APPENDIX ON HOURLY ELECTRICITY CONSUMPTION

Version submitted to public consultation for the next Adequacy & Flexibility study 2024-34

28/10/2022

1.1. General process

The tool, which is based on the methodology and tools developed in the ENTSO-E adequacy assessment, allows hourly electric load projections to be performed based on a set of input data, carried out in two main steps:

As part of a first step, the model maps the historical relations between climate and electrical load for each simulated country:

- for each market node, the historical relation between climate and load time series is determined (i.e. the thermosensitivity of the load);
- these observed historical relations between the climate and electrical load for each market node is then applied on a set of 200 artificial climate years incorporating the climate in 2025 to obtain the load series forecast;
- the resulting profiles are adapted to take into account the consumption growth due to economic growth, population growth and energy efficiency. Additional corrections were made through the incorporation of special days (e.g. corrections are made for holiday periods, exceptional events, etc.);
- the resulting predicted load series therefore include present-day market characteristics in terms of the amount of electrification in industry, appliances, heating, cooling and transport.

As a second step, the tool incorporates the effect of additional electrification, on top of the existing devices already taken into account in the total consumption profiles obtained after the first step:

- the different TSOs communicate their assumptions to ENTSO-E, reflecting the estimated evolutions in the market of the different factors driving electricity consumption (e.g., penetration of heat pumps, electric vehicles, additional baseload, sanitary water, air conditioning)[1];
- these assumptions are translated into inputs for the different electrification technologies and the different components are split into climate-dependent and climate-independent components;
- the final load profiles are adjusted, taking into account additional consumption from the different electrification technologies.

[1] Note that for Belgium more granular assumptions are used than for other countries, as this depends on the data available in the PEMMDB (Pan European Market Modelling Database)

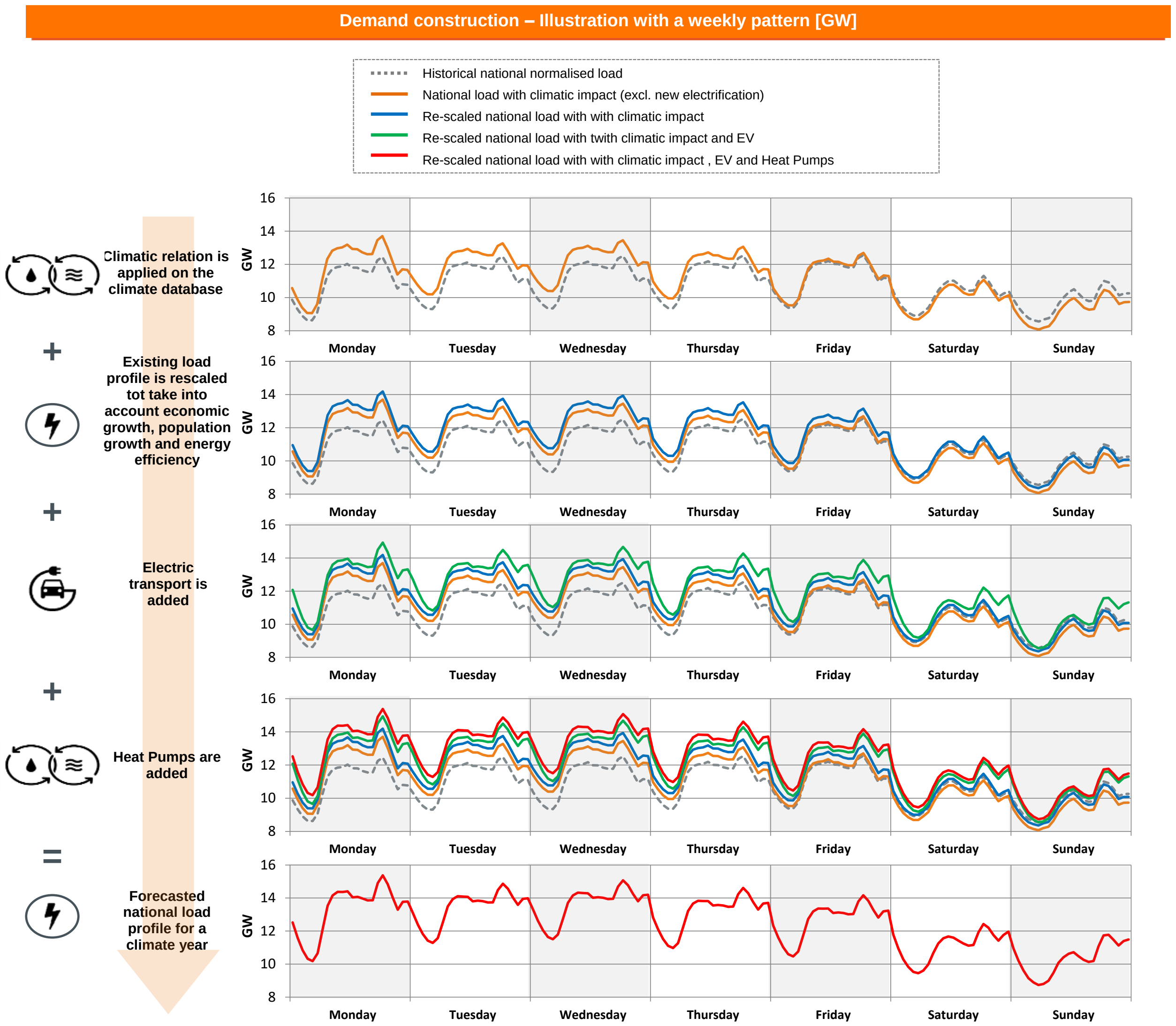

Figure 1: Hourly demand construction – example with a weekly pattern[2]. This example excludes additional electrification from industry or data centers.

1.2. Electrification of transport

The construction of hourly profiles for electric transport consists of 3 main steps as shown in Figure 2.

- In a first phase the total annual electricity demand due to electric road transport is determined by the evolution of the number of electric vehicles, the assumed yearly driven amount of kilometers and the efficiency.
- In a second phase this annual consumption is redistributed over each day of the year by using a seasonal scaling function (where charging is higher in winter due to lower battery efficiencies caused by colder temperatures) and by taking into account the difference between weekday/weekend charging.
- In the final step, the daily electricity demand for electric transport is redistributed to each hour of the day using an intraday scaling profile. Those profiles depends on the flexibility assumed in the system, for which the methodology and assumptions are available in the study by Delta-EE which is included separately in this public consultation.

[2] Note that the values shown are illustrative for the process and not necessarily correspond to real profiles used in the simulations

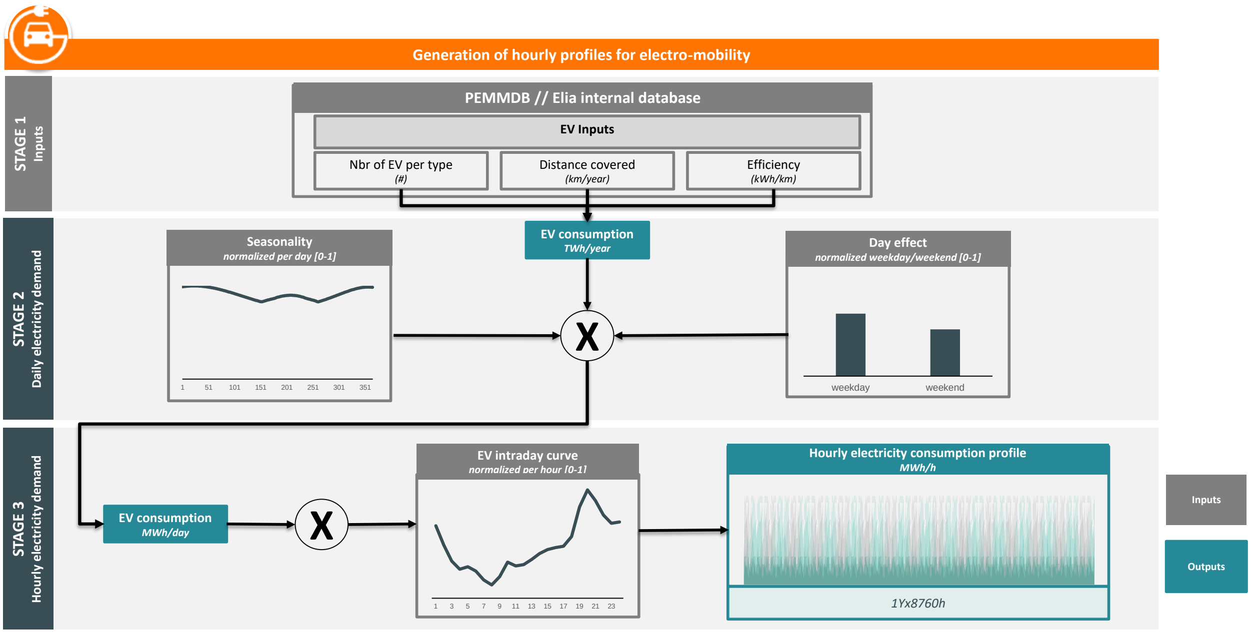

Figure 2: Construction of hourly electricity demand profiles for electro-mobility

1.3. Electrification of heating

The construction of hourly profiles for heat pumps consists of a set of steps as shown in Figure 5.

1. In a first phase the evolution of the number of heat pumps is determined per sector and type. A distinction is made per sector (residential, tertiary), type of heat pump (ground-water, air-water, air-air, HP with back-up) and per status of the building (new, renovated[3]).
2. In a second phase the primary heating need of a building equipped by a space heating heat pump is determined. It is assumed that heating demand follows a linear relationship with ambient temperature. Different linear relations are assumed per sector (residential, tertiary), month and type of day (weekday, weekend). As a consequence, two days with the same daily average temperature could result in a different heating demand[4]. The result of this step is the daily heating demand in kWh.
3. Subsequently, daily heating demand is translated into daily electricity demand by applying the coefficient of performance curves (COP) per type of heat pump and building. As shown in Figure 3, it is assumed that flow temperatures in renovated buildings are higher than in new builds, with a slightly reduced efficiency as a consequence.

[3] Note that we will not assume heat pumps to be installed in buildings with poor insulation levels
[4] For example a day in May with an outside temperature of 10°C will lead to a lower heating demand than the same type of day in January, because the majority of buildings have switched to non- space heating mode

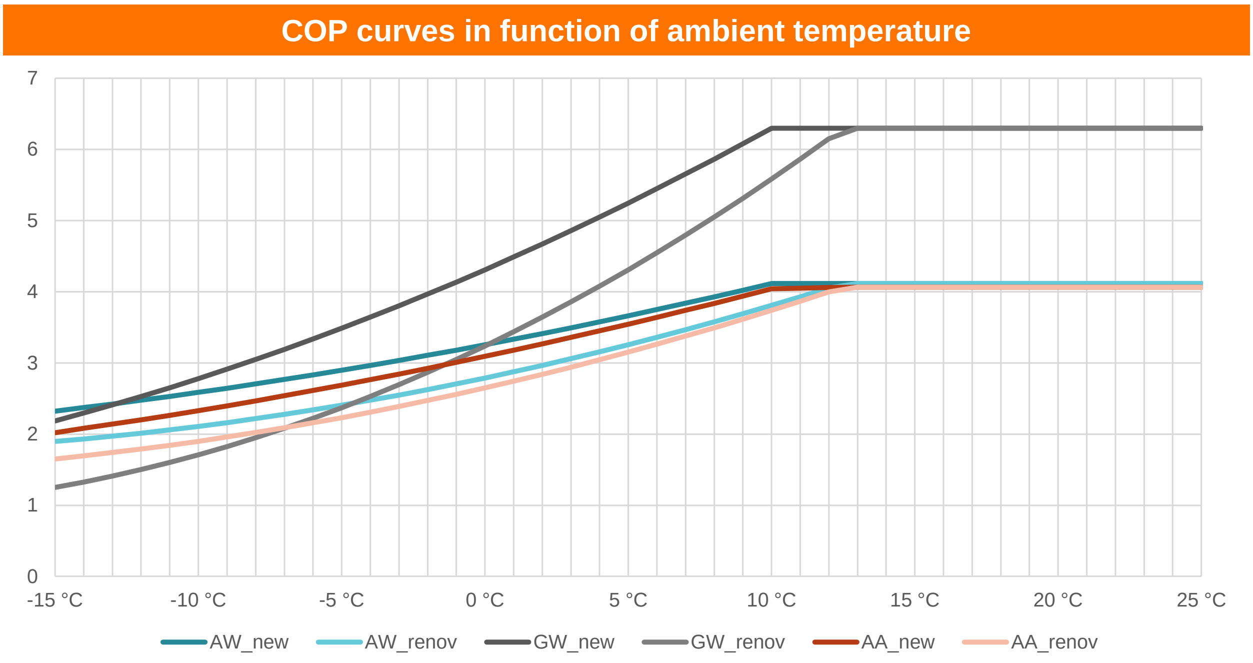

Figure 3 COP curves in function of outside temperature based on[5] [Time series of heat demand and heat pump efficiency for energy system modeling | Scientific Data (nature.com)]

4. At the same time the steering method for each heat pump is taken into account. For heat pumps which have a non-electric back-up and/or are used as secondary heating unit, it is assumed that from 5°C a back-up heating system is activated which delivers the residual heat (Figure 4), while the contribution diminishes to become 100% from -15°C. Additionally, for all-electric heat pumps it is often the case that a direct electric resistance back-up is in place to cover heating needs which cannot be fully covered by the heat pump (at cold temperatures). For this study we propose to assume that air-water and air-air units in renovated buildings will have this type of back-up in place which is activated once temperatures drop below -2°C and reaches 100% from -15°C. Those assumptions are

[5] Time series of heat demand and heat pump efficiency for energy system modeling | Scientific Data (nature.com)

derived from studies done by E-Cube[6] and the Federal Plan Bureau in collaboration with Artelys[7].

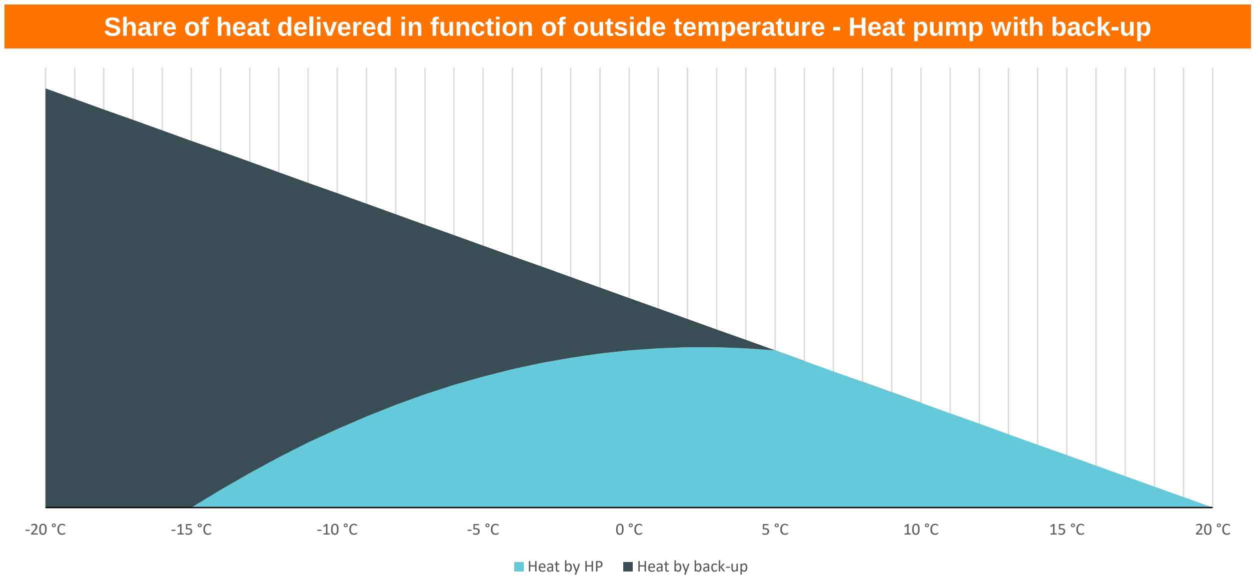

Figure 4: Steering method for a heat pump supplied by another heating source as back-up

5. In the final step the daily electricity demand per heat pump is divided to each hour of the day using an intraday scaling profile. Those profiles depends on the flexibility assumed in the system, for which the methodology and assumptions are available in the study by Delta-EE which is included separately in this public consultation.

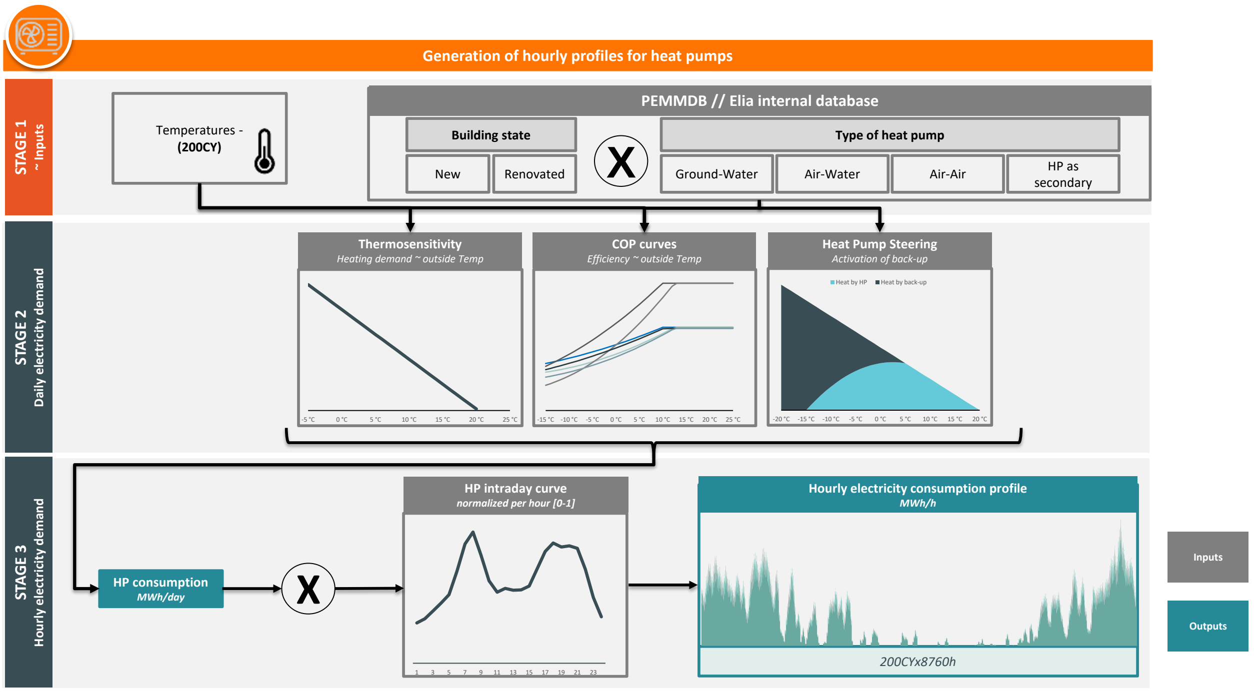

Figure 5 construction of hourly electricity demand profiles for heat pumps

1.4. Electrification of industry and data centers

Additional electrification from industry and data centers (if considered) will also be added to the hourly electricity consumption profiles by means of typical profiles. Those are not yet constructed and will be based on information from the type of process that will be electrified. It is important to note that, depending on the process, the additional electrification might also add additional flexibility to the system (which will be also accounted for as 'demand-response').

[6] E-CUBE-EWI-2030-Peak-Power-Demand-in-North-West-Europe-vf3.pdf (uni-koeln.de)
[7] Microsoft Word - WP_2004_FUELFORFUTURE_12221.docx (plan.be)