer Goldsmiths PSS to a new double busbar at the Southfield Road PSS site would allow installation of 66/11-6.6kV transformers at Goldsmiths.
    c. 66kV Circuits from Willesden to Perivale double busbar
    d. Greenford 66/11kV Primary Transformers
    e. 66kV Circuits from Perivale 66kV double busbar to Greenford PSS
2. At the HV level, decommissioning of the 6.6kV network should be continued with this rationalised to 11kV. The EHV requirements to enable this would be complete by 2033 if the options raised here are progressed. The DNOA process should be carried out for the HV system needs so that the work can be delivered throughout ED3, allowing for complete voltage rationalisation across Willesden GSP before the end of ED3.
3. SSEN should continue to engage with prospective large energy users (such as the OPDC and data centre providers) in the area to understand solutions for connecting these customers.
4. Continued collaboration with NGET and rollout of further innovative solutions like the West London ramping agreement will enable connections ahead of transmission reinforcement dates (subject to distribution capacity).

Actioning these recommendations will allow SSEN to develop a network that supports local net zero ambitions and enables growth in the local economy. By doing so, this will ultimately contribute to net zero targets at a national level.

Appendix A DFES 2024 Projections

DFES 2024 Scenarios

NESO publishes the FES framework annually, and this is adopted for the DFES. The 2024 edition outlines three new scenarios (Holistic Transition, Electric Engagement, and Hydrogen Evolution) that achieve net zero by 2050 against a Counterfactual. The scenario framework is shown below in Figure 18.

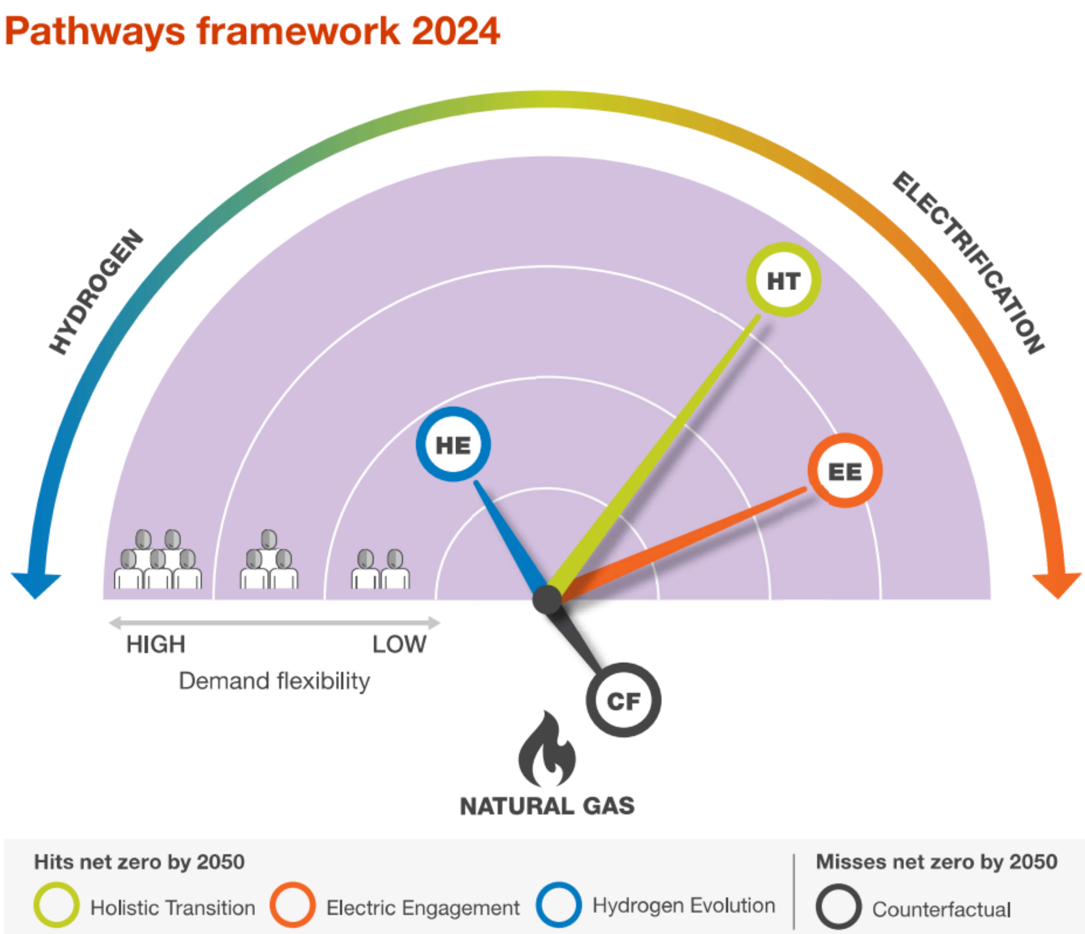


Figure 18 The FES 2024 scenario framework (source: NESO)

Distributed Energy Resource

DFES Projections

Generation

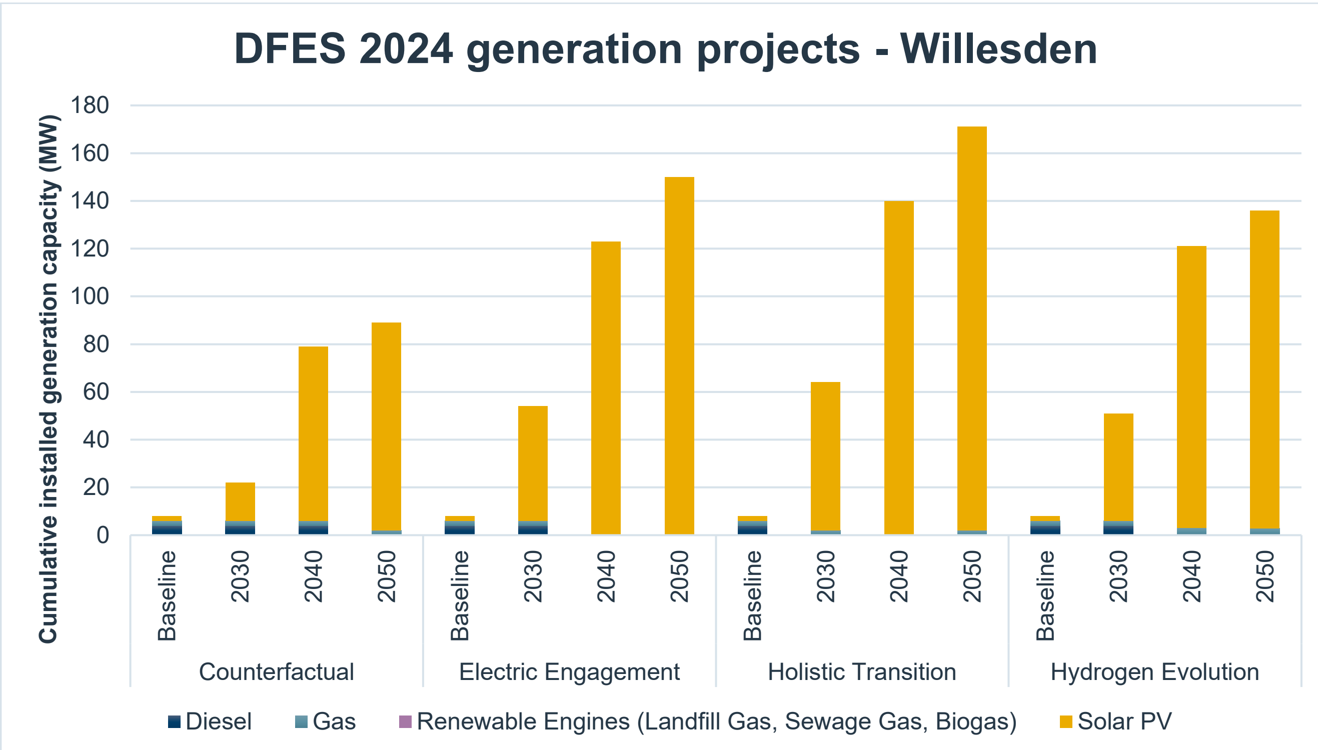


Figure 19 Projected cumulative distributed generation capacity Willesden GSP (MW). *Source: SSEN DFES 2024*

Transport Electrification

DFES Projections

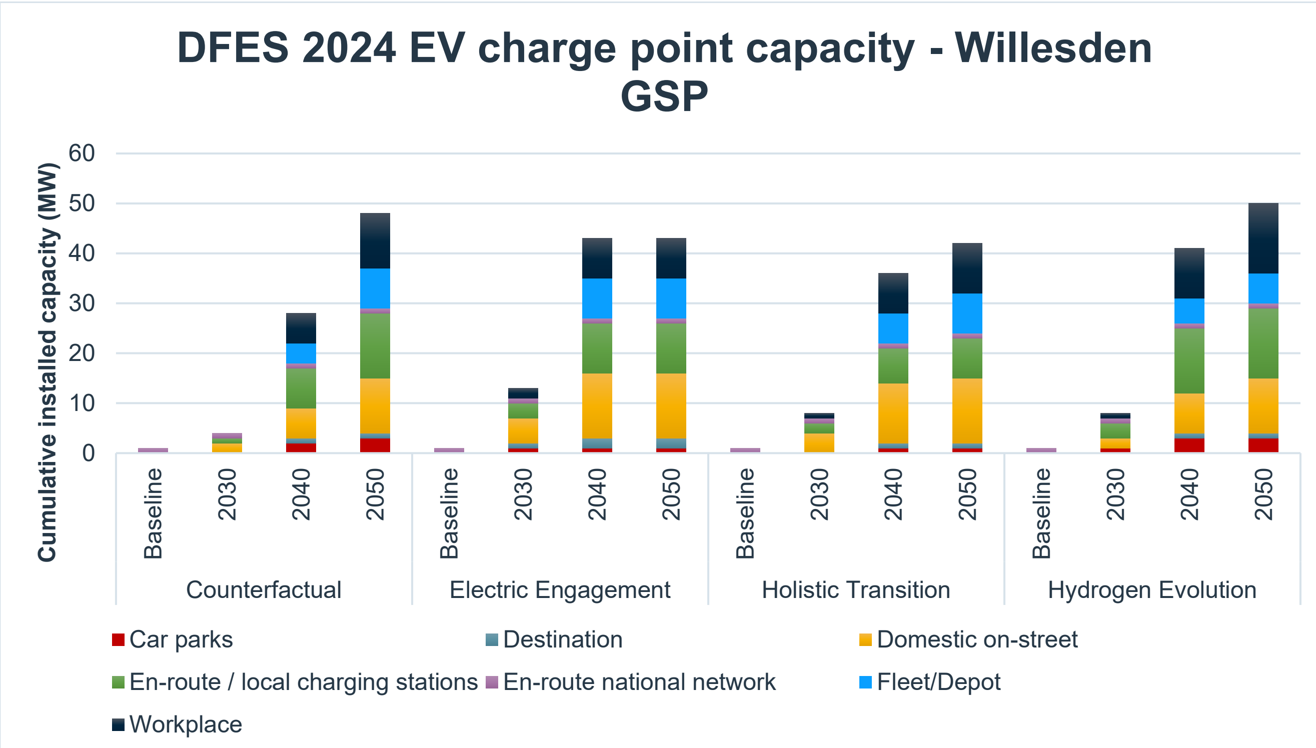


Figure 20 Projected EV charge point capacity across Willesden GSP. *Source: SSEN DFES 2024*

Electrification of heat

DFES Projections

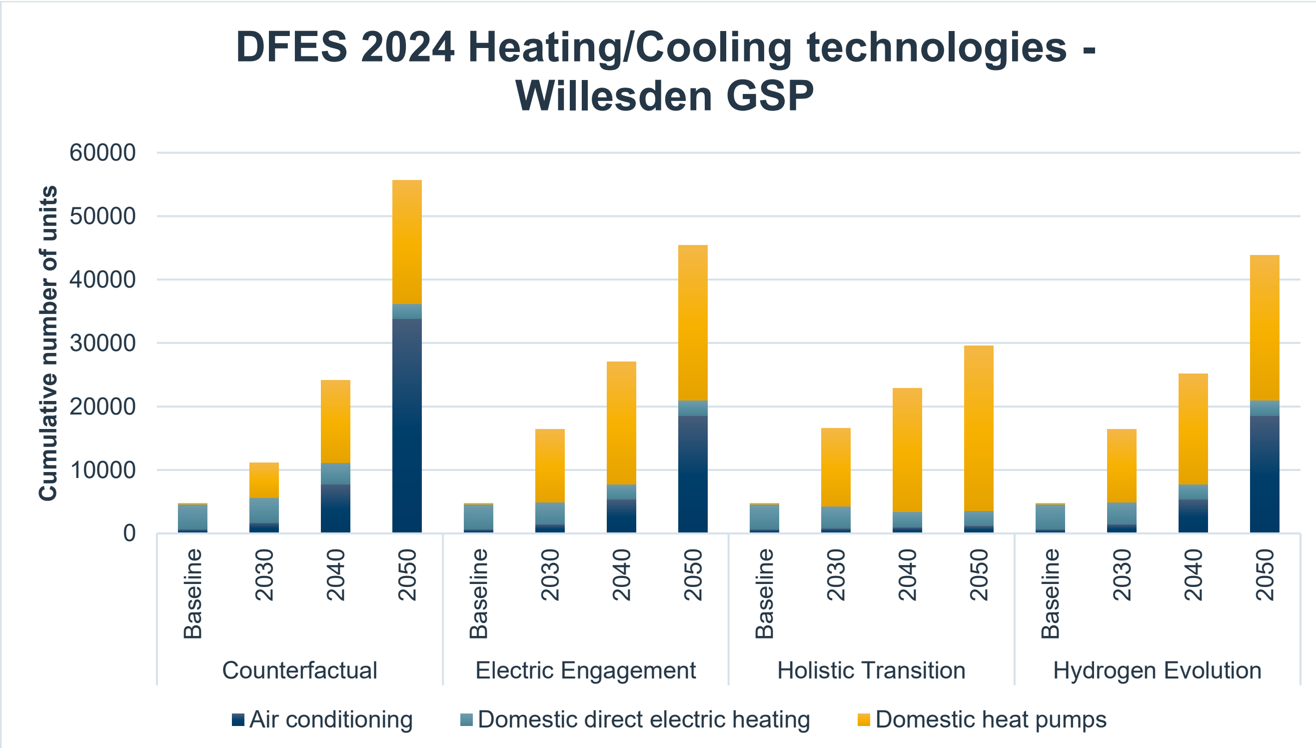


Figure 21 Projected number of heating/cooling technologies across Willesden GSP. *Source: SSEN DFES 2024*

New building developments

DFES Projections

Only one non-domestic new development sub technology is projected to arise under Willesden GSP in the DFES 2024 analysis. This is 970,634m^2 of floorspace categorised as other. This information was shared with SSEN as part of the DFES data exchange with local authorities. This floorspace is likely related to the new development at Old Oak and Park Royal.

Appendix B EHV/HV spatial plans for other DFES scenarios

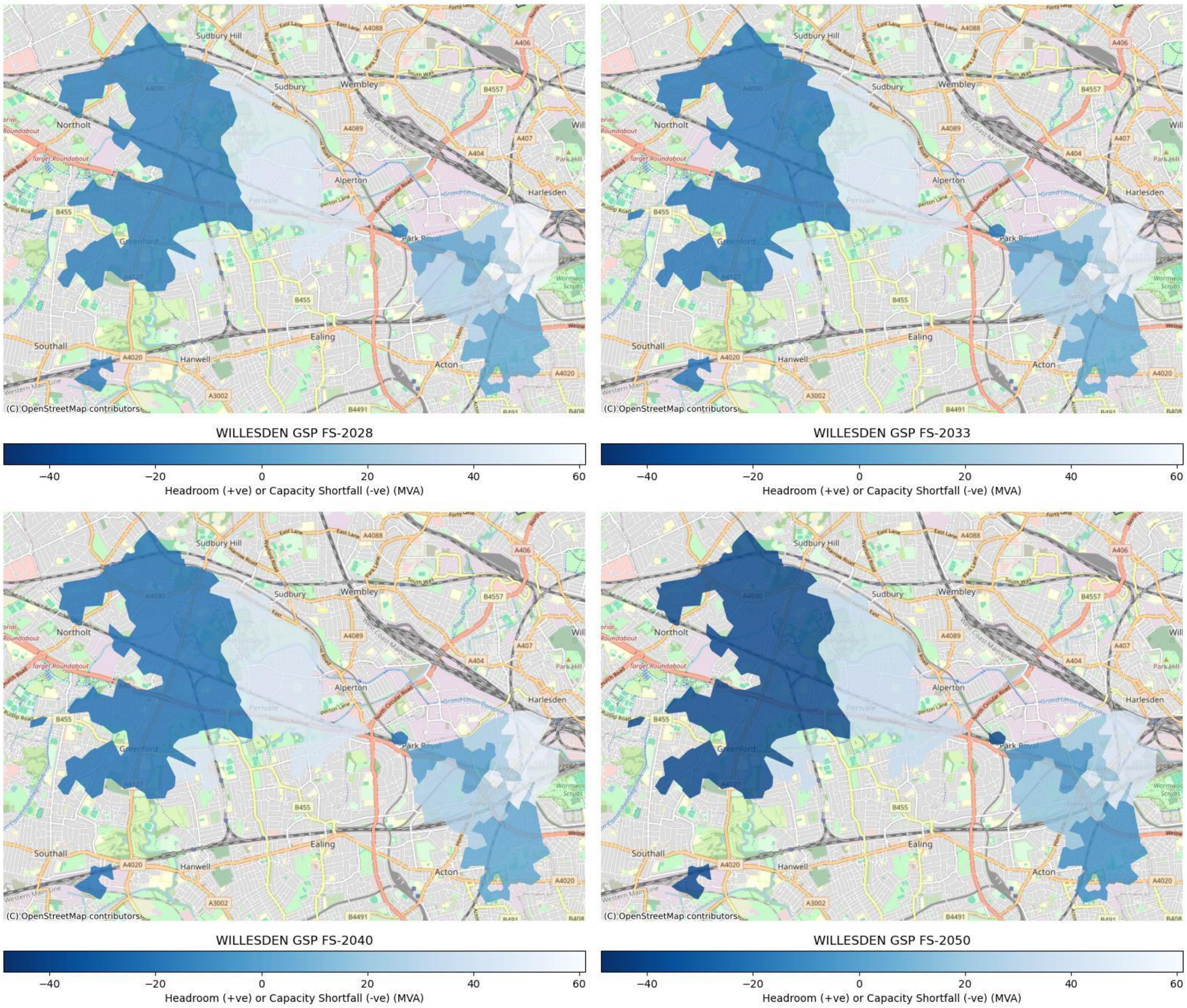


Figure 22 Willesden GSP - EHV/HV Spatial Plan - Falling Short

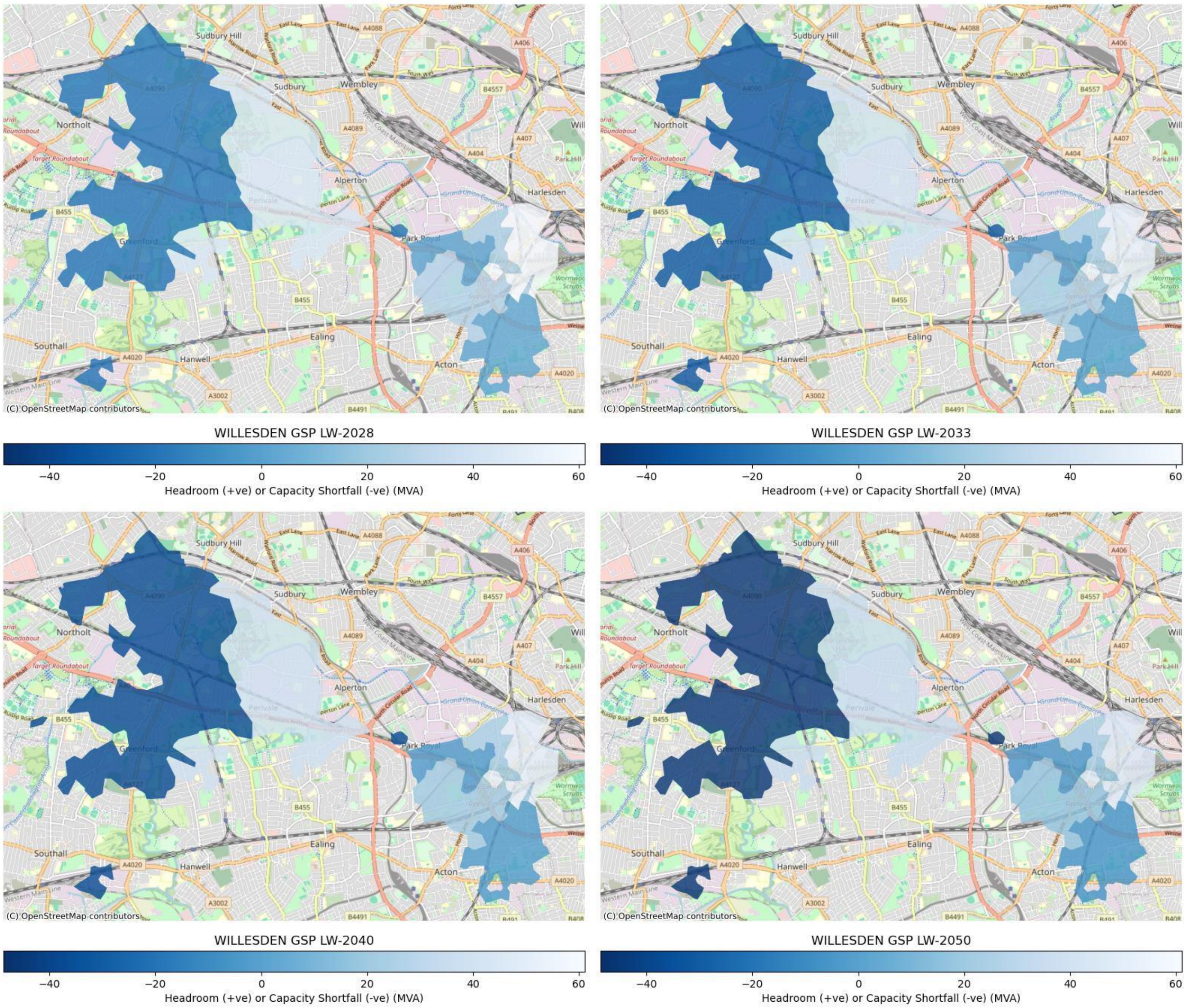


Figure 23 Willesden GSP - EHV/HV Spatial Plan - Leading the Way

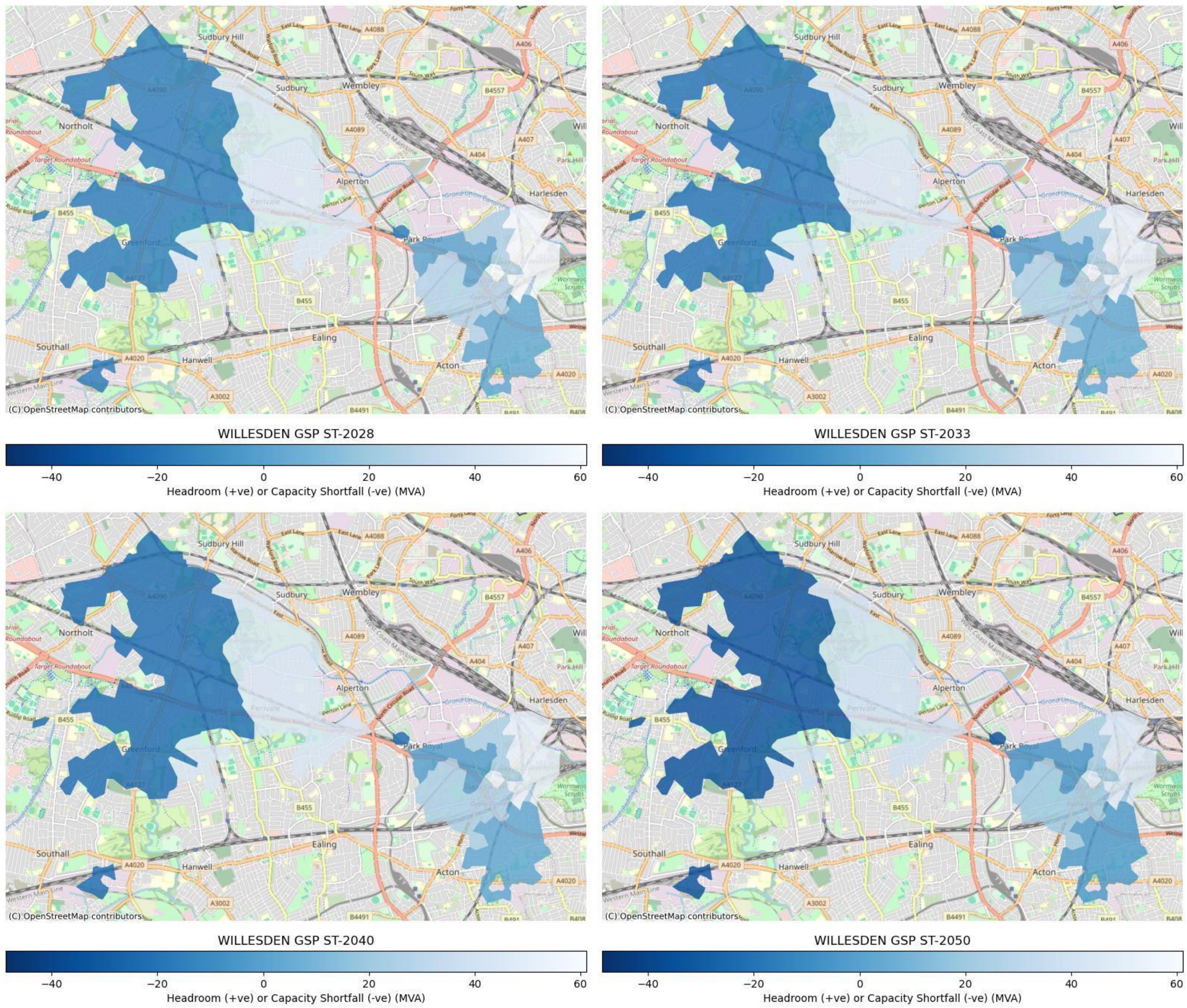


Figure 24 Willesden GSP - EHV/HV Spatial Plan - System Transformation

Appendix C HV/LV spatial plans for other DFES scenarios

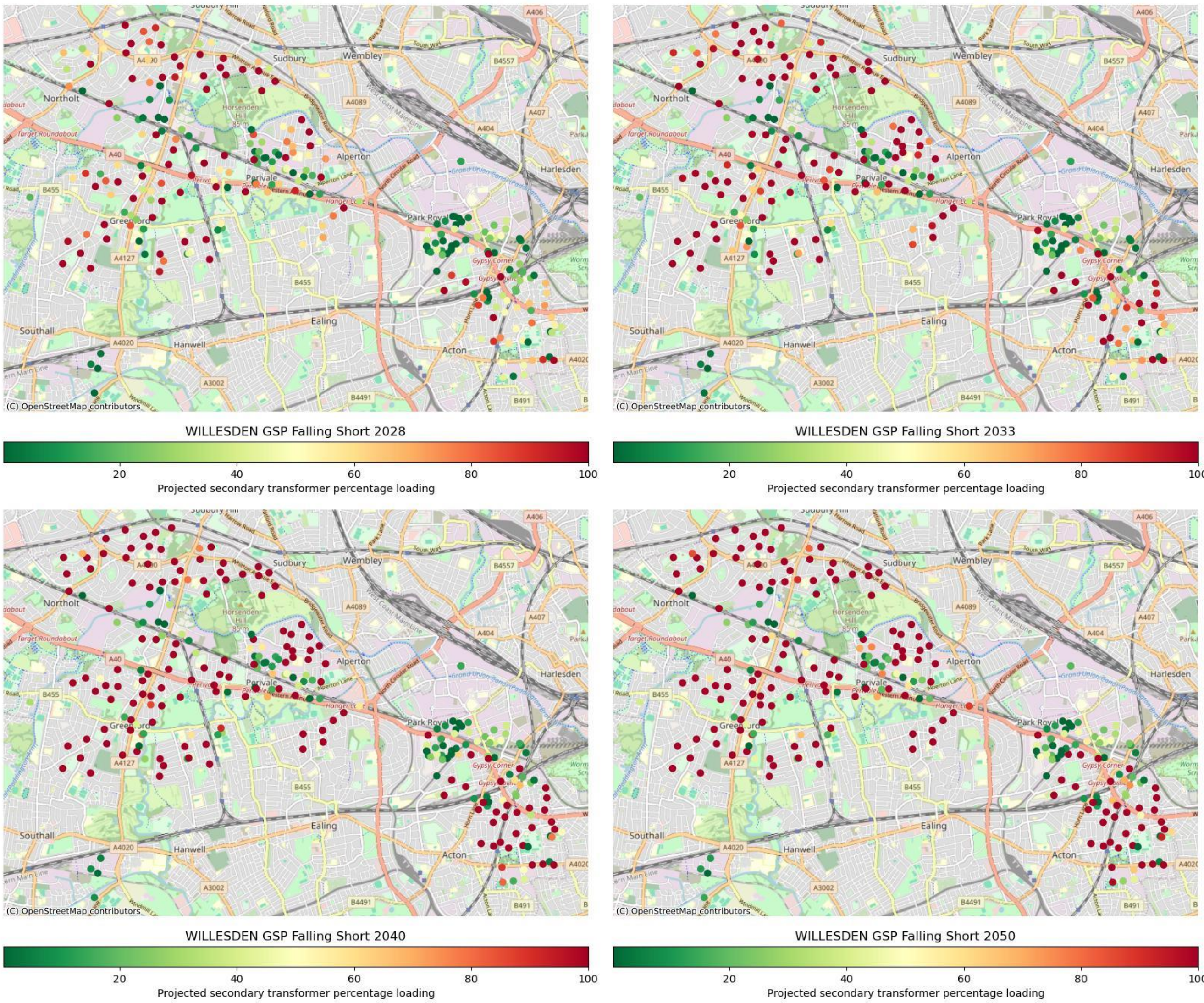


Figure 25 Willesden GSP - HV/LV Spatial Plan - Falling Short

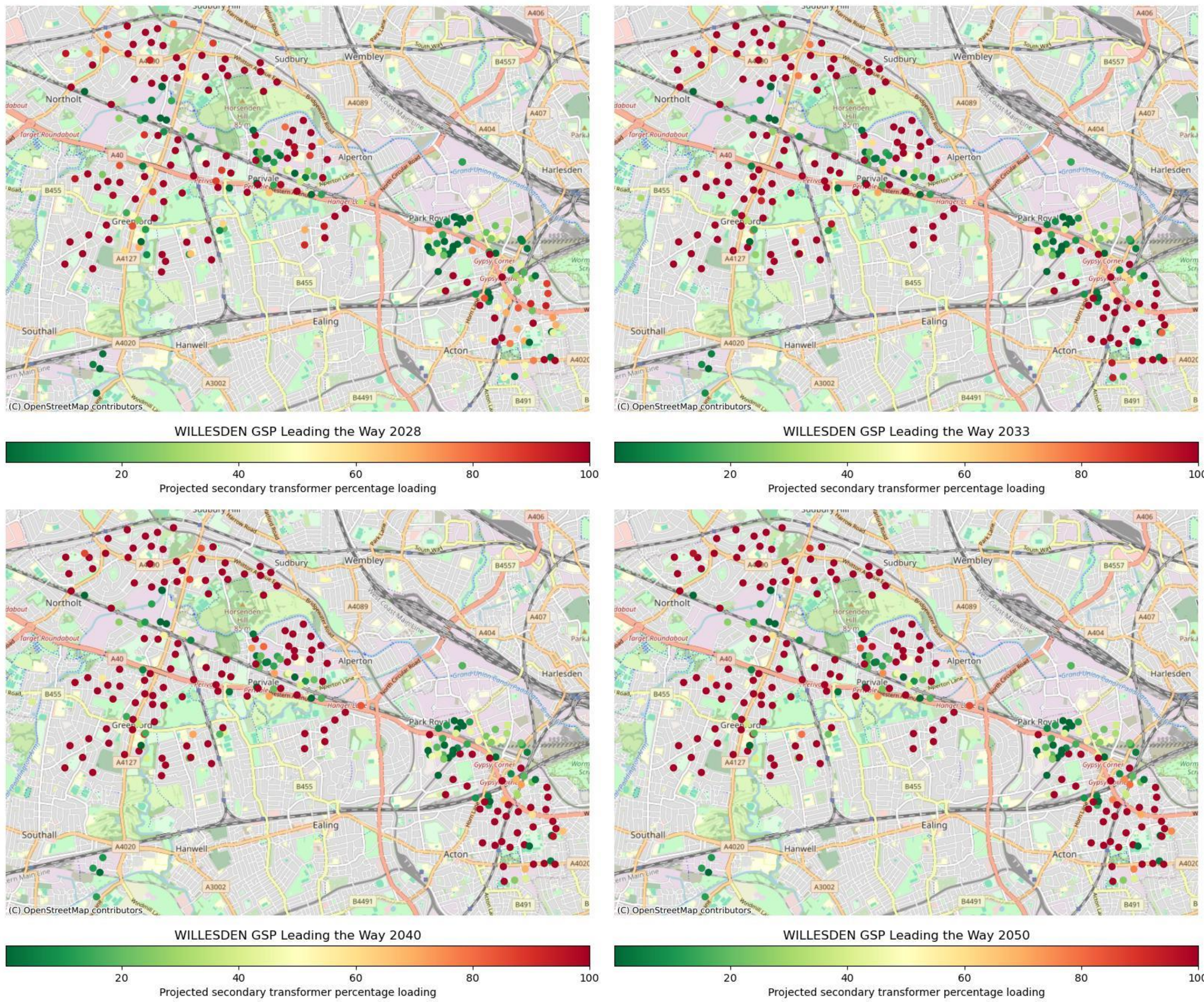


Figure 26 Willesden GSP - HV/LV Spatial Plan - Leading the Way

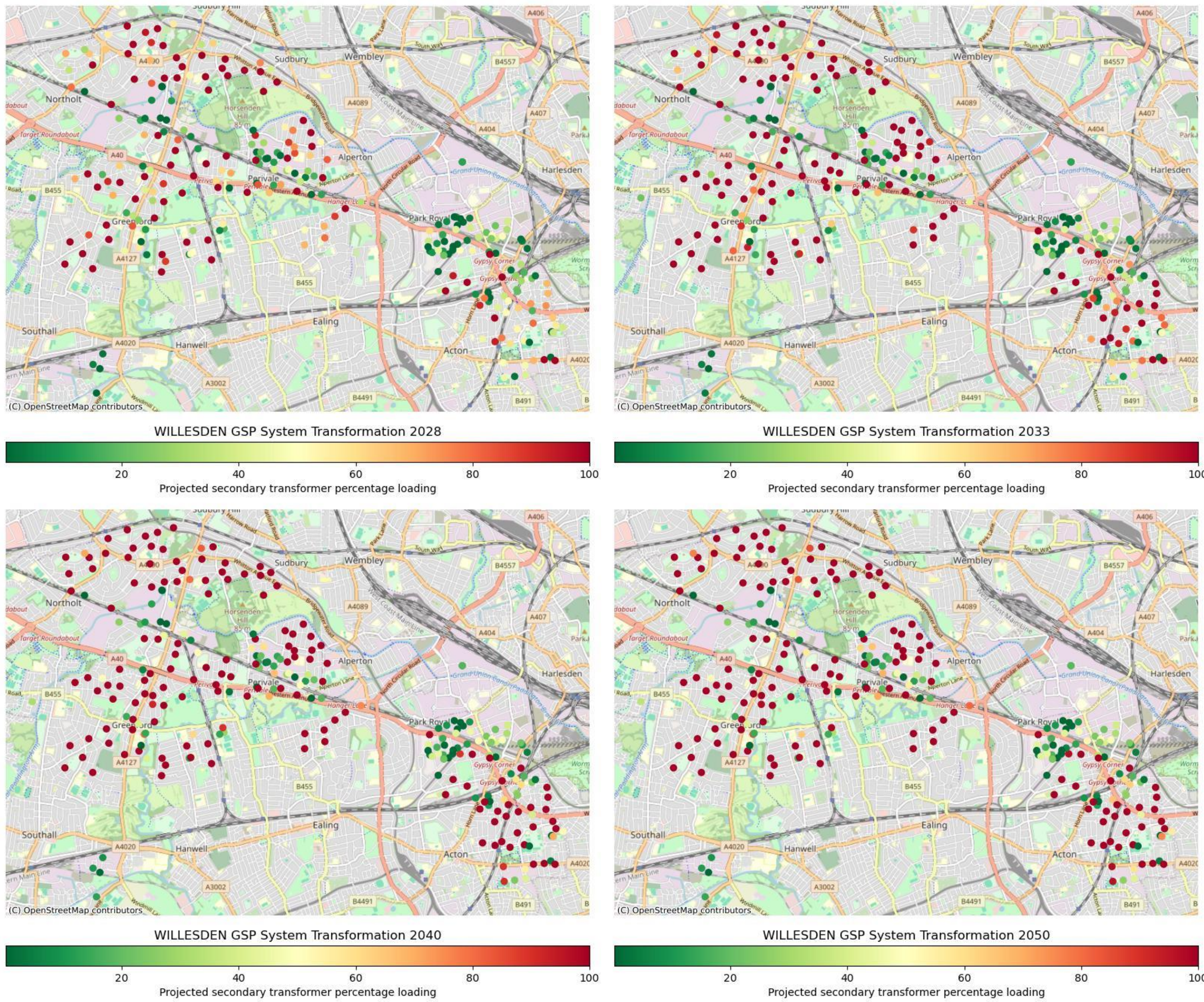


Figure 27 Willesden GSP - HV/LV Spatial Plan - System Transformation

Appendix D Relevant DNOA Outcome Reports

DNOA Outcome Report

Park Royal and Perivale (Park Royal & Perivale PSS) Ref. 0724-32

Scheme description

- Park Royal Substation is located in the West London area. Postcode area(s): HA0, N16, NW10, UB1 – UB6, W3, W5, W7, W11, W13.
- Load related – Thermal overloading on the transformers at Park Royal primary substation in FCO conditions.

Proposed option

- Asset solution: Upgrade transformers at Park Royal substation and uprate substation to 11kV. Add a new 66kV bus board at Perivale Substation to reconfigure the connections of Park Royal, Perivale, and Greenford substations.
- Assessment concluded that the necessary flexibility is not available during the required timeframe.
- Capacity Released: 10.4MVA at Park Royal primary substation and 38.1MVA at Perivale primary substation.

System need requirement

J	F	M	A	M	J	J	A	S	O	N	D

DNOA History

2024/25	2025/26	2026/27	2027/28	2028/29
Initial assessment				

Indicative flexibility price (if available):

- Availability: N/A
- Utilisation: N/A

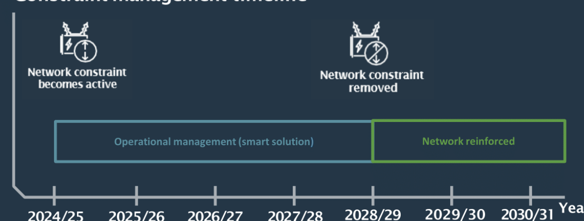
Reinforcement timeline

- Park Royal substation will be operationally managed to until reinforcement delivery.
- Reinforcement delivery by 2028/29.

Estimated peak MW outside firm network capacity under each scenario
Grey text relates to estimated peak MW without reinforcement delivery

	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
CT	3.08	3.08	3.08	3.09	- (3.62)	- (4.25)	- (4.74)
ST	3.08	3.08	3.08	3.09	- (3.62)	- (4.27)	- (4.79)
LTW	3.07	3.07	3.07	3.08	- (3.54)	- (4.09)	- (4.56)
FS	3.07	3.07	3.07	3.08	- (3.50)	- (4.00)	- (4.48)

Constraint management timeline



42 | Scottish and Southern Electricity Networks Distribution | **DNOA Outcomes Report July 2024**

Appendix E Glossary

Acronym	Definition
AIS	Air Insulated Switchgear
ANM	Active Network Management
BAU	Business as Usual
BSP	Bulk Supply Point
CB	Circuit Breaker
CBA	Cost Benefit Analysis
CER	Consumer Energy Resources
CMZ	Constraint Managed Zone
CT	Consumer Transformation
DER	Distributed Energy Resources
DESNZ	Department for Energy Security and Net Zero
DFES	Distribution Future Energy Scenarios
DNO	Distribution Network Operator
DNOA	Distribution Network Options Assessment
DSO	Distribution System Operation
DSR	Demand Side Response
EHV	Extra High Voltage
EJP	Engineering Justification Paper
ER P2	Engineering Recommendation P2
NESO	National Energy System Operator
NGET	National Grid Electricity Transmission
ENA	Electricity Networks Association
EV	Electric Vehicle
FES	Future Energy Scenarios
FS	Falling Short

GIS	Gas Insulated Switchgear
GSPs	Grid Supply Point
HV	High Voltage
kV	Kilovolt
LAEP	Local Area Energy Planning
LCT	Low Carbon Technology
LENZA	Local Energy Net Zero Accelerator
LV	Low Voltage
LW	Leading the Way
OHL	Overhead Line
PSS	Primary Substation
PV	Photovoltaic
NSHR	Network Scenario Headroom Report (part of the Network Development Plan)
MW	Megawatt
MVA	Mega Volt Ampere
ODM	Operational Decision Making
RESOP	Regional Energy System Operation Planning
RIIO-ED1/2	Revenue = Incentives + Innovation + Outputs, Electricity Distribution 1 / 2 (regulatory price control periods)
SDP	Strategic Development Plan
SEPD	Southern Electric Power Distribution
SLC	Standard Licence Condition
SSEN	Scottish and Southern Electricity Network
ST	System Transformation
UM	Uncertainty mechanism
VFES	Vulnerability Future Energy Scenarios
WSC	Worst Served Customers

CONTACT

whole.system.distribution@sse.com

Scottish & Southern Electricity Networks