Dorset Council

GRID CAPACITY ASSESSMENT

Constraint Analysis

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1 GLOSSARY OF TERMS

Term	Description
BSP	Bulk Supply Point
CT	Consumer Transformation (FES)
DFES	Distribution Future Energy Scenario
DNO	Distribution Network Operator
EV	Electric Vehicle
GSP	Grid Supply Point
LCT	Low Carbon Technology
LW	Leading the Way (FES)
PSS	Primary Substation
SP	Steady Progression (FES)
ST	System Transformation (FES)

2 INTRODUCTION

Dorset Council wish to assess the availability of grid capacity in the Council area as they continue to develop their programme to decarbonise, whilst also ensuring that there is sufficient grid capacity for future housing and economic growth. All route maps to Net Zero are anticipated to result in increased electrification of both transportation and residential heating, both of which will result in increased loading on the electrical distribution networks.

Dorset is already experiencing barriers to the development of potential employment sector sites due to existing grid constraints, and Dorset Council wish to understand the extent of potential grid constraints. A key employment sector which is prevalent across the Council area is that of advanced engineering and manufacturing, which is renowned for having higher than average energy demands. The food and drink sectors are also prevalent in Dorset, albeit to a lesser degree.

In conjunction to the increased electrical demands, the need to decarbonise the electricity supplies will rely partly on an increase in local distributed renewable and low carbon energy generation. For Dorset this is expected to be dominated by substantially increased capacity of Solar PV, and to a lesser extent onshore wind. There may also be the opportunity for Dorset to benefit from the addition of large-scale offshore wind farms, and potentially for future modular SMR nuclear reactors being deployed at the historic Winfrith nuclear site.

WSP have been engaged to undertake analysis of the grid capacity in Dorset, focussing mainly on the Primary Substations (PSS) and corresponding Bulk Supply Points (BSPs), to determine the probable areas of constraint, that if not addressed, may limit the ability of Dorset to deliver the growth to meet the area's needs alongside the Net Zero agenda in the required timescales.

2.1 KEY OBJECTIVES

The key objectives of this study are to analyse and map existing Distribution Network Operators (DNOs) substation capacity forecasts and to compile proposed and projected demands and generation information from Dorset Council. The two sets of information will be combined and compared to help inform the Council of probable and known grid constraints imposed by substation capacities. The objectives are summarised below:

1. Summary of how Future Energy Scenario forecasts are produced
2. Review and Discuss SSENs Long Term Development Plans for Dorset Distribution Networks
3. Utilise DNO's Distribution Future Energy Scenario (DFES) data, to map projected substation headroom for Dorset
4. Prepare visualisation maps that illustrate the DFES data for the base year and at five-year intervals from 2025 to 2040.
5. Gather and Consolidate a range of information for Dorset Council including proposed development plans, EV charging hubs, existing town and village data and solar PV farms and develop high level demand projections for the gathered information where feasible.
6. Undertake analysis to assign the demands from the Dorset Council information to local PSS and BSPs.

7. Map the Dorset Council information and data so that it can be visualised and compared with the DNO DFES information.
8. Assess and discuss the key findings from the analysis and visualisation to help Dorset Council to understand probable future grid constraints that, if unaddressed, may inhibit Dorset's future housing and employment growth and its journey to Net Zero.

3 FUTURE ENERGY SCENARIOS

3.1 OVERVIEW

Future Energy Scenarios (FES) are prepared annually by National Grid to illustrate four different scenario trajectories for decarbonising the energy systems, three of which will enable Great Britain to achieve its carbon commitments by 2050. National Grid base the overall trajectories, and reduction timelines on the Carbon budgets prepared by the UK Climate Change Committee (CCC). The UK's Sixth Carbon Budget was published Dec 2020 A breakdown of historical emissions by sector, and the overall trajectory required to attain Net Zero by 2050 is illustrated in Figure 1. Further information can be found at the CCCs website.

Of particular note from the historical carbon emission breakdown, is the relatively small reduction in carbon emissions, that have been achieved from 1990 to 2018, for the transport and building sectors. This means that there are significant reductions required in these areas in the next two decades

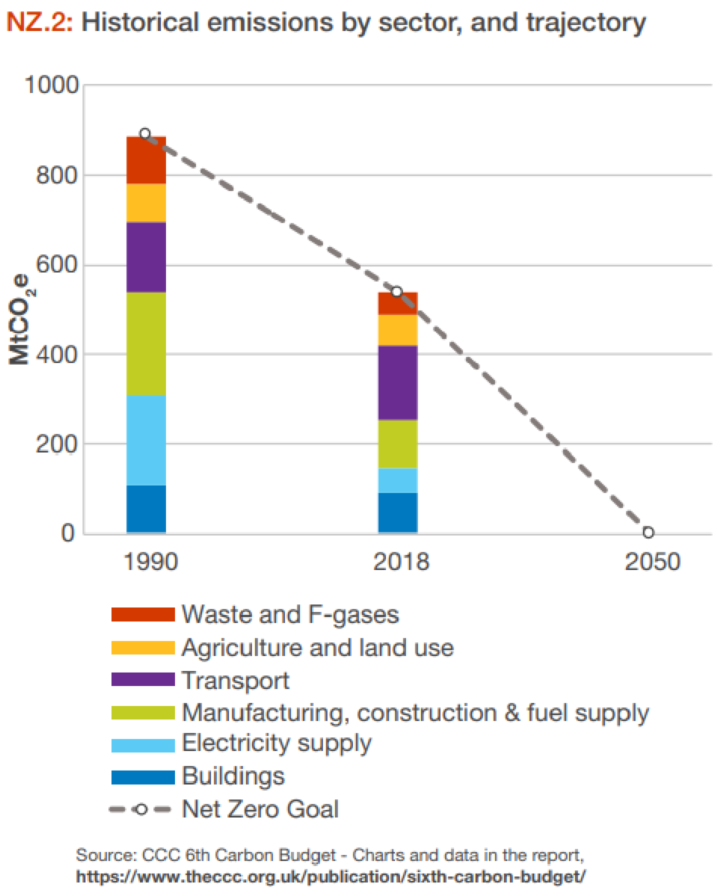

Figure 1 - Climate Change Committee, 6th Carbon Budget, breakdown of emissions by sector, and overall trajectory to 2050

3.2 FES – SCENARIO DESCRIPTIONS

National Grid has defined four distinctive energy scenarios that illustrate the potential impacts on the energy and electricity systems of a range of approaches to meeting our 2050 Net Zero target. Three scenarios achieve the required reduction in GHG emissions by 2050. The fourth scenario, Steady Progression (SP) projects historic BAU reductions out to 2050, and shows a failure to meet Net Zero by 2050 if the historic rate of reductions is maintained.

Consumer Transformation (CT) and System Transformation (ST) represent two different ways to reach Net Zero by 2050 – either by focussing on changing the way that we use energy (CT) or by focussing mainly on changing the way in which we generate and supply energy (ST).

Leading the Way (LW) describes our fastest credible decarbonisation journey, achieved through a combination of high consumer engagement with world leading technology and investment – allowing GB to reach Net Zero before 2050. It effectively takes the best aspects of the CT and ST scenarios.

Key aspects of the four FES, in conjunction with the relative speed of decarbonisation are shown in Figure 2.

For further information refer to National Grid published FES material (Future Energy Scenarios 2021 | National Grid ESO)

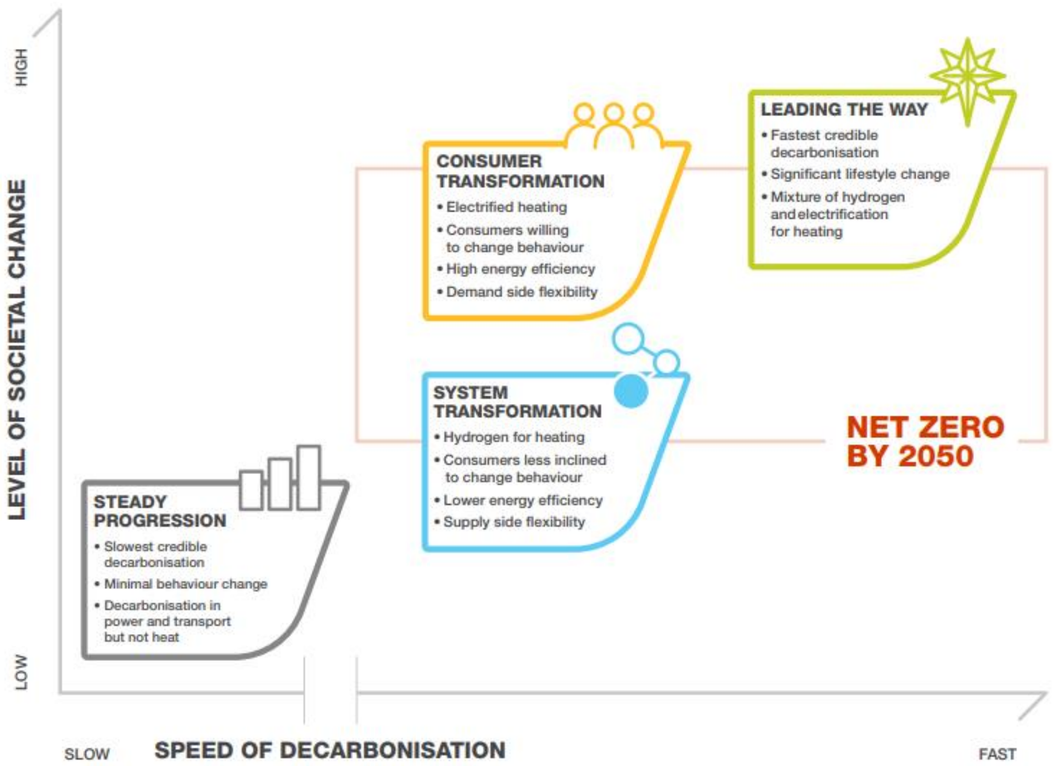

Figure 2 – Future Energy Scenarios (FES) – Key Principles and Relative Speed of Decarbonisation (National Grid)

The UK's Climate Change Committee actively review current progress on decarbonising the UK, and generate the Carbon Budgets that are required in order for the UK to meet its legally binding carbon reduction commitments. The Carbon Budgets, for each five-year interval from 2025 to 2035, are set out in conjunction with the FES carbon trajectories in Figure 3. Steady Progression represents the UK's carbon trajectory if our rate of carbon reductions are not significantly increased, and is not compliant with the UK's responsibilities to help maintain a maximum 1.5°C global temperature rise as set out in the Paris Agreement.

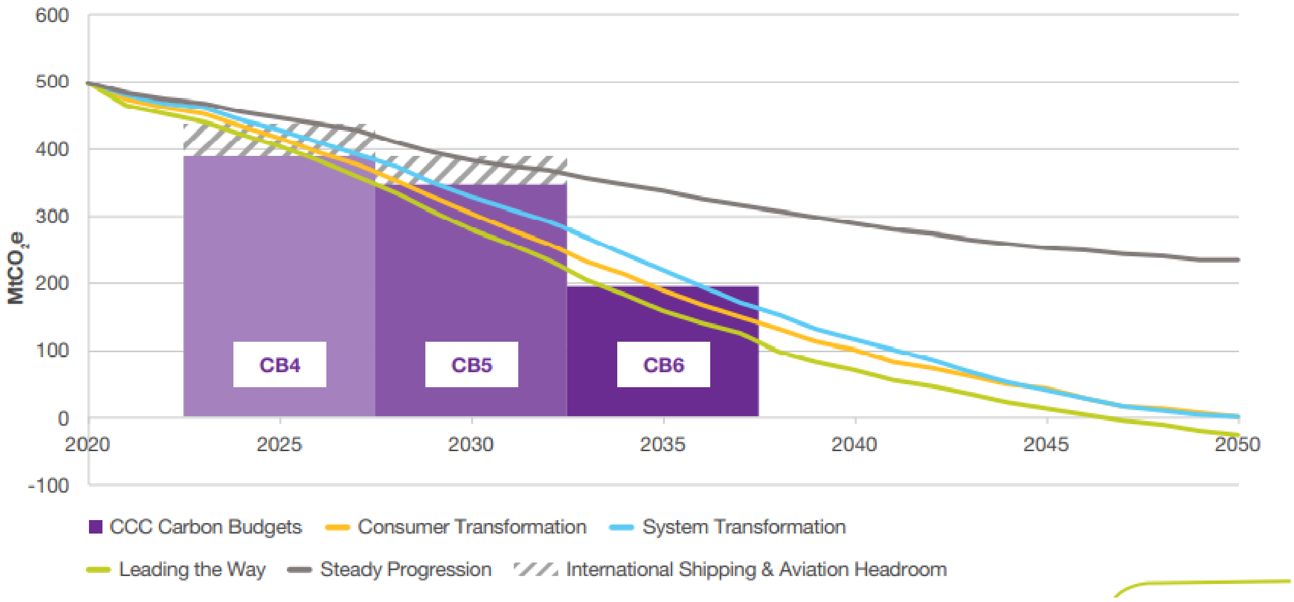

Figure 3 – Climate Change Committee Carbon Budgets, and FES Carbon Trajectories (National Grid)

A result of decarbonising our energy systems, is that we will also see significant improvements in energy efficiency, meaning that we need less energy to fuel a future low or Net Zero carbon energy system. The projected total annual energy demands in 2050, for each FES scenario, are illustrated in Figure 4, alongside the current (2020) annual energy demand. The demands are split down by fuel/energy type. The increased reliance on electricity can be seen in all future energy scenarios and is particularly prevalent for the Consumer Transformation scenario, which sees an almost doubling of annual electricity demand. The other carbon compliant scenarios (ST and LW) rely more heavily on hydrogen, particularly so for System Transformation.

The corresponding projected peak electrical demands for the different FES are shown in Figure 5. The peak demands are most relevant for the operation and capacity planning of the electricity networks, as exceeding network capacities can result in potential brown-outs or black-outs, resulting in loss of network supply, potentially for large numbers of customers in times of the highest demand.

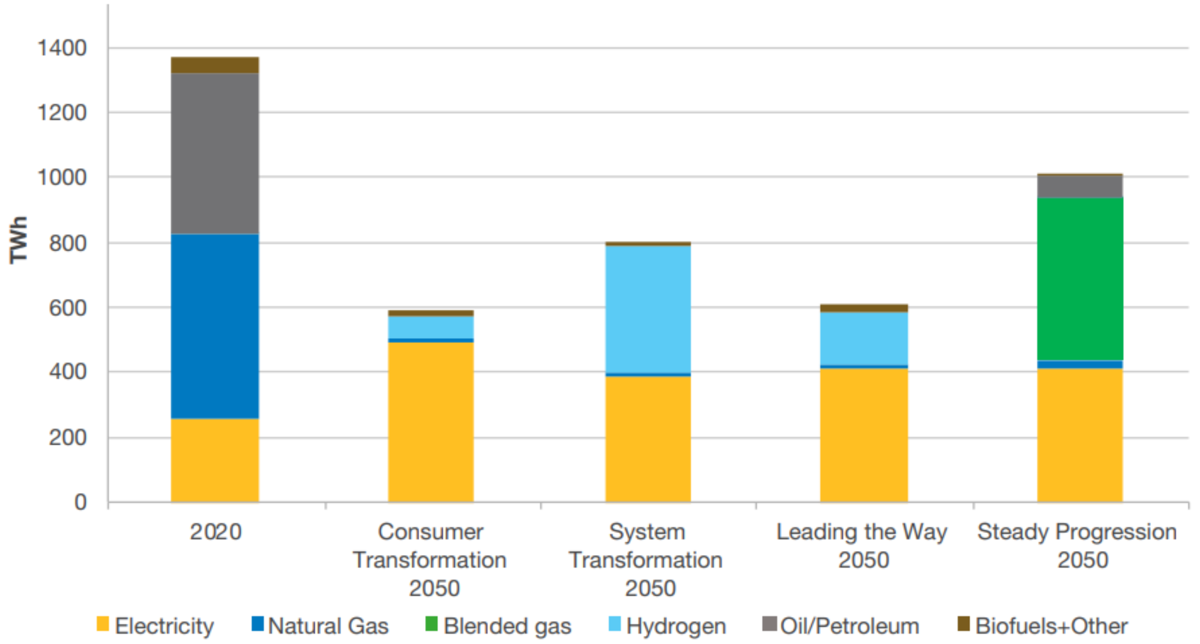

Figure 4 – Annual end consumer (including residential, road transport and I&C) energy demand by fuel type (National Grid)

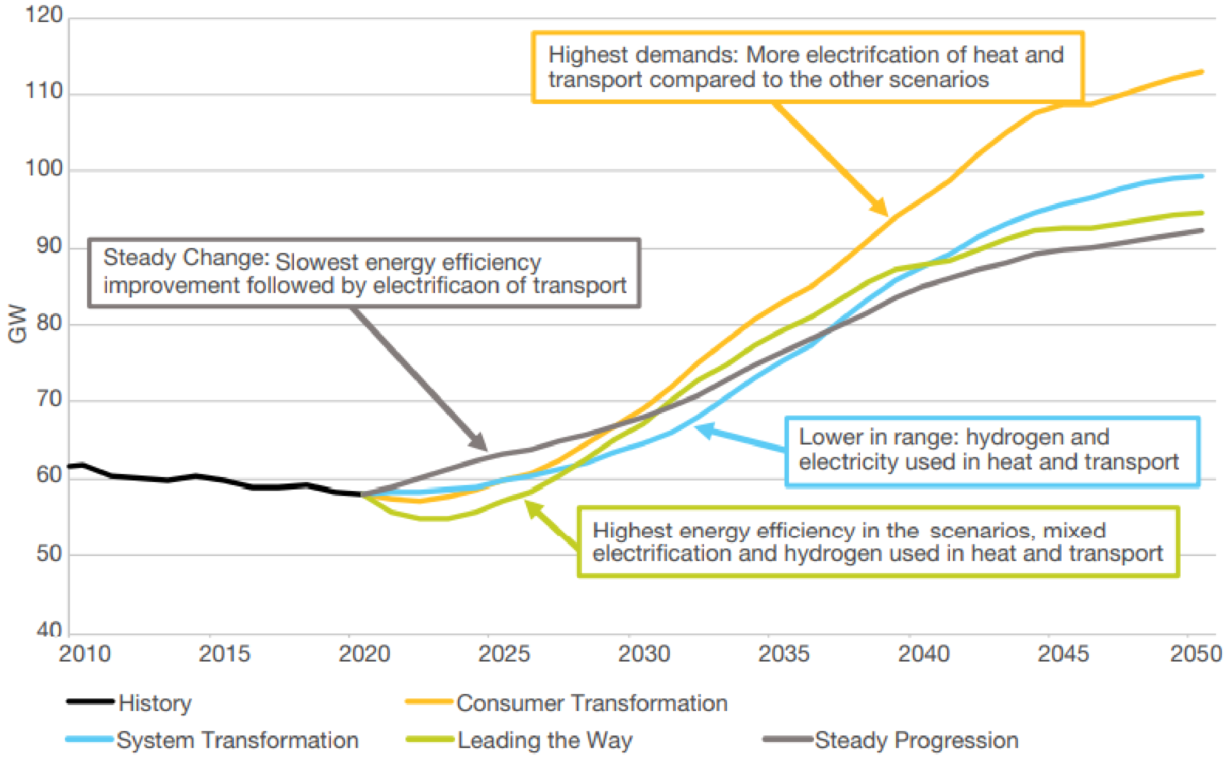

Figure 5 – Future Energy Scenarios (FES) – Projected UK Peak Demand (National Grid)

3.3 FES TO DFES

The FES analysis is undertaken for the whole of GB and is predominantly focussed on the resulting electricity demands at the transmission level.

The Distribution Network Operators (DNOs) undertake annual forecasting to generate Distribution Future Energy Scenarios (DFES). The DFES incorporate regional factors to enable the local level strategic planning of the GB distribution networks. The DNOs engage with local stakeholders, including the local authorities, to understand the plans and delivery progress of local developments.

The DNOs use the DFES based projections as supporting evidence for their own business development plans, including to develop the business cases for future network investments.

The DFES forecast share a common framework and technology definitions as the FES forecasts, including the key scenario definitions described in the previous section (Section 3.2).

DFES DATA

Some of the DNOs publish the DFES scenario information, for each substation, showing the changes in forecast demand, generation, and substation headroom from the current year until 2050.

WSP have sourced this information from SSEN, which covers all but three of the Dorset substations. The final three substations, located to the far West of Dorset, are operated by WPD. WPD have not yet made their DFES substation forecasts data publicly available, although it is possible to view different individual data sets via their heat map web portal.

The DFES substation data sourced from SSEN has been reviewed and prepared for visualisation on GIS maps.

The DFES data is primarily aimed at Primary Substations (PSS) and the Bulk Supply Points (BSPs) that supply the primary substations with power. Grid Supply Points (GSPs) act as the bridge between the electricity transmission system, operated by National Grid, and the BSPs which are operated by the DNOs.

GRID IMPACTS OF ADDITIONAL DEMANDS

If a PSS has insufficient capacity for a new demand, such as a new residential or employment sector development, it may be possible to expand the capacity of the substation to accommodate the new demand or alternatively a new PSS will be required. In either case, the additional demand will need to be supplied from the corresponding BSP, increasing the demand on the BSP, which in turn will require additional power from the GSP that supplied the BSP. Expansion or development of a new BSP will generally be much more costly and take longer to plan and deliver than a PSS. Similarly, if a GSP needs to be expanded in capacity, this will generally be much more costly and take longer to plan and deliver than a BSP.

The DFES data only reflects the forecast loadings and associated headroom at the substations, it does not consider the potential constraints imposed by network line or cable capacities. Alongside the future expansion of existing or development of new substations, work may also be required to expand overhead line capacity or underground cable capacity to facilitate additional future electrical demands. Such works to reinforce the necessary lines and cables can also be very costly and take considerable time to plan, design and deliver.

The DNO has a responsibility to ensure that the distribution network has sufficient capacity to meet future electricity demands, whilst maintaining a cost-effective approach to network reinforcement. Specific developments may trigger the need to reinforce areas of the network, or the network may need to be reinforced due to incremental increase in the demand from existing connected customers.

Where the new connection of specific developments trigger a network reinforcement, the developer is required to cover a proportion of the associated cost, up to two voltage levels above the voltage that the connection is made. Part of the cost is usually attributed to all network users in the area.

This latter driver for reinforcement is expected to occur on an ongoing basis as the result of decarbonising our energy systems, in particular it will be driven by the electrification of heat and transport. The costs associated with reinforcements that are triggered by incremental increases in connected customer demand, are borne by all of the connected customers and represent an element of their electricity bill.

Network reinforcements that are not directly triggered by a connection request (e.g. for a new development) are assessed and need to be approved by Ofgem, the electricity and gas regulator, in order for a DNO to be able to recover the cost for the reinforcement from the network customers.

Ofgem, does allow for proactive reinforcement of the network, in anticipation of increased future demand, however the onus is on the DNO to be able to adequately evidence the need for reinforcement, and that the proposed reinforcement represents best value for the connected customers.

4 PLANNED DNO ED2 NETWORK REINFORCEMENTS

4.1 SSEN

The GB DNOs prepare investment plans to cover each price control period. The DNO investment plans for the RIIO ED2 price control period, which runs from 2023-2028 have recently been submitted to Ofgem for review and approval. The ED2 submissions are aligned to the DNOs long term development strategies.

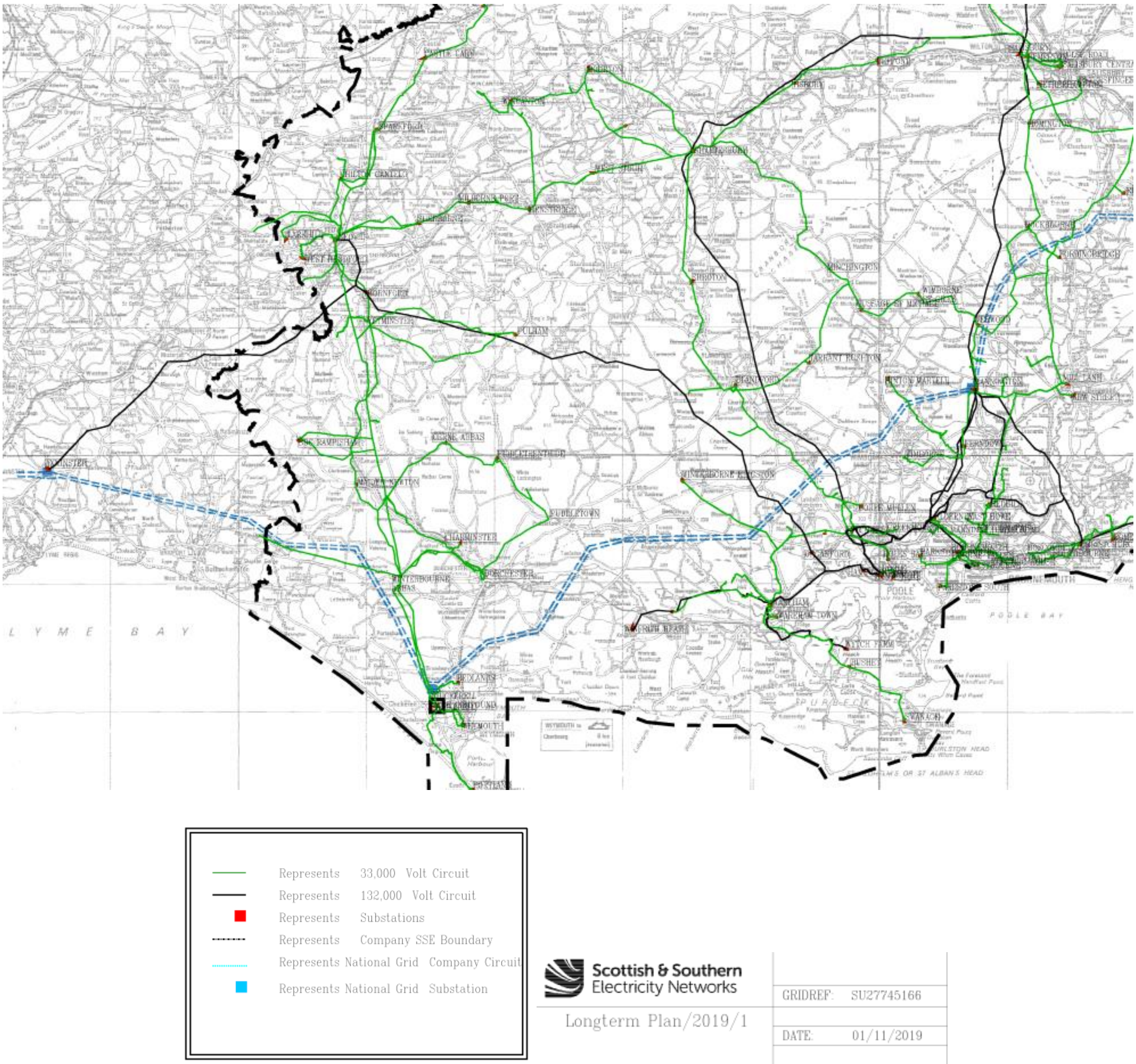

Figure 6 – SSEN Long Term Plan Electricity Network covering Dorset County, Showing Network Topology for 33kVand 132kV.

The DNOs publish their Long Term Develop Statement (LTDS) each year. The latest LTDS published by SSEN was released in 2021, and includes planned works up to 2025.

Details of Network Development Proposal are included within the LTDS, and these are separated into the categories for reinforcement (Network Reinforcement Projects) and replacements (Asset Replacement Projects) which are triggered by the decreasing health of an asset.

The proposed works that fall within the Network Reinforcement Projects for the GSPs that serve Dorset are shown below in Table 4-1. The planned reinforcements include the expansion of the primary substation capacity at Dorchester Town and 132kV network improvements related to the Salisbury/Amesbury 132kV tee. There are currently no other planned reinforcements relating to PSS or BSPs in Dorset listed in SSENs LTDS.

Table 4-1 – SSEN LTDS Planned Network Reinforcement Projects

GSP	Name	Estimated Completion	Impact on distribution Network Capability
Chickerell	Dorchester -Dorchester Town 33/11kV Substation Redevelopment	Sep-21	Reinforcement of the existing transformers with higher rated assets to increase the substation firm capacity at Dorchester Town primary (90002)
Mannington	Mannington 132/33 kV substation - Mill Lane 33/11 kV substation	Jul-24	Replacement of 400 A 33 kV isolators at Mannington (89250) and Mill Lane (89202)
Mannington	kV Network Improvements	Dec-23	Installation of a 132 kV isolator at Amesbury 132 kV substation (10510-10513) and connection on to Salisbury/Amesbury tee 132 kV circuit 2.

5 FES FORECASTS FOR DORSET GSPs

5.1 OVERVIEW

There are three GSPs that supply Dorset with electricity. The GSPs act as the bridge between the high voltage electricity Transmission system, operated by National Grid, and the Distribution system operated by the DNOs. It is noted that the GSPs that supply electricity to Dorset also supply electricity to neighbouring areas, so there will be BSPs and PSS outside of the Dorset County boundary that impact on the projected GSP peak demands.

The GSPs supplying Dorset with electricity are:

- **Axminster**
- **Chickerell**
- **Mannington**

Key characteristics including current capacities and the number of BSPs and PSSs supplied by each GSP are shown below in Table 5-1.

Table 5-1 – GSP details for Dorset

GSP	Transformer Capacity (MW)	No. of BSPs in Dorset	Total Dorset BSP Capacity (MW)	2020 Dorset BSP Peak Capacity (MW)	No. of PSS in Dorset	Total Dorset PSS Capacity (MW)	2020 Dorset PSS Peak Capacity
Axminster	Shared Site	1	129	103	4	30	34
Chickerell	290	1	114	88	9	127	87
Mannington	960	8	819	477	24	392	232

FES Forecasts for Dorset GSPs

The annual forecasted change in peak demands for the GSPs that supply electricity to Dorset County are illustrated in this section of the report. These are shown for the CT, ST and LW FES scenarios. These can be considered in the context of the overall carbon budgets and GB wide FES scenarios presented in section 3.2, and the DFES scenarios shown in section 3.3.

The forecast graphs show the projected peak demands, split by the type of demand. The primary vertical axis (lhs) shows the value of each demand type, the secondary (rhs) axis shows the Total peak demand. The key for the different types of demand is shown below in Figure 7. It is of note that the Residential demands represent the baseline residential demands, excluding heat-pumps/electrical heating and future EV charging. The electric vehicle charging, and heat-pump categories capture the expected electrical demand growths resulting from the decarbonising of heat and transport.

The projections for each GSP for the CT and ST FES scenarios are shown in Figure 8 to Figure 13. All scenarios result in a reduction in the residential baseload demand, as a result of improved efficiencies of electrical appliances and lighting. The heat-pump based demands are shown to increase steadily to 2045, whereas the EV based demands rise quickly to around 2033, and then more gradually. The premise being that more demand management and the potential for lower car ownership leads to a more gradual future rate of increase in EV generated peak demand. This premise is more uncertain and relies more on demand side management than for the electrification of heat.

R	Residential
E	Electric Vehicle
C	Commercial
I	Industrial
H	Heat pumps
D	District Heat
T	Transmission Direct Connects

Figure 7 – Types of Demand in the GSP FES forecasts

5.2 DORSET GSP FES FORECASTS - CONSUMER TRANSFORMATION

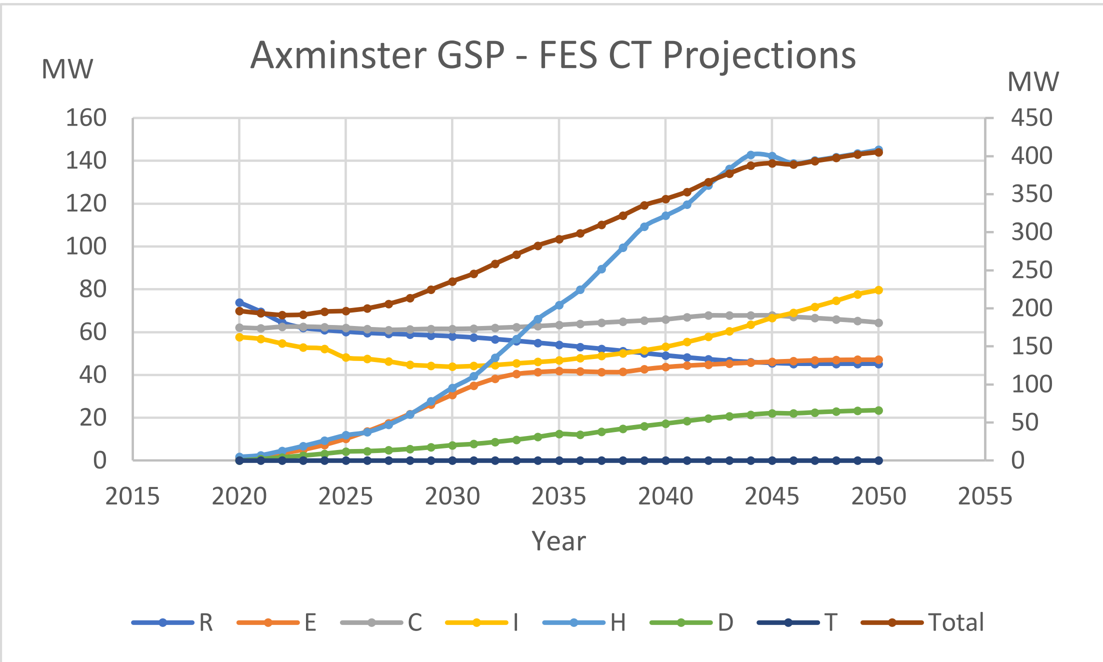

Figure 8 - Axminster GSP FES Forecasts - Consumer Transformation

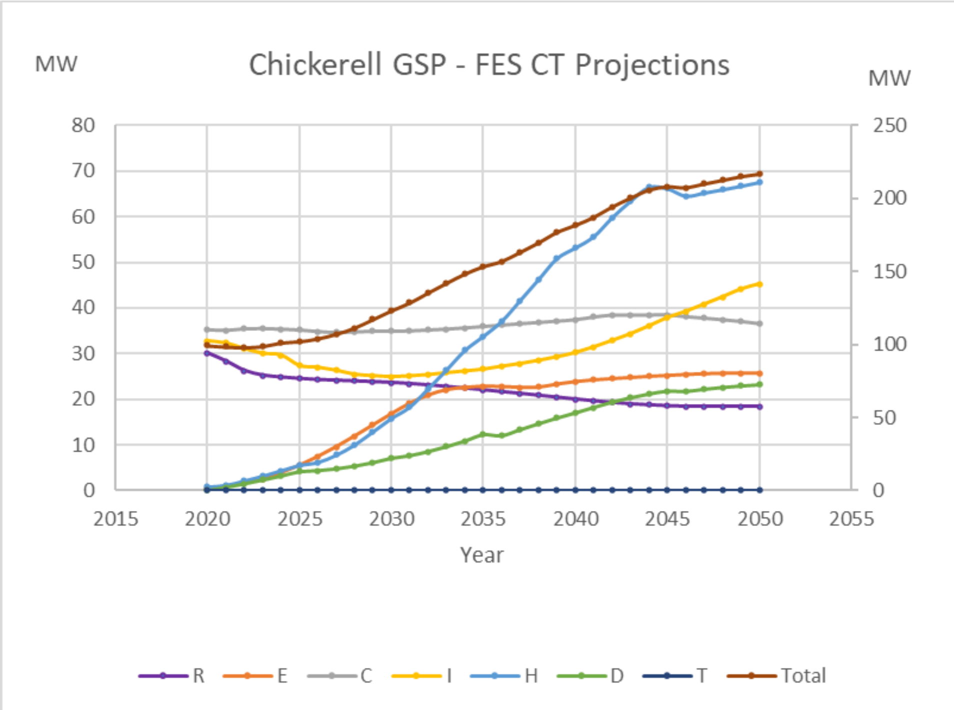

Figure 9 - Chickerell GSP FES Forecasts - Consumer Transformation

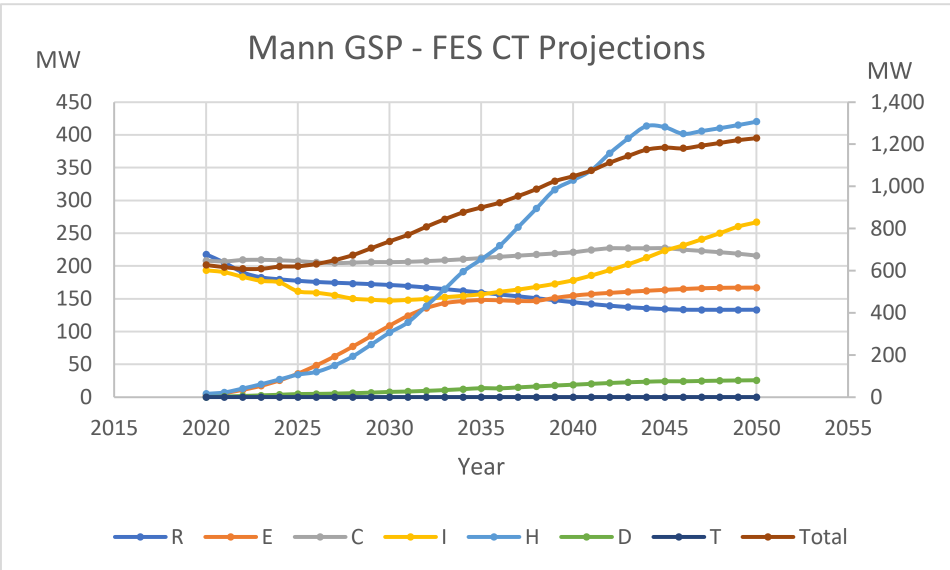

Figure 10 - Mannington GSP FES Forecasts - Consumer Transformation

5.3 DORSET GSP FES FORECASTS - SYSTEM TRANSFORMATION

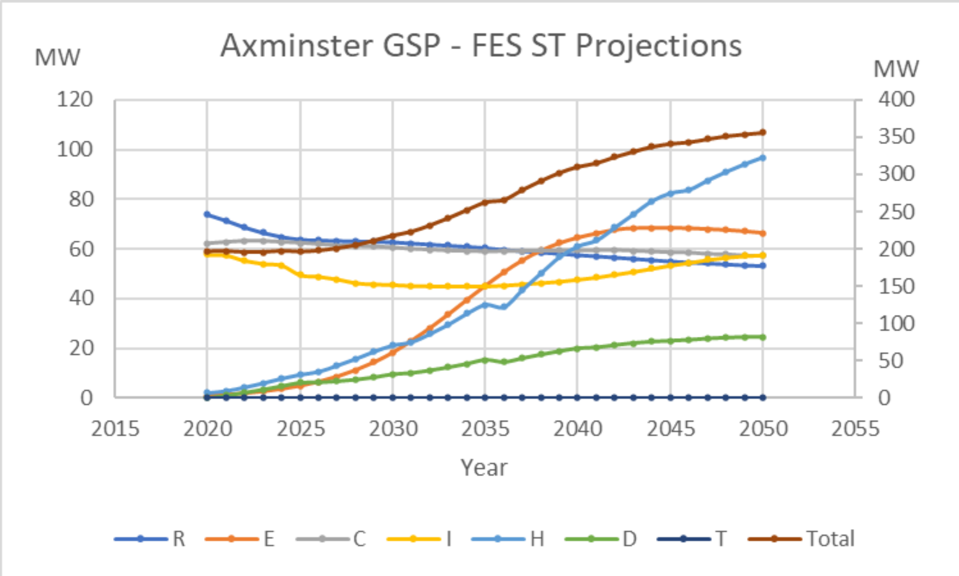

Figure 11 - Axminster GSP FES Forecasts - System Transformation

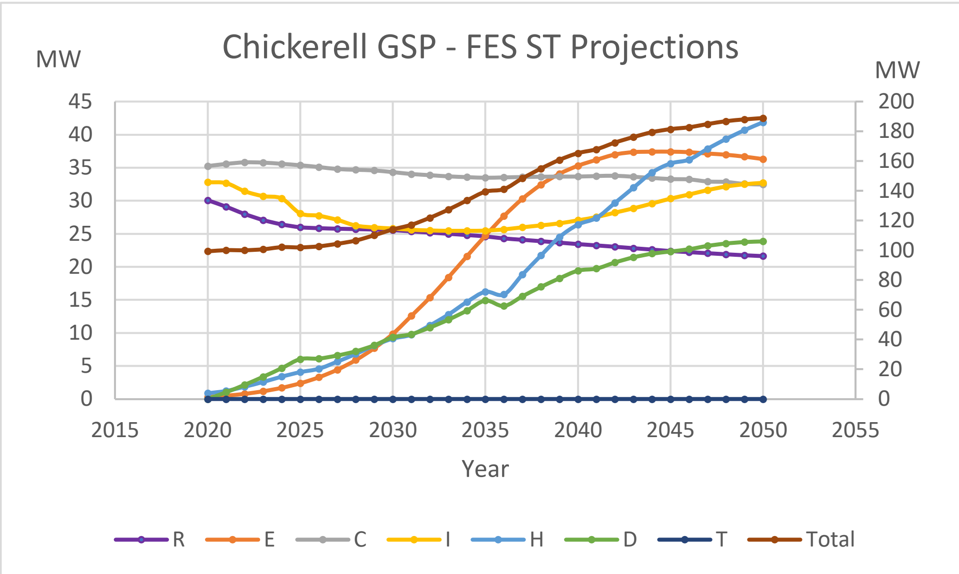

Figure 12 - Chickerell GSP FES Forecasts - System Transformation

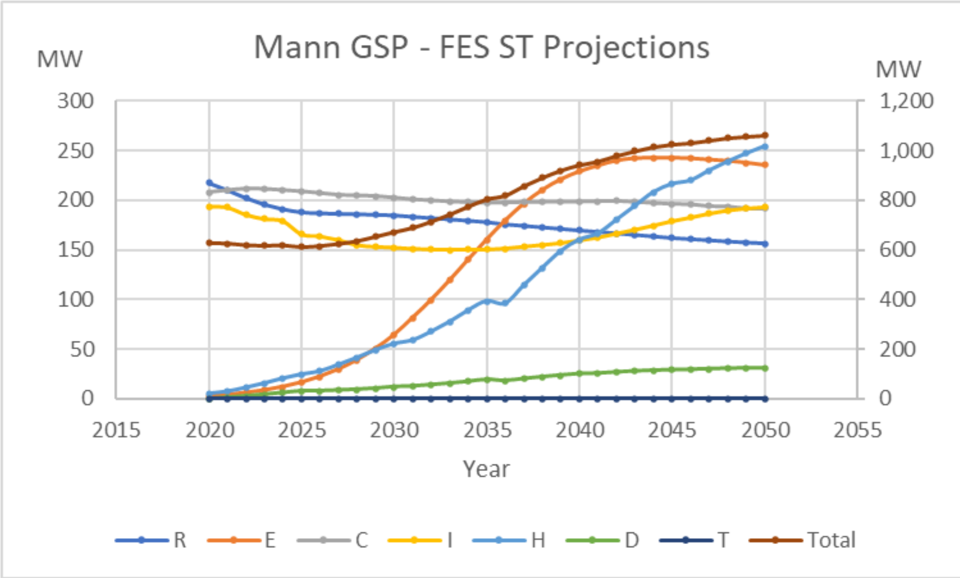

Figure 13 - Mannington GSP FES Forecasts - System Transformation

6 DFES FORECASTS FOR DORSET BSPs AND PSS

The DFES forecast data available from SSEN has been reviewed and prepared for visualisation. The Council's development programmes, for new residential and employment sector developments extend to 2038, with a more comprehensive set of information being available for the years between 2022 and 2030. We have therefore focussed the visualisation on 2020 (to act as the baseline), 2030 and 2040.

The following set of figures (Figure 14 to Figure 16) illustrate the projected headroom at the BSPs and PSS for each time interval under the CT DFES. Distinct bands have been created to capture the headroom, these have been colour coded in the GIS visualisation maps, where the green range shows available head room, shading to pale green/white when approaching zero headroom. The red range shows where the current substation capacity has been exceeded, with deep red showing the largest exceeding of headroom and pale red/yellow shows a slightly exceeded headroom.

The GSPs are included for reference, as are the BSPs that lie outside of the Dorset County border, that are supplied from the GSPs that provide Dorset with electricity.

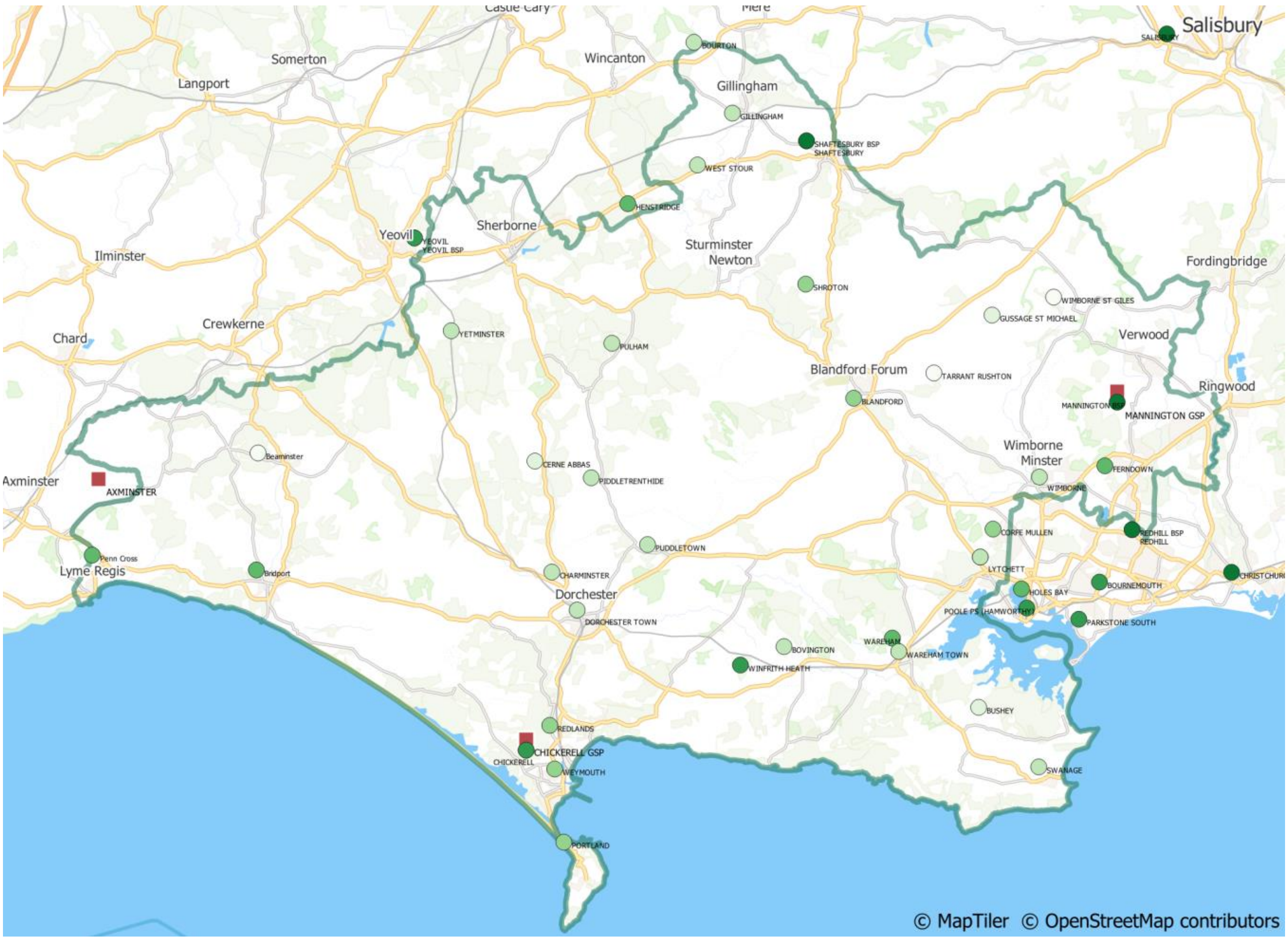

Figure 14 - GSPs, BSPs and PSS serving Dorset, Showing DFES CT Scenario Loadings for 2020

Figure 15 - GSPs, BSPs and PSS serving Dorset, Showing DFES CT Scenario Loadings for 2030

Under the SSEN DFES CT scenario projections, several PSS and BSPs are forecast to exceed their current capacities by 2030. This is especially evident around the Chickerell and Dorchester areas.

Figure 16 - GSPs, BSPs and PSS serving Dorset, Showing DFES CT Scenario Loadings for 2040

By 2040 the DFES CT scenarios show that the capacity is expected to be exceeded at the majority of substations. The deep red shows where the capacity is exceeded by the greatest amount. Where individual primary substations cannot meet the local demand, they may be able to be expanded in capacity, and where this is not possible due to limited space or network constraints, a new Primary substation would be required. The Primary Substations are in turn, supplied by a Bulk Supply Point. The BSPs also have capacity limits, and expanding the capacity of a BSP, or constructing a new BSP will generally be much more costly and time consuming than for a PSS. All substation reinforcement needs adequate time for planning, design and implementation which may take several years to fulfil. Additionally, there may be capacity limitations associated with the overhead lines or underground cables that connect the PSS, BSPs and GSPs. Addressing network constraints of this nature may take many years of planning and implementation.

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7 PROJECTED DORSET FUTURE DEMANDS

7.1 DEVELOPMENT PLANS

Dorset Council has provided a projected residential and employment sector development scenario based on the emerging Dorset Council Local Plan. This includes existing committed development as well as development proposals that have been subject to consultation. The current programme for Residential developments stretches over the period to 2038, although the details regarding proposed volumes for new developments are more certain from 2022 to 2030 than from 2030 to 2038. It is anticipated that there will be additional developments, that have not yet been planned, from 2030 onwards and it is difficult to predict where these will take place.

A summary of the current development plans is included in Appendix A.

The Employment sector development scenario includes land allocated for development, but the detail about the expected developments on an annual basis, or the composition of the anticipated mix of different employment sector business types is market led and therefore difficult to predict with any degree of certainty. To overcome this, various assumptions based on existing and expected future employment development trends, have been used to estimate the future employment sector developments scenario.

Both sets of data have been used to provide a visual reference for projected DFES maps and also to inform potential demands for the proposed developments, to provide a comparison and additional layer of information when considering probable grid constraints and necessary reinforcements.

RESIDENTIAL DEMAND PROJECTIONS

The indicative residential demand projections have been developed from the planned residential developments that Dorset Council are currently aware of. The demand projections are intended to provide an indication of typical demands created from the proposed developments under the premise that there is a steady progression towards the electrification of heat and transport as the County progresses on its journey to carbon neutrality. An average peak heat demand and EV charging demand has been assigned for each five-year interval, which incorporates a factor for the diversification of peak loads. This reflects the fact that not all electricity users will have their heating and hot water on at the same time, and not all EV users will be charging their cars simultaneously.

In practice the peak demands are expected to continue to be seen in the winter months of November to January, where the combination of heating due to severe cold weather snaps, additional need for lighting and the increased EV charging demands (which occur due to lower battery efficiencies and increased demand for cabin heating and vehicle lights) all contribute to maximising the peak demand at this time of year.

The resulting diversified peak demands used to generate the residential demand projections are set out in Table 7-1 below. The tabulated demands for each five-year interval are applied to the cumulative dwellings that are expected to exist for each year, resulting in a total peak demand for each year. The future peak demands for each dwelling are projected to be higher than the current peaks due to the total usage of electric heating (rather than partial usage of electric heating for a new home built before

2025) and the increased uptake of EV charging in future years, and the potential for standard EV charging capacities to increase in future years.

If housing thermal efficiency standards were substantially improved via new buildings regulations, for example by being aligned to Passive House standards, then the peak demand associated with severe cold weather snaps may be slightly lower than those used in the illustrative forecasts. Similarly, the use of hybrid heat pump systems, that also utilise a separate fuel source and heat conversion appliance, such as hydrogen fuelled boilers, could result in reduced peak electrical demands on the network. Both of these measures would require additional capital expenditure. Hybrid heating that uses heat pumps and hydrogen boilers would also incur additional ongoing operational costs, and so may not be considered best value for housing developers and homeowners.

Table 7-1 – Assumed Average Electrical Diversified Peak Demand per Future Dwelling

Indicative Diversified Peak per Dwelling (kW)			
2020-2025	2026-2030	2031-2040	2041-2050
6	9	10	10

Each of the planned residential developments has been assigned the nearest Primary Substation so that the demand can be mapped to its locality and a comparison of the DFES projections can be undertaken. Some of the new residential developments will require the addition of a new primary substation and so will not necessarily impact on the existing nearest primary substation. However, the new demand will still need to be met by a nearby Bulk Supply Point, and so will impact on the overall local grid capacity regardless of whether a new primary substation is constructed.

The demands for each planned development have been aggregated to the corresponding settlement, in order to provide more informative visualisations. The calculated indicative numeric demands have been divided into separate bands to enable the visualisation mapping. The size of the residential symbol (house symbol) represents the corresponding demand band. The bands are shown in Table 7-2 below.

Table 7-2 - GIS Bands for Residential Developments at each Settlement

kW Lower	kW Upper	GIS Band
0	1000	1
1001	2000	2
2001	5000	3
5001	10000	4
10001	20000	5
20001	30000	6
30001	100000	7

EMPLOYMENT SECTOR DEMAND PROJECTIONS

There are reports of current grid capacity issues that constrain economic growth across the Council area, at a number of important employment sites. This indicates a current need to investigate and resolve grid capacity issues at these locations, through dialogue with DNOs.

Demand projections have been developed to provide indicative estimations of peak electrical demands associated with new Employment developments. Average building floor areas have been attributed for each hectare of development land, these have been based on information provided Dorset Council regarding historic ratios of development land to building floor area and accounts for parking, green areas and access. A combination of different building types has been used based on CIBSE guide TM46, applying a given ratio of typical industrial to office space for such developments in Dorset. The resulting benchmark based annual demands have been translated to electrical peak demands, which combines electrical baseload, a conversion of fossil fuel heating to electric heating (accounting for efficiency improvements), and provision for EV charging for a proportion of the employees.

The actual makeup of employment sector development will depend on many factors including future market demands and potential future business incentives. The projected demands are considered to provide a reasonable reflection of typical expected demands, these can be refined when information regarding the nature of the business types that will utilise the employment sector land, and building fabric, operational efficiencies and EV charging details are firmed up.

The resulting projected demands have been assigned to the nearest primary substation and corresponding BSP, and form part of the aggregated demands that are discussed and illustrated in the subsequent section.

The employment sector demands have also been aggregated for each settlement and are shown in Figure 17. The purple diamonds represent planned employment sector demands, where the size of the icon reflects the demand band expected at the corresponding settlement.

Bandings for the employment sector related electrical demands, at each settlement are shown in Table 7-3 below.

Table 7-3 - GIS Bands for Employment Sector Developments at each Settlement

kW Lower	kW Upper	GIS Band
1	1000	1
1001	2000	2
2001	5000	3
5001	10000	4
10001	15000	5
15001	200000	6

Further detail in relation to the residential and employment sector GIS bandings, per settlement, can be found in the additional Appendix B.

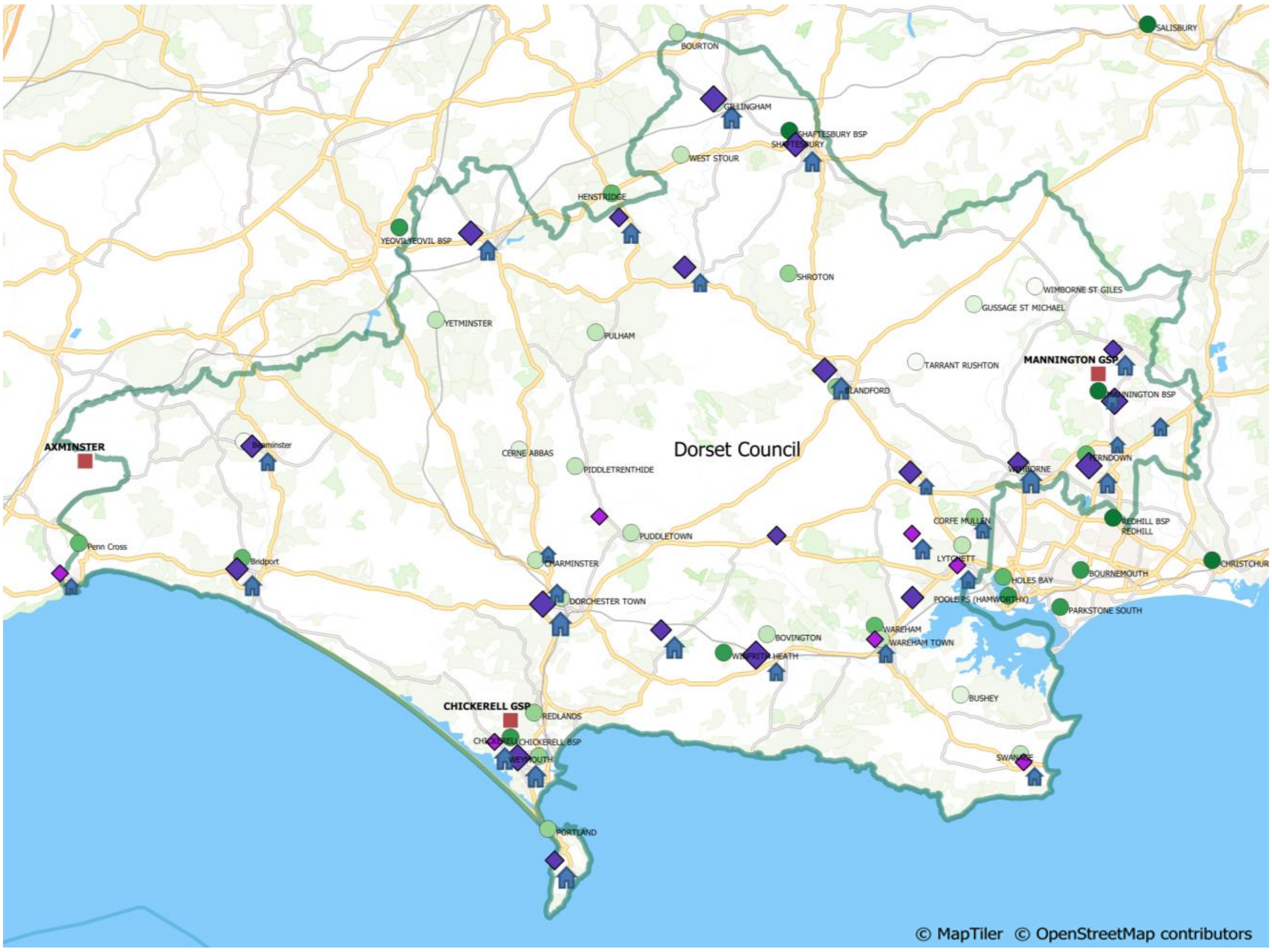

Figure 17 - Dorset Planned Residential and Employment Sector Developments, and Substations with Headroom Indicators for 2020

The DFES baseline (2020) substation demand headroom capacity is shown to be sufficient to meet existing peak demands. However, the DFES forecast for 2030 show that many substations in the vicinity of proposed residential and employment sector developments are expected to have demands that exceed their current capacities (refer to Figure 18). The situation becomes more severe by 2040 (refer to Figure 19). As the DNOs utilise their DFES forecasts as a key tool in planning network reinforcements, it is likely that they are already planning to address the forecast network constraints. It will be important for Dorset Council to maintain regular dialogue with SSEN and WPD to ensure that the DNOs are aware of planned development locations and volumes so that any reinforcements are of sufficient capacity for the long-term development plans in the County, and do not just address the near-term demand projections.

Figure 18 - Dorset Planned Residential and Employment Sector Developments, and Substations with Headroom Indictors for 2030

Figure 19 - Dorset Planned Residential and Employment Sector Developments, and Substations with Headroom Indictors for 2040

7.2 EV CHARGING

Dorset Council is developing its own EV charging programme, and the County is also assessing the decarbonising of the public transport systems and public EV charging infrastructure. Locations for potential EV charging Hubs, existing charging stations and Council charging facilities are shown in Figure 20. At this stage there is insufficient information available to be able to assess the probable charging capacities for each location. Future charging for public transport, including electric buses and autonomous vehicles is likely to have charging capacities of 200kW and higher for each EV charger. These ultra-rapid charging facilities, which are more aligned with existing petrol or diesel refuelling timescales, will place considerable extra demand on the distribution network, and will need to be adequately assessed and catered for when planning the associated network reinforcements.

Mobility Hubs, which will cater for a range of future EV's including buses, may require several MWs of capacity, similar in the scale to the electrical demand created by a new large residential development site.

The locations of the potential EV charging infrastructure are shown in Figure 20 alongside the projected substation headroom under the DFES CT scenario for 2030.

The uptake of home charging is not shown in Figure 20. This will put additional load on the network; however, it is assessed for each settlement when considering the projected future electrical demands for Dorset (refer to section 7.3 for more details).

It is evident that network reinforcements will be required in many areas in order for Dorset to decarbonise its transport via electrification.

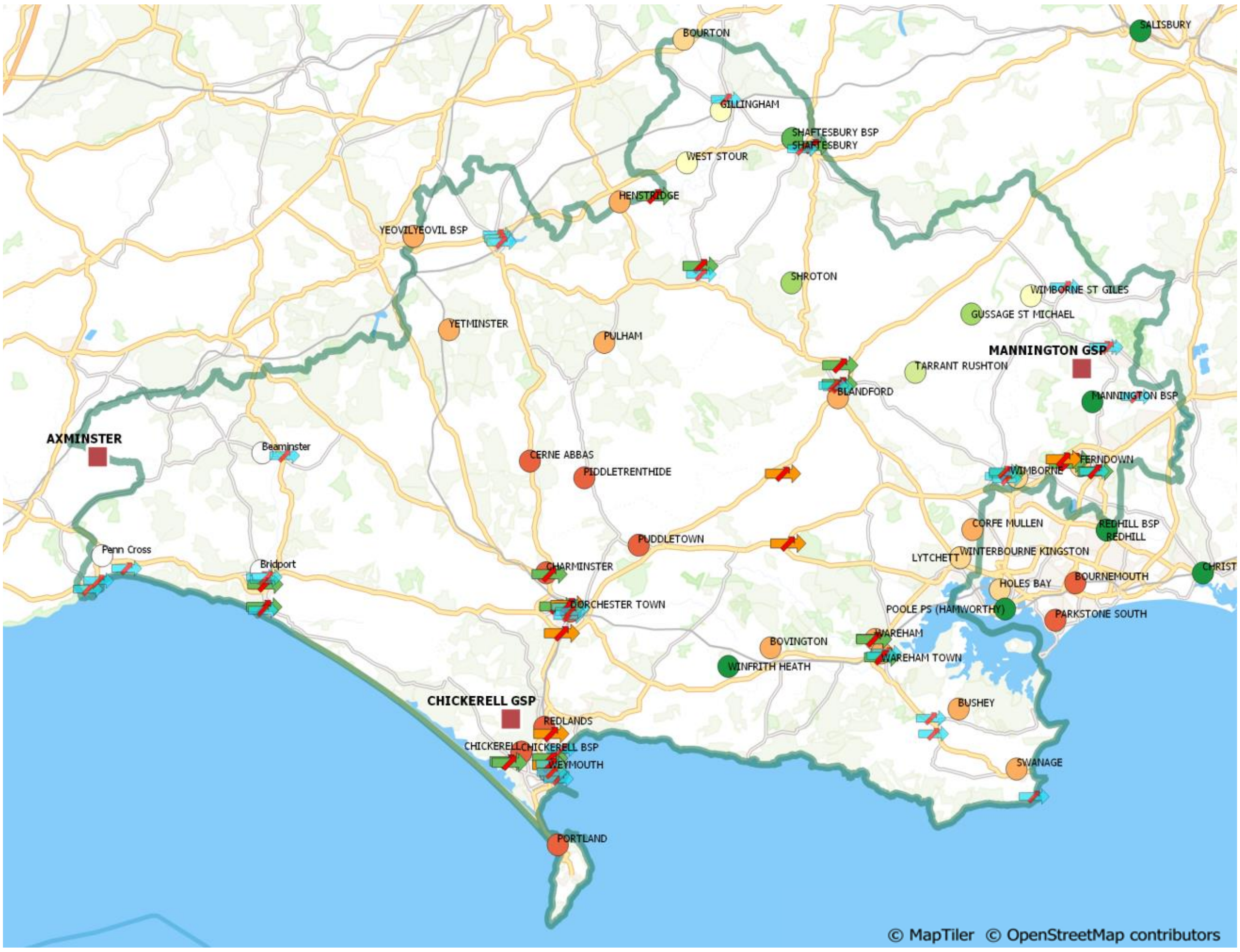

Figure 20 - Dorset Planned and Probable Public and Council EV Charging Locations and Substations with Headroom Indicators for 2030

7.3 ELECTRIFICATION OF EXISTING DWELLINGS HEAT AND EV CHARGING

In addition to the new electrical demands that will result from the development of new residential and employment sector, the decarbonising and inherent electrification of heat and transport will introduce significant additional demands on the electrical networks.

The number of dwellings in each village and town in Dorset, has been used to provide an indicative assessment of new electrical demands resulting from existing homes. The new demands have been assigned to the nearest existing PSS and the corresponding BSP.

High level projection scenarios for the conversion from fossil-fuel based heat and transport, to electrically fuelled heat and transport were developed. These considered existing carbon budgets and FES and DFES projections and assigned percentage of dwellings being converted to electric heating or EV charging for each five-year interval. The indicative demands associated with decarbonising heat and transport are composed of two key aspects:

1. The proportion of dwellings that will convert from fossil fuels to electrical heating and EVs for each period
2. The averaged peak demand that can be expected from the new electric heating and EV charging

For reference, the FES projections for the uptake of heat pumps are shown in Figure 21. The FES forecast project that around 82% of all dwellings will be electrically heated (either by resistive heating, only heat pumps, or hybrid heat pump systems) by 2050 under the CT scenario. Any systems that are electrically heated (without the use of a heat pump) will generally produce a higher peak load than for a heat pump based heating system, whereas hybrid systems that may for example use a low carbon fuelled boiler in conjunction with a heat pump will generally produce a lower contribution to peak demand than a standalone heat pump based heating system.

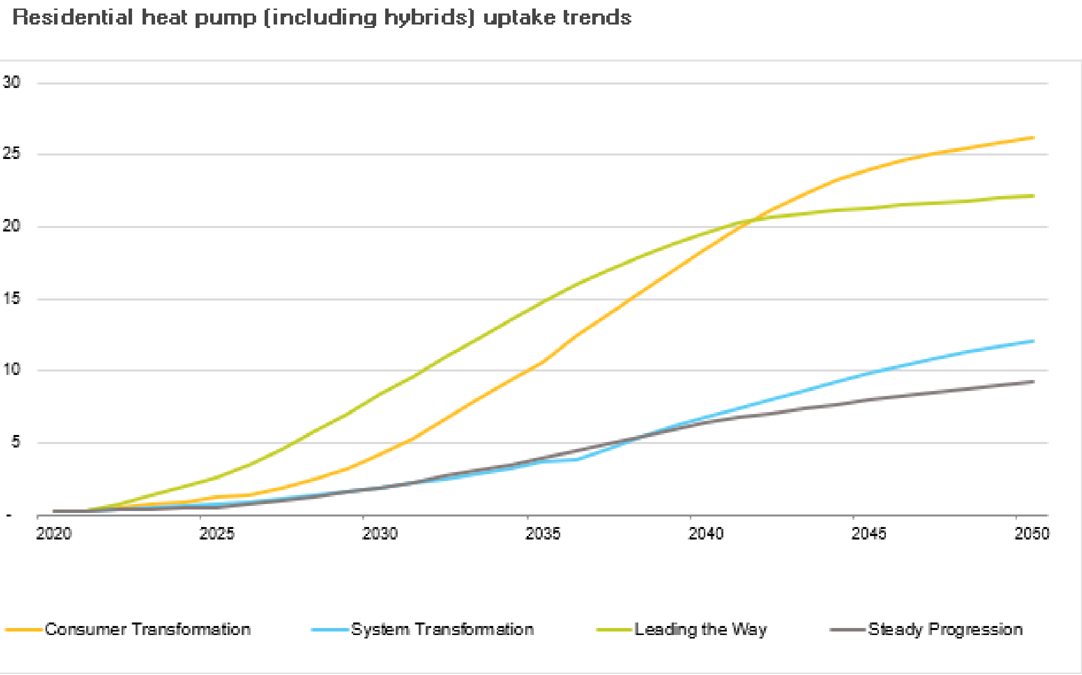

Figure 21 – National Grid FES GB Heat Pump Forecasts

For reference, the projections for uptake for EVs under the National Grid FES scenarios are shown in Figure 22. With between around 70% and full uptake being forecast by 2040, dependant on the scenario.

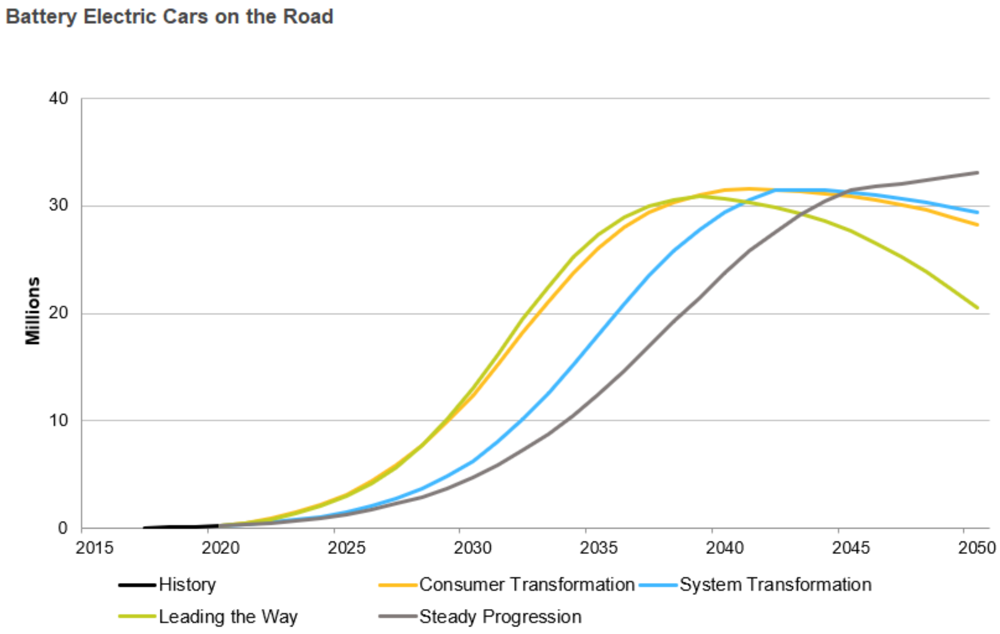

Figure 22 – National Grid FES GB EV Forecasts

Conversion of Dwellings Scenario Projections

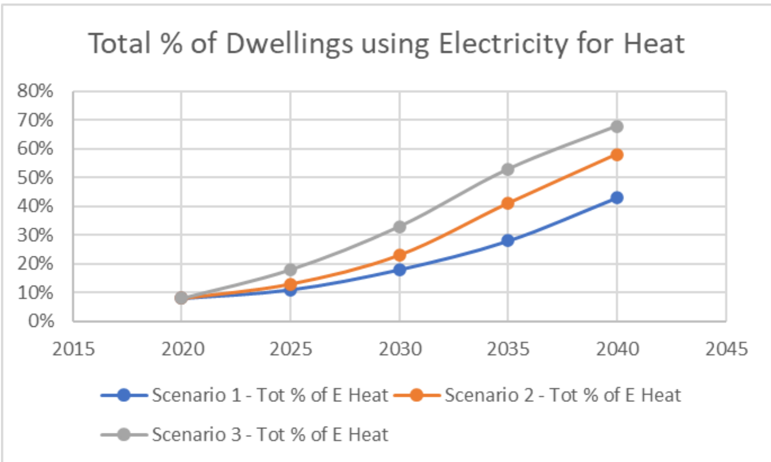

Figure 23 - Scenarios for Dorset Projected Uptake of Electrical Heating in Existing Dwellings

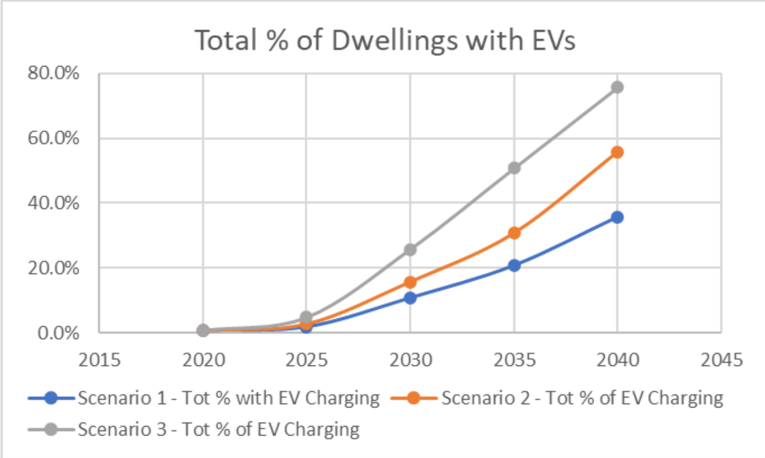

Figure 24 - Scenarios for Dorset Projected Uptake of EV Charging in Existing Dwellings

Scenario 2 has been used to undertake the projected demand assessments for the existing dwellings. This relates to the equivalent of around 60% of dwellings having electrical heating and hot water (currently around 10% in Dorset) and around 58% of dwellings having EV charging by 2040, This would either be at the dwelling itself or catered for in new public charging facilities that would provide the same indicative electrical demand. These forecasts are considered to be on the conservative side of FES forecasts, however if FES forecast volumes are delivered in practice, they may be accompanied by improved demand management and hybrid heat pump systems, both of which may help to reduce the effective impact on the peak demand on the network.

Diversity factors are applied to the expected heating and EV charging electrical demands, to produce a total indicative peak demand per dwelling. It is of note that older housing stock is less thermally efficient than newly built housing, and so will have a relatively higher heating electrical demand. Accordingly, slightly higher peak heating demands have been used for existing dwelling than for planned new dwellings. The retrofitting of building insulation and other building fabric improvements will help greatly in reducing future space heating demands on existing dwellings, and in many cases will be essential if older dwellings are converted from gas heating to heat-pump based heating.

It is also of note that the peak electrical demand is likely to be aligned to periods of extreme cold weather, when everyone is simultaneously heating their homes, and when many heating systems will be running continuously in older dwellings, offering limited scope for demand side management to move heating away from peak periods of electrical demand. Additionally, air source heat pumps, which can provide highly efficient heating for much of the year, will suffer significant reduction in efficiencies during prolonged periods of extreme cold weather in the UK (in particular due to the relatively high humidity in UK winter conditions). This will result in the further amplifying the contribution of space heating to the peak demand, putting increased pressure on the electrical networks when they are most needed to maintain consumer comfort.

The peak electrical demands have been estimated for all villages and towns in Dorset, where an average peak demand per dwelling has been applied to generate the settlement level peak demands. It is noted that if demand side management is employed in the future on a wide scale, which for example would aim to restrict EV charging to periods of lower overall demand on the grid, then the additional demand from EV charging may have a lower impact on the daily peak than that presented in these forecasts. The realisation of large-scale demand side management is still uncertain, and some of it may resolve around the application of higher electricity charges in peak periods, to help dissuade use, rather than a hard restriction on the ability to charge EVs. Counteracting the potential benefits of demand side management, is that the forecast does not include provision for any public or commercial rapid/ultra-rapid charging, which if used during peak demand periods may easily counteract the benefits realised from demand side management of home-based charging. Figure 25 below illustrates the villages and towns

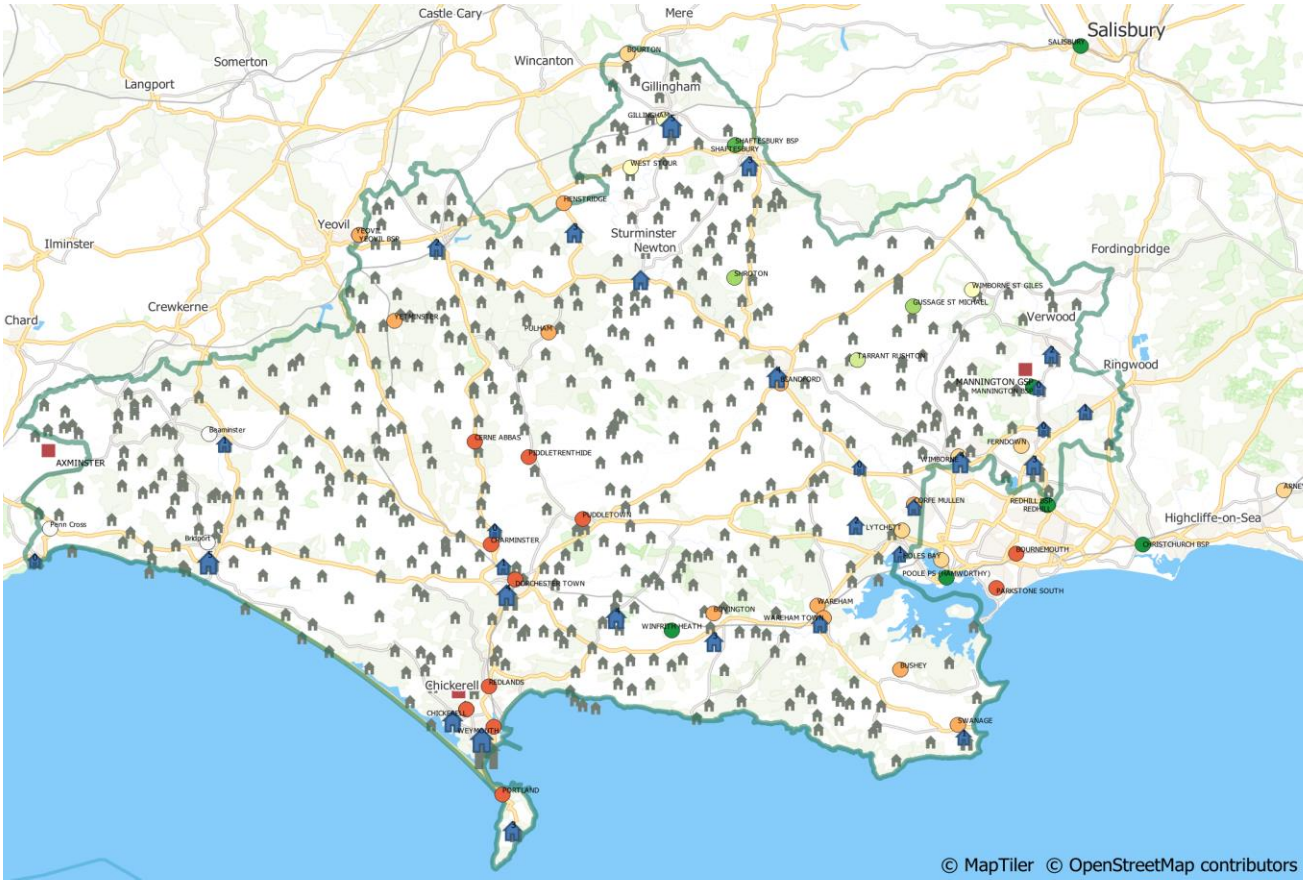

Figure 25 – Dorset Settlements used for Future Demand Projections for Existing Dwellings

7.4 COMBINING PROJECTED DORSET FUTURE DEMANDS AND COMPARISON WITH SUBSTATION LOADS FROM DFES PROJECTIONS

The projected demands for the planned residential and employment sector developments, in combination with electrification of heat and EV charging for the existing dwellings, has been combined for each PSS and corresponding BSP. Any electrical demand growth resulting from increased electrification of heat and EV charging for non-residential premises and for new public EV charging infrastructure has not been included. When these are established and subsequently added to the aggregated substation demands, the future demand projections for Dorset will increase accordingly.

The substation level projections, for each five-year interval, have been compared against the DFES CT scenario projections at each substation (refer to Figure 26 to Figure 29). The difference between the Dorset forecasts and the DFES CT forecasts have been calculated and mapped into bands for GIS visualisation. In a similar manner to the substation headroom capacity mapping, the red colourings show where the Dorset projection exceeds the DFES projection for a substation, and the green colourings show where the DFES projection is in excess of the Dorset projection.

For many substations it appears that the Dorset projections exceed the DFES projections by 2030, both for PSS and BSPs. This is particularly evident around Chickerell, but also around Blandford, Shaftsbury, and Gillingham.

If a strong energy efficiency programme was implemented to reduce building energy demands, which was accompanied by residential demand side management to move flexible demands away from peak periods then it will be possible to reduce the Dorset forecasted demands that result from decarbonising heat and transport. This would in turn reduce the differences observed between the Dorset forecasts and those produced by the DNOs. In counterbalance to these potential demand reductions, it is noted that the demands resulting from decarbonising existing non-residential buildings and those associated with new public and commercial EV charging infrastructure are not currently accounted for in the Dorset forecasts, both of which will further increase the demands on the network.

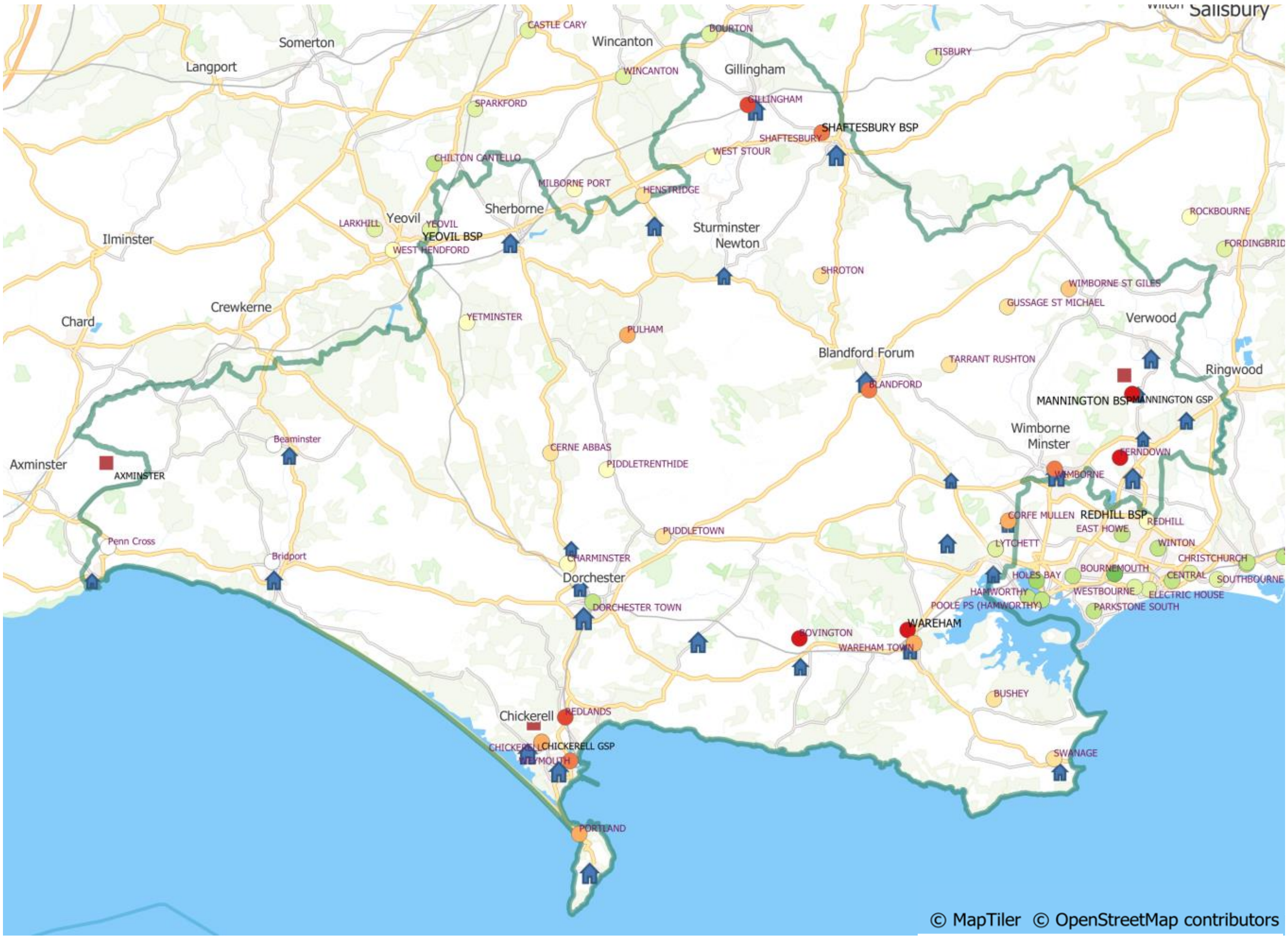

Figure 26 – Comparison of Dorset Projected Demands and DFES (CT) Projected demands for 2025 for PSS and BSPs

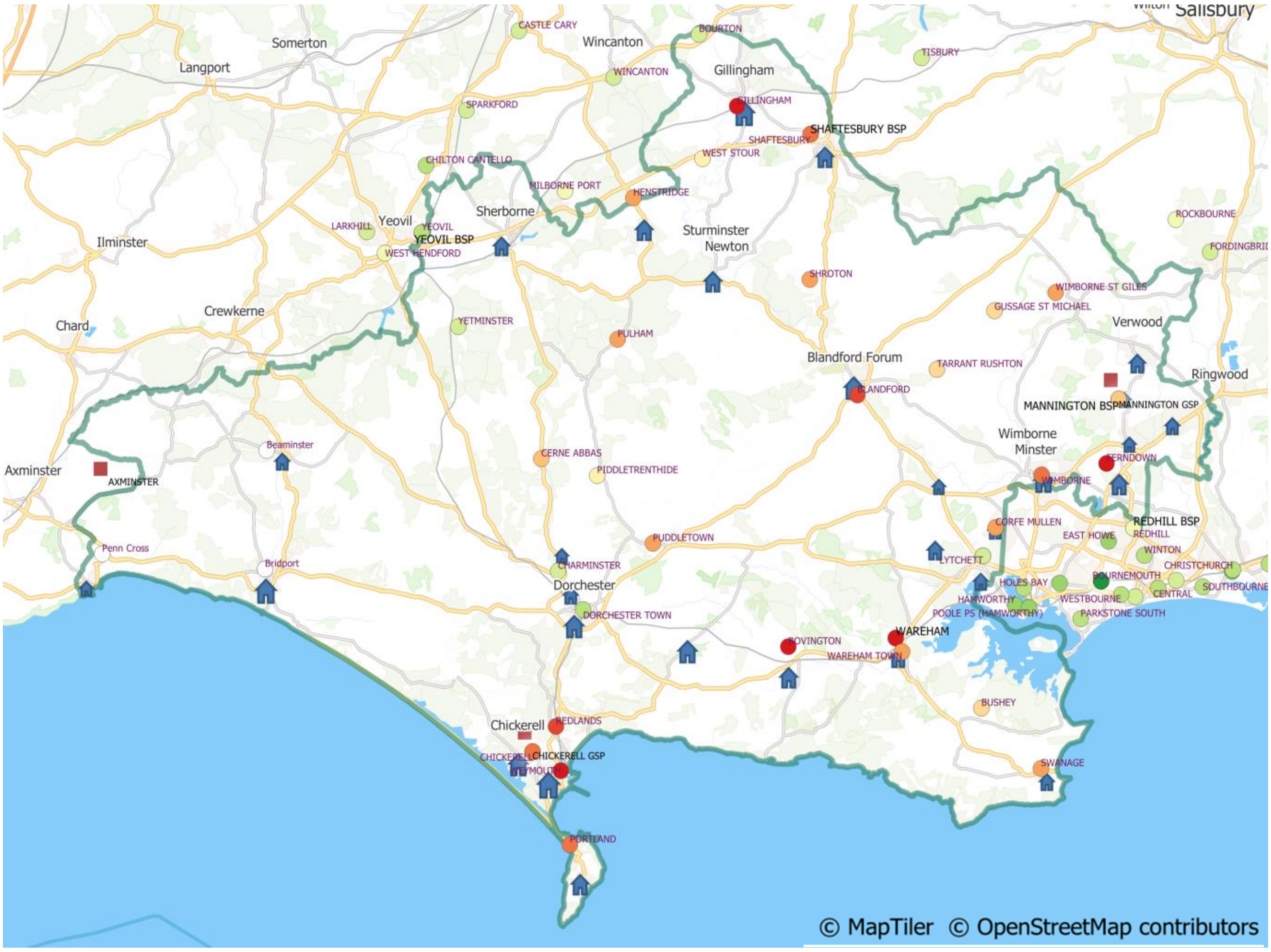

Figure 27 – Comparison of Dorset Projected Demands and DFES (CT) Projected demands for 2030 for PSS and BSPs

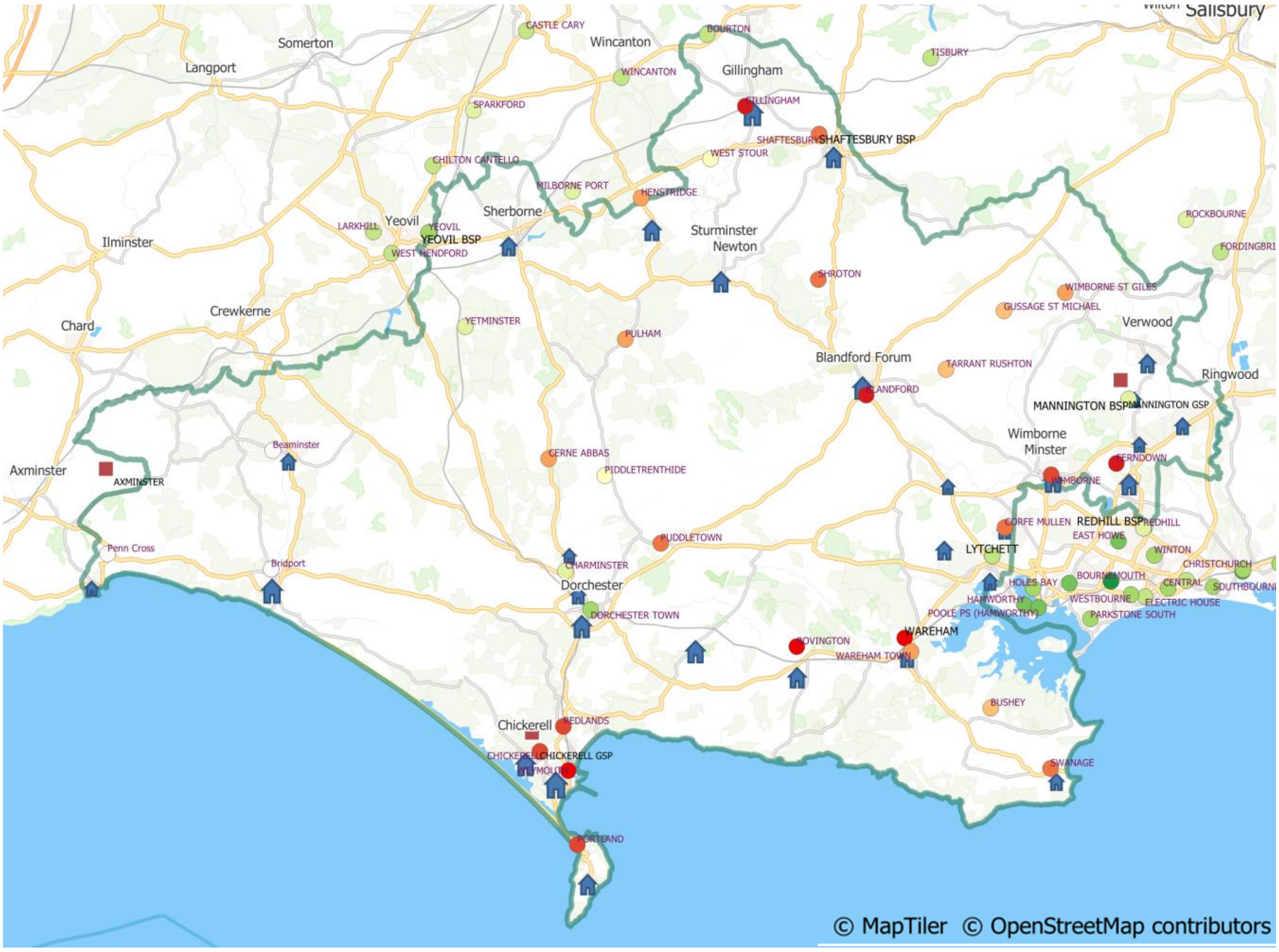

Figure 28 – Comparison of Dorset Projected Demands and DFES (CT) Projected demands for 2035 for PSS and BSPs

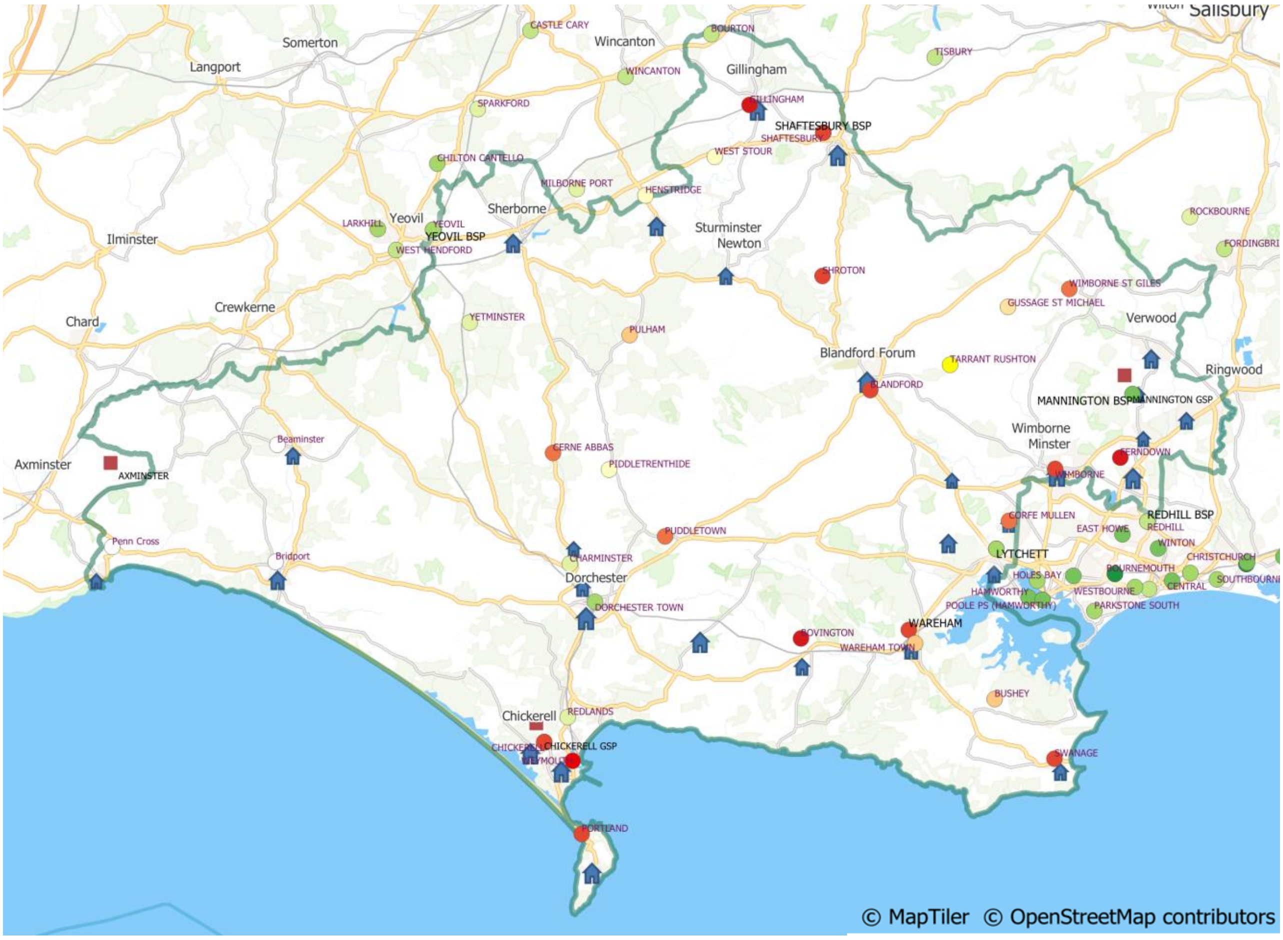

Figure 29 – Comparison of Dorset Projected Demands and DFES (CT) Projected demands for 2040 for PSS and BSPs

7.5 GENERATION HEADROOM AND PROPOSED SOLAR PV

The DFES scenario information also shows the projected Headroom for generation at the substations. The projected generation headroom at each substation for 2020, 2030 and 2040 are illustrated Figure 30 to Figure 32. The locations of the planned/potential and existing operational Solar PV installations are shown alongside the generation headroom indicators. The size of the Solar PV icons represents the capacity of the proposed Solar array or Solar farm, with planned capacities ranging up to 40MW at a single location. The average capacity for all Solar developments, that have a known capacity, is around 8MW.

Figure 30 – Current Substation Generation Headroom and Proposed Solar PV Locations

Figure 31 – DFES Projected Substation Generation Headroom (2030) and Proposed Solar PV Locations

Figure 32 – DFES Projected Substation Generation Headroom (2040) and Proposed Solar PV Locations

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The UK has committed to legally binding carbon emission targets to achieve Net Zero by 2050. The necessary carbon reductions and related carbon budgets have been clearly set out by the Climate Change Committee. National Grid and the DNOs have an agreed approach to assessing the probable impacts on the electricity networks, under four different decarbonisation scenarios. Only three of these scenarios are projected to deliver the necessary carbon reductions required by 2050. This report has primarily focussed on the Consumer Transformation Scenario, as this is considered the most achievable and carries the least uncertainty regarding available low carbon technologies and infrastructure. The Consumer Transformation scenario relies on the extensive electrification of heat and transport with a smaller role to be played by hydrogen for both of these demand types. The main alternative scenario being System Transformation which has a much heavier reliance on hydrogen including for heating and transport.

It is anticipated that hydrogen will play an important role as the UK decarbonises, however the delivery of an extensive hydrogen infrastructure and associated market economy carries much greater uncertainty than for one more reliant on electrification. Additionally, the hydrogen generation and conversion cycle can be considerably less efficient for heating and transport than one based on electrification.

Under the Consumer Transformation scenario, the DNOs DFES projections are showing that many existing substations are expected to run out of headroom capacity, for both demand and generation, by 2030. This will necessitate the expansion of substation capacities and the addition of new substations alongside other network reinforcements including probable capacity increases for overhead lines and underground cables that form the fabric of the electricity distribution network.

An indicative projection of the electrical demands associated with planned new residential and employment sector developments has been undertaken, based on typical peak demands that may be expected. An outline assessment of the new electrical demands associated with the electrification of heat and EV charging for existing dwellings has also been undertaken. All estimated demands have been assigned to the nearest Primary Substation and consequently to the corresponding Bulk Supply Point.

The demand growth has then been compared against the DFES CT demand growth for each PSS and BSP and visualisation maps generated. These reveal that without additional measures to help minimise peak loads (such as increased energy efficiency measures, demand side management for consumer demands and embedded generation and storage) the new peak demands for Dorset are likely to exceed those projected by the DFES CT scenario for many PSS and BSPs. This is especially the case when considering that the public vehicle charging infrastructure and increased electrification of existing non-residential premises has not been quantified in the future Dorset demand analysis, and so will add additional peak demands when this can be included.

For the employment sector, there is often uncertainty around the types of uses that are likely to come forward, as employment development is often market-influenced, and therefore difficult to predict. Employment uses vary significantly in terms of the demands they can place on the electricity grid, and this in turn creates uncertainty around the grid capacity required to accommodate development and the infrastructure improvements required to address capacity issues. This can place constraints on economic growth if there is insufficient capacity available in the electricity grid. A key employment sector which is prevalent across the Council area is that of advanced engineering and manufacturing, which is renowned for having higher than average energy demands. The food and drink sector is also prevalent in Dorset, albeit to a lesser degree. Notably, there are reports of current grid capacity issues that constrain economic growth across the Council area, at a number of important employment sites. This indicates a current need to investigate and resolve grid capacity issues at these locations, through dialogue with DNOs.

The DNOs have a responsibility to ensure that the distribution networks are able to accommodate incremental demand increases on the network and to facilitate the reinforcement of network assets to enable new developments to be connected to the network. For new developments, a significant proportion of the incurred costs from associated network reinforcements will be borne by the developer, whereas the majority of costs associated with reinforcement to accommodate incremental demand increases, for existing residential connections, will generally be incurred by all regional electricity consumers via charges within their electricity billing.

Most substation capacity expansions and new substations will have an expected lifespan that will be beyond 2050, and therefore the full projected loads associated with achieving Net Zero will need to be considered when reinforcing the electricity networks.

This report highlights areas of probable constraint related to proposed developments and the decarbonising of heat and transport, providing Dorset Council with the means to engage with the DNOs in order to investigate and resolve potential upcoming grid constraints before they impact on the economic development within Dorset or the transition to Net Zero.

8.2 RECOMMENDATIONS

It is recommended that regular dialogue is conducted with the two DNOs that serve Dorset. SSEN provides the majority of the electrical distribution network serving Dorset and should therefore be engaged with accordingly.

An assessment of EV charging infrastructure is required, including firming up of the options and details regarding the decarbonising of public transport.

The sharing of information regarding planned residential and employment sector developments, alongside known and probable development of EV charging infrastructure will also be critical. Where the DNOs are planning network reinforcements it will be helpful to understand their projected peak demands and to check that these align with the expectations of Dorset Council for the relevant timescales that need to be considered.

9 APPENDIX A – DEVELOPMENT PLAN SUMMARY

9.1 EMPLOYMENT SECTOR

Settlement	Total estimated contribution to Employment Supply (ha)	Reports of Grid Capacity Issues	Notes
Blandford	6.7		
Ferndown	8.5		
Verwood	0.7		
Wimborne	2		
Woolsbridge	12.9		
Bere Regis	0.7		
Holton Heath	5.7	y	Anecdotal reference to capacity issues
Sturminster Marshall	3.3		
Wool	38.4	y	Reports of capacity issues relating to B25 substation and switchgear
Dorchester	17	y	Anecdotal reference to capacity issues
Weymouth	13		
Portland	0.8	y	Capacity issues at Portland Port potentially restricting future growth
Crossways	2.5		
Gillingham	12.8	y	Anecdotal reference to capacity issues
Shaftesbury	6.6		
Sherborne	8		
Stalbridge	0.7		
Sturminster Newton	2.9	y	Reports of no significant available capacity for additional development.
Bridport	4.8	y	Anecdotal reference to capacity issues

Settlement	Total estimated contribution to Employment Supply (ha)	Reports of Grid Capacity Issues	Notes
Beaminster	4.5		

NB: The figures presented represent a snapshot of estimates from circa December 2021.

9.2 RESIDENTIAL

Settlement	Estimated number of planned homes from existing allocations /permissions	Estimated number of planned homes from proposed allocations	Total estimated number of planned homes per settlement
Corfe Mullen	112	130	242
Upton	92		92
Blandford	605	900	1,505
Ferndown	520	950	1,470
Swanage	90	150	240
Verwood	230	100	330
Wareham	207		207
West Moors		60	60
Wimborne/Colehill	969	430	1,399
Lytchett Matravers	196	160	356
Sturminster Marshall		285	285
Wool	470	300	770
St Leonards	37		37
Dorchester	1,040	3,600	4,640
Weymouth	2,170	550	2,720
Chickerell	810		810
Portland	348		348
Charminster	82	68	150
Charlton Down		90	90
Crossways	1,179	465	1,644
Gillingham	2,050	70	2,120
Shaftesbury	332		332
Sherborne	269	1,200	1,469
Stalbridge	460	150	610
Sturminster Newton	292		292
Beaminster	170	120	290
Bridport	986	195	1,181
Lyme Regis		40	40

NB: The figures presented represent a snapshot of estimates from circa December 2021.

Appendix B – Settlement level GIS bandings for residential and employment future planned development

Residential sector

Settlement	GIS banding			
	2025	2030	2040	2050
Beaminster	1	1	2	3
Blandford	3	4	5	5
Bridport	2	4	4	5
Charlton Down	0	0	1	1
Charminster	1	1	1	1
Chickerell	3	4	4	4
Corfe Mullen	1	2	2	3
Crossways	3	4	5	5
Dorchester	4	4	6	7
Ferndown	2	3	5	5
Gillingham	3	4	5	6
Lyme Regis	0	0	1	1
Lytchett Matravers	2	2	3	3
Portland	3	3	3	3
Shaftesbury	2	2	2	3
Sherborne	2	3	5	5
St Leonards	1	1	1	1
Stalbridge	2	3	3	4
Sturminster Marshall	0	0	3	3
Sturminster Newton	1	3	3	3
Swanage	1	1	2	2
Three Legged Cross	0	0	0	0
Upton	1	1	1	1
Verwood	2	2	3	3
Wareham	1	2	2	3
West Moors	0	0	1	1
Weymouth	3	5	6	6
Wimborne/Colehill	4	4	5	5
Wool	1	3	4	4

Employment sector

Settlement	GIS banding
Blandford	3
Ferndown	5
Verwood	1
Wimborne	2
Woolsbridge	4
Bere Regis	1
Holton Heath	3
Sturminster Marshall	3
Wool	6
Lytchett Matravers	0
Upton	0
Swanage	0
Wareham	0
West Moors	0
Dorchester	5
Weymouth	4
Portland	1
Crossways	2
Chickerell	0
Piddlehinton	0
Gillingham	4
Shaftesbury	3
Sherborne	4
Stalbridge	1
Sturminster Newton	3
Bridport	3
Beaminster	3
Lyme Regis	0

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