Public

# tRESP

# Consistent Planning Assumptions: Methodology and Detailed Design

# Appendix 4

# User Guidance for Specific CPA values

NESO
National Energy System Operator

# Contents

## Scope and Principles

### Scope

This tRESP CPA user guidance:

- sets out the approach for DNOs to apply specific tRESP CPAs when developing their demand forecasts to inform their network investment plans for their ED3 business plan submissions to Ofgem.
- provides clarity to avoid ambiguity in how the tRESP CPAs should be applied.
- is presented as an appendix to the tRESP CPA Methodology and Detailed Design.
- sets out the conditions under which DNOs may adopt more granular modelling than is set out in the minimum process described in the tRESP CPA Methodology and Detailed Design.

Ofgem has advised that DNOs should assume that they may be expected to provide evidence that they have applied the tRESP outputs in accordance with the user guidance.

The tRESP CPA user guidance does not cover Ofgem or NESO's approach to review whether DNOs have correctly applied the CPAs. Information in these areas will follow in Ofgem's business plan guidance in May 2026, after the tRESP CPA values and this CPA user guidance are set in January 2026. Ofgem's business plan guidance is also expected to include information on checks of network plan alignment to tRESP outputs, data requirements in the Ofgem ED3 Business Plan Data Tables (BPDT) and a new assurance template for ED3.

This appendix to the methodology provides guidance on specific numbered CPAs in the value workbook. The wider context for user guidance is set out in the section "Guidance to use tRESP CPAs: End-to-End Modelling Processes and Interactions with Pathways" in the CPA Methodology and Detailed Design. The CPAs are relevant to all distribution voltage levels (LV, HV and EHV as they are defined by Ofgem in the ED2 Regulatory Instructions and Guidance Glossary) but are not relevant to the sizing of sole-use assets or service cables.

The tRESP CPAs pertain to active power, with reactive power assumptions (e.g. power factors) considered out of scope. DNOs should take an evidence-based approach when calculating the reactive power impact of these technologies.

## Principles in setting tRESP CPA user guidance

As described earlier in the methodology, the purpose of tRESP CPAs is to drive consistency in DNO modelling by setting a common approach and data inputs for electric vehicles (EVs), domestic heat pumps (HPs), and residential energy efficiency modelling.

The design of the CPAs and the associated user guidance balance the following principles:

- Achieving consistency in approach between DNOs.
- Ability to reflect real local differences where evidence exists.
- Additional complexity of the modelling implementation compared to existing DNO modelling approaches.

Regarding the final point on complexity, the key consideration is the cost and time available to adjust existing DNO approaches and systems, either to increase or decrease complexity, to enable implementation of the CPAs. It is important to note that that DNOs must be able to implement any changes in 2026 and that DNOs have often already started to implement the tRESP CPAs. While further development of approaches to implement full RESP CPAs in subsequent years is not explicitly considered in the complexity principle, tRESP CPAs may indicate a direction of travel for full RESP modelling.

Impacts on the feasibility or complexity of checking whether DNOs have correctly applied the CPAs, or data required for such a check, is not a principle for decisions in the tRESP CPA user guidance.

The guidance on application of the CPAs should be read in conjunction with the tRESP CPA value workbook (latest version v2.3), primarily the description, data processing comment and default values comment in the EV CPA Summary, HP CPA Summary and EE CPA Summary tabs. Information from the workbook may be repeated for clarity below.

# Electric Vehicles

## EV01 Vehicle mileage

The EV01 CPA defines the number of kilometres travelled in one year per vehicle.

The CPA is defined at the granularity of the DNO licence area and by two vehicle categories, small EVs (as EV01_BB1-BB2, referring to cars, vans, and motorcycles), and large EVs (as EV01_BB3-BB4, referring to buses and coaches, and heavy goods vehicles).

The minimum granularity to align with the CPA is to reflect mileage for small EVs and large EVs separately and at licence area resolution. However, noting some DNOs already reflect modelling by more granular vehicle types in their analysis and that some DNOs reflect modelling of vehicle mileage at higher geospatial granularity, the following guidance is provided. To align with the CPA:

- DNOs shall apply the CPA at the level of the licence area, either:
  - by applying the same mileage for all vehicles irrespective of assumed location of registration or charging.
  - or by applying a different mileage value for different locations within the licence area, as long as the mean value of the mileage for the licence area equals the default value (rounding to the same 100 km per year per vehicle). The demonstration of the consistency of the mileage distribution with the mean should be weighted by the number of vehicles, stating the data source from which the variation in mileage within the licence area is inferred.

For example, for a licence area with mileage for small EVs of 15,000 km/year, where local data indicates that there is a significant variation in this value between the North of the region (an area with 500 total vehicles registered, both EVs and non-EVs) and the South of the region (an area with 1,000 total vehicles registered), consistency with the guidance would be demonstrated by the following:

$$Weighted\ average_{mileage} = \frac{North_{mileage} * North_{total\ vehicles} + South_{mileage} * South_{total\ vehicles}}{North_{total\ vehicles} + South_{total\ vehicles}}$$

$$15{,}000 = \frac{20{,}000 * 500 + 12{,}500 * 1{,}000}{500 + 1{,}000} \tag{1}$$

In this example, the mileage assumption for the North of the licence area is set at 20,000 km/year and that for the South of the licence area is set at 12,500 km/year.

- DNOs shall apply the CPA to all EVs, either:
  - by applying the EV01_BB1-BB2 value to small EVs (applied to both Lct_BB001 and Lct_BB002, disaggregated spatially from the tRESP Pathways) and the EV01_BB3-BB4 value to large EVs (applied to both Lct_BB003, Lct_BB004, disaggregated spatially from the tRESP Pathways)
  - or by modelling separately each of the vehicle types available from the data source referenced (e.g. splitting Lct_BB001 into “cars and taxis”, “light commercial vehicles”, and “motorcycles”) if the sum of vehicles matches the Pathways volumes for each GSP and the same DfT data source is followed[1,2], as this has been assessed as a credible CPA data source.

**Supporting information**

The CPA is based on Department for Transport (DfT) and Driver and Vehicle Licencing Agency (DVLA) data, specifically the number of kilometres travelled from TRA0206 and TRA8905 tables[1]

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[1] TRA0206 and TRA9805 datasets available from: gov.uk/government/statistical-data-sets/road-traffic-statistics-tra

divided by number of vehicles from VEH0105 tables[2] to get mileage per vehicle. Default values are averaged over two historic years (2023-2024).

Table TRA8905 provides vehicle kilometres for three selected vehicle types at local authority resolution, Cars and Taxis, Light Commercial Vehicles, and Heavy Goods Vehicles. Table TRA0206 provides vehicle kilometres for two additional vehicle types, Motorcycles, and Buses and Coaches by nation and region in GB, i.e. Scotland, Wales and the nine English Government Regions.

Where local authority data is available, this was used to derive values for the total vehicle kilometres at licence area resolution. For Motorcycles, and Buses and Coaches, the licence area values are a weighted average of the government region data for the regions overlapping each licence area, weighted by vehicle registrations rather than geographic area.

Table Veh0105 provides the number of registered vehicles by body type (Cars, Light Goods Vehicles, Motorcycles, Buses and Coaches, and Heavy Goods Vehicles) at local authority resolution and by region and country in GB. These values were used to find the total number of vehicles in each licence area, before the mileage per vehicle was found. For the sake of consistency, total number of Motorcycles, and Buses and Coaches at licence area were found using the regional values, applying the same weighting as for the vehicle kilometres.

**Alternative options considered**

In the draft versions of the CPAs up to V1.2, mileage values were provided at the government office regions, however, these do not map neatly to the DNO licence areas (see Figure 1). To reduce modelling complexity for DNOs and align to the resolution of other CPAs (e.g. HP05), we provide the mileage values per DNO licence area instead.

[2] VEH0105 dataset available from: gov.uk/government/statistical-data-sets/vehicle-licensing-statistics-data-tables

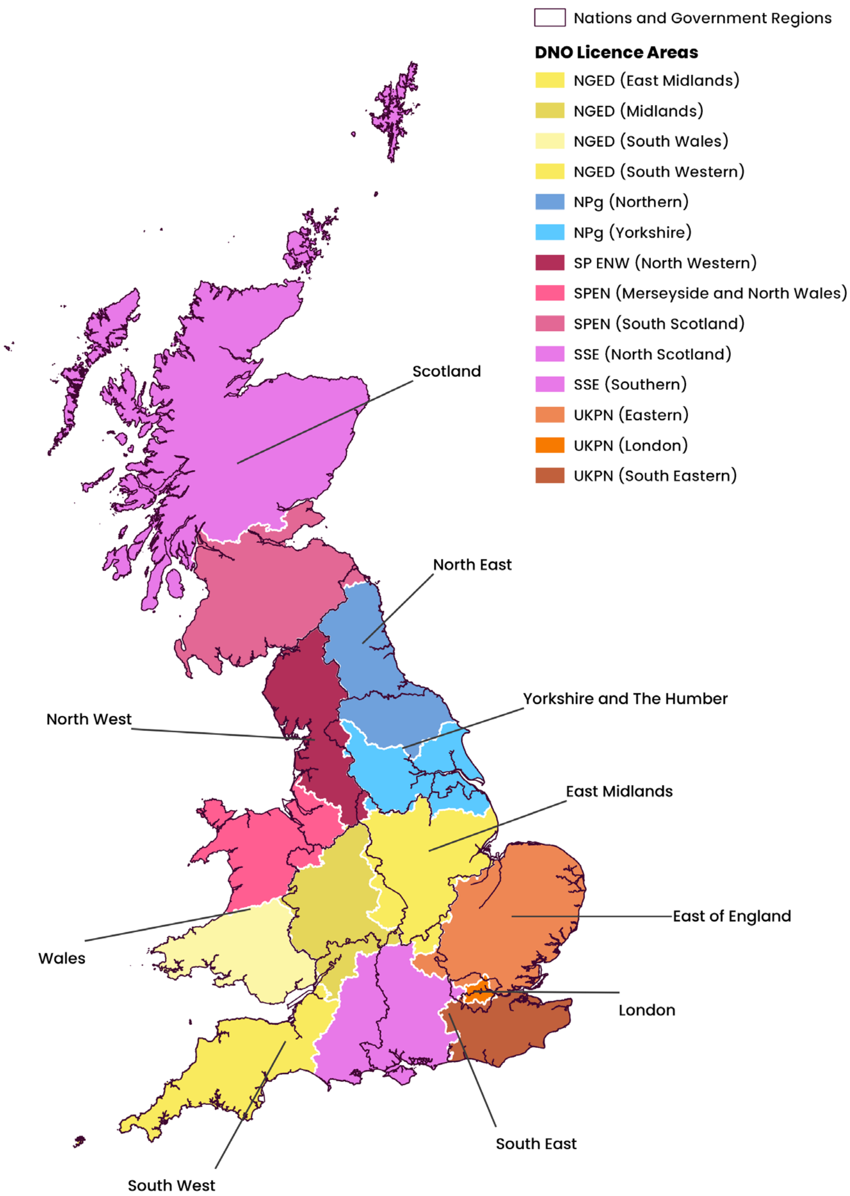


*Figure 1: DNO licence areas overlaid with Scotland, Wales, and English Government region boundaries.*

Providing data at government office region also brings ambiguity in how these values would be applied to assets within each licence area. The following options were considered but not deemed appropriate for this CPA.

1. Provide mileage data by government region and assign the majority government region to a DNO licence area.

   This approach was not deemed appropriate as there is not a clear majority region for several DNO licence areas e.g. SSEN South and NPG Yorkshire. Additionally, more than one DNO licence area is often influenced by the same government region, e.g. both SP

Merseyside and North Wales and SP Electricity North West are influenced by the Merseyside conurbation. As indicated by Figure 6 in the Detailed Design and Methodology document, there are clear differences recorded between these regions that should be captured within the modelling.

2. Provide mileage data by government region and direct the application of these values to network assets within the corresponding government region.

   This option leads to high modelling complexity, necessitating different values to be applied to different assets within the same licence area. There is a trade-off between this increased modelling complexity and the simplification of assigning averaged mileage values at licence area level. Both are a compromise, but our position is that the modelling by government region is more complex without obvious advantage, given input data is already averaged across a government region.

3. Provide mileage data by government region but direct the DNOs to create a weighted average figure suitable for each licence area.

   With the position that a licence area resolution of data is the most suitable, there is an option where the DNOs carry out the mapping between government region and licence area themselves. However, there is a risk that this leads to a slightly different approach being taken by different DNOs. Therefore, we believe that to ensure consistency and to limit the calculations required by the DNOs, this should be provided by NESO in the format that should be used.

## EV02 Distance in EV mode

The EV02 CPA defines the proportion of annual mileage for plug-in hybrid EVs (PHEVs) that is travelled using the electric function.

The CPA is presented as a default value and an allowable range. The default represents the expected average proportion of mileage in EV mode, while the range is provided only for spatial/vehicle type variation, where DNOs have supporting evidence. Any variation within the range must maintain an overall mean equal to the default value (with an allowable tolerance of 1%).

The data is defined at GB-level and applies to PHEVs only (EV02_BB2 for small PHEVs and EV02_BB4 for large PHEVs). The minimum process to align with the tRESP CPA Methodology and Detailed Design, is for DNOs to apply the relevant default value for GB to their licence area. However, we recognise that there may be a difference in travel patterns between specific vehicle types and/or locations that result in different utilisation of the electric function of plug-in hybrid EVs. DNOs may therefore choose to go beyond that minimum process to align with the CPA by modelling distance in EV mode at a higher granularity, provided the following two conditions apply:

1. DNOs shall apply the CPA either:
    - by applying the same EV-mode proportion for all PHEVs regardless of location

  - or if local data exists, by applying a spatial distribution of EV-mode proportions, ensuring each value applied is within the range provided and also that the mean across all vehicles is equal to the default value (within rounding error).

2. DNOs shall apply the CPA to all PHEVs, either:
   - by applying the EV02_BB2 value to small PHEVs (applied to Lct_BB002 from tRESP Pathways) and the EV02_BB4 value to large PHEVs (applied to Lct_BB004 from tRESP Pathways)
   - or by deriving separate EV-mode proportions for cars, vans, motorcycles, buses and coaches, and heavy goods vehicles, ensuring the weighted mean aligns with the default value (within rounding error).

## EV03 EV efficiency

The EV03 CPA describes the amount of electrical energy an EV consumes to travel one kilometre (kWh/km), with lower values indicating higher efficiency. This CPA is a default value for each vehicle category (Lct_BB001, Lct_BB002, Lct_BB003, Lct_BB004) and is defined at GB-level for every year out to 2050. The values do not vary by representative day and reflect the average efficiency over the year.

The CPA is based on Department for Transport (DfT) data, specifically table A1.3.11 of the TAG data book.[3] The TAG data book provides the efficiency of Electric Cars, Electric Light Goods Vehicles (LGVs) and Electric Public Service Vehicle (PSV).

Default values for Lct_BB001 and Lct_BB002 are weighted average values for Electric Cars and Electric LGVs in the TAG data book; default values for Lct_BB003 and Lct_BB004 are the Electric PSV values.

The minimum granularity is to reflect efficiency for small battery EVs (BEVs), small PHEVs, and large EVs separately, linked to the building block definition in the tRESP Pathways. Noting some DNOs already reflect modelling by more granular vehicle types in their analysis, the following options are provided. To align with the CPA:

1. DNOs shall apply the CPA to all EVs, either:
   - by applying the default values to the vehicle types as defined by tRESP Pathways (i.e. Lct_BB001, Lct_BB002, Lct_BB003, Lct_BB004)
   - or by modelling separately each of the vehicle types available from the TAG data book (e.g. splitting Lct_BB001 into Electric Cars and Electric LGVs) if the sum of vehicles matches the Pathways volumes for each GSP *and* the same DfT data source for efficiency is followed, as this has been assessed as a credible CPA data source.

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[3] Department for Transport TAG data book available from: gov.uk/government/publications/tag-data-book

2. DNOs shall use the default value across the whole DNO licence area, no geospatial variation should be applied.

## EV04 Proportion of charging by charger type

The EV04 CPA describes the distribution of charging demand to different charger types (domestic, workplace, slow/fast public, rapid public, HGV depot), represented as the proportion of required charging energy (kWh) from each charger type. The CPA is defined for each vehicle category (Lct_BB001, Lct_BB002, Lct_BB003, Lct_BB004) as the proportion of charging energy met by domestic, workplace, public slow/fast, public rapid and HGV depot charging. These proportions sum up to 100% for each vehicle type. The CPA is presented as a set of default values, with an allowable range, defined at GB level.

The minimum process set out in the tRESP CPA Methodology and Detailed Design, is for DNOs to apply the relevant default value for GB to their licence area.

However, we recognise that there will be variation in availability and usage of charging infrastructure within DNO licence areas. DNOs may therefore choose to go beyond that minimum process to align with the CPA by modelling the proportion of charging by charger type at a higher spatial granularity, provided that the following conditions apply:

1. At licence area level, DNOs shall apply the CPA, either:
   - by applying the proportions to the vehicle types as defined by tRESP Pathways (i.e. Lct_BB001, Lct_BB002, Lct_BB003, Lct_BB004)
   - or by introducing a variation by vehicle type (e.g. separate for cars, vans, and motorcycles within Lct_BB001-2), *on the condition that* the resulting charging distribution for the aggregate vehicle types equals the default value.

   For example, for the energy demand from Lct_BB001 at domestic charge points ($LctBB001_{energy\text{-}domestic}$), this would be calculated either by multiplying the total energy demand from Lct_BB001 ($LctBB001_{energy}$) with the relevant CPA value ($EV04BB1_{domestic}$) or by deriving separate values for the energy demand at domestic charge points from cars, vans and motorcycles, provided the sum of these values is equal to the aggregate result (Equation 2).

$$LctBB001_{energy,domestic} = LctBB001_{energy} * EV04BB1_{domestic} = car_{energy,domestic} + van_{energy,domestic} + motorcycle_{energy,domestic} \quad (2)$$

   where, for example

$$car_{energy,domestic} = car_{energy} * EV04BB1_{domestic,car\ variation} \quad (3)$$

2. At the GSP level, the charging distribution should fall within the range provided, on the condition that:

- the resulting charging distribution at licence area resolution equals the default value
- and the proportions used sum up to 100% for each vehicle type.

3. Below the GSP level, DNOs may use local data/insights to distribute charging proportions spatially, on the condition that the resulting impact aligns with the default CPA value. That is, when the charging energy from each charger type connected to downstream network assets is aggregated up to the GSP level, the resulting charging distribution is within the range provided, and when aggregated up to the licence area resolution is equal to the default value of the CPA.

We do not prescribe a specific method for the disaggregation of the GSP outputs to specific lower voltage network assets. As an example, the distribution of charging by charger type can be implemented using the following steps:

- Determine the total electricity consumption by charger type at GSP-resolution.
- For all substations of a given substation level (e.g. for each primary substation downstream of the GSP, represented as a-f in Figure 2), determine how demand from each charging type (domestic, workplace, public slow/fast, public rapid and HGV depot charging) is distributed between these network assets. That is, what proportion of demand from each charger type occurs within each substation's feeding area. For example, the domestic charging distribution could align to off-street parking availability and HGV depot charging should only be applied to locations of HGV depots. Specific projects, such as charging infrastructure development at motorway service areas (MSAs) could also influence the distribution of rapid public charging.

## Public

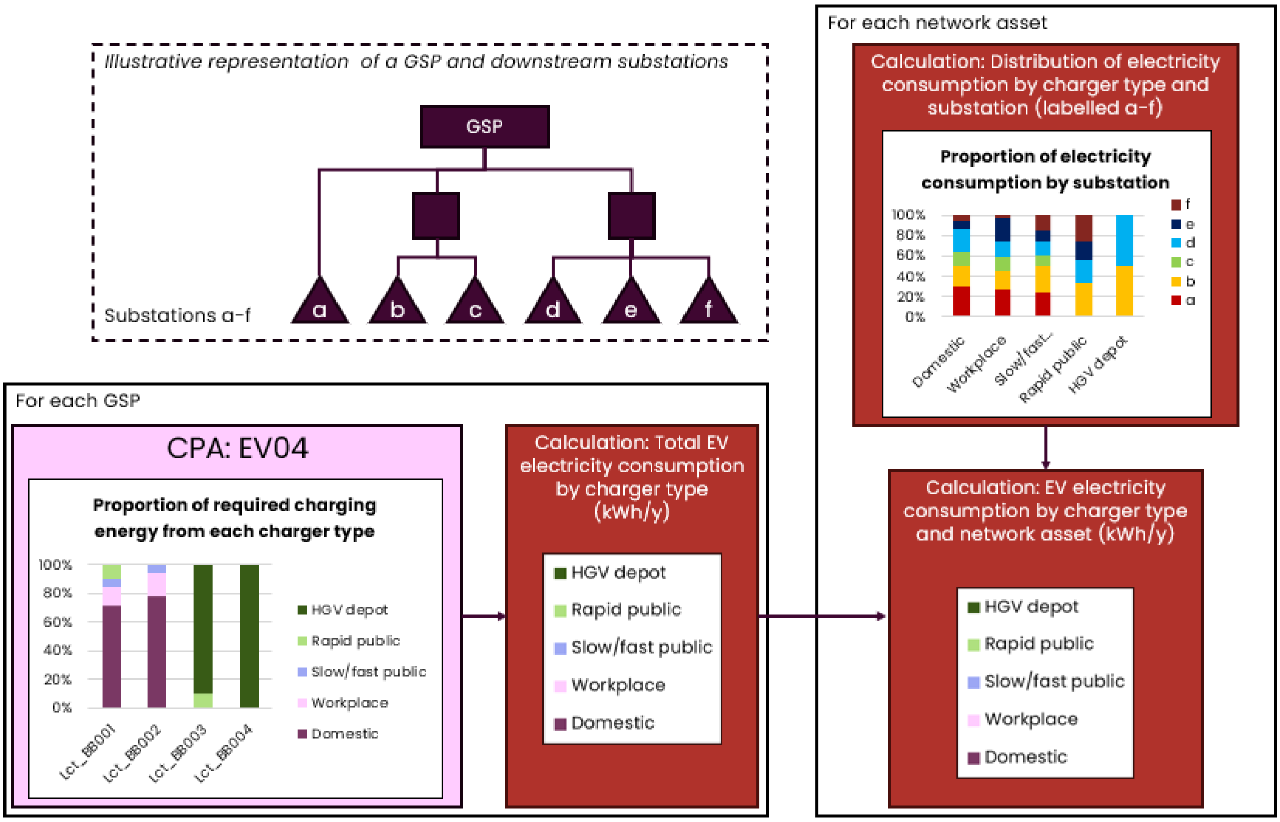


*Figure 2: Illustrative explanation of how charging distribution below the GSP level may be determined.*

This CPA focuses on the location and distribution of charging activity rather than overall scale, therefore this CPA is different and offers more flexibility. This approach allows DNOs to draw on their existing detailed modelling, studies, and local knowledge, which they have already developed and are best placed to apply. It recognises that mandating a highly granular, site-specific methodology would be impractical because doing so would risk oversimplifying the detailed insights DNOs already hold or require replicating extensive studies to provide a uniform approach, which is neither feasible nor desirable at this stage.

Strict alignment to the default values at GSP-level was considered but deemed not viable. While the charging distribution may apply to the average GSP, differences exist at this resolution. For example, not all GSP areas will host HGV depots or rapid public charging facilities, and the split between domestic and workplace charging can vary between areas. Therefore, a range is introduced to capture these variations.

### EV05 Proportion of consumers by behaviour

The EV05 CPA describes the proportion of consumers using each of the defined domestic charging behaviours. The two behaviours considered are ‘no flexibility’ and ‘demand shift in response to static time-of-use tariffs’. The CPA is defined at GB-level for every year out to 2050.

This CPA refers to domestic charging only and should be applied alongside the EV06 CPA, which includes two half-hourly profiles for domestic charging, one that describes ‘no flexibility’ and another which describes ‘demand shift in response to static time-of-use tariffs’. The resulting domestic charging demand for each year and each half hour is then found with the following formula:

$$Dom\_EV\_demand_{Year\_HH} = EV05\_noFlex_{Year} * EV06\_dom\_noFlex_{HH} + EV05\_Flex_{Year} * EV06\_dom\_Flex_{HH}$$

DNOs shall use the default value across the whole DNO licence area.

## EV06 Normalised half-hourly profile

The EV06 CPA describes the fully diversified kW demand at each half-hour from different charger types, scaled to the annual kWh electricity consumption from EVs. The CPA is defined for each charger type (domestic, workplace, slow/fast public, rapid public, HGV depot) at GB level and does not vary by year or representative day.

- DNOs shall use the default value across the whole DNO licence area, no geospatial variation should be applied.
- DNOs shall apply the CPA to the EV charger types defined in tRESP (domestic, workplace, slow/fast public, rapid public, HGV depot), no further technology detail should be used.

## EV07 Diversity-correction curve

The EV07 CPA is a table of scaling factors, used to adjust fully diversified profiles for assets with few end users, like those at lower voltages. These values define a curve that plots the diversity scaling factors against the number of EVs at the network asset. To represent the curve, each default value is defined for a range of EV numbers. This CPA is defined for each charger type (domestic, workplace, slow/fast public, rapid public, HGV depot) at GB level and does not vary by year or representative day.

To align with the CPA, DNOs shall first assess whether a diversity-correction is required for each asset (see EV08) and then follow the guidance below:

1. DNOs shall use the relevant default value across the whole DNO licence area. Apart from the variation that occurs due to different assets having a different number of EVs, no geospatial variation should be applied.
2. DNOs shall apply the CPA to the EV charger types defined in tRESP (domestic, workplace, slow/fast public, rapid public, HGV depot), and no further technology detail should be used.
3. DNOs shall apply the CPA based on the cumulative number of EVs (including the baseline) located within the catchment area of the network asset being considered. While we do not set out the detailed methodology for disaggregating the number of vehicles below the GSP-resolution, high-level principles are provided in section “Disaggregation to other voltage levels and specific network assets”. Not all vehicle types are relevant for all

charging types, e.g. electric HGVs will not charge at domestic charge points, nor will passenger cars charge at HGV depots. Therefore, when assessing the number of EVs at each asset, the following mapping between charging type and vehicle type should be applied.

a. Domestic charging: Lct_BB001 + Lct_BB002 (BEV and PHEV cars, vans, motorcycles)
b. Workplace charging: Lct_BB001 + Lct_BB002 (BEV and PHEV cars, vans, motorcycles)
c. Public slow/fast charging: Lct_BB001 + Lct_BB002 (BEV and PHEV cars, vans, motorcycles)
d. Public rapid charging: Lct_BB001 + Lct_BB002 + Lct_BB003 + Lct_BB004 (all BEV and PHEV vehicles)
e. HGV depot charging: Lct_BB003 + Lct_BB004 (BEV and PHEV HGVs and buses and coaches)

4. The default value for the range that the number of vehicles falls within should be applied, we do not expect DNOs to interpolate between the values of this function to derive an exact value for each number of vehicles.
5. The diversity-correction factor for each asset should be assessed for modelled EV volumes for every year between 2025 and 2035, and at 5-year intervals out to 2050 at minimum. If modelling capability allows, diversity-correction factors may be derived at more frequent time intervals for each asset. The diversity-correction factor should be applied for the higher year to all preceding years within each interval; for example, the 2040 factor should be used for 2035-2040 and the 2050 factor for 2045-2050.

We recognise that, particularly for LV networks, some DNOs model the impact of diversity using P-Q curves, as described in ACE Report No. 49 (ACE 49) [4] published by the Energy Networks Association. ACE 49 provides guidance on how DNOs can calculate demand and voltage regulations for LV networks. It defines P-Q curves as a way to approximate the impact of diversity. ACE 49 assumes that total demand is normally distributed and uses the mean and standard deviation of an observed dataset to define P and Q values, which are key statistics that can characterise a diversity correction curve. The tRESP CPAs are based on calculated results for each sample size (i.e. for increasing numbers of EVs) to define the shape of the diversity correction curve, rather than an assumed distribution. The tRESP CPAs are also set separately for EV and domestic HP, not expressed in relation to total demand.

[4] Association of Consulting Engineers (now Association for Consultancy and Engineering) & Electricity Council, *ACE Report No. 49 Report on Statistical Method for Calculating Demands and Voltage Regulations on LV Radial Distribution Systems* (London, 1981). Now maintained within the Energy Networks Association (ENA) historical document catalogue. P-Q curves are demand definitions within ACE 49, relating to mean and standard deviation, not active and reactive power.

The differences between these approaches for quantifying the impact of diversity – an assumed distribution versus empirical data – means that it is not appropriate for P and Q values to be provided as part of the tRESP CPAs.

However, if required for the purposes of modelling implementation, DNOs may curve-fit to derive P and Q values from the tRESP CPA diversity correction curves, defining the P and Q values for the EV group size set out in the 'Number of electric vehicles – lower bound' column of the EV07 tab in the tRESP CPA value workbook. When using this approach, DNOs should provide evidence that the derived P-Q curve is numerically equivalent to the diversity correction curves defined in EV07, by demonstrating that any error arising from the curve-fitting approach has been minimised (e.g. to minimise the overall deviation from the tRESP CPA curve, optimising the curve-fit across a defined range for the number of EVs).

### EV08 Minimum count for full diversification

The EV08 CPA is closely linked to EV07 and describes the minimum number of EVs at a network asset required for the charging profile at that asset to be considered fully diversified. If the cumulative number of EVs (including the baseline) at a given network asset is higher than this minimum, the diversity correction (EV07) is not required.

To align with the CPA, DNOs shall carry out a diversity correction check for each asset to determine whether a diversity-correction scaling factor is required.

DNOs shall carry out the check for modelled EV volumes for every year between 2025 and 2035, and at 5-year intervals out to 2050 at minimum. If modelling capability allows, this may be done at more frequent intervals, aligned with the calculations for EV07.

We recognise that the guidance asks for a high degree of modelling complexity to perform the diversity correction check (and subsequent scaling, if required) at every network asset, across all voltage levels, and for each year between 2025-2035. Feedback from DNOs has indicated that, in some cases, the impact of adopting more complex approaches may be limited. For example, when calculating total substation demand for EHV assets with low EV numbers, the difference between applying a diversity scaling factor and not applying one may be immaterial, as EV demand represents a small proportion of overall substation demand. Similarly, carrying out diversity correction checks annually may offer limited additional benefit compared to a five-year interval.

However, we do not define specific exceptions to the guidance for such cases and the CPA approach remains the intended methodology. It remains the responsibility of each DNO to ensure that, when assessing the overall impact at a network asset, their approach is equivalent to the approach set out by the CPAs and this guidance.

### EV09 Charge point utilisation

The EV09 CPA describes the total time a charging station is actively used to charge EVs, represented as the number of hours in a year or a utilisation proportion (%). This CPA is defined for each charger type (domestic, workplace, slow/fast public, rapid public, HGV depot) at GB level and does not vary by year or representative day.

The charge point utilisation is not a critical assumption to the end-to-end process for deriving network peak impacts from EVs. Therefore, this CPA is provided as a reference only, to illustrate how the number of charge points can be derived in the context of the broader methodology. DNOs may therefore adopt an alternative assumption where appropriate and deviation from the default values does not constitute a misalignment with the CPA methodology.

## EV10 Size of chargers

The EV10 CPA describes the rated capacity or the maximum amount of electrical power that a charger can deliver to an EV at any given moment. This CPA is defined for each charger type (domestic, workplace, slow/fast public, rapid public, HGV depot) at GB level and does not vary by year or representative day.

Like the charge point utilisation, this CPA is not a critical assumption to the calculation of network peak impacts and is provided as reference to demonstrate how the number of charge points may be derived. DNOs may therefore adopt an alternative assumption where appropriate and deviation from the default values does not constitute a misalignment with the CPA methodology.

## Heat pumps

### HP01 Size of HP

The size of heat pump provides the $kW_{th}$ installed capacity of heat pumps per dwelling category, indicated by the dwelling thermal heat loss, for existing stock (referred to as existing build in the CPA workbook) and new builds. The values are provided at GB level and do not vary by year or representative day. The values for existing builds should be applied to existing dwelling stock at the baseline date (31st March 2025). The values for new builds should be applied to dwelling stock built after the baseline date.

As illustrated in the end-to-end process diagram in Figure 5 of the tRESP CPA Methodology and Detailed Design, to align with the CPA DNOs shall disaggregate the tRESP Pathway outputs to calculate the heat pump numbers by dwelling category and by network asset. We do not set out a detailed methodology for disaggregating heat pump numbers below GSP resolution. Instead, high-level principles are outlined in the section "Disaggregation to other voltage levels and specific network assets". Likewise, we do not specify the detailed approach for splitting heat pump numbers by dwelling category. Where possible, DNOs should draw on knowledge of the local area, including (but not limited to):

- existing proportions of dwelling categories
- suitability of typical dwellings in the area for heat pump installation for each dwelling category
- historic trends in heat pump connections by dwelling category

to determine an appropriate allocation by dwelling category.

The heat pump numbers by dwelling category and by network asset should then be used in conjunction with HP01 and HP02 to calculate the heat pump installed capacity at each network asset by dwelling category ($kW_{th}$). The minimum process set out in the tRESP CPA Methodology is for DNOs to use the relevant default value for HP01 across the whole of GB.

However, we recognise that in practice, there will be variation in dwelling heat loss and therefore heat pump sizes between nations and regions. This could be driven by a number of factors including variation in the distribution of dwelling ages, and variation in dwelling design heat loss (within a given age band and dwelling category).

The default value for the size of heat pump HP01 for existing builds for each dwelling category has been calculated as a weighted average across the dwelling age bands provided in the Building

Research Establishment source[5], based on the distribution of dwelling ages in England and Wales[6] identified from council tax data.

To capture the impact of the regional variation in the distribution of dwelling ages, DNOs may choose to go beyond the minimum process to model heat pump sizes for existing builds for each licence area by modelling heat pump sizes based on the specific distribution of dwelling ages in the area, provided that three conditions are met as listed below. However, as the modelling complexity is high, we do not consider that variations between licence areas should be part of the minimum modelling granularity and there is no expectation on DNOs to add this modelling.

**Conditions for going beyond the minimum process to align with the CPA**

1. The dwelling age distribution is the only input that shall be changed by DNOs, i.e. the dwelling design heat loss values shall be taken from the same Building Research Establishment source as the default values[5].
2. Either council tax data for the relevant area is used to provide the dwelling age distribution, or the source used by the DNO for the dwelling age distribution is provided alongside justification as to why it is more appropriate than council tax data (the default value data source).
3. For each dwelling category and licence area, the calculated values for heat pump size shall be within the allowable ranges presented in the CPA workbook for each dwelling category.

We recognise that DNOs may have more accurate or granular data on dwelling ages, so the source for dwelling age distribution is not specified, provided that condition 2 is met. The tolerance in condition 3 has been set based on the impact of using dwelling age distributions for different government regions using council tax data.

Variation in dwelling design heat loss within a given age band and dwelling category is not captured in the Building Research Establishment source[5] (for example, detached houses built between 1900-1929 in Wales may have a different dwelling design heat loss to detached houses built between 1900-1929 in London). We are not aware of a data source that can provide this information, especially given the challenges of ensuring a consistent methodology across all nations and regions. Given the scope of the selected source, additional regional variation in dwelling design heat loss beyond variation in dwelling age distribution is not considered in the tRESP CPAs.

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[5] Building Research Establishment, *Domestic Annual Heat Pump System Efficiency (DAHPSE) - Estimator - BETA*

[6] Whilst the dataset used is for England and Wales, we have checked that these values are also appropriate for Scotland by comparing to data from the Scottish House Condition Survey 2023.

## HP02 Dwelling thermal efficiency factor

The dwelling thermal efficiency factor is a CPA to account for improvements in building fabric efficiency and is defined as a proportion of the baseline efficiency (i.e. the factor is 1 at baseline and less than 1 in future years). The CPA is provided as an annual default value for existing dwellings.

As illustrated in the end-to-end process diagram, the dwelling thermal efficiency factor is to be used to adjust the assumed installed heat pump capacity at each network asset.

This CPA is only to be applied to existing dwelling stock at the time of baseline (31 March 2025). The cumulative total of new builds from 2025 onwards should therefore be excluded from the calculation when the factor is applied. Note that this is not just new builds in the calculation year, but all dwellings built since baseline. This avoids the implication that significant thermal efficiency improvements will be made to dwellings built to current thermal efficiency standards (e.g. 2021 revisions to Part L of the Building Regulations[7]). This is because the current standards are considerably more stringent than the energy efficiency standards in place when the majority of existing dwellings were built, and so limited additional improvement is expected to these dwellings. Whilst it would be more accurate to set different cutoffs aligned with other Building Regulation updates, we anticipate that this nuance is likely within error margins given the impact of other factors (e.g. regional variation, dwelling-specific design, heat pump installation quality).

The CPA should be applied annually, although the value remains fixed from 2035 to 2050. The default value for the dwelling thermal efficiency factor is to be used across all nations and regions and all voltage levels.

We recognise that there may be regional variation in dwelling thermal efficiency improvements, for example due to local energy efficiency initiatives or the suitability of existing dwelling stock. However, it is challenging to find consistent data sources for these improvements, especially as the methodology for local studies may not be fully transparent without additional engagement.

## HP03 Efficiency of HP

This CPA provides the heat pump coefficient of performance (COP), i.e. how much heat energy is produced for every unit of electrical energy consumed. This CPA is provided for each representative day and DNO licence area.

To align with the CPA, DNOs shall apply the relevant value for the representative days defined in tRESP ('peak demand winter day', 'peak demand shoulder season day', 'peak demand summer day', 'overall minimum demand day').

The minimum process set out in the tRESP CPA Methodology, is for DNOs to use the default value across the whole DNO licence area, with no geospatial variation applied.

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[7] Ministry of Housing, Communities and Local Government, *Conservation of fuel and power: Approved Document L - GOV.UK*

However, if a DNO has chosen to model the temperature difference at a more spatially granular level (as outlined in *HP05 Temperature difference)*, to align with the CPA the DNO shall also model HP03 to the same spatial granularity. The COP table from the Electrification of Heat (EoH) source[8] shall be used to determine the appropriate COP, using the calculated representative outdoor air temperature for each substation at the chosen level of spatial granularity, interpolating linearly between relevant temperature values as required. The EoH table of values has been reproduced below for ease of reference.

| External Air Temperature (°C) | COP |
|---|---|
| -10 | 2.08 |
| -9 | 2.11 |
| -8 | 2.22 |
| -7 | 2.29 |
| -6 | 2.32 |
| -5 | 2.3 |
| -4 | 2.33 |
| -3 | 2.37 |
| -2 | 2.44 |
| -1 | 2.5 |
| 0 | 2.57 |
| 1 | 2.65 |
| 2 | 2.72 |
| 3 | 2.81 |
| 4 | 2.89 |
| 5 | 3.01 |
| 6 | 3.12 |
| 7 | 3.21 |
| 8 | 3.29 |
| 9 | 3.33 |
| 10 | 3.37 |
| 11 | 3.35 |
| 12 | 3.33 |
| 13 | 3.26 |
| 14 | 3.14 |
| 15 | 3.02 |
| 16 | 2.95 |
| 17 | 2.87 |
| 18 | 2.83 |

*Table 1: COP values based on external air temperature, to be used if DNOs model HP05 at a greater spatial granularity (reproduced from DESNZ Electrification of Heat study)*

[8] Energy Systems Catapult, *Electrification of Heat Analysis 2*

## HP04 Specific HP heat output

The specific heat pump heat output is defined as the daily thermal output of the heat pump ($kWh_{th}$) relative to the installed capacity ($kW_{th}$) and the temperature difference between target inside air temperature and the outdoor air temperature (˚C). The values are provided for each representative day and are applicable across all of GB. This CPA should be combined with HP01, HP03 and HP05 to calculate the daily electricity consumption as specified in the "Heat pumps: end-to-end process and list of assumptions" section in the tRESP CPA Methodology and Detailed Design.

DNOs shall use the values provided for the relevant representative day. No geospatial variation should be applied.

## HP05 Temperature difference

The temperature difference CPA provides the temperature difference between target inside air temperature (assumed to be 21˚ C) and the calculated representative outdoor air temperature. Both default values and ranges are provided for the temperature difference, for each DNO licence area and for two representative days ('peak demand winter day' and 'peak demand shoulder season day').

The minimum process set out in the tRESP CPA Methodology, is for DNOs to use the relevant default value across the whole DNO licence area.

However, we recognise that there will be outdoor temperature variation within licence areas. DNOs may therefore choose to go beyond that minimum process to model temperature at a higher spatial granularity by modelling at any given substation level (e.g. for each Bulk Supply Point, primary, secondary substation), provided that three conditions are met as listed below. However, as the modelling complexity is high, and granular modelling of temperature variations by DNOs is not widespread currently, temperature variations within licence areas are not part of the minimum process and there is no expectation on DNOs to add this modelling.

**Conditions for going beyond the minimum process to align with the CPA**

1. The temperature difference values used for each substation fall within the specified range set out in the CPA value workbook for the licence area.
2. The mean across all substations (at the chosen level of granularity) in the licence area is equal to the default value, to within the allowable tolerance set out in Table 2. Note that this is the tolerance between the DNO-calculated mean and the default for the CPA. This is distinct from the allowable range set out in the CPA value workbook, which is referred to in condition 1.
3. The calculated representative outdoor air temperature value represents the same quantity as in the tRESP CPAs i.e.:

- for the peak demand winter day, the calculated representative outdoor air temperature value represents the average daily temperature of the coldest day in an average weather year.
- for the peak demand shoulder season day, the calculated representative outdoor air temperature value represents the average daily temperature of the coldest day in a mid-temperature month in an average weather year.

| DNO Licence Area | Tolerance for average value (°C) |
|---|---|
| East Midlands | ±0.2 |
| Eastern | ±0.2 |
| London | ±0.2 |
| Merseyside and North Wales | ±0.5 |
| Midlands | ±0.2 |
| North Scotland | ±0.8 |
| North Western | ±0.4 |
| Northern | ±0.5 |
| South Eastern | ±0.3 |
| South Scotland | ±0.6 |
| South Wales | ±0.6 |
| South Western | ±0.4 |
| Southern | ±0.4 |
| Yorkshire | ±0.3 |

*Table 2: Tolerance for the mean temperature value across all substations at the chosen granularity within a licence area, if a DNO chooses to model temperature at a more granular spatial level*

This approach enables DNOs to model within-licence area outside temperature variation, whilst remaining consistent with the default CPA values provided. The tRESP CPA values for HP05 have been determined based on taking the average value for a licence area across 12 km squares (this being the granularity of the source dataset).

If DNOs opt to model outside temperature difference at a more granular spatial level, a tolerance is needed for the DNO-calculated mean because averaging across substations rather than 12 km squares will likely generate a slightly different result. This is expected given the even spatial granularity of the 12 km squares, compared to the uneven spatial granularity of substations. As the spread of observed temperatures varies by region, the tolerances provided in Table 2 have been set relative to the range of observed temperatures, by allowing ±0.5 standard deviations from the mean.

The source temperature data at 12 km squares used in the calculation of the CPAs does not necessarily align with network asset topology and the areas served by network assets. If DNOs choose to model temperature differences within a licence area, there is no expectation that this higher granularity would be at the 12 km square level, so we have chosen not to provide the processed data at that level.

There is no expectation to use exactly the same source data set for outdoor air temperature as used in the calculation of the CPAs, so DNOs may use other spatial temperature data sources, provided that the three conditions for the range, mean and definition of the data are met, or the temperature source is adjusted such that the conditions are met.

## HP06 Normalised half-hourly profile

The HP06 CPA describes the fully diversified kW demand at each half-hour for different representative days, scaled to the daily kWh electricity consumption of heat pumps. The CPA is defined for each representative day (peak demand winter day, peak demand shoulder season day, peak demand summer day, overall minimum demand day) at GB level and does not vary by year. To align with the CPA:

- DNOs shall use the default value across the whole DNO licence area, and no geospatial variation should be applied.
- DNOs shall apply the CPA to the representative days defined in tRESP (peak demand winter day, peak demand shoulder season day, peak demand summer day, overall minimum demand day).

DNOs that consider seasons other than summer, winter and shoulder (i.e. spring/autumn) or individual months may interpolate between the three provided peak day profiles. We will not set out a specific approach to interpolation (which could introduce significant unnecessary complexity), but DNOs should justify their interpolation approach based on ambient temperature profiles or other relevant factors in the nation or region.

For 'peak demand winter day' and 'peak demand shoulder season day', the profiles are presented split into three different consumer behaviours (continuous, daytime and bimodal), plus a profile which is a weighted average across the consumer behaviours. These separate behaviours have been provided for reference only, to offer visibility of the expected patterns of usage that make up the overall profile. However, as both the consumer behaviour profiles (in the HP06 split) and the proportion of customers by behaviour (HP07) are fixed out to 2050, DNOs shall not use the separate behaviour profiles and shall instead use the weighted average profile across all behaviours that has been provided.

## HP07 Proportion of consumers by behaviour

This CPA has been provided for reference only, as DNOs shall use the weighted average profile across all behaviours that has been provided in HP06. DNOs may use this CPA to support with sensitivity analyses or other internal modelling, but the assumption does not feed into the tRESP end-to-end CPA process for heat pumps. Deviation from the default values therefore does not constitute a misalignment with the CPA methodology.

## HP08 Diversity-correction curve

The HP08 CPA is a table of scaling factors, used to adjust fully diversified profiles for assets with few end users, like those at lower voltages. These values define a curve that plots the diversity scaling factors against the number of heat pumps at the network asset. To represent the curve, each default value is defined for a range of heat pump numbers. This CPA is defined for each representative day (peak demand winter day, peak demand shoulder season day, peak demand summer day, overall minimum demand day) at GB level and does not vary by year.

To align with the CPA, DNOs shall first assess whether a diversity-correction is required for each asset (see HP09) and then follow with the guidance below:

- DNOs shall use the relevant default value across the whole DNO licence area. Apart from the variation that occurs due to different assets having a different number of heat pumps, no geospatial variation should be applied.
- DNOs shall apply the CPA across all heat pump technologies (i.e. combining hybrid and non-hybrid heat pumps) and all dwelling categories (i.e. combining detached houses, semi-detached and end-terraced houses, mid-terraced houses and flats).
- DNOs shall apply the CPA to the representative days defined in tRESP ('peak demand winter day', 'peak demand shoulder season day', 'peak demand summer day', 'overall minimum demand day').
- DNOs shall apply the CPA based on the cumulative number of heat pumps (including the baseline) located within the catchment area of the network asset being considered. While we do not set out the detailed methodology for disaggregating the number of heat pumps below the GSP-resolution, high-level principles are provided in the section "Disaggregation to other voltage levels and specific network assets".
- The default value for the range that the number of heat pumps falls within should be applied. We do not expect DNOs to interpolate between the values of this function to derive an exact value for each number of heat pumps.
- The diversity-correction factor for each asset should be assessed for modelled heat pump volumes for every year between 2025 and 2035, and at 5-year intervals out to 2050 at minimum. If modelling capability allows, diversity-correction factors may be derived at more frequent time intervals for each asset. The diversity-correction factor should be applied for the higher year to all preceding years within each interval; for example, the 2040 factor should be used for 2035-2040 and the 2050 factor for 2045-2050.

We recognise that, particularly for LV networks, some DNOs model the impact of diversity using P-Q curves, as described in ACE Report No. 49 (ACE 49) published by the Energy Networks Association. ACE 49 provides guidance on how DNOs can calculate demand and voltage regulations for LV networks. It defines P-Q curves as a way to approximate the impact of diversity. ACE 49 assumes that total demand is normally distributed and uses the mean and standard deviation of an observed dataset to define P and Q values, which are key statistics that can characterise a diversity correction curve. The tRESP CPAs are based on calculated results for each sample size (i.e. for increasing numbers of heat pumps) to define the shape of the diversity correction curve, rather than an assumed distribution. The tRESP CPAs are also set separately for EV and domestic HP, not expressed in relation to total demand.

The differences between these approaches for quantifying the impact of diversity – an assumed distribution versus sampling empirical data – means that it is not appropriate for P and Q values to be provided as part of the tRESP CPAs. However, if required for the purposes of modelling implementation, DNOs may curve-fit to derive P and Q values from the tRESP CPA diversity correction curves, defining the P and Q values for the heat pump group size set out in the 'Number of heat pumps – lower bound' column of the HP08 tab in the tRESP CPA value workbook. When using this approach, DNOs should provide evidence that the derived P-Q curve is numerically equivalent to the diversity correction curves defined in HP08, by demonstrating that any error arising from the curve-fitting approach has been minimised (e.g. to minimise the overall deviation from the tRESP CPA curve, optimising the curve-fit across a defined range for the number of heat pumps).

### HP09 Minimum count for full diversification

The HP09 CPA is closely linked to HP08 and describes the minimum number of heat pumps at a network asset required for the demand profile at that asset to be considered fully diversified. If the cumulative number of heat pumps (including the baseline) at a given network asset is higher than this minimum, the diversity correction (HP08) is not needed.

To align with the CPA, DNOs shall carry out a diversity correction check for each asset to determine whether a diversity-correction scaling factor is required, for each representative day.

DNOs shall carry out the check for modelled heat pump volumes for every year between 2025 and 2035, and at 5-year intervals out to 2050 at minimum. If modelling capability allows, this may be done at more frequent intervals, aligned with the calculations for HP08.

We recognise that the guidance asks for a high degree of modelling complexity to perform the diversity correction check (and subsequent scaling, if required) at every network asset, across all voltage levels, and for each year between 2025-2035. Feedback from DNOs has indicated that, in some cases, the impact of adopting more complex approaches may be limited. For example, when calculating total substation demand for EHV assets with low heat pump numbers, the difference between applying a diversity scaling factor and not applying one may be immaterial, as heat pump demand represents a small proportion of overall substation demand. Similarly, carrying out diversity correction checks annually may offer limited additional benefit compared to a five-year interval.

However, we will not define specific exceptions to the guidance for such cases and the CPA approach remains the intended methodology. It remains the responsibility of each DNO to ensure that, when assessing the overall impact at a network asset, their approach is equivalent to the approach set out by the CPAs and this guidance.

# Energy Efficiency

## EE01 Residential energy efficiency

The EE01 CPA refers to electricity consumption from residential appliance and lighting (kWh/household) compared to the base year of 2025 (i.e. year ending 31$^{st}$ March 2025).

While residential baseload demand is not considered as part of the tRESP Pathways, the reduction in residential appliance and lighting demand due to efficiency is an area of high uncertainty that has a high impact on total demand. Therefore, we set out a CPA for this parameter to start bringing consistency into this area for network planning for the ED3 business plan.

Residential baseload demand is one component of the total underlying demand. Here, underlying demand refers to electricity demand from the existing customer base connected to the distribution network, including from both domestic and non-domestic customers and any low-carbon technologies (LCTs) already in operation within the DNO licence areas. Through our work and bilateral engagement with DNOs, we found considerable differences in how DNOs address underlying demand in their future demand estimates for business planning. Therefore, this section provides user guidance tailored to each existing modelling approach.

The following situations describe existing processes taken by DNOs and how the EE01 CPA should be applied in each case. Please note that different situations can apply to calculations at different voltage levels, i.e. a DNO's approach for LV demand might fall under Situation 1 while that for EHV demand might fall under Situation 3. The description of the situations has been written with reference to substations, but the same approaches can be applied to circuit demand.

**Situation 1: Per substation split to a category of domestic appliance and lighting demand**

Domestic demand is a separate component of the modelling, treated as annual kWh per household/connection and is split up into (a) appliance and lighting demand and (b) non-HP electric heating. This split is available at substation level. This domestic demand does not include any demand from air conditioning or low carbon technologies such as heat pumps or EVs. The annual kWh figure is modelled for every future year and a normalised profile is applied to this parameter to translate annual demand to peak demand. New build demand is treated separately. To align with the CPA:

- DNOs shall apply the EE01 CPA as a scaling factor to the appliance and lighting demand (a) for all future modelled years, as appropriate. The CPA should be applied to all substations within the DNO licence area, either by applying the same factor to all substations across the area or by applying a spatial distribution that results in the same overall reduction in energy at the licence area level, to within an allowable tolerance of 0.5%. The CPA is not applied to new builds i.e. demand from additional domestic premises after the base year.

**Situation 2: Per substation split to a category of non-LCT domestic demand**

As situation 1, but the domestic demand is not split up into the subcategories (a) and (b). To align with the CPA:

- DNOs shall ensure this CPA is applied to appliance and lighting demand only. While we do not set out the reduction in other domestic demand, we note that there is a risk of overestimating the reduction in baseload demand if this CPA is applied to the total domestic demand.
- DNOs shall at minimum determine the proportion of the baseload domestic demand (kWh) that is from appliances and lighting at DNO licence area level. The EE01 CPA shall then be applied to this portion of the demand as in situation 1. Reductions in demand for non-HP electric demand could be drawn from HP02 but that is not a requirement. The CPA is not applied to new builds.

**Situation 3: Per substation split to domestic and non-domestic demand**

As situation 2 but there is no separate consideration of demand from existing low-carbon technologies. In this situation, the same guidance as for situation 2 applies. To align with the CPA:

**Situation 4: Demand is not split by category by substation**

Underlying demand is treated as one component and consists of domestic, non-domestic, and low-carbon technology demand at baseline. This underlying demand is represented as peak demand (kW) only and annual demand (kWh) is not considered.

- DNOs shall ensure this CPA is applied to appliance and lighting demand only. While we do not set out the reduction in other underlying demand, we note that there is a risk of overestimating the reduction in baseload demand if this CPA is applied to the total underlying demand.
- DNOs shall at a minimum determine the proportion of the baseload underlying demand (kW) that is from appliances and lighting for each voltage level at the DNO licence area resolution, and apply EE01 to that proportion of demand at all assets under that voltage level. This should be done for each voltage level (e.g. for primaries and secondaries separately) to reflect the different balance between domestic and non-domestic customer load at each voltage. The minimum process is to derive these values at DNO licence area resolution, but a method that considers the difference in the domestic-and non-domestic split at each substation – particularly at primary substation and above - is encouraged to mitigate risk of over/under-estimating demand reductions at local level. The EE01 CPA shall then be applied to this portion of the demand. The CPA is not applied to non-domestic load, LCT demand, or domestic new builds.

Limitations to the approach for situation 4:

- The approach assumes that reduction in energy consumption directly translates to reductions in peak demand. This is a reasonable approximation for domestic demand when considered on its own, as annual consumption reductions can generally scale to peak reductions. However, when combined with other demand components, this assumption becomes less suitable. At substation level, total peak demand is often driven by non-domestic loads, which may peak at a different time than domestic loads. As a result, while domestic efficiency gains may reduce the overall substation peak, the reduction is unlikely to be proportional to the energy savings. Ideally, domestic and non-domestic profiles should be treated separately, though this would require significant changes to DNO processes.
- If appliance and lighting demand proportions are calculated at DNO licence-area level rather than for individual substations, local variations can be missed. Substations differ in their domestic/non-domestic customer mix, so applying broad averages risks over/under-estimating the impact at a local level, even if the overall effect looks reasonable.
- If domestic peak contribution is estimated from customer numbers rather than actual load share, domestic impact may be overstated since non-domestic customers typically consume more energy.

**Alternative options considered**

An alternative option considered was to provide projections for energy efficiency gains for other components of baseload demand, in case these were treated as one component (Situation 4). This approach was not pursued because it goes beyond the scope of the CPA and would result in NESO giving different levels of input to DNOs depending on their existing methodology. Additionally, different types of non-domestic customer may have different expected energy efficiency gains. Instead, the guidance was designed to maintain consistency in the level of information provided while still accommodating different approaches.