BELGIUM CONSUMER FLEXIBILITY POTENTIAL

FINAL REPORT FOR ELIA

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Executive Summary

Executive summary

Belgium Consumer Flexibility Potential – Implicit flexibility

Consumer flexibility could potentially shift up-to 9,000MWh on an average winter day reducing peak loads by up to 1,400MW*, compared to natural behavior by 2035.

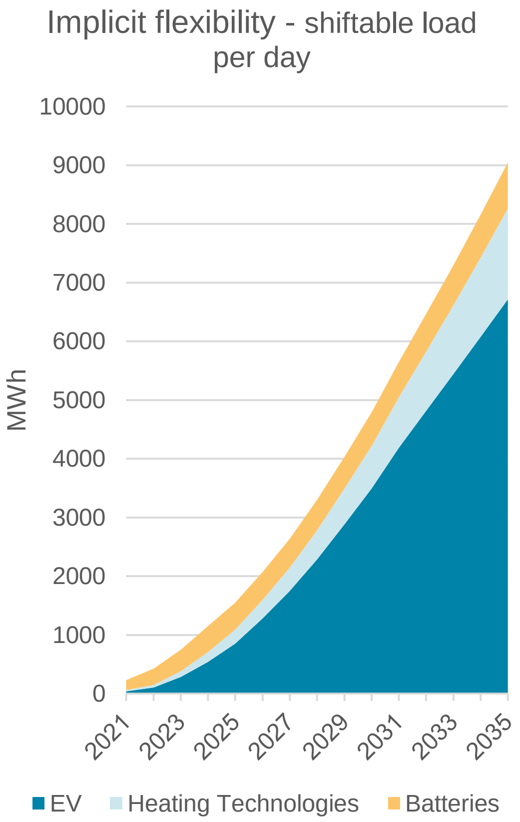
Electric vehicles have the greatest potential to shift load each day, estimated at a maximum of 6600 MWh of shiftable energy per day.

Electric vehicles and batteries have similar potential to reduce peak load.

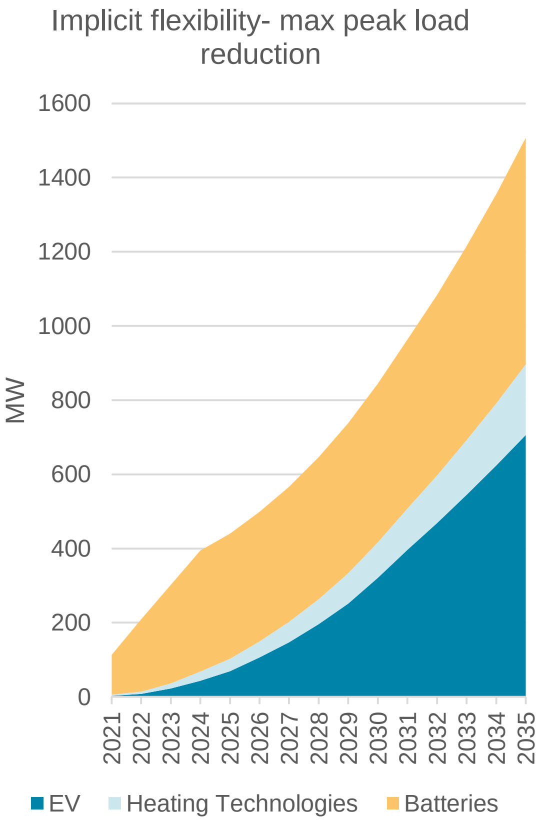
Consumer flexibility potential in the residential and tertiary sector in Belgium has been investigated and estimated to 2035.
Electric vehicles, electric heating technologies and behind the meter batteries were identified as most likely to have significant impact until 2035. Cooling loads and home appliances were excluded due to estimated low penetration and low impact at the national level.

Potential for load shifting
Electric vehicles provide the greatest potential for load shifting, providing 75% of the overall potential from 2030 onwards. This is driven primarily through smart charging of residential electric vehicles; however commercial depot smart charging and bi-directional charging becomes significant from 2030. Heating and batteries have a smaller potential to shift daily demand

Potential for peak load reduction.
The rapid growth in home batteries provides the greatest immediate potential reduction in peak load. By 2035, EVs and batteries have similar potential. Heating technologies have a smaller impact on peak load reduction.



Implicit flexibility - shiftable load per day



Implicit flexibility- max peak load reduction

* Note this is only potential load reduction compared to no flexibility.
Precise load reduction estimation would need calculation though dispatch modelling

Executive summary

Belgium Consumer Flexibility Potential – Explicit flexibility

Consumer flexibility could potentially provide up to 1,000 MW of explicit flexibility; primarily though electric vehicle smart and bi-directional charging.

Heating and batteries have lower potential to provide market driven flexibility.

Heating technologies are less flexible compared to EVs, while batteries have a greater focus on optimisation of solar generation and local demand.

Market driven flexibility

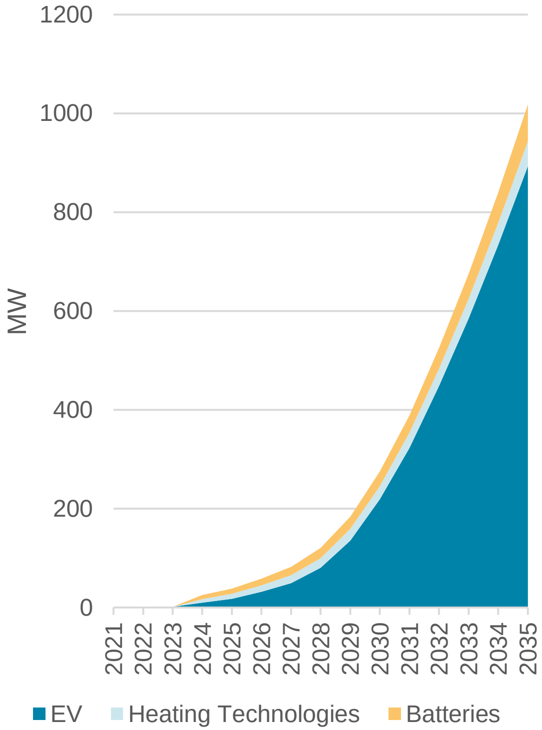
The consumer flexibility could provide up to 1,000 MW of explicit flexibility by 2035. Explicit flexibility is dominated by electric vehicles, providing up to >85% of the flexible capacity by 2035.

This is due to three key factors:

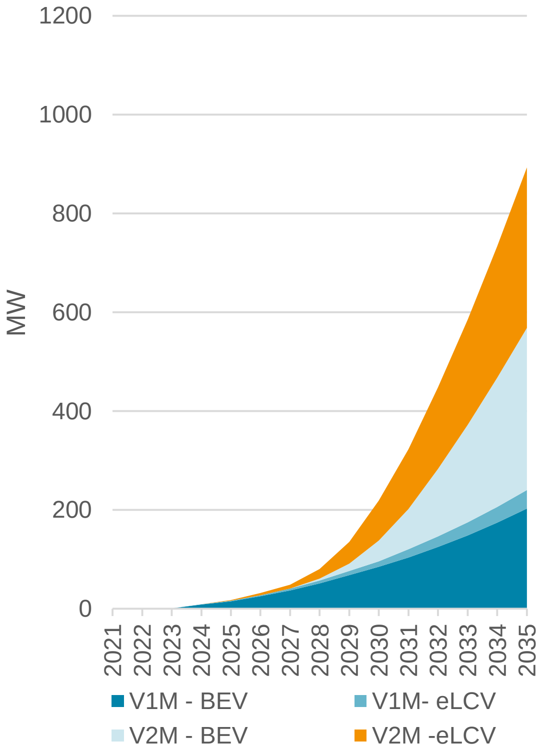
- The very high growth in BEV's from <100,000 today to >2.5M by 2035
- The relatively high power consumption compared to heating technologies
- The high potential of bi-directional charging. Bi-directional charging uptake from 2028 greatly increases the capabilities of electric vehicles to provide market driven flexibility.

Batteries and heat pumps are estimated to have smaller potential for explicit flexibility, due to a lower total number of assets and lower power ratings, but also increased focus on providing implicit flexibility to optimise local consumption.

Explicit flexibility - max peak load reduction



Electric vehicles explicit flexibility max peak demand reduction



* Note this is only potential load reduction.
Actual load reduction would need calculation though dispatch model.

Executive summary

Belgium Consumer Flexibility Potential – unlocked inventory

Consumer flexibility could potentially provide up to 1,000 MW of explicit flexibility; primarily though electric vehicle smart and bi-directional charging.

Smart meters are a critical enabler for all assets, allowing the accurate measurement and valuation of flexibility.

Electric vehicles
Smart charging of residential battery electric vehicles has the most immediate potential, however from 2028 the introduction of bi-directional charging can greatly increase both the implicit and explicit potential flexibility. By 2035 almost 100% of residential EV charging could be unlocked. Commercial charging is expected to unlock fully quicker, by 2029 but at lower total volumes.

Heating technologies
Potential flexibility from heating technologies is dominated by hot water shifting, due to the low customer impact, low cost and inbuilt energy storage. Heat pump flexibility is limited due to the diversity of demand and the need to pre-heat, requiring advance notice. Overall, over 60% of heat pumps could be unlocked by 2035, and 50% of domestic hot water.

Behind the meter batteries
Battery flexibility potential is currently linked primarily to supporting PV optimisation but could increasingly support flexibility against time of use of capacity tariffs, especially in winter months.

A framework for unlocking demand side flexibility has been described, showing the key factors necessary.
The key factors identified to unlock flexibility are:

- Penetration of smart assets to provide control capability
- Penetration of digital/smart meters to provide appropriate metering
- Minimising customer impact and offering complexity
- Availability of local and market control signal

Control signal and market barriers have been simplified, and flexibility has been defined into two types:

1. implicit flexibility driven by local signals
2. explicit flexibility driven by market signals.

Local signals are already available and increasingly available in Belgium, while market signals are expected to become more widely available from 2024 following market reforms and new initiatives.

Glossary

Term	Description
aFRR	Automatic frequency restoration reserve
ASHP	Air source heat pump
BEV	Battery electric vehicle
DSF	Demand side flexibility
eLCV	electric light commercial vehicle
EV	Electric vehicle
CAGR	Compound annual growth rate
Explicit flexibility	Flexibility focused on revenue generation, described on slide 14 and 15
FCR	Frequency containment reserve
GSHP	Ground source heat pump

Term	Description
HEM	Home energy management
HP	Heat pump
Hybrid Heat pump	Hybrid heat pump
Implicit Flexibility	Flexibility focused on cost avoidance, described on slide 14 and 15
mFRR	Manual frequency restoration reserve
PHEV	Plug in hybrid electric vehicle
RR	Replacement Reserve
Smart Meter	digital meter capable of electronic communication and measurement of house load
Smart Thermostat	Connected thermostat capable of remote management of heating set points

Overview

Project aims, methodology and framework

Project aims and approach

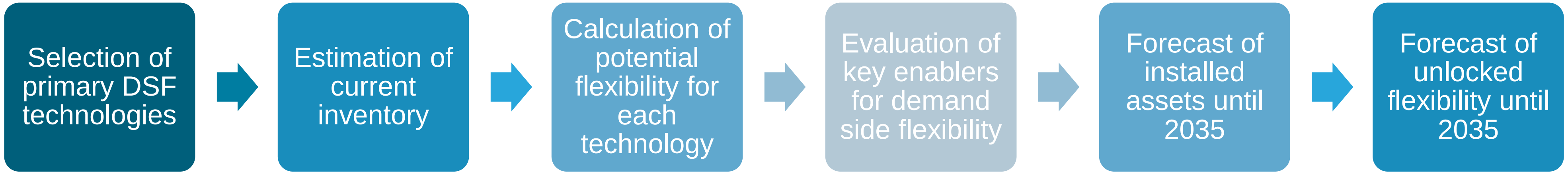
What is the potential consumer flexibility from now until 2035

The project aims:

- To estimate the potential demand side flexibility from residential and tertiary sectors
- To evaluate the key enablers of demand side flexibility
- Calculate the technical potential flexibility from each asset type
- Estimate the maximum achievable penetration based on current market plans and policy

In this study, a single scenario was evaluated focusing on the central forecast of asset installations from Elia. This scenario considers the current market situation and planned interventions. Alternative policy/market arrangements have not been considered. The aim of the study was to estimate the maximum achievable potential based on the current plans.

The overall project approach is described below at a very high level. A step wise process was used to establish the potential flexibility from average assets by analyzing natural and flexible profiles, and by forecasting of enablers to 2035 to estimate the % of unlocked capacity for each asset and flexibility type. The detailed approach is outlined in the report.



Selection of primary DSF technologies

Estimation of current inventory

Calculation of potential flexibility for each technology

Evaluation of key enablers for demand side flexibility

Forecast of installed assets until 2035

Forecast of unlocked flexibility until 2035

Technologies selection

Technologies considered for large scale demand side flexibility

Air conditioning, commercial refrigeration and residential appliances have been excluded from further analysis, more detail is available in annex 1

Category	Residential Technologies	Commercial Technologies	Included in the study?
Electric Vehicles and Charging points	Passenger Plug in Hybrid (PHEV) Battery Electric Vehicles (BEV) EV charge points: Public charging EV charge points: Home charging	Light commercial electric vehicles EV charge points: Employee EV charge points: Depot	Yes
Electric heating loads	Air & ground source heat pumps Hybrid heat pumps	Air & ground source heat pumps Hybrid heat pumps	Yes
Cooling Loads	Air conditioning systems	Air conditioning systems Commercial refrigeration	No
Energy Storage	Home batteries Hot water storage(covered in heating)	Commercial batteries	Yes
Misc. loads	Lighting Appliances & white goods		No

Excluded technologies

Outcome of initial investigation on loads to exclude from the analysis

Air conditioning and residential appliances are unlikely to provide significant capacity for demand side flexibility, especially when compared to HP and EV.

Cooling loads

Overall cooling loads are estimated to have relatively low flexibility in aggregate, this finding in combination with the low precision data available is expected to reduce confidence in the further analysis. It is therefore **recommended air conditioning and commercial refrigeration are not selected for detailed assessment.**

Key findings:

- There is a limited data on demand and capacity for air conditioning and commercial refrigeration.
- Estimates for air conditioning and commercial refrigeration demand are highly sensitive to input assumptions.
- Research shows due to the cyclic nature of refrigeration, the load shedding potential, compared to rated capacity is low.
- Air conditioning is not expected to majorly increase in Belgium over next 15 years, residential AC is expected to be highly portable and therefore not available for flexibility services.

Miscellaneous loads

The majority of residential lighting, appliances and electronics demand is expected to have very limited flexibility. Where flexibility is available this is forecast be dwarfed by electric heating and electric vehicles in the near future. **On the basis of the low impact and high fragmentation of this segment it is recommended these loads are not selected for detailed assessment.**

Key findings:

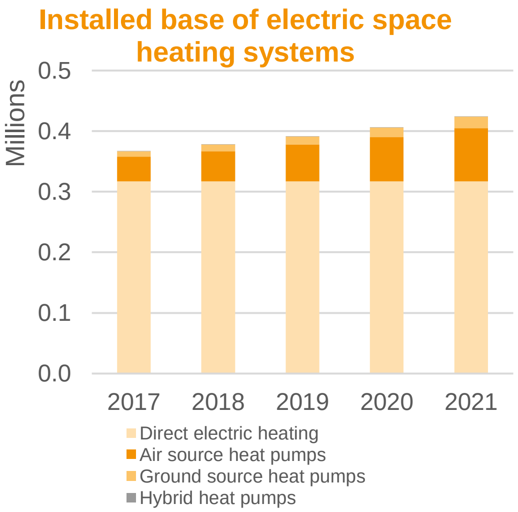
- The majority of loads in the home, e.g. lighting, cooking, audio-visual are expected to not be suitable for flexible operation.
- Remaining potentially flexible loads(cold and wet appliances and water heating are estimated to account for less than <20% of the peak load(without electric space heat of EV charging).
- When compared with homes with both electric heating and EV charging the overall potential drops to less than 6%.
- Multiple assets are required to be integrated to deliver the benefits.

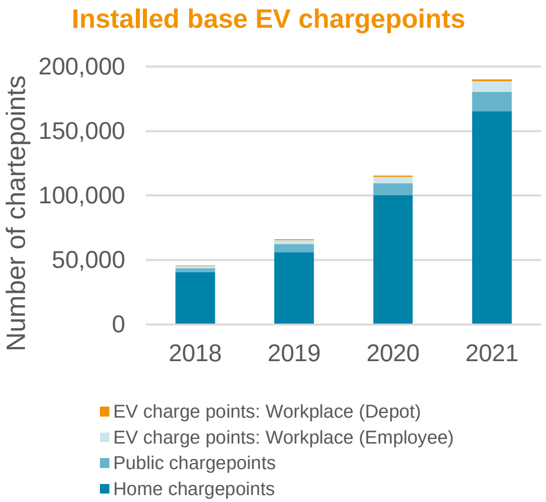
Technology inventory

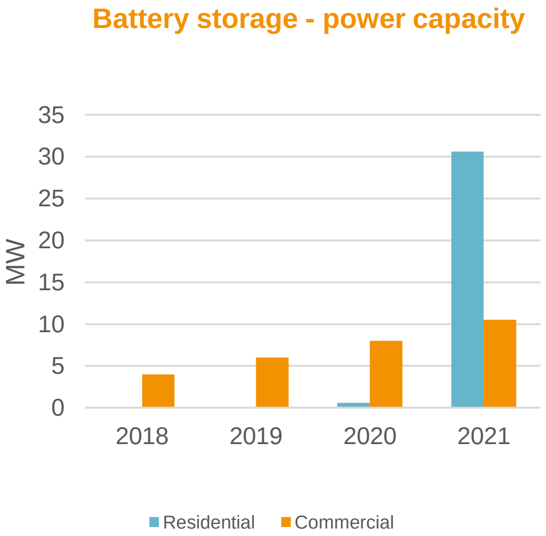
Current installed base and growth rates for key technologies

The inventory of selected technologies has been estimated for years 2018-2021, showing the current installation rates with more detailed information provided in annex 2.

- Heat pumps sales have been steadily growing at a stable rate of 20% a year since 2018, with stable growth through pandemic.
- EV charging profiles and flexibility is driven by how it is charged and the available charging infrastructure, the number of chargepoints has been estimated based on the existing EV stock
- Home and commercial battery storage has been estimated, recent incentives in Flanders have caused a huge increase in installations in 2021, which is expected to continue through to 2024 rapidly growing this sector.







Framework for consumer flexibility

How is flexibility unlocked and defined?

In the following slides an overview of the frameworks used to describe how demand side flexibility is unlocked, the key factors considered.   In addition, how flexibility value streams can be collated to simplify national level analysis such as this project. The current status of demand side flexibility in Belgium is provided and overview of key timeline events.

Unlocking Flexibility
The key factors to calculate the total available capacity for demand side flexibility are as follows:

- Asset volume
- Asset Flexibility
- Control signal
- Control Capability
- Appropriate metering
- Customer Barriers

The following slides explain the key elements for each of these factors and how they are considered in this study.

Types of flexibility
Following slides describe the two core value streams consider in this study.

- Implicit flexibility – local signals
- Explicit flexibility – market driven signals

Explicit flexibility is potentially more complex to deliver from a stakeholder point of view, as it requires the development of a virtual power plant.

This has not been explored in detail in this project, however the key stakeholders defined by Delta-EE for delivering virtual power plants is described. This value chain has not been specifically used within this study, however it is provided to explain the key elements required to deliver explicit flexibility and why Delta-EE expects this to more challenging than implicit flexibility.

Key factors influencing the accessibility of flexibility

What is needed to unlock demand side flexibility?

Unlocked capacity of demand side assets is defined by the availability of a suitable control signal, enabling assets to provide control and appropriate metering and the overcoming of customer barriers to engage with a flexibility service.

Asset Volume	Asset flexibility	Control signal	Control capability	Appropriate metering	Customer barriers
Load of installed base of flexible assets	Capability of assets to provide flexibility around demand	Market or local need that provides signal for when and how flexibility is required	Capability to receive and respond to market signal	Ability to accurately measure the energy usage in timeframes relevant to flexible services	Degree of engagement and participation

Overview of the key factors needed to unlock flexibility

What is needed to unlock demand side flexibility?

Asset volume
This defines the total installed base, and its rated capacity. Factors that incentivise technology deployment or that require technology deployment are the primary enablers. This is considered in the installed base forecasts.

Asset flexibility
Assets have a primary function and demand profile that defines the capability of that asset to provide flexibility in coordination with any inherent energy storage. The demand profile defines the temporal limitations to flexibility and also when increased load is required to compensate for reductions in demand.

Control signal
A local or market signal is necessary to drive the flexible operation of assets. The type of signal will also determine the necessary control capabilities required and appropriate metering. Some types of flexibility have higher value and therefore can provide stronger signals, unlocking more flexibility.

Control Capability
Depending on the required control signal, the asset(s) must have the necessary capability to respond appropriately and optimise performance as required to meet the necessary flexibility needs. These enabling technologies may be present in households/businesses, but not utilised for this purpose.

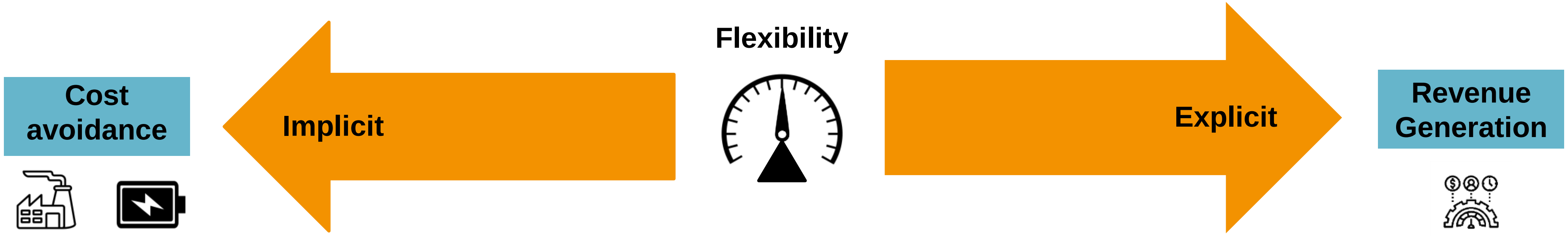
Appropriate metering
Monetising flexibility requires measuring the dynamic electricity load from the household with sufficient accuracy for the control signal and flexibility service provided. These systems must also be appropriately connected such that services can be effectively measured and billed by the correct parties.

Customer barriers
With control signals and assets available, the complexity of the service offering and the impact on the customer comfort will be the key final barriers to participation in flexibility services before consideration of the scale of customer benefit.

Flexibility is monetised in two broad ways

Implicit (cost avoidance) and explicit (revenue generation)

Demand side flexibility can be separated into two types to simplify the analysis, these have different barriers and implications for delivery



Flexibility

Cost avoidance

Implicit

Explicit

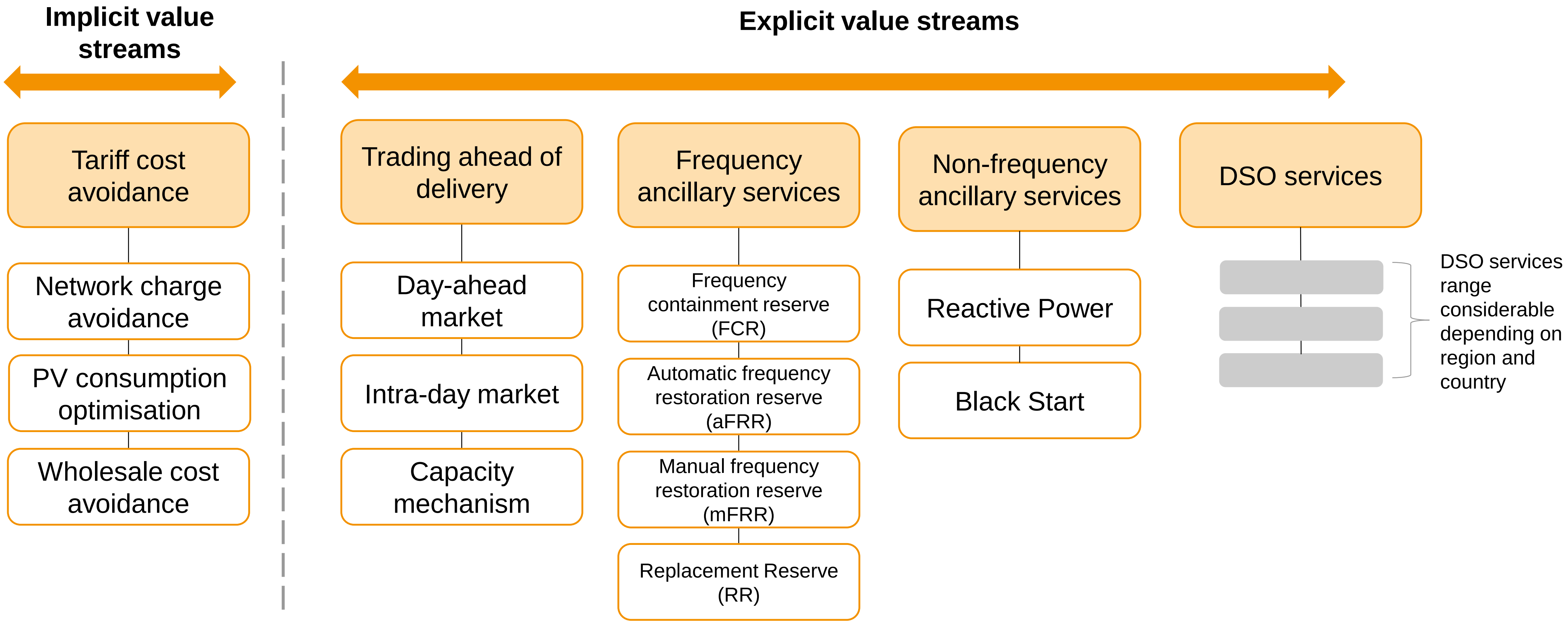
Revenue Generation

E.g. time-of-use network charges or capacity tariffs: system operators incentivise consumers to alter the timing of their consumption in order to reduce grid congestion

E.g. ancillary services: system operators pay for active frequency control

Flexible assets can access a wide range of electricity system value streams across Europe

There is a wide range of value streams available for each type of flexibility. In this study segmentation, each value stream was not considered.



Implicit value streams

- Tariff cost avoidance
  - Network charge avoidance
  - PV consumption optimisation
  - Wholesale cost avoidance

Explicit value streams

- Trading ahead of delivery
  - Day-ahead market
  - Intra-day market
  - Capacity mechanism
- Frequency ancillary services
  - Frequency containment reserve (FCR)
  - Automatic frequency restoration reserve (aFRR)
  - Manual frequency restoration reserve (mFRR)
  - Replacement Reserve (RR)
- Non-frequency ancillary services
  - Reactive Power
  - Black Start
- DSO services

DSO services range considerable depending on region and country

Trading in explicit flexibility value streams functions

The term ‘VPP’ (virtual power plant) describes the functions required to trade aggregated flexibility

Delta-EE VPP value chain framework: There are six functions needed to deliver a VPP. These functions define the VPP value chain. These are essential for trading explicit flexibility (i.e. ancillary services).

Customer acquisition	Marketing to and contracting with customers.
Asset monitoring & control	Monitoring asset availability and performance. Control each asset individually to achieve the desired group-level response.
Aggregation	Aggregating assets into a co-ordinated group that can act as a single entity.
Optimisation	Determine the best use of assets and value streams in response to price and weather forecasts, end-user needs and asset parameters.
Interface with value streams	Trading of flexibility with buyers including TSO, DSO and other traders. This includes registration and pre-qualification of assets.
Billing/ settlement	Sharing value with asset owners.

A VPP coordinates individual assets such that the group acts as a single unit. The VPP optimises both individual assets and the aggregated group to maximise value.

A VPP trades its aggregated asset group into one or more value streams. These value streams may be inaccessible to an individual asset.

Companies are increasingly specialising within these functions, and are forming partnerships to fully cover the VPP value chain.

Example:

One example of how different players operate across the value chain is with the Tiko / Engie partnership. Engie provides a route to residential customers (in France), interfaces with the value streams and handles billing and settlement. Tiko monitors, controls, aggregates and optimises the underlying assets.

Market openness for demand side flexibility in Belgium

Market is open for flexibility, but is yet to be tested and exploited commercially.

	Can DSF access the market?	Is aggregation allowed?	Is a BRP agreement required?	Is storage allowed?
FCR	Yes	Yes	No	Yes
aFRR	Yes	Yes	Yes	Yes
mFRR	Yes	Yes	Yes	Yes
RR	NA	NA	NA	NA
DA/ID	Yes	Yes	Yes	Yes
Resource Adequacy	Yes	Yes	No	Yes

Ancillary services

- All ancillary services are open to DSF. BRP agreements for aFRR and mFRR present a notable barrier.

Residential flexibility

- FCR is open to residential load whilst aFRR is undergoing trials. Thermovault has the only residential offering providing FCR, however ~5 other players are investigating residential aggregation/participation.
- Slow smart meter roll-out has hindered residential flexibility. Deployment varies considerably within regions, with Flanders having the highest level of deployment.

Network charges

- A residential capacity tariff is planned to be introduced in Flanders which will increase the case for self-consumption and implicit flexibility. In Wallonia a prosumer tax will disincentivise solar PV and again, increase the case for implicit flexibility.

- Net metering was removed in January 2021- this was the catalyst for self-consumption/implicit flexibility.

Wholesale market

- Day/night retail tariffs are common. There are two dynamic tariffs based on wholesale prices (Engie and Energie.be) offered to residential customers. This is expected to increase with the change in network tariffs incentivising implicit flexibility.

- Consumer Centric Market Design published by Elia in 2021 which aims to remove necessity of BRP agreement for wholesale participation by 2023/2024.

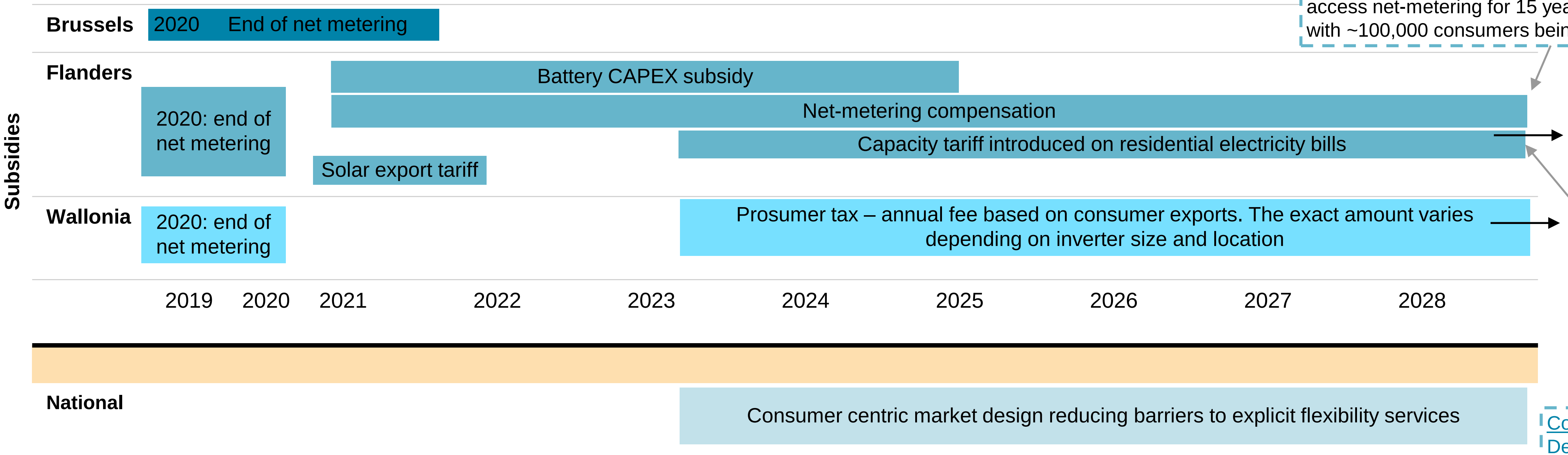
DSO flex

- There are no commercial DSO offerings.

Key market developments that will influence DSF in Belgium

The phase out of net metering and introduction of capacity tariffs (in Flanders) in 2023 will enable greater flexibility for residential assets. Consumer focused market reform could reduce barriers to explicit flexibility.

The Flanders Government is compensating consumers that bought new PV systems in 2020 (before net-metering deadline) under the understanding they could access net-metering for 15 years. This law was removed with ~100,000 consumers being compensated.



Subsidies

Brussels

2020 End of net metering

Flanders

2020: end of net metering

Battery CAPEX subsidy

Net-metering compensation

Capacity tariff introduced on residential electricity bills

Solar export tariff

Wallonia

2020: end of net metering

Prosumer tax – annual fee based on consumer exports. The exact amount varies depending on inverter size and location

2019 2020 2021 2022 2023 2024 2025 2026 2027 2028

National

Consumer centric market design reducing barriers to explicit flexibility services

The non-electricity component of consumer tariffs (e.g. grid fees and taxes) will move from x/kWh on a yearly basis to a monthly calculation based on capacity (use of system). This incentivises self-consumption optimisation

Consumer Centric Market Design published by Elia in 2021 which aims to remove necessity of BRP agreement for wholesale participation by 2023/2024.

Forecasting - inventories

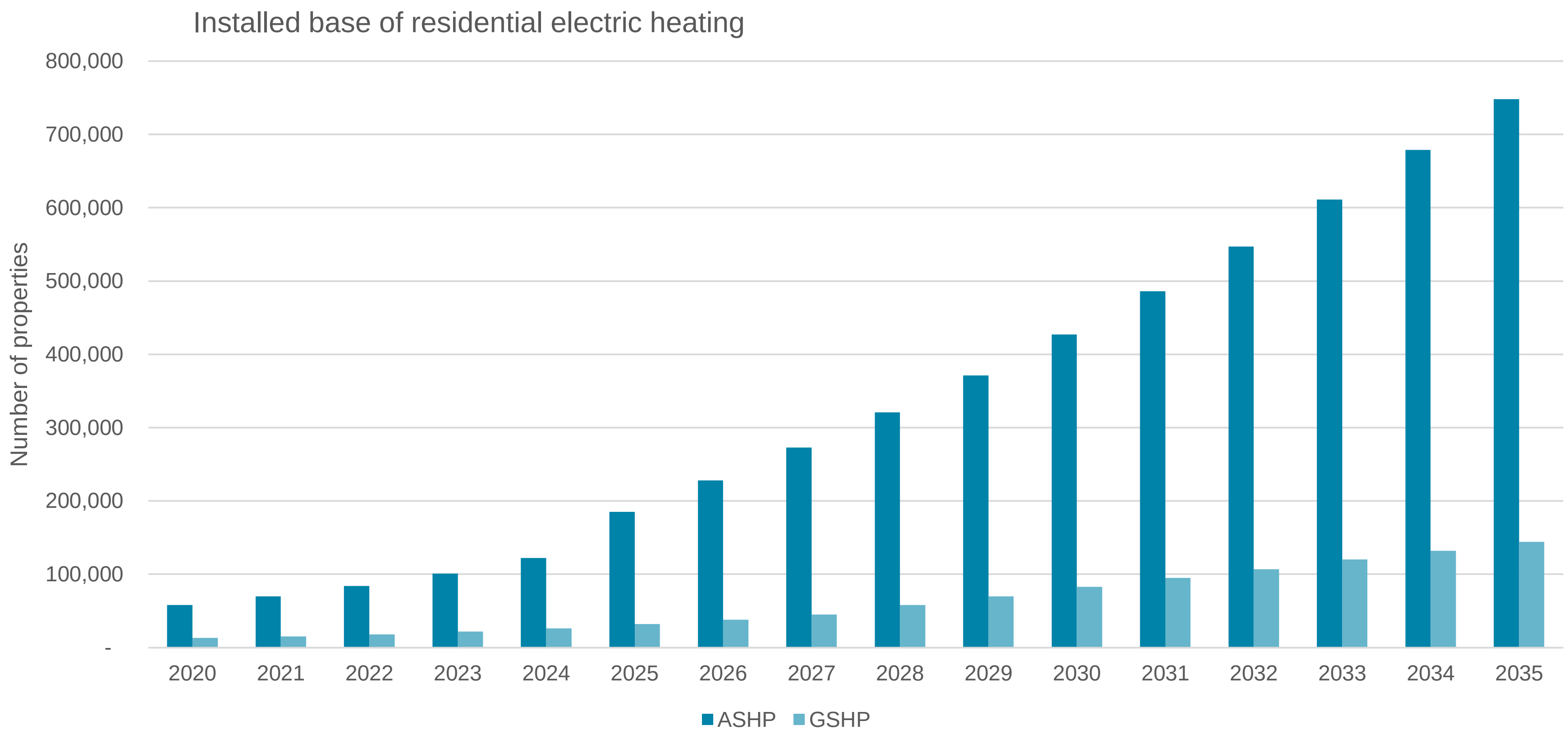
> **Heating technologies**
> **EVs & charge points**
> **Batteries**
> **Enabling technologies**

Heating technologies

Installed base of Heat pumps 2020-2035

Air source heat pumps are forecast to be the dominant electric heating system by 2029.

Integrated Delta-EE forecasts for Electric space heating, domestic hot water tanks and DHW heat pumps with Elia central heat pump forecasts.



Source: HP data: Elia
Electric space heating: calculated by Delta-EE

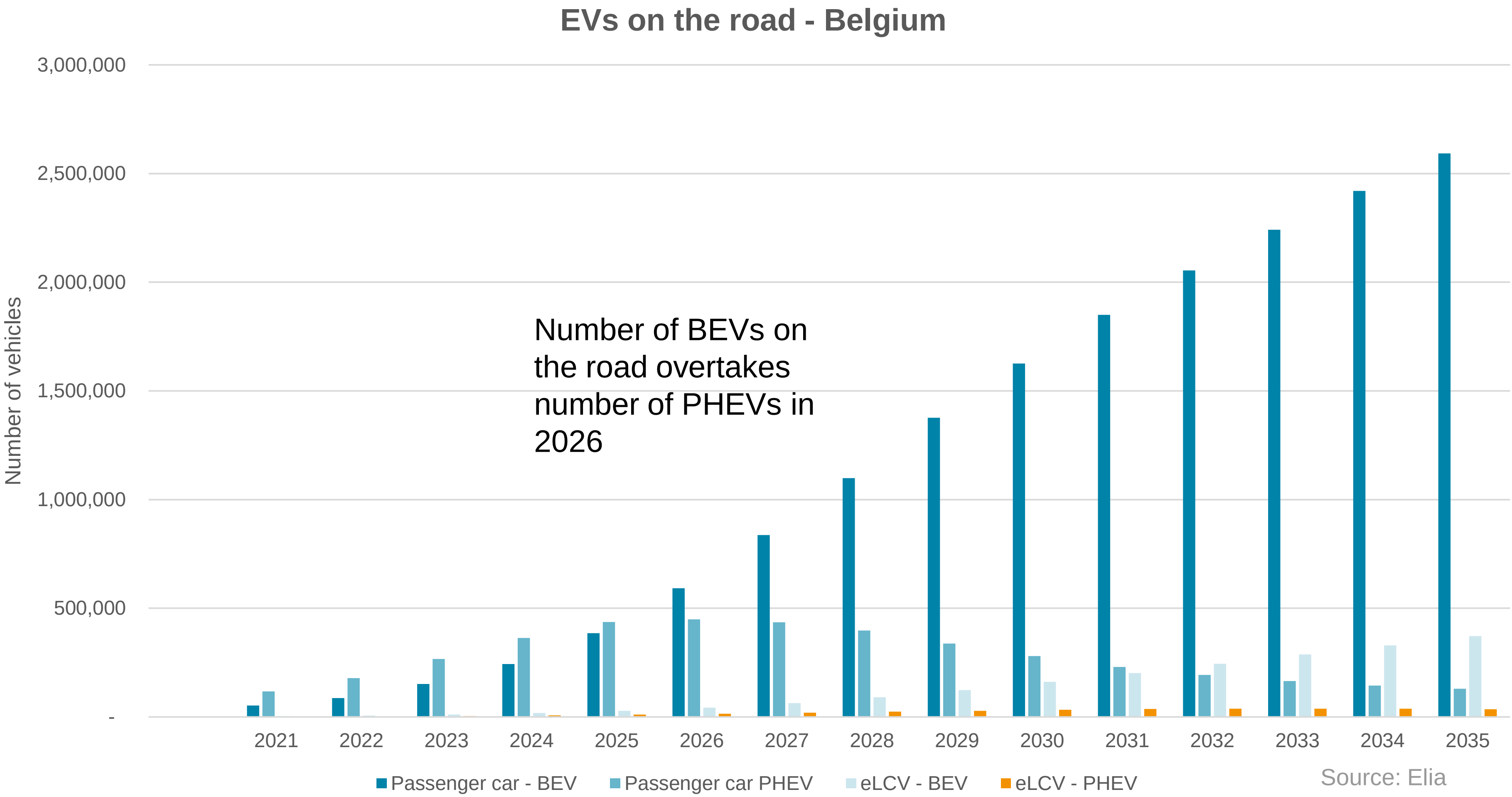
Electric vehicles

Installed base 2020-2035

CAGR* of BEVs from 2022-2035 is 20%.

PHEVs increase in number up to 2026 before starting to reduce.

eLCVs on the road increase at the quickest pace of 37% CAGR from 2022-2035.



Number of BEVs on the road overtakes number of PHEVs in 2026

Source: Elia

* Compound annual growth rate

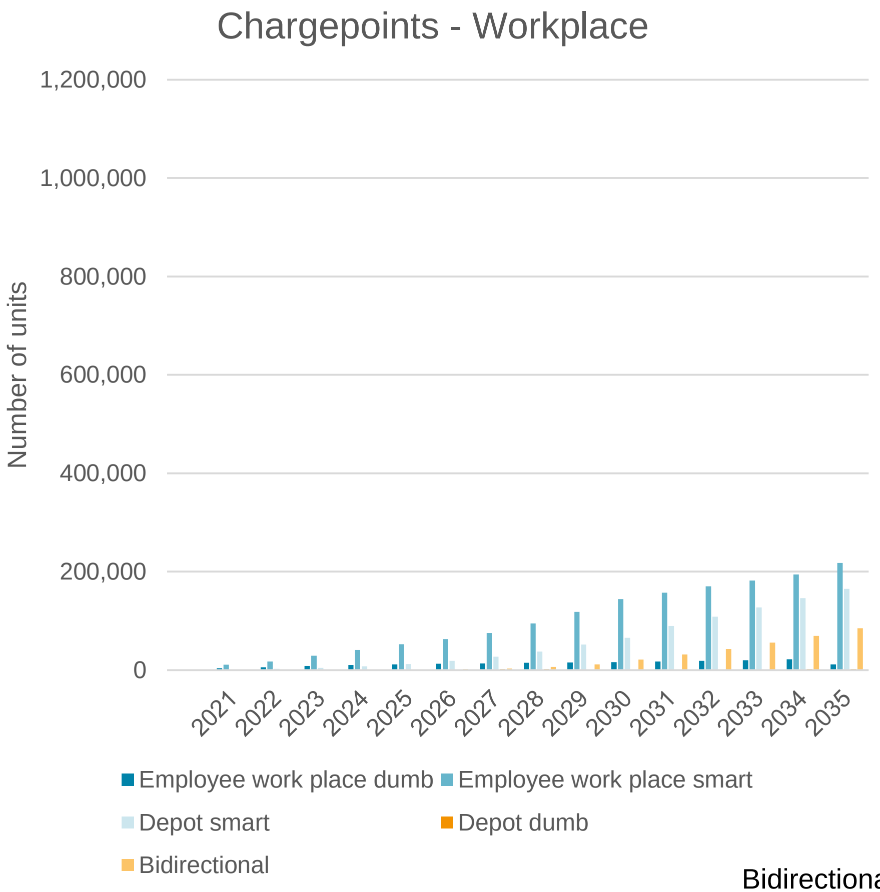
Chargepoints

Chargepoint forecast calculated from EV growth

Smart chargepoints for BEVs increase at a CAGR* of 23% from 2022, hitting over a million units by 2035.

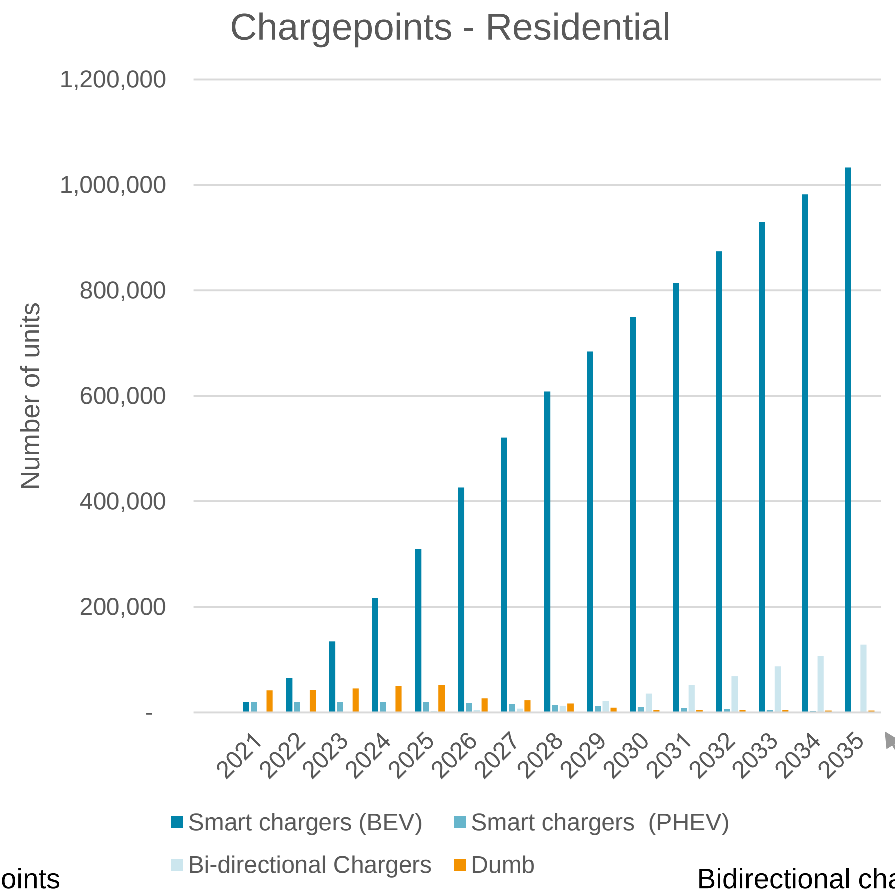
Dumb home chargepoint numbers peak in 2025 before reducing to ~3,000 in 2035.

Depot smart chargepoints increase at a CAGR of 38% from 2022-2035.



Source: Calculated by Delta-EE

Bidirectional chargepoints could be 17% of all workplace chargepoints by 2035)



Source: Calculated by Delta-EE

Bidirectional chargepoints could be 10% of all home chargepoints by 2035)

* Compound annual growth rate

Approach to chargepoint forecasts

Ratio of EVs:Chargepoints across different segments

Ratios (2030)

Home (Passenger cars:CPs)

2.17

Workplace employee (Passenger cars:CPs)

11.9

Workplace depot (eLCVs:CPs)

2.43

Why forecast chargepoints?

When investigating EV charging the segmentation of chargepoints provides more accurate estimation of EV charging segmentation, for different charging types (e.g. smart bi-directional).

Process for calculating chargepoint forecast

- Using the EV forecast from Elia a ratio of EVs:home chargepoints was used to calculate the number of home chargepoints for each year
- The ratio is calculated from looking at average ratios of historical sales of EVs:Home chargepoints in Europe to provide a final ratio of EVs on the road to installed base of home chargepoints
- This ratio of sales is adjusted by Delta's EV research team out to 2030 to account for several factors, such as drop in policies, renewal rates and families with two EVs. The sales ratio feeds through to the installed base ratio
- The above process is repeated for the other segments of EV charging which are in focus here: workplace employee charging and workplace depot charging
- For home charging the sales of passenger cars and eLCVs is used, for employee charging only passenger cars are used, for workplace depot only sales of eLCV are used

Connected / Smart chargepoints

- Customer research in Europe shows an average of ~60% of home chargepoints have smart functionality. The lowest country (Norway) has ~49%. Due to the large proportion of PHEVs to BEVs in Beligum, the lower value of 49% was used to represent the number of smart home chargepoints in Belgium.
- Due to recent tax incentives introduced by the Belgian Government the percentage of new sales of home chargepoints which are smart is expected to be high (~90%). This proportion grows out to 2030, fuelled by high electricity prices and the EU's Clean Energy Package measures which encourage the uptake of this technology. From this, the installed base of connected home chargepoints could be calculated.
- From discussions with fleet experts the existing stock of depot and employee charging is likely to be slightly higher than home at ~75%. Fleet managers and employers have more incentive to purchase chargepoints with smart functionality to manage the charging of their fleet and organize employee billing.
- The % of connected workplace charging will increase out to 2030 at a similar pace to home CPs
- Despite the split for BEVs to PHEVs currently being 70:30 in favour of PHEVs, the current smart charging split is estimated to be lower, around 50:50 as PHEVs are less incentivised to pay for the slightly more expensive smart chargepoint

Bidirectional chargepoint forecast approach

Based on vehicle OEM intentions with V2X

Vehicle market share

- Data on vehicle sales for passenger car EV (not PHEV) and eLCV was collected to calculate approximate market share
- As Belgium has had relatively slow BEV uptake, the market share of France's BEVs was used in proxy to avoid the unrealistic bias of a smaller sample size
- Approximations were made on when each vehicle manufacturer would introduce vehicles with bidirectional capability

EV forecasting

- The market share of the BEVs and eLCVs was forecast out to 2030 (based on today's market share of ICE vehicles)
- Elia's EV and eLCV forecasts were used to approximate how many vehicles of each manufacturer there would be between 2022 – 2030
- From this, the number of vehicles sold with bidirectional capability could be deduced

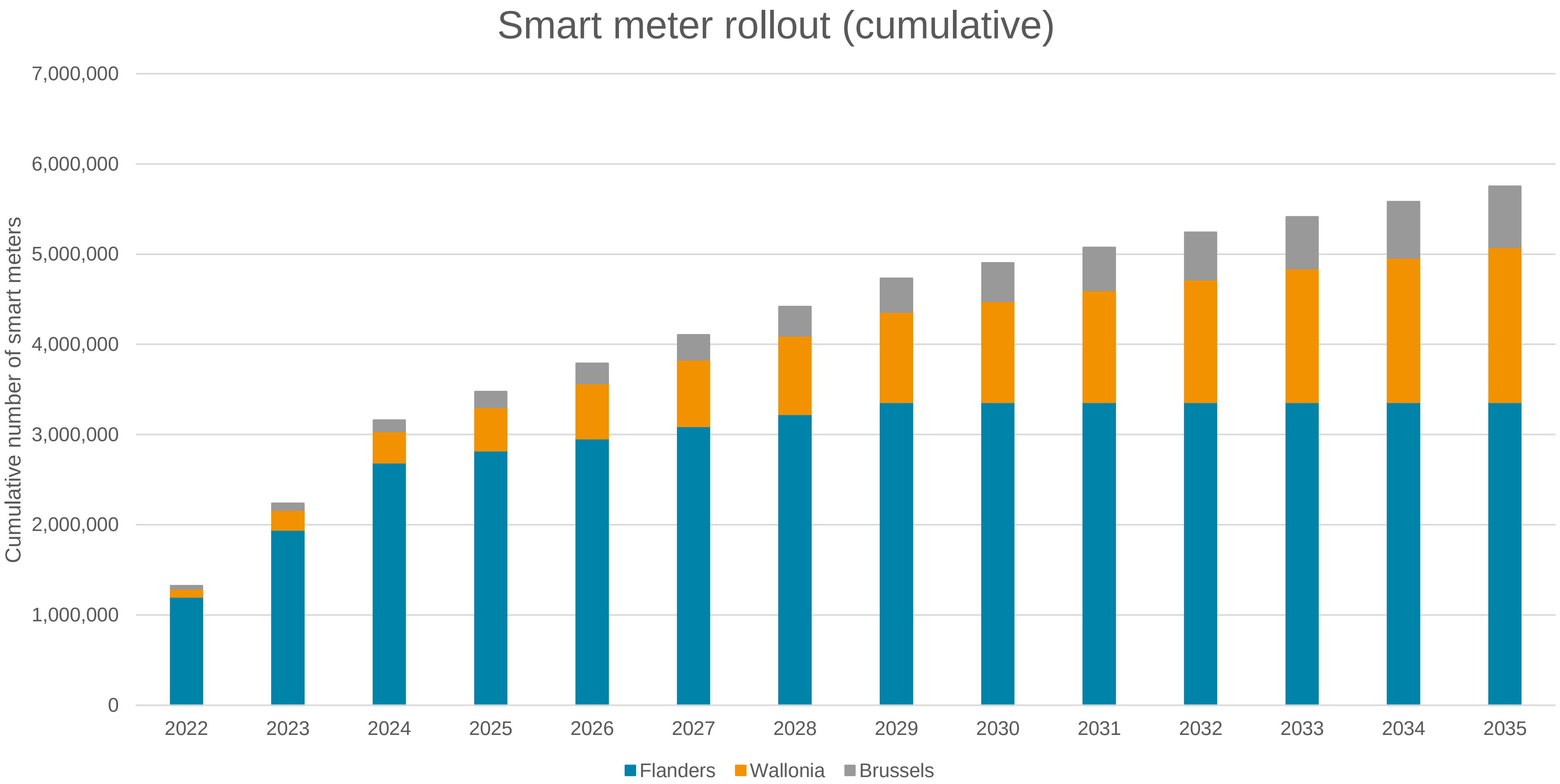
Chargepoint forecasting

- A ratio of vehicle sales to chargepoints was used (from Delta's EVCS) to calculate the number of chargepoints sold with these vehicles in each customer segment (home, workplace, public)
- A given percentage was applied to these sales on how many would be V2G in each market, this information came from desk based research and calls with industry
- The number of bidirectional chargepoints sold in each year was the result
- The figures have been reviewed by V2G chargepoint manufacturers and industry is in agreement with the forecast

Enabling technologies

Smart Meters (1/2)

Flanders region leading the smart meter rollout as they aim to cover 80% of the residential stock by 2024. Wallonia and Brussels to see a gradual increase.



Source: calculated by Delta-EE

Enabling technologies

Smart meters (2/2)

Regions in Belgium have already introduced the possibility of dynamic price contracts as a result of the EU Directive 2019/944.

Known data points:

- **2021**: only 30,000 units installed in Brussels over previous 4 years.
- **2022**: Wallonia hopes to install 90,000 units by the end of year. Flanders have already installed 1,200,000 units.
- **2023**: Brussels is installing around 40,000 units per year from this year.
- **2024**: Flanders will install smart meters in 80% of households.
- **2029**: Flanders will install smart meters in 100% of their building stock. Wallonia predicted to install 1M smart meters by this year.

Sources: https://lumiworld.luminus.be/slimme-investeringen/digitale-meters-stand-van-zaken/ &https://www.linkedin.com/pulse/smart-meter-reality-belgium-frederic-butaye/ and Elia.

Filling the gaps:

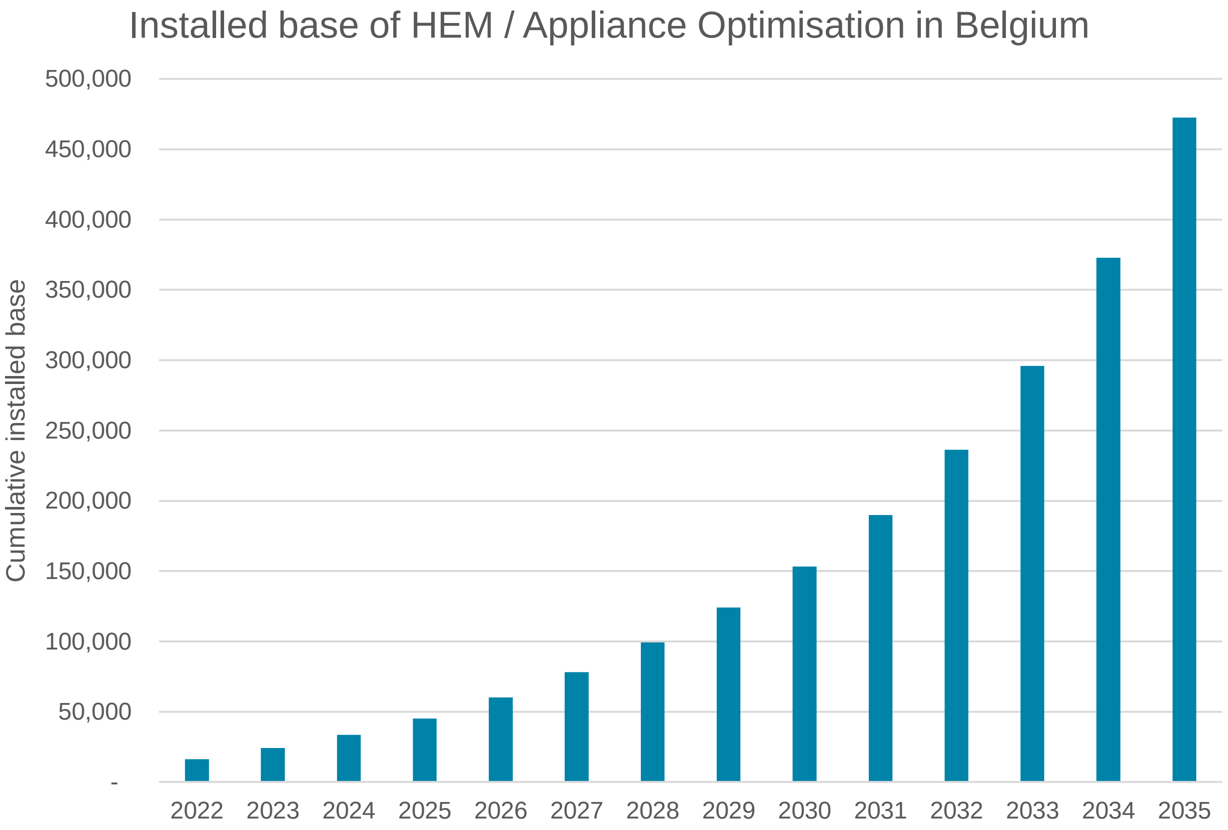
- Cumulative smart meter rollout was initially done for each of the three regions separately based on the known data points and Belgium building stock.
- The number of installs for years in between the known data points were estimated based on gradual equal increase.
- Since Brussels is installing around 40,000 units per year since 2023. It would take approximately until 2036 for Brussels to reach 100%.
- Flanders will install all smart meters by 2029 therefore there no/very small increase expected after.
- The same incremental increase has been assumed for Wallonia between 2030 and 2035.

Enabling technologies

Home Energy Management (HEM)

Key factors affecting the forecast:

- **Adoption of solar PVs and home batteries** in turn corresponds in an **increase in home energy management (HEM)** and appliance optimisation (AO) adoption to manage the distribution of energy between the technologies.
- Rapid increase between 2031-2035 is based on an increase in sales of assets (solar PV, batteries etc.)



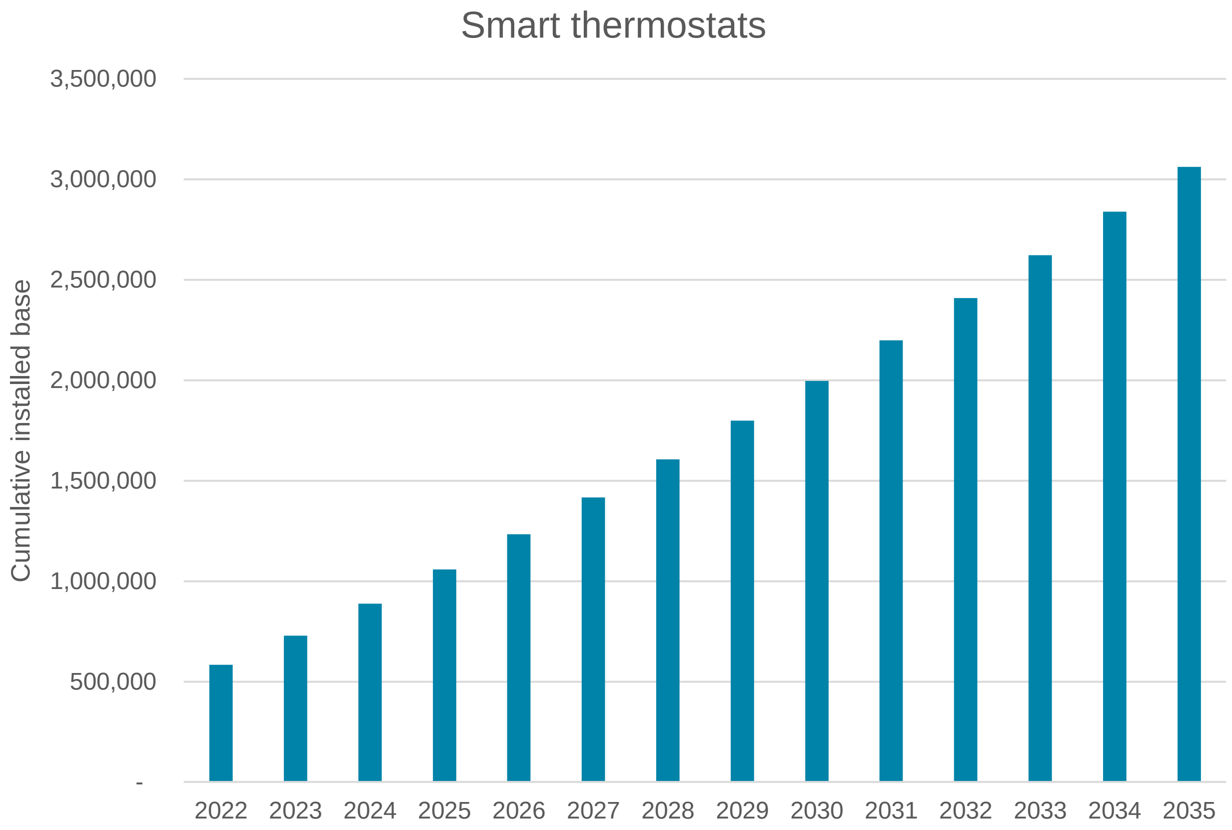
Source: Calculated by Delta-EE

Enabling technologies

Smart thermostats

Breakdown of the forecast:

- Steady increase is expected in smart thermostats until 2035.
- Between 2031 and 2035, we expect considerable number of smart thermostats to be replaced with new models.



Source: Calculated by Delta-EE

Unlocked inventory

> **Heating technologies**
> **EVs & charge points**
> **Batteries**

Overview of flexibility types

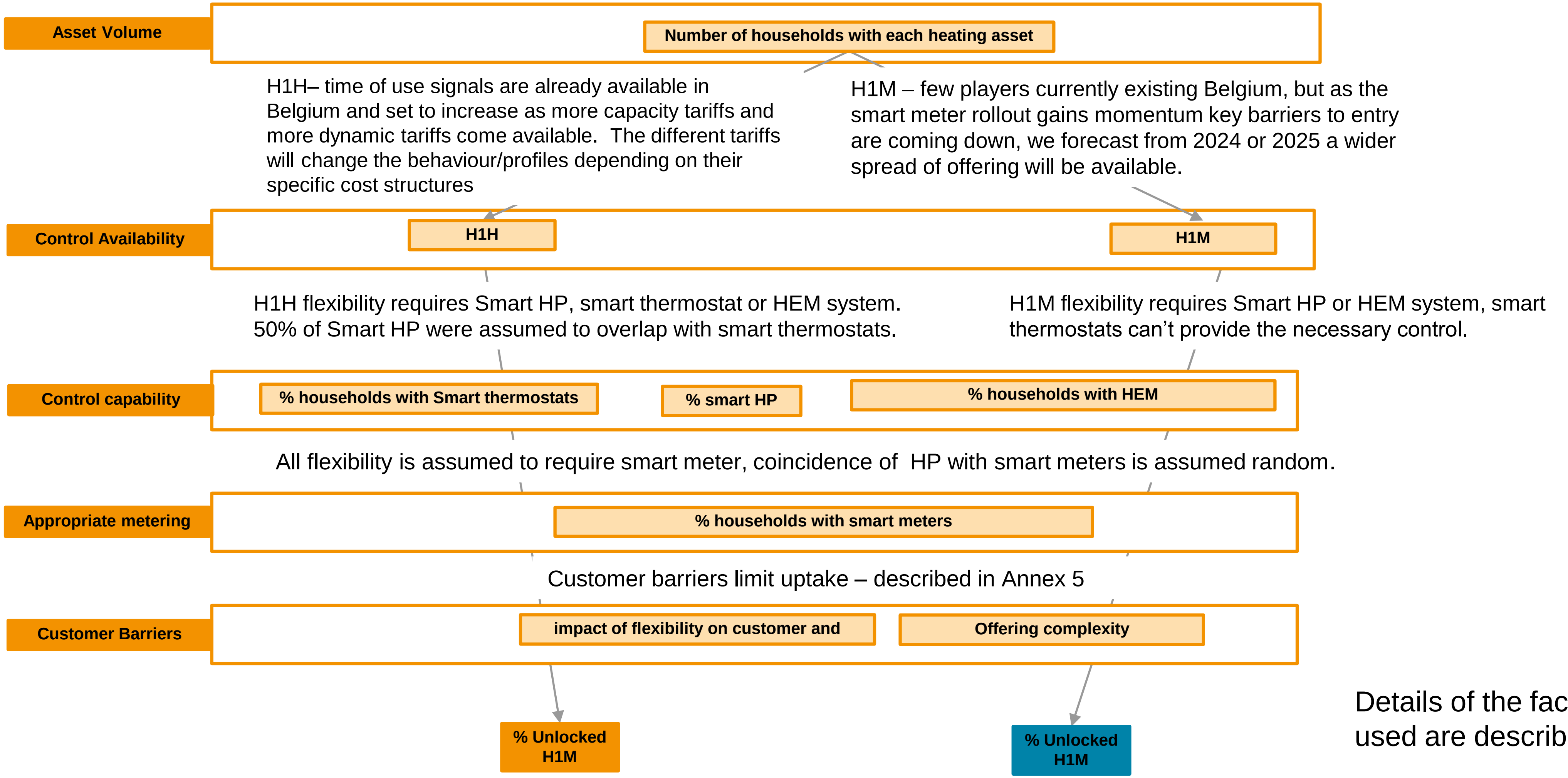
Breakdown of key factors for each flexibility type

Flexibility for each asset type has been coded as per this table, describing the key factors required that unlock flexibility for each type as defined for this study.

Code	Technology type	Description	Control Signals	Control Capability	Appropriate Metering	Customer participation barriers
V1H	Electric Vehicle	Smart charging - implicit flexibility	Static & Dynamic time of use tariffs, capacity tariffs, PV optimisation	Smart Charger	Smart Meter	Perception of loss of control, offering perception/clarity
V1M	Electric Vehicle	Smart charging - implicit & explicit flexibility	Ancillary services, Interval balancing, trading, DSO services	Smart Charger	Smart Meter	Perception of loss of control, vehicle plug in duration, offering perception/clarity
V2H	Electric Vehicle	Bi-directional smart charging - implicit flexibility	Static & Dynamic time of use tariffs, capacity tariffs, PV optimisation	Bi-directional smart charger and suitable BEV	Smart Meter	Investment costs, perception of loss of control, vehicle plug in duration, offering perception/clarity
V2M	Electric Vehicle	Bi-directional smart charging - implicit & explicit flexibility	Ancillary services, Interval balancing, trading, DSO services	Bi-directional smart charger and suitable BEV	Smart Meter	Investment costs, perception of loss of control, vehicle plug in duration, offering perception/clarity
H1H	Heating Technology	Flexible operation - implicit flexibility	Static & Dynamic time of use tariffs, capacity tariffs, PV optimisation	Smart HP or HEM or smart thermostat	Smart Meter	Impact on comfort(dependant on flex type/asset)
H1M	Heating Technology	Flexible operation - implicit & explicit flexibility	Ancillary services, Interval balancing, trading, DSO services	Smart HP or HEM	Smart Meter	Impact on comfort(dependant on flex type/asset), offering perception and clarify, perception of loss of control

Approach to identifying heating unlocked potential

Smart meters and ToU tariff uptake will impact residential flex



Asset Volume

Number of households with each heating asset

H1H– time of use signals are already available in Belgium and set to increase as more capacity tariffs and more dynamic tariffs come available. The different tariffs will change the behaviour/profiles depending on their specific cost structures

H1M – few players currently existing Belgium, but as the smart meter rollout gains momentum key barriers to entry are coming down, we forecast from 2024 or 2025 a wider spread of offering will be available.

Control Availability

H1H

H1M

H1H flexibility requires Smart HP, smart thermostat or HEM system. 50% of Smart HP were assumed to overlap with smart thermostats.

H1M flexibility requires Smart HP or HEM system, smart thermostats can't provide the necessary control.

Control capability

% households with Smart thermostats

% smart HP

% households with HEM

All flexibility is assumed to require smart meter, coincidence of HP with smart meters is assumed random.

Appropriate metering

% households with smart meters

Customer barriers limit uptake – described in Annex 5

Customer Barriers

impact of flexibility on customer and

Offering complexity

% Unlocked H1M

% Unlocked H1M

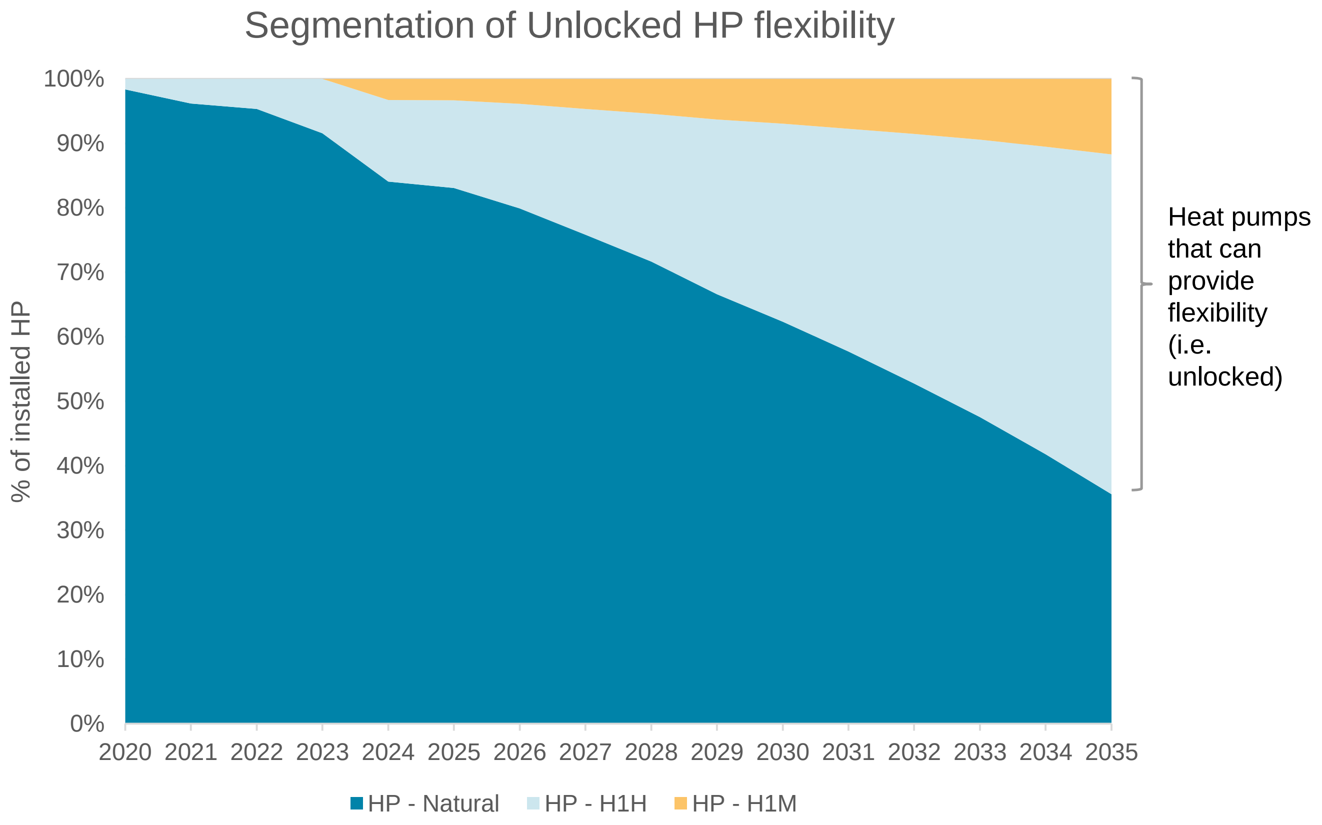
Details of the factors used are described in Annex 5

Unlocked flexibility – residential heat pumps

Residential Heat pumps

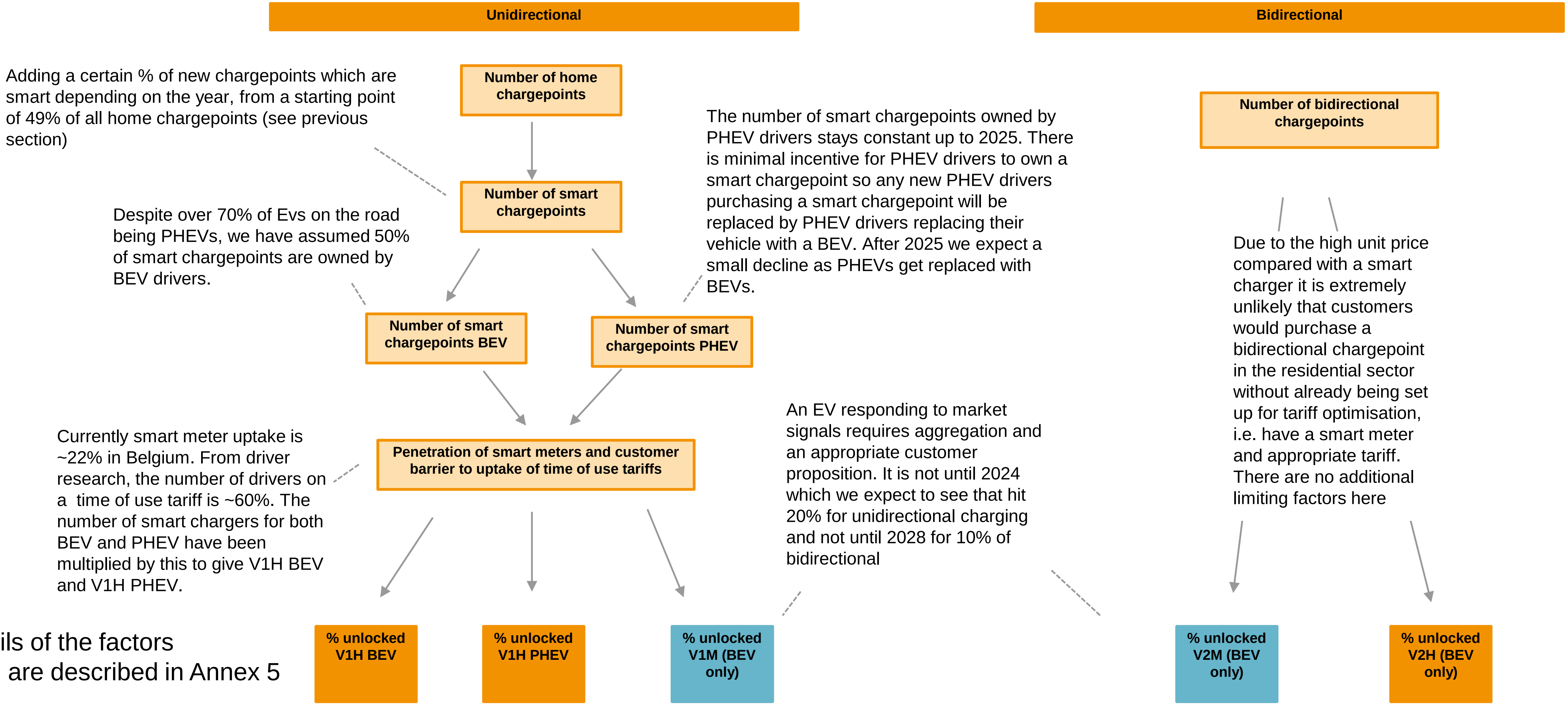
By 2035, over 50% of heat pumps could be unlocked to operate flexibly

- A steady and growing increase in the proportion of heat pumps capable of flexibility from local signals (H1M) is forecast, growing from 4% in 2022 to 53% by 2035.
- As local control signals are already available and increasing, the primary factors driving the increases are the introduction of smart meters and the increasing penetration of smart heat pumps and smart thermostats.
- The uptake of heat pumps for flexibility driven by market signals is forecast to be slower, due in combination to the need for smarter appliances (not just smart thermostat) and the increased complexity of the offering for the customers.



Approach to identifying unlocked residential EV charging

Smart meters and ToU tariff uptake will impact residential flex



Unidirectional

Bidirectional

Adding a certain % of new chargepoints which are smart depending on the year, from a starting point of 49% of all home chargepoints (see previous section)

Number of home chargepoints

Number of smart chargepoints

Despite over 70% of Evs on the road being PHEVs, we have assumed 50% of smart chargepoints are owned by BEV drivers.

Number of smart chargepoints BEV

Number of smart chargepoints PHEV

The number of smart chargepoints owned by PHEV drivers stays constant up to 2025. There is minimal incentive for PHEV drivers to own a smart chargepoint so any new PHEV drivers purchasing a smart chargepoint will be replaced by PHEV drivers replacing their vehicle with a BEV. After 2025 we expect a small decline as PHEVs get replaced with BEVs.

Number of bidirectional chargepoints

Due to the high unit price compared with a smart charger it is extremely unlikely that customers would purchase a bidirectional chargepoint in the residential sector without already being set up for tariff optimisation, i.e. have a smart meter and appropriate tariff. There are no additional limiting factors here

Currently smart meter uptake is ~22% in Belgium. From driver research, the number of drivers on a time of use tariff is ~60%. The number of smart chargers for both BEV and PHEV have been multiplied by this to give V1H BEV and V1H PHEV.

Penetration of smart meters and customer barrier to uptake of time of use tariffs

An EV responding to market signals requires aggregation and an appropriate customer proposition. It is not until 2024 which we expect to see that hit 20% for unidirectional charging and not until 2028 for 10% of bidirectional

% unlocked V1H BEV

% unlocked V1H PHEV

% unlocked V1M (BEV only)

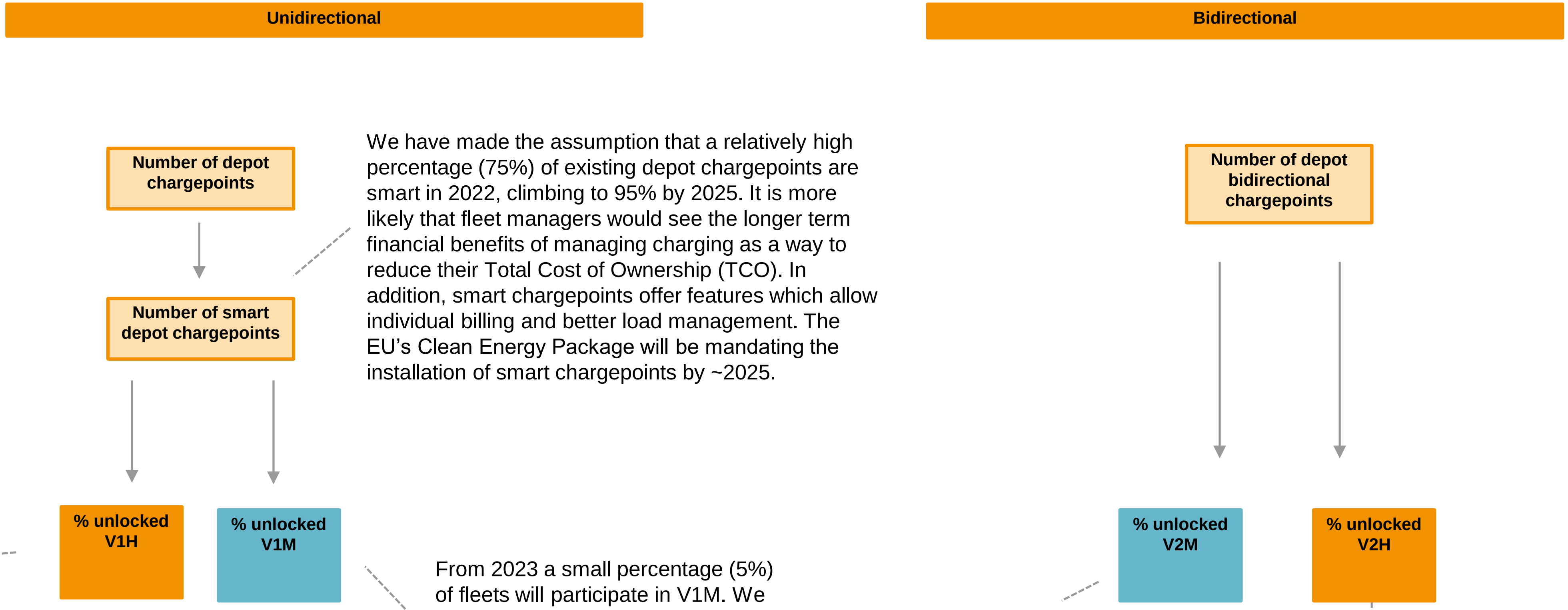
% unlocked V2M (BEV only)

% unlocked V2H (BEV only)

Details of the factors used are described in Annex 5

Approach to identifying unlocked commercial EV charging

Fleets will be more incentivised to participate in flexibility



We have made the assumption that a relatively high percentage (75%) of existing depot chargepoints are smart in 2022, climbing to 95% by 2025. It is more likely that fleet managers would see the longer term financial benefits of managing charging as a way to reduce their Total Cost of Ownership (TCO). In addition, smart chargepoints offer features which allow individual billing and better load management. The EU's Clean Energy Package will be mandating the installation of smart chargepoints by ~2025.

We have assumed that 100% of depots with smart charging currently manage the charging in response to a local signal. This could be ToU tariffs or capacity tariffs.

From 2023 a small percentage (5%) of fleets will participate in V1M. We expect market participation will be earlier for depot charging compared to home, as higher capacities will be available reducing barriers to participation. Plug in times will be more reliable and easy to control than in residential settings – this is a driver of revenues and key to business cases

V2M uptake in fleets will be around 10% of all bidirectional charging. Some barriers will remain to V2M until around 2025 but the % of V2M participation will increase steadily as these barriers are removed / addressed.

The bidirectional chargers which are not participating in V2M will all be participating in V2H. Fleet managers purchasing a bidirectional chargepoint will do so on a tariff that allows optimisation of the charging to reduce the TCO of the fleet

Details of the factors used are described in Annex

EV charging segments not suitable for flexibility

Why are some segments not included?

Plug in time and vehicle availability are strong drivers of values for flexibility. Without these, business models are unlikely to support smart charging

The current focus of smart charging companies has been residential and workplace settings.

Public charging: Destination (7-22kW)

- Destination charging locations include shops, supermarkets, tourist attractions, leisure centres etc
- Drivers are likely to be at these locations for 1-4 hours, this is unlikely to be long enough for smart charging or grid services

Public charging: Rapid (transit, 50kW+)

- Drivers will charge at these sites for a quick top up so smart charging / V2G would not be suitable

Public charging: On street

- Vehicles may be parked here for 8+ hours potentially making them suitable for smart charging
- However, residents are unlikely to plug in unless they need to fully charge, meaning there will be limited opportunity to shift the charging times
- In addition to this, the customer proposition would be complex as there would need to be an explanation as to why a vehicle isn’t charging at certain times. This would be easier with a home chargepoint as the ratio is one driver to one chargepoint, but with public infrastructure there could be several drivers using one unit

Workplace: Employee charging

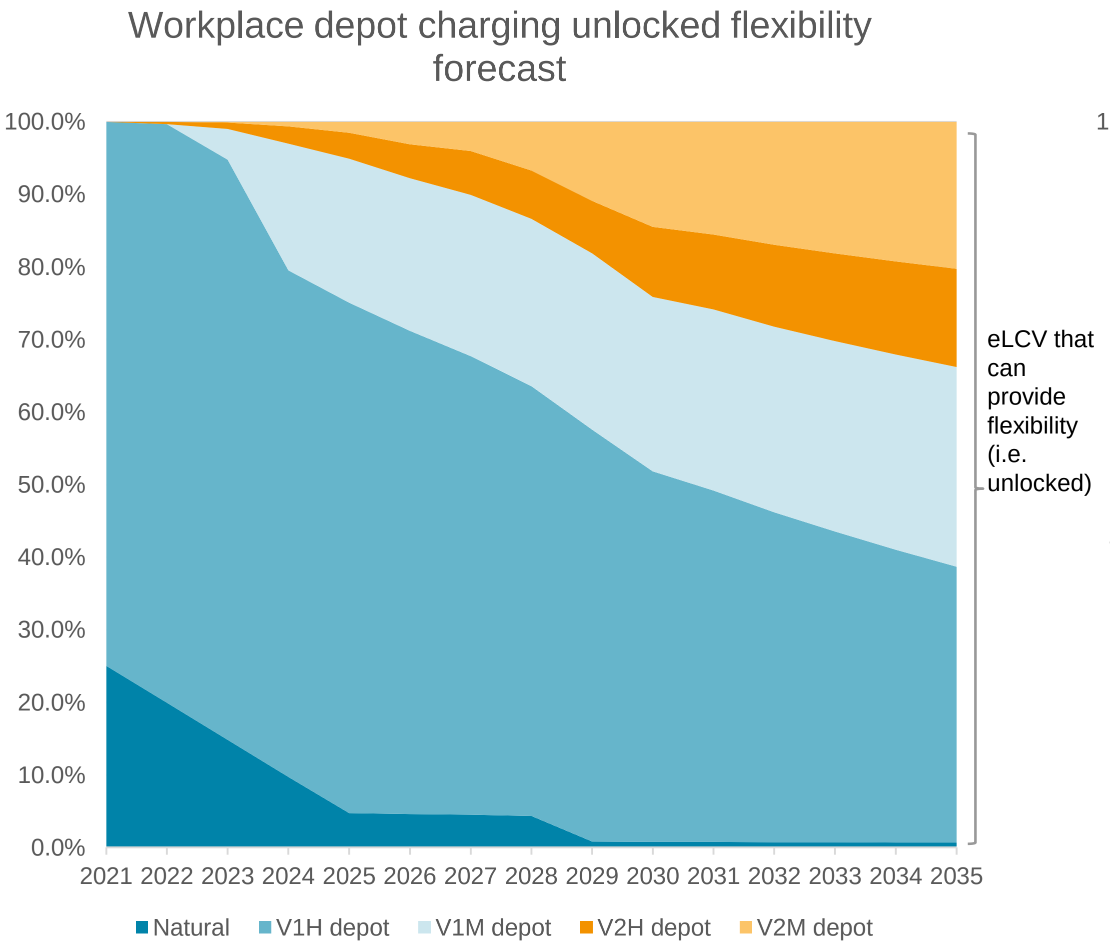
- It is likely that a high percentage (75%) of employee charging will be smart. This will be used by employers to monitor usage and control billing of employees
- Plug in times per session may be relatively high. ~8 hours per day. The timing of this plug in time however (9am-5pm) means there will be limited opportunity to shift demand to cheaper prices, reducing the business case for smart charging
- There is also uncertainty on vehicle availability throughout the week. Unlike with fleets where the fleet manager can control which vehicles park where and when, plug in availability may be lower as employees are unlikely to plug in every day

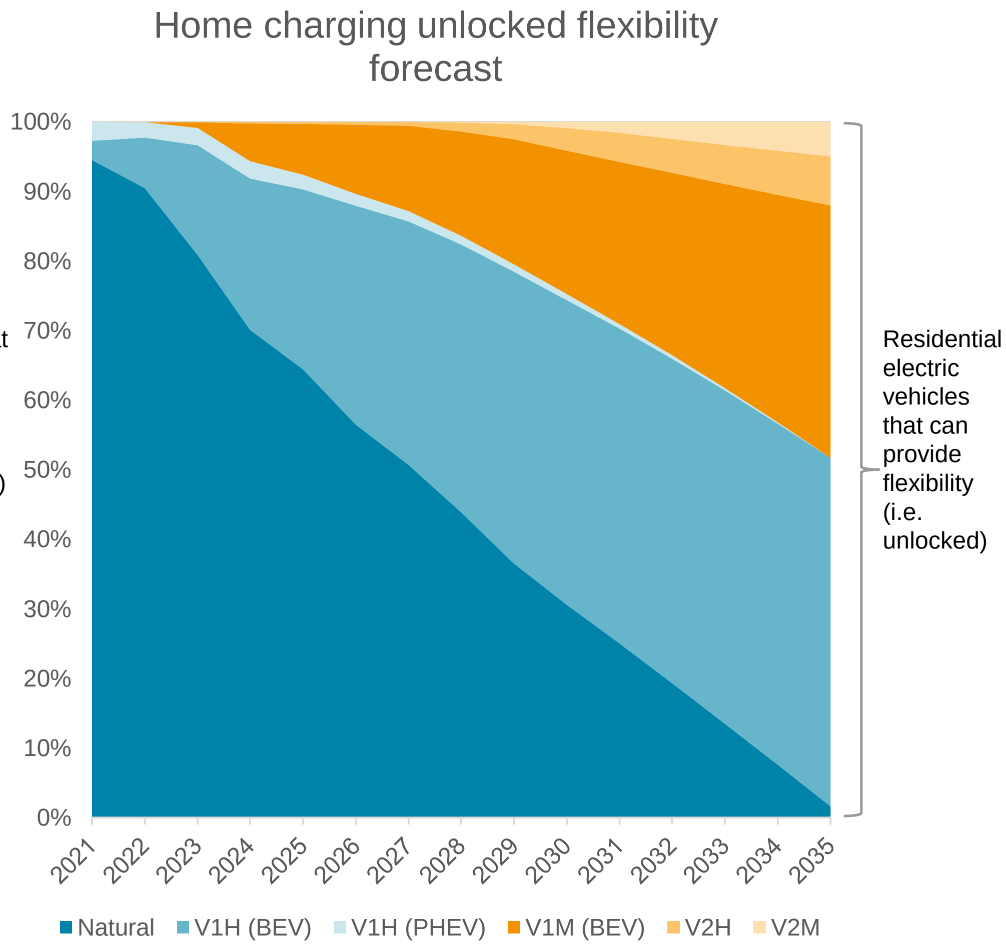
Unlocked flexibility from home and depot EV charging

V1H will be more common sooner for depot vehicles

Employee charging has not been included here. For work places the focus of smart charging and bidirectional will be the fleets, as this is easier to control.

Employees are unlikely to want to participate in V2G at work and there will be limited options for cheaper times during the working day.



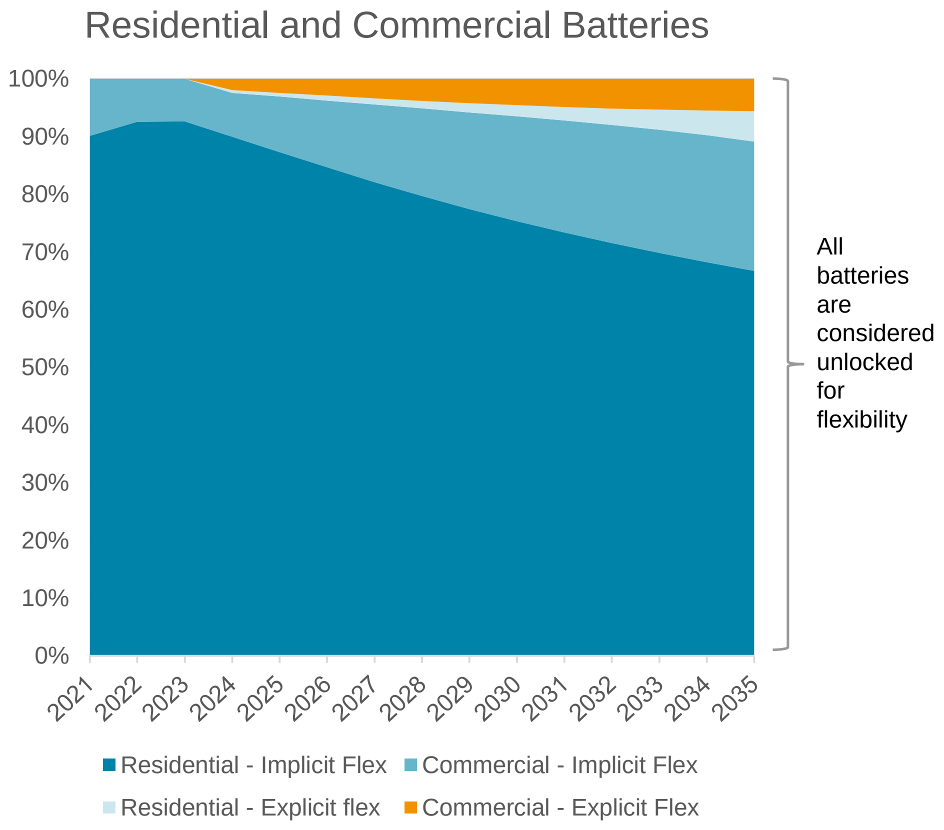


Batteries unlocked flexibility

The primary role of behind the meter batteries is implicit flexibility

The purpose of batteries is to provide flexibility to the consumer by definition; therefore all existing capacity can be assumed unlocked, however only limited capacity is available for market driven flexibility.

- Unlike EV’s and heating technologies, batteries don’t have a natural demand, however they are typically installed for a specific purpose.
- The primary purpose for installing residential and commercial batteries is for PV consumption optimization, therefore providing implicit flexibility. However, this will be seasonally dependent on the solar irradiance.
- As time of use and capacity tariffs become more widespread, along with smart meters, batteries can also provide a role in winter months and properties without solar.
- Due to this significant primary use for residential and commercial batteries the penetration of batteries for implicit flexibility is low, the penetration of home energy management systems as a proxy for residential homes, as these systems could mediate between local flexibility and market driven flexibility.
- With limited data on commercial batteries in Belgium, the penetration has been assumed to be limited to 25% of installations, but we note there is high uncertainty on the data in the commercial sector.


Residential and Commercial Batteries

Potential unlocked capacity

How could the % of unlocked assets translate into MW and MWh of shiftable load.

Approach to calculating potential unlocked capacity

Combining technical potential, unlocked inventory and inventory forecasts

Indicative potential flexibility is described, however specific time and seasonal limitations need to be considered

Analysis of natural and flexible load profiles allows the estimation of the maximum amount of MWh that can be shifted per day and the potential peak load reduction in MW for each type of flexibility and technology.

Combining these factors with the penetration of different types of flexibility allows the forecast of the unlocked MWh of flexible load per day and the potential MW reduction in peak loads.

The calculation is aimed to provide an overall estimate of the potential for shifting demand and maximum peak load reduction.

For implicit flexibility, this shows the impact of switching from natural load. The key factors that could change this forecast include limitations/changes to flexible profiles along with the technology and penetration forecasts.

For explicit flexibility, these figures show the potential load reduction, that could be delivered to the market, however there are specific limitations that are not included. The final potential for load reduction and the capacity to provide it is dependent on:

- Time of day
- Seasonality
- Recent asset history
- Value vs. implicit flexibility

The availability of different assets is potentially quite variable, to provide a more detailed view on the potential of explicit flexibility a detailed set of assumptions on the hourly capacity of different assets is required. Due to the increasing complexity of assumptions required, our view is this level of forecasting could be misleading for a new an uncertain market.

Summary of technical flexibility – average winter

Daily MWh and Max MW per 1,000 installations

Technical flexibility is normalized to take into account natural diversity of operation in demand assets. This significantly reduces the potential peak load changes per asset.

Technical flexibility is calculated by comparing natural charging profiles and flexible profiles.

Peak load reduction is limited due to the diversity consumer assets meeting their primary demands.

Flexibility type	Asset	Daily MWh (average winter) per 1000 unlocked normalised installations	Max MW peak load reduction (average winter) per 1000 unlocked normalised installations
Space heating and hot water flex	ASHP	2.3	0.32
	GSHP	1.8	0.27
	HySHP	12.9	0.84
Space heating only	ASHP	1.0	0.20
	GSHP	0.9	0.15
Hot water only	DHW HP	1.3	0.20

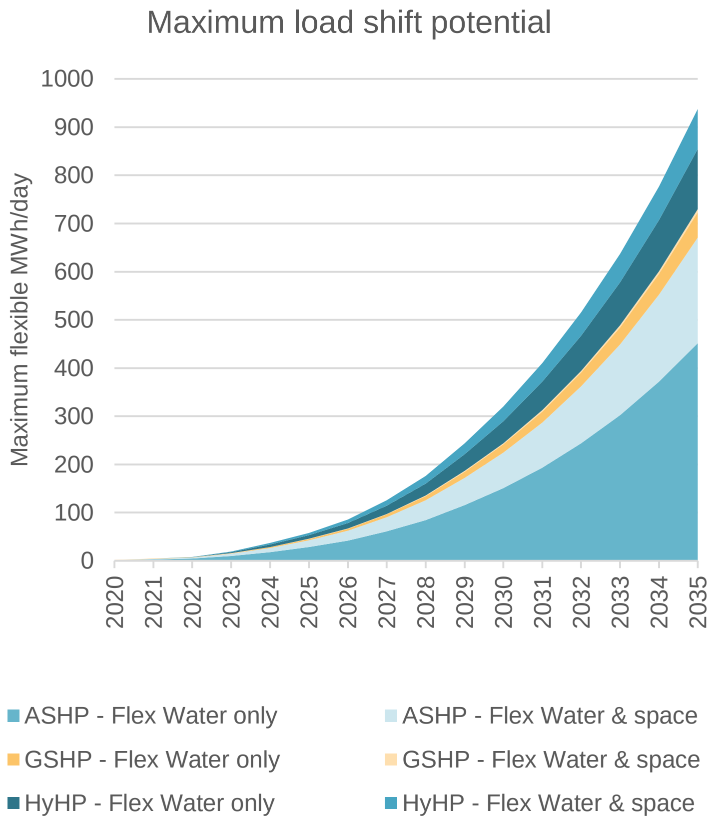
Flexibility type	Asset(s)	Daily MWh(average winter) per 1000 vehicles	Max MW peak load reduction (average winter) per 1000 unlocked chargers
V1H Smart Charging TOU	BEV	6.7	0.54
	PHEV	4.0	0.55
V1H Smart Charging PV	BEV	6.7	0.85
	PHEV	4.0	0.85
V2H	BEV	16.7	2.05
	BEV + HP	16.7	3.05
	BEV + PV	10	2.05
V2M	BEV	16.7	6.38
	BEV + HP	16.7	6.38
	BEV + PV	10	6.38

Heating technologies - flexibility potential

Implicit flexibility

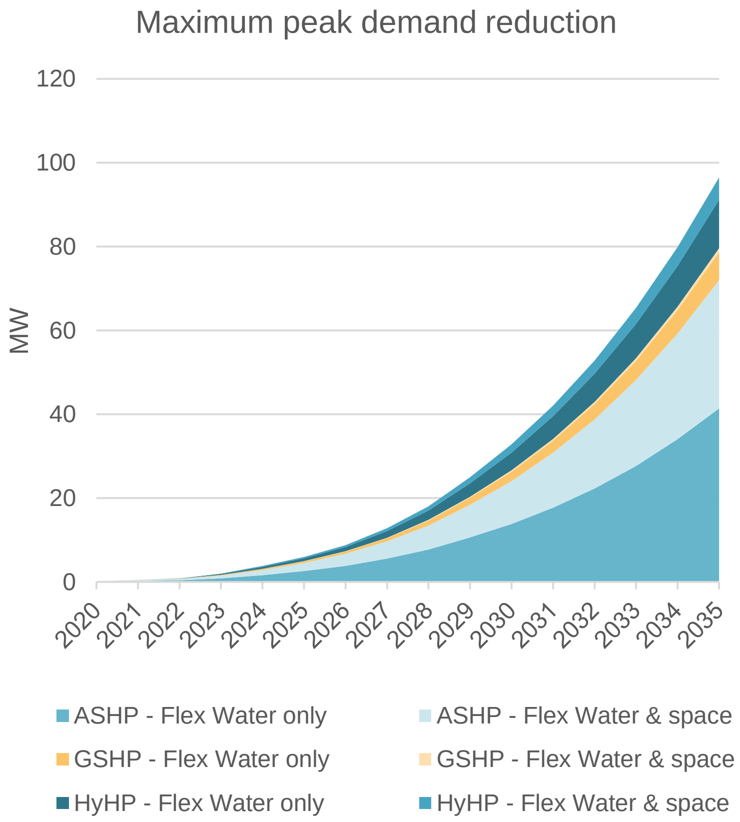
Heating technologies could potentially shift >900 MWh per day away from peak times, reducing peak load by up to 100MW.

Air source heat pumps will provide the greatest proportion of flexibility by 2035.



Due to the high peak energy consumption of direct electric hot water, it can also provide high peak demand reduction.

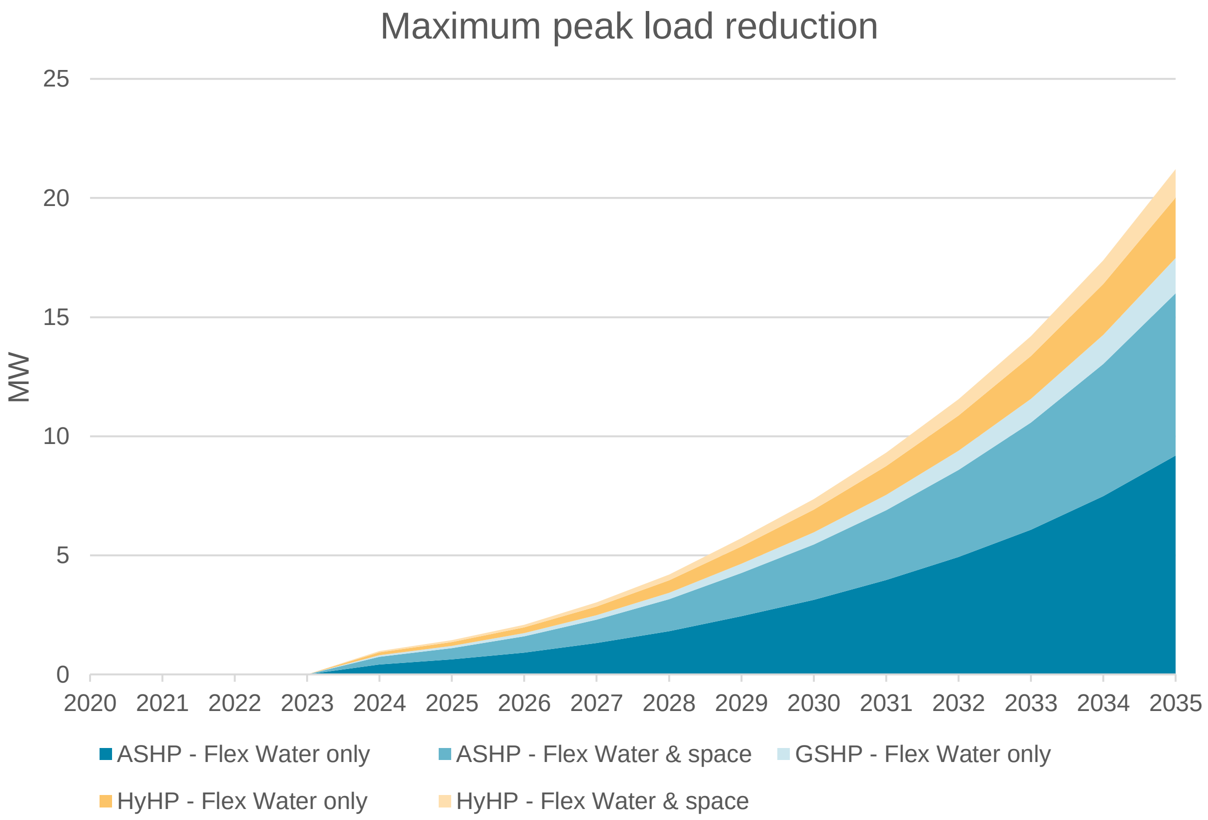
Overall, peak demand reduction is only ~100MW.



Heating technologies - flexibility potential

Explicit flexibility – market driven

- Overall potential for market driven flexibility from heat pumps is estimated at 10-50MW.
- Note, daily MWh has not been estimated for explicit flexibility as the timing of flex has a high impact on the potential duration.



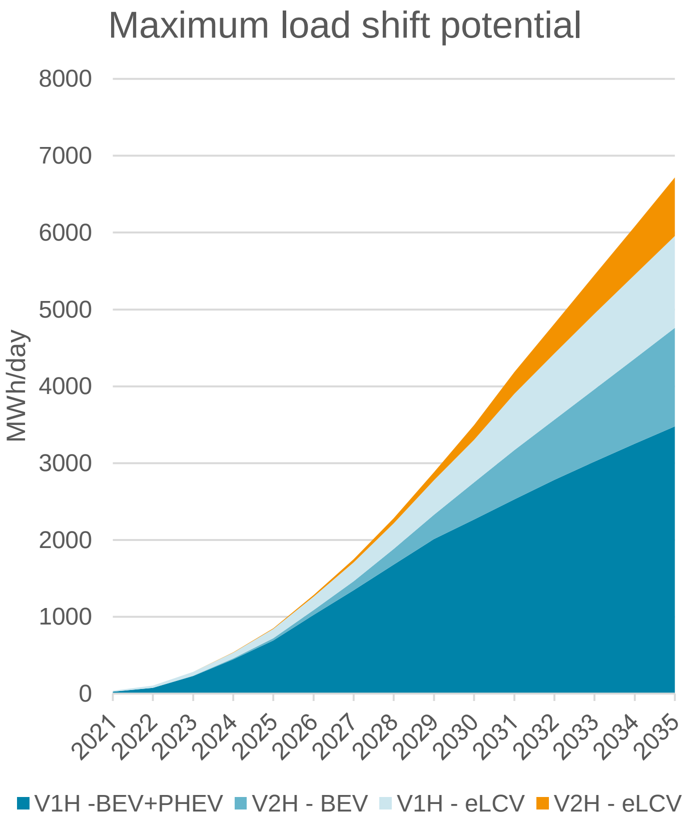
Electric vehicle - flexibility potential

Implicit flexibility

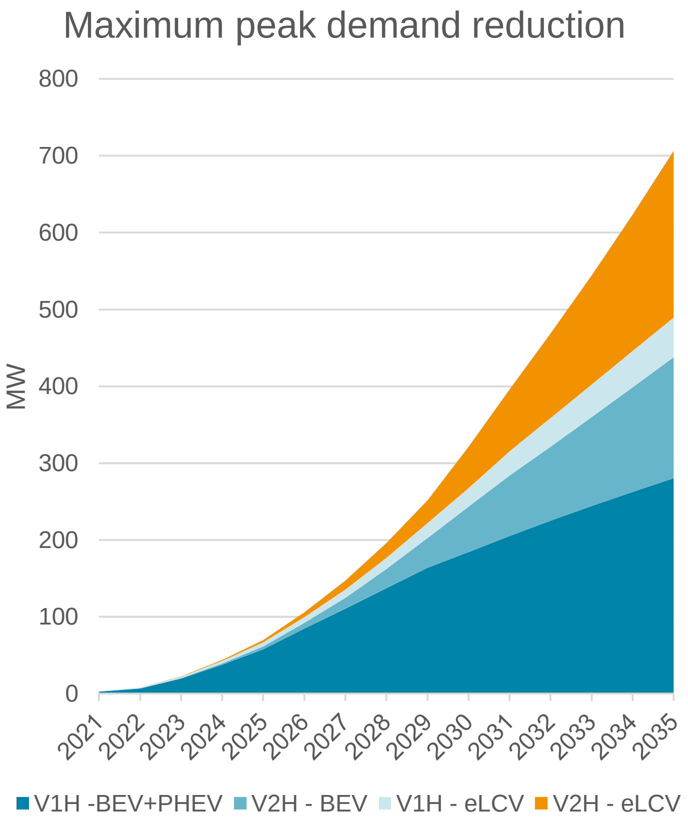
Smart charging EV's have the potential to shift up to 700 MW and 6,600 MWh/day away from peak periods by 2035.

Until 2029 residential smart charging is the main driver of implicit flexibility.

From 2030, bidirectional charging and the tertiary sector grows more rapidly.


Maximum load shift potential

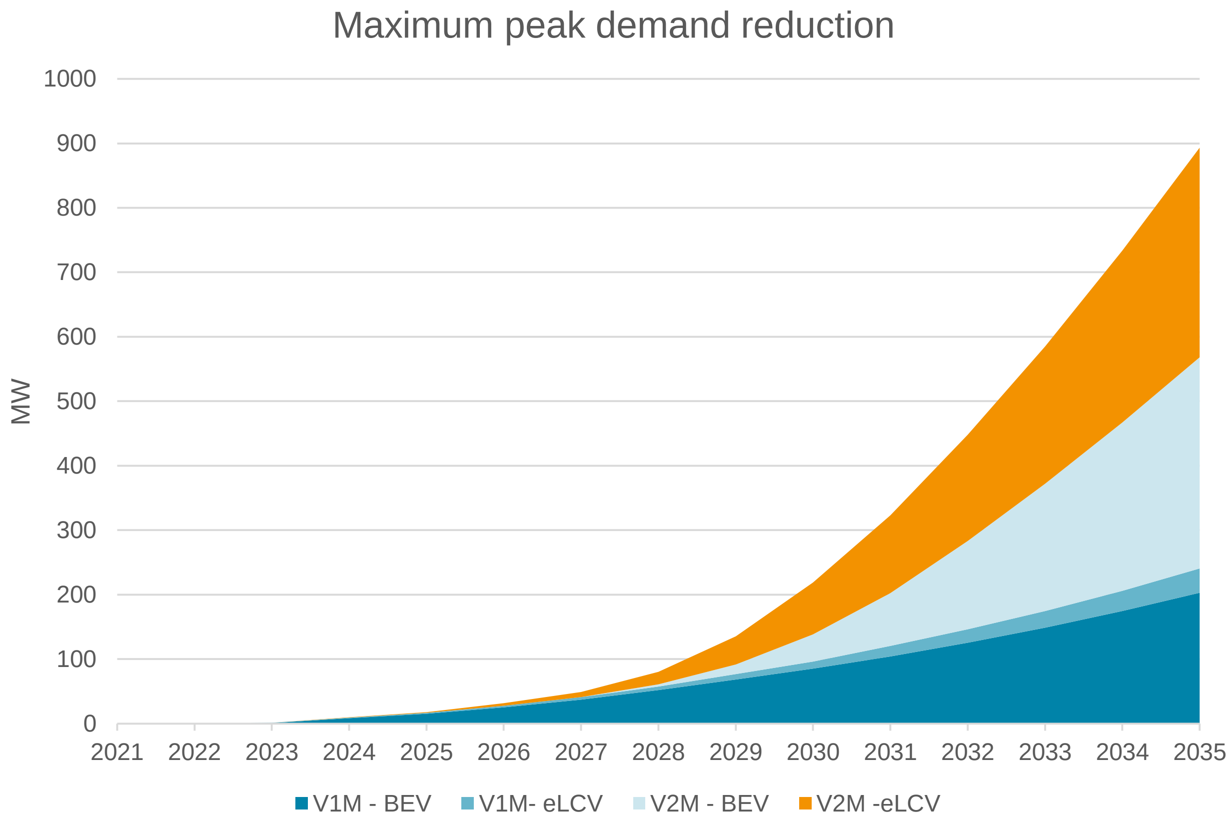
Smart charging could potentially reduce peak demand by up to 500MW by 2035, primarily driven by smart charging, but increasingly bidirectional charging in 2030-2035.


Maximum peak demand reduction

Electric vehicle - flexibility potential

Explicit flexibility

- Electric vehicles could potentially provide 900 MW of explicit flexibility by 2035.
- Until 2027, potential explicit flexibility is likely to remain relatively small <100MW mostly from residential smart chargers.
- From 2028 the introduction and adoption of bi-directional charging could unlock significant flexibility in both residential and commercial sectors.

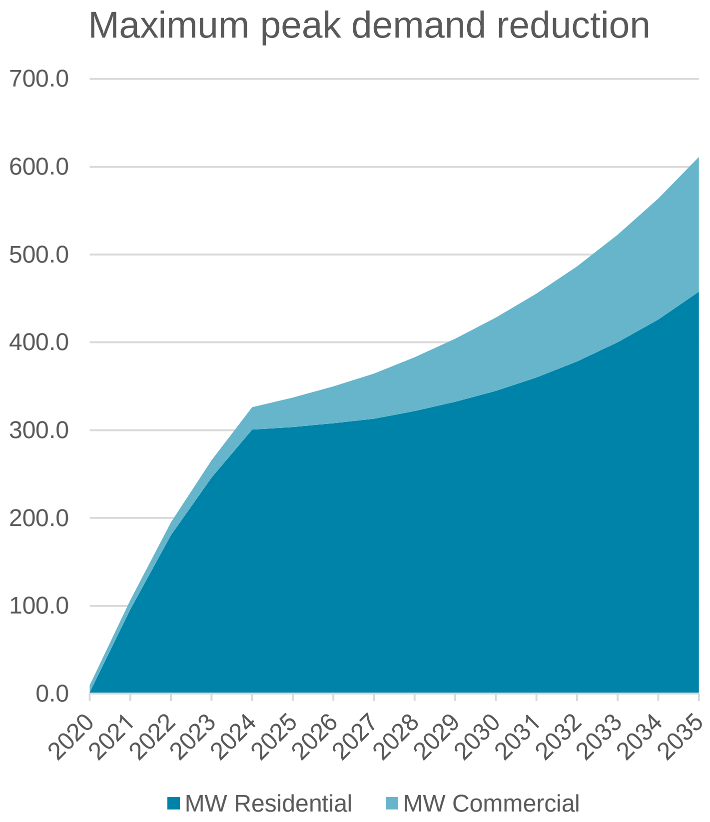


Battery - flexibility potential

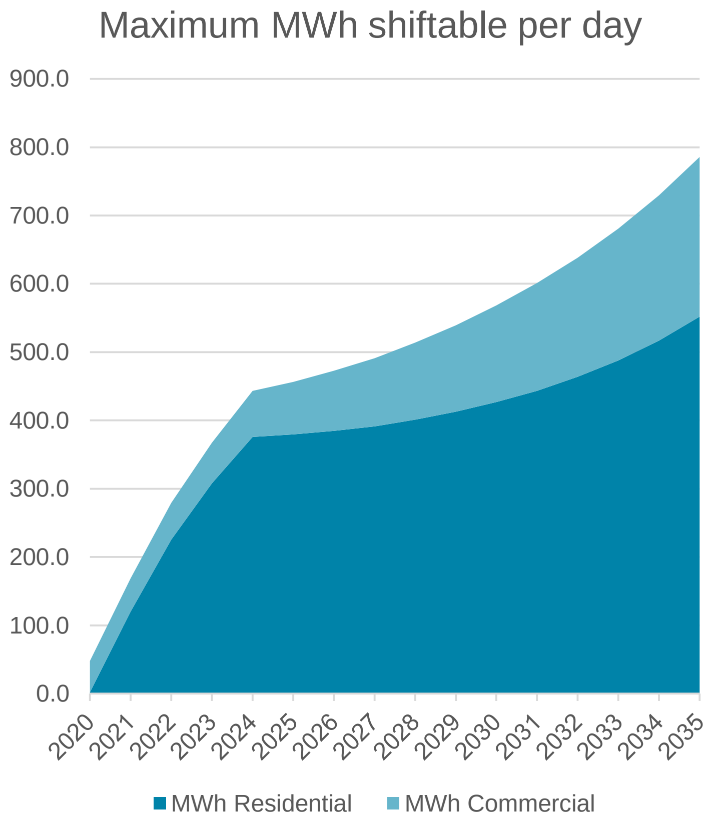
Implicit flexibility

When driven by the combination of smart solar PV optimisation with time of use or capacity tariff optimisation, batteries can potentially shift 600MW and 800MWh away from peak by 2035

The rapid growth in residential batteries, driven by subsidy in Flanders creates the capacity until 2024, with steady increases until 2035. The peak demand reduction is high compared to the number of installations due to the high rated capacities



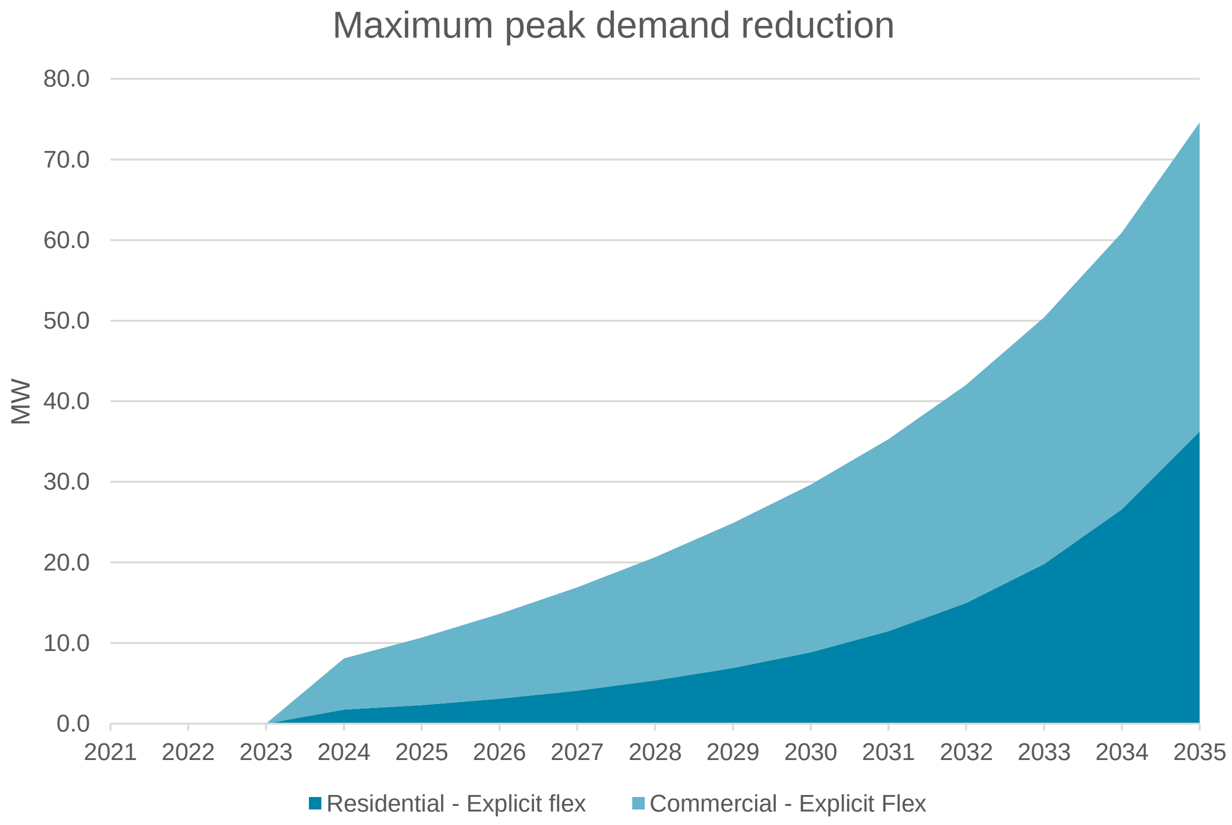
Batteries have the potential to be cycled multiple times per day, however it has been assumed that typically the full capacity is cycled only once per day, due to the night/day cycle.



Battery explicit - flexibility potential

Explicit flexibility – market driven

- Flexibility provided by battery technology is dominated by implicit flexibility, leaving limited capacity for explicit market driven flexibility.
- We forecast a slower growth in residential markets, linked to installation of home energy management systems to balance the value of implicit and explicit flexibility.
- We would expect faster uptake in commercial sector, but this is limited to 25% penetration, due to uncertainty and lack of data in this sector.



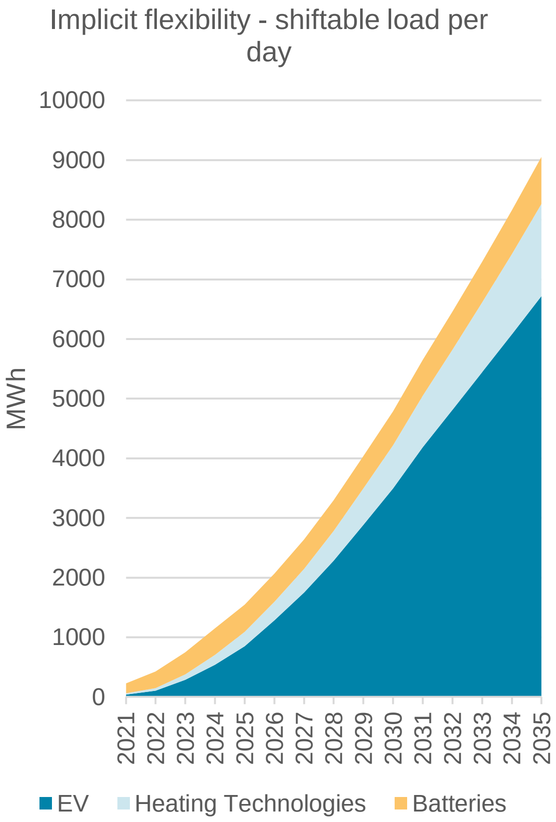
Summary

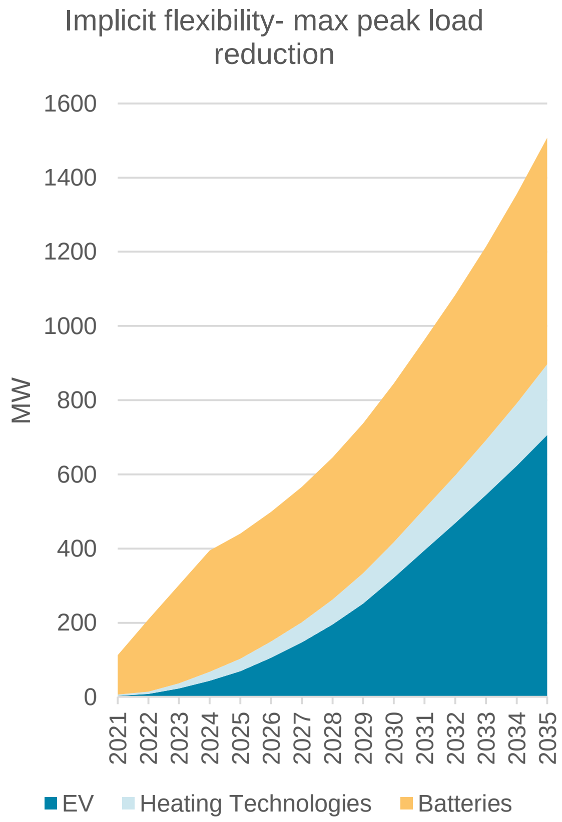
How do technology types compare?

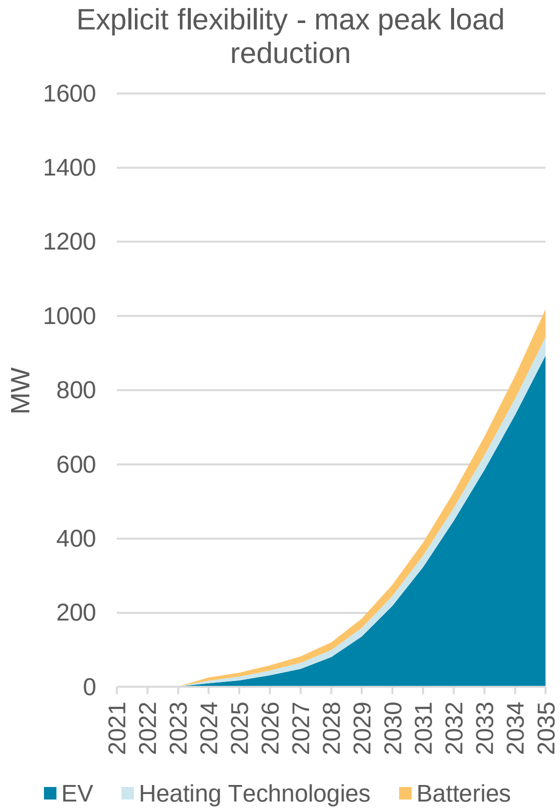
Market driven flexibility(explicit flexibility) is forecast to be dominated by electric vehicles, due to the high number of EV's forecast, but also high potential of bidirectional charging

EV's have the potential to provide the greatest amount of load shifting per day.

However, batteries could have a faster and significant impact on peak load reduction, by 2035, EV's have an equal impact.







Note these figures are for an average winter day.

Annex

Annex 1 – Technology assessment and selection

Demand side flexibility technology list

Initial capability scoring

Cooling loads and misc. loads were identified as potentially relatively low capacity and capability to provide demand side flexibility.

Before discounting a more detailed analysis was undertaken to estimate overall potential.

The DSF technologies and key digital enabling technologies were initially grouped and scored for residential and commercial sectors

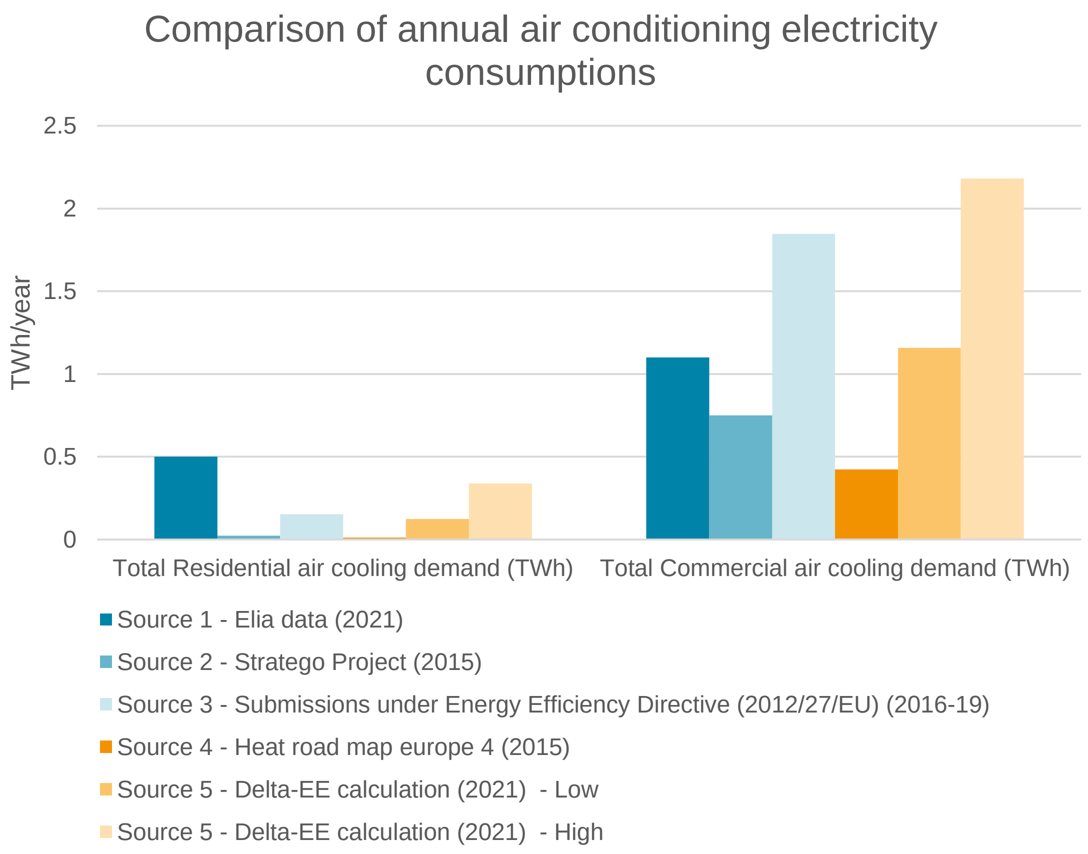
Category	Residential Technologies	Commercial Technologies	Relative capacity in 2035 (1-5)	Relative capability for flexibility (1-5)
Electric Vehicles and Charging points	Passenger Plug in Hybrid (PHEV) Battery Electric Vehicles (BEV) EV charge points: Public charging EV charge points: Home charging	Light commercial electric vehicles EV charge points: Employee EV charge points: Depot	3	4
Heating Loads	Air & ground source heat pumps Hybrid heat pumps	Air & ground source heat pumps Hybrid heat pumps	3	3
Cooling Loads	Air conditioning systems	Air conditioning systems Commercial refrigeration	2	2
Energy Storage	Home batteries. Hot water storage(covered in heating)	Commercial batteries.	1	5
Misc. loads	Lighting Appliances & white goods		1	1
Digital enabling technologies	Home Energy Management systems(HEM) Connected Thermostatic Radiator Valves(TRV) Smart meters Smart thermostats		N/A	N/A

Cooling loads

Residential and commercial air conditioning annual demand

Data for air conditioning inventory and demand is missing and calculations are highly sensitive to input assumptions due to the low market penetration.

- Direct data is limited so other studies used bottom up methodologies to estimate air conditioning demand.
- Reviewing recent studies (2015-2019), there is high variability in air conditioning energy estimates.
- As penetration of air conditioning in Belgium is low (1-5% residential, 15-30% commercial), small changes in these assumption can make significant difference in outcome.
- Most calculations require assumed efficiency of AC and building stock insulation to provide average performance, these assumptions are directly proportional to the result, therefore highly sensitive.
- Delta-EE estimated high and low values for AC demand, considering different estimates for penetration, there is more than 100% difference between low and high estimates demonstrating this sensitivity and lack of precision in bottom up estimates.



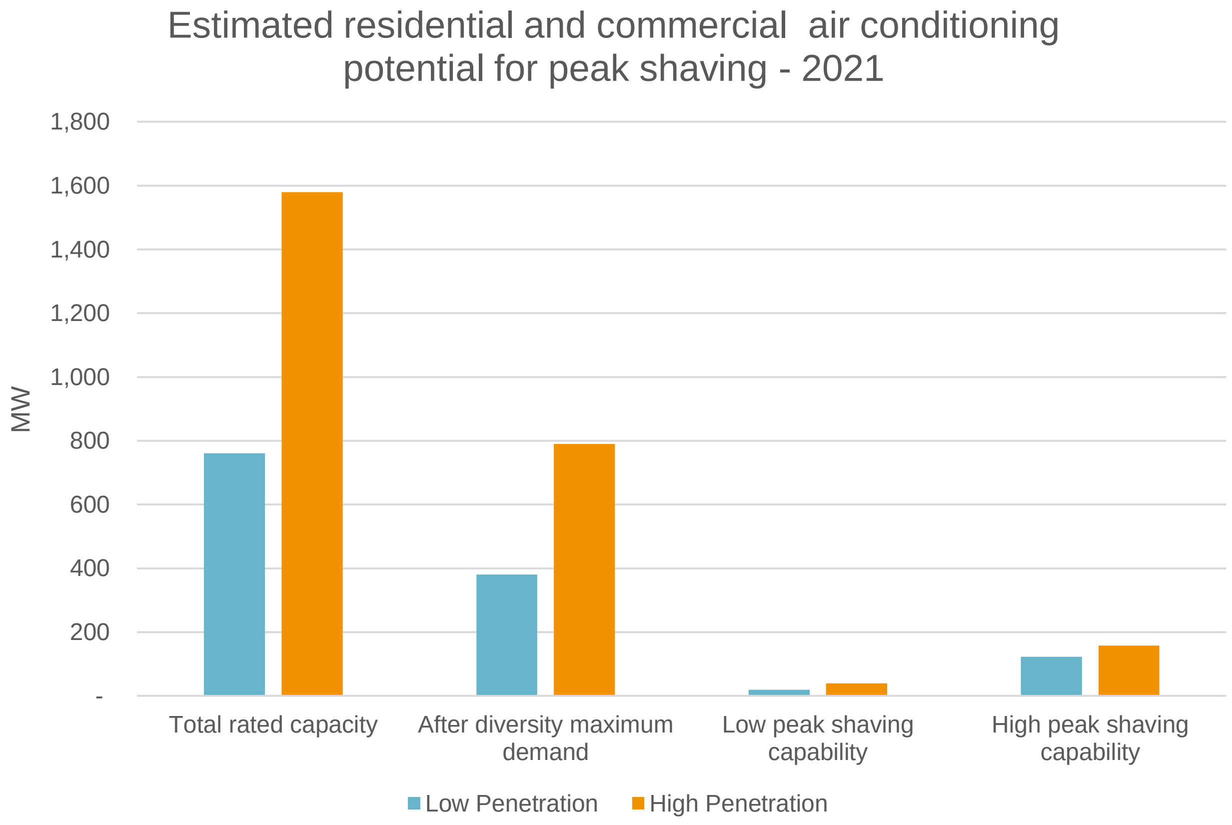
Comparison of annual air conditioning electricity consumptions

Cooling loads

Residential and commercial air conditioning – peak shaving potential

While the total rated capacity for air conditioning is estimated in 100’s MW range, however the average demand and potential for peak shaving is limited.

- Existing studies calculated the annual energy use, but did not estimate the installed capacity of AC units or estimate the peak power.
- Installed capacity and the peak load are the key characteristics required to estimate the potential for providing demand response flexibility.
- Delta-EE developed own bottom up methodology to estimate the annual energy consumption and estimate the installed capacity, after diversity peak demand and potential to provide peak shaving.
- High and low penetration of AC has been estimated, along with high and low potential for peak shaving, this provides a overall range of current capacity at 19 to 158MW.
- This before considering uptake and engagement with flexibility services and markets.



Source: Calculated by Delta-EE

Cooling loads

Commercial refrigeration

Available data on annual demand and total rated capacity in of commercial refrigeration in Belgium is limited. Identified estimates provide high variance and low confidence.

- Accurate data or estimates for market size for commercial refrigeration/cooling were found to be limited.
- Two sources were found that estimate the annual commercial refrigeration demand in Belgium, 1) submission under the EC Energy Efficiency Directive and estimates from the Heat Road Map 4 project.
- A simple calculation has been undertaken to estimate the commercial refrigeration peak shaving potential, on the basis that refrigeration typically runs all year round.
- The resulting calculation estimates peak shaving potential of 10-102MW, the high range demonstrate the high uncertainty in the data and capabilities.

	Low demand estimate	High demand estimate
Annual demand (TWh)	0.96	2.55
Average capacity(if running at 100% load 8760/year) (MW)	110	291
Estimated ADMD (MW)	192	509
Low estimate peak shaving potential (MW)	10	25
Estimated peak shaving potential (MW)	38	102

Miscellaneous loads – lighting and appliances etc.

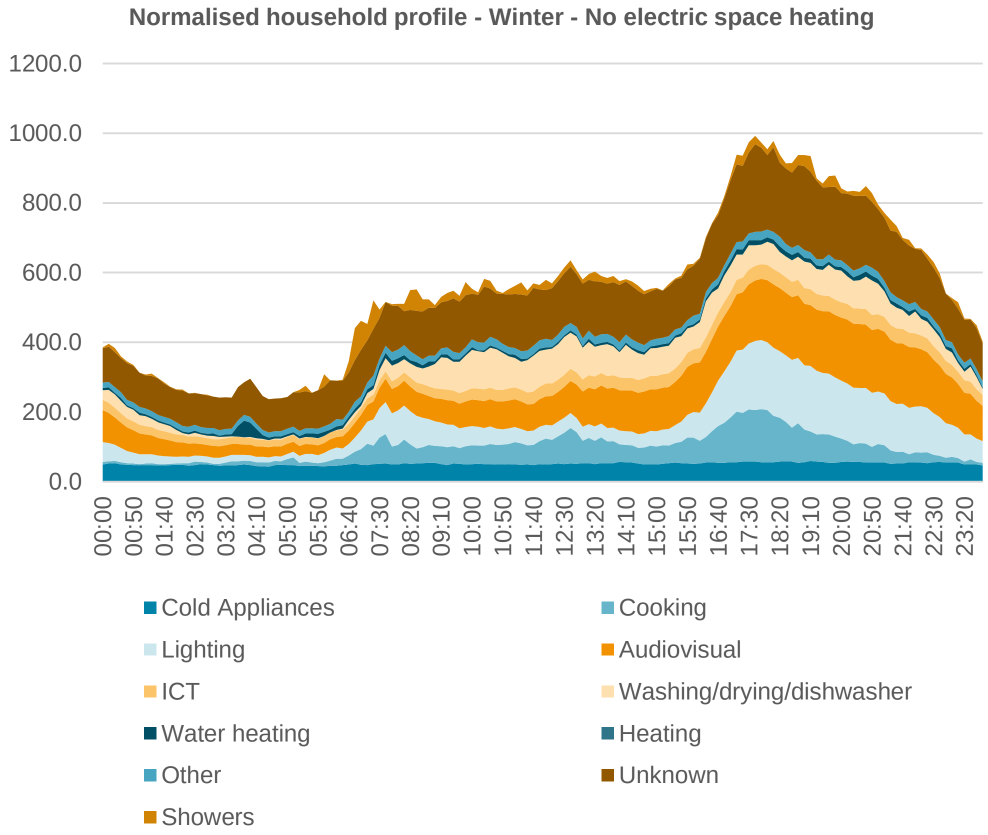
Normalised household profile in winter without electric space heat

The flexibility impact from miscellaneous appliances in the home is limited. Even in homes w/o electric space heating, the capacity accessible for flex is insignificant.

Below we outline which types of appliance loads in the home can be considered for flexibility.

- Cold appliances → Flexible load
- Washing/drying/dishwasher → Flexible load
- Water heating → Flexible load*
- Cooking → Non-flexible load
- Lighting→ Non-flexible load
- Audiovisual→ Non-flexible load
- IT/communication → Non-flexible load
- Showers → Depends on water heating
- Other/Unknown → Not clear

Without water and space heating, for the household profile illustrated in the graph, the **capacity accessible for flexibility amounts to <15% of peak load.** When considering households with electric heating and/or an EV, the flexibility potential from miscellaneous loads becomes relatively insignificant (more detailed shared on the next slide).



*Water heating is covered in heat pump analysis – included here for completeness for houses with electric water heating

Source: The Household Electricity Survey

Notes on the household profile:
The Household Electricity Survey monitored a total of 250 owner-occupier households across England from 2010 to 2011. While we assume the consumption profiles are still representative, we expect appliances to have improved in efficiency on the order of **30-50%** since 2011 as efficiency standards improve.

The 'unknown' electricity use accounts for a sizable fraction (30-40%) electricity use in the profile. This was believed to be **unmetered lights** and **appliances** used 24/7.

Miscellaneous loads – appliances etc.

Normalised flexibility for misc. loads across 3 household examples

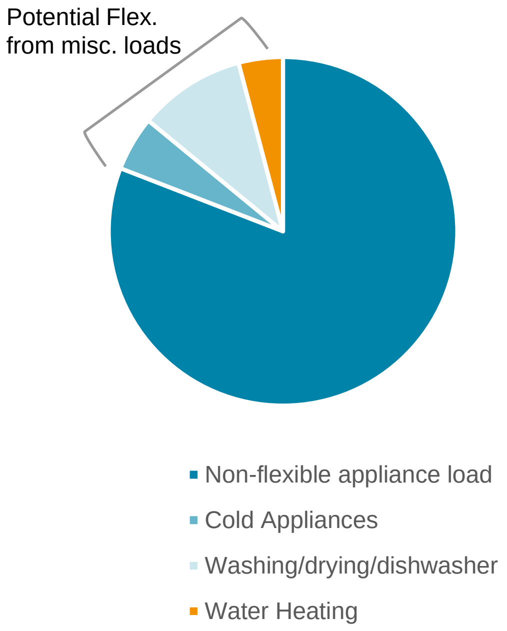
Flexibility potential from misc. loads is not significant, especially as adoption will be low and challenging to manage.

Electric space heating (like heat pumps) and EV charging loads are a higher priority target.

Home with non-electric space heating

Normalised peak demand across households amounts to **~1,200W.**

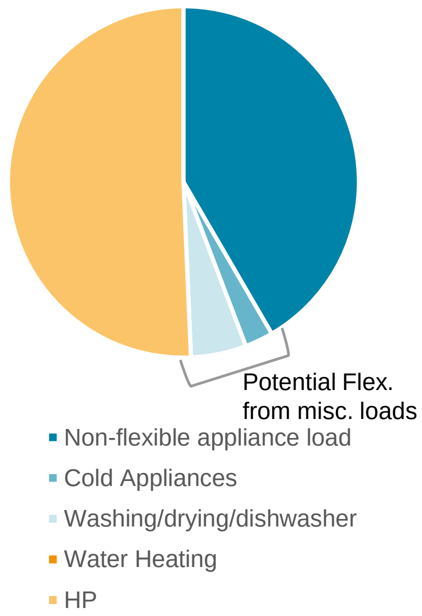
Normalised flexibility from the miscellaneous loads amounts to **~20%** (225W)



Home with air source HP

Normalised peak demand across households amounts to **~2,200W.**

Normalised flexibility from the miscellaneous loads amounts to **~8%** (177W)

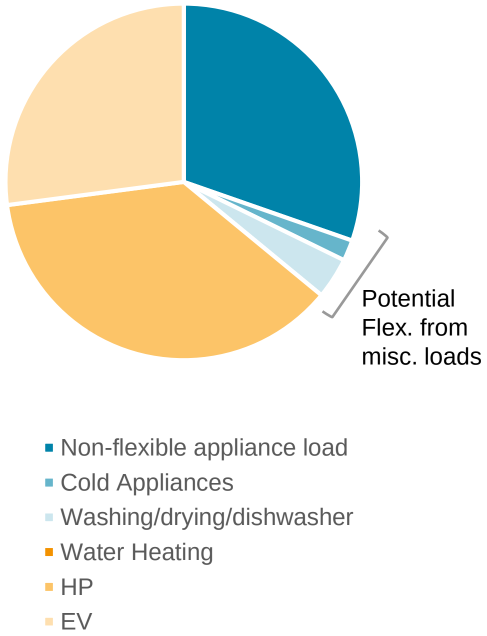


* Note flex load is slightly lower as water heating is delivered by heat pump)

Home with air source HP & EV

Normalised peak demand across households amounts to **~3,000W.**

Normalised flexibility from the miscellaneous loads amounts to **~6%** (177W)



* Note load is slightly lower as water heating is delivered by heat pump)

Data and assumptions

Air conditioning and commercial refrigeration

Key data used to estimate capacity, demand and peak shaving capability of air conditioning and in residential and commercial sectors. Commercial refrigeration assumptions are summarised

Air conditioning penetration

Residential

The penetration of air conditioning was estimated and a low value of 1.9% of household and a high value of 5.2% of household. Heat Road Map Europe 4 provided the low estimate in 1.5% in 2015 and 2.7% in 2030.   BSRIA estimated total residential units at 258700 in 2017, combined with 4.9 million households provided value of 5.2%. Stratego Project estimated 2.5% in 2015.

Commercial

Stratego Project estimated 14.29% in 2015, which was used as a low figure assuming little growth. Heat Road Map Europe 4 provided the low estimate in 23.8% in 2015 and 33.3% in 2030, interpolating linearly 26.9% was used for 2020.

Average air conditioning size and annual demand

Residential buildings were estimated to be size range of 80-150m2, typical AC cooling capacity was estimated at 18000 BTU, with an energy efficiency rating(EER) of 10, providing rated power of 1.8kW per unit. Commercial buildings were calculated on the basis of area, a typical 25BTU/ft^2 cooling load was assumed with EER of 10, peak load 27W/m^2. Sources: 1 2 3

Specific cooling demand was taken from Heat Road Map Europe 4 at 10.8 and 52.7kWh/m^2 per year for residential and commercial sectors respectively.

Air conditioning ADMD

The average demand of air conditioning is typically around 20-30% of the rated demand, however it is assumed peak load in summer is higher and therefore ADMD has been assumed to be 50% of the rated load, similar to heat pumps.

AC Potential for peak shaving.

A wide range of studies into AC capability for peak shaving were identified, which provided a range of peak load reductions. Due to the wide range of studies, in different countries and climatic conditions, the findings are not all directly comparable, but the overall range was approximately 5-30% reduction in peak load. However the highest peak reduction were typically in countries with high AC demand(e.g. USA, Texas), a range of 5-20% was assumed. Sources: 1 2 3 4 5 6 7 8

Commercial refrigeration

Assumed to operated 8760 hours per year, with average load of 30% rated capacity. ADMD is assumed to by 50% of rated capacity.   Peak shaving capability is assumed to be 5-20%.

Annex 2 - Inventory

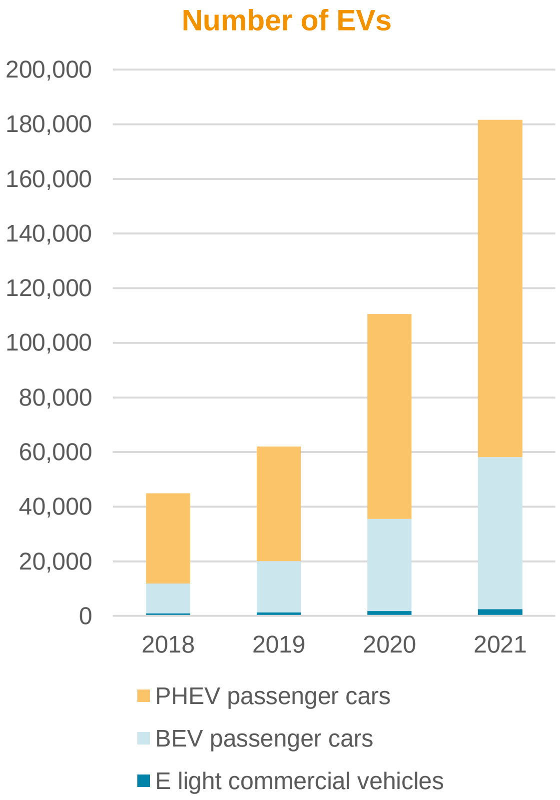
Electric Vehicles and Chargepoints

Number of EVs on the road and installed chargepoints in Belgium

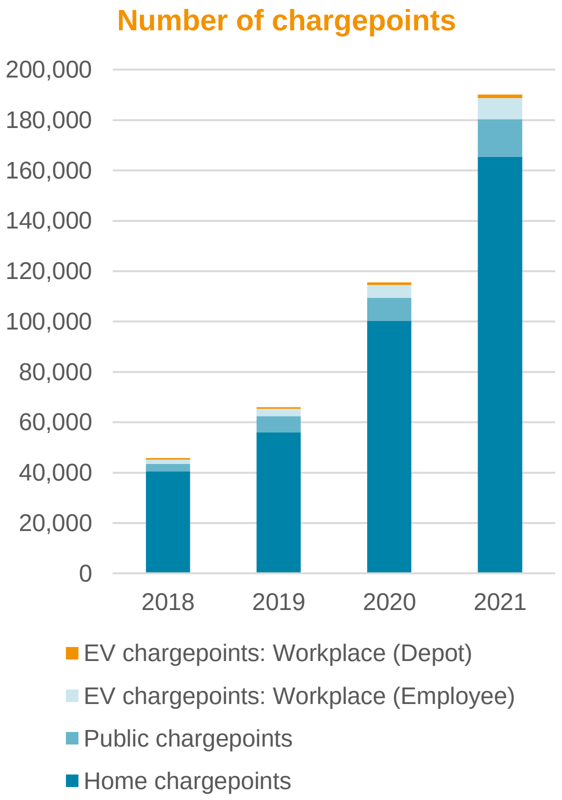
PHEVs currently dominate the vehicle parc with the majority of Belgians charging using home chargepoints.

Growth in number of EVs and chargepoints

- BEV numbers have been low in comparison with Belgium's neighbour, the Netherlands. It is expected that sales will pick up over the next few years, currently 55,000 in 2021.
- PHEVs are more popular than BEVs, although this is expected to change towards the end of the decade as BEV sales outpace PHEV. A small number of eLCVs are on the road in Belgium (2,500 in 2021).
- Home chargepoints make up the vast majority of the installed base (165,386 in 2021).
- There has been recent growth in public charging infrastructure.
- Workplace chargepoints are estimated to be low (~8,000 in 2021).



Source: European Alternative Fuels Observatory



Source: Calculated by Delta-EE

Heating Technologies

Installed base of electric technologies for space and water heating

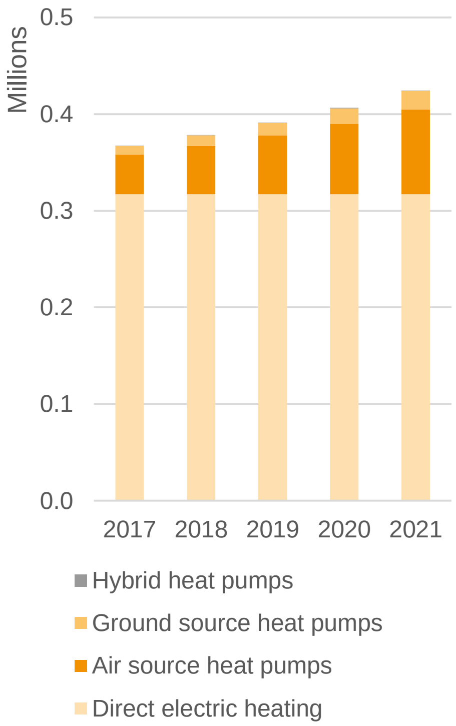
Only a small proportion of homes in Belgium are currently heated by heat pumps, though the installed base is growing steadily as heat pump sales increase year on year.

Estimates of the number of heat pumps and direct electric space heating systems were taken from the European Heat Pump Association (EHPA). For 2021, a 20% increase in the heat pump installed base was assumed in line with historical growth rates.

Around 6% of homes in Belgium have direct electric space heating systems and about 17% have direct electric hot water systems. The total installed base has remained relatively constant.

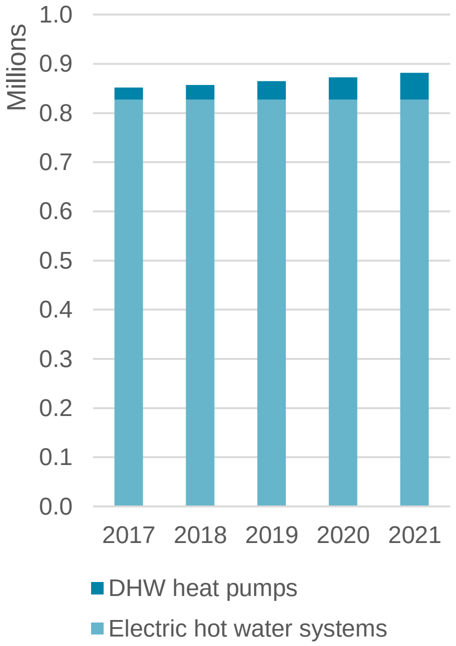
The installed base of heat pumps has grown steadily over the last few years. Almost 90,000 air source heat pumps are now installed. About 75% of these are air-water systems and 25% are air-air systems used predominantly for heating. The installed base of ground source heat pumps is close to 20,000 and around 55,000 heat pumps are for DHW only. Only a few hundred packaged hybrid heat pump systems have been sold in Belgium. It is uncertain how many heat pumps have been installed as hybrid systems with existing boilers.

Installed base of electric space heating systems



Source: EHPA

Installed base of electric water heating systems



Source: EHPA, calculations by Delta-EE

Energy Storage

Residential and commercial batteries

There is a steady increase in commercial batteries in the last few years, residential batteries are more rapidly expanding.

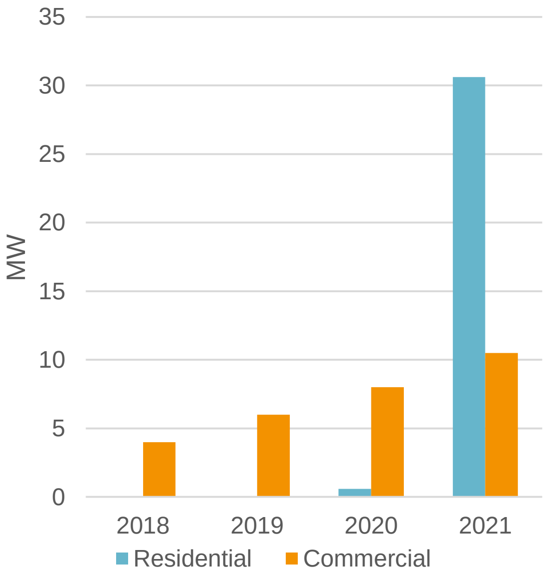
Residential

- There are capex incentives for residential batteries in Flanders, although the premium is decreasing annually with an end date of 2025.
- The incentives caused a sharp increase in installation in 2021 with the market increasing from a few hundred to ~7,000 installations.
- Going forward, we expect steady growth until 2024 then a drop in 2025.

Commercial and Industrial

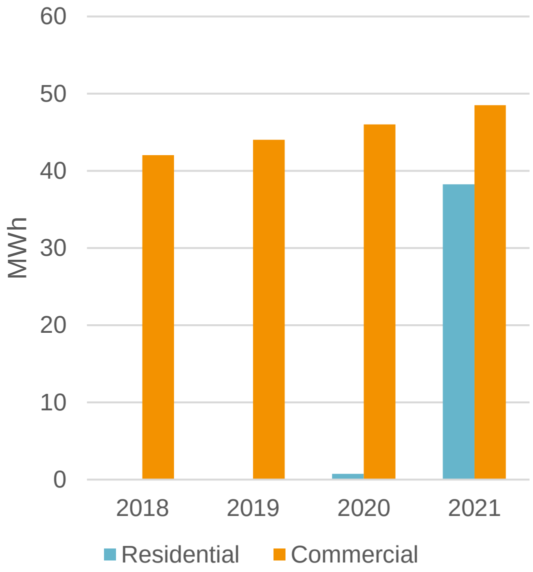
- Limited growth is expected in this sector with the market dominated by specialist projects.

Battery storage - power capacity



Source: Calculated by Delta-EE

Battery storage - storage capacity



Source: Calculated by Delta-EE

Digital enabling technologies

Smart meters and connected home assets

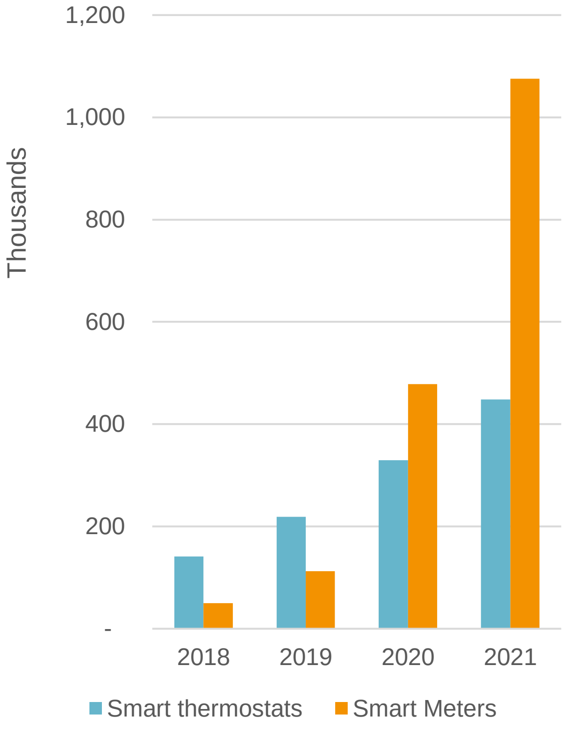
Rapid roll out of smart meters in Flanders is driving growth, but may not be replicated in other regions. Steady growth in other connected home technologies.

Smart Meters
Installations mostly driven by Flanders who are aiming for 80% of connections to have smart meter by the end of 2024 (100% by 2029). In Wallonia and the Brussels-Capital Region, complete or near-complete coverage is not expected until after 2030. Consumers can refuse a smart meter installation until 2025.
Sources: 1 2 3 4 5 6 7 8 9 10 11

Smart Thermostats, Connected TRVs and HEMs

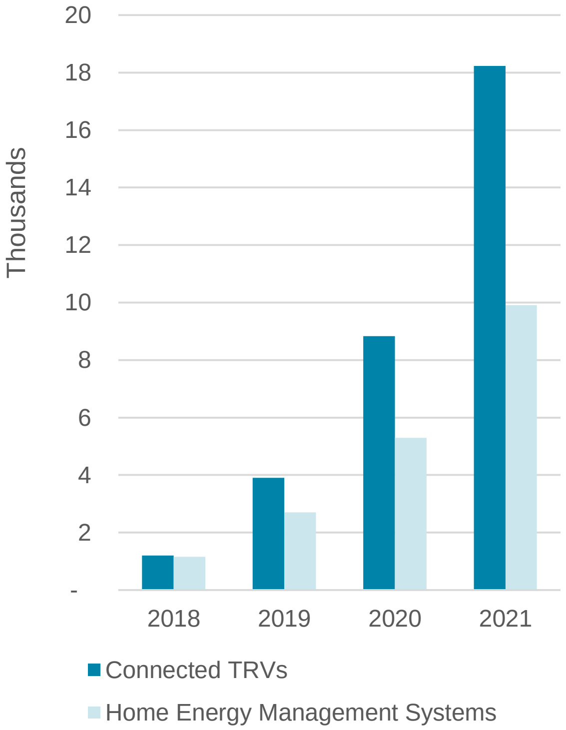
Smart thermostats are the most installed connected home assets at over 400k units and growing at a steady rate. Connected TRVs and HEMs system currently in 10 thousands range but growing rapidly with annual growth rate of >80%/year.

Smart meters and thermostats - units



Source: Calculated by Delta-EE

HEM and connected TRVs- units



Source: Calculated by Delta-EE

Annex 3 – Natural load profiles

Electric Vehicles and chargepoints

Unmanaged charging load from Belgium’s EV fleet

Demand profiles from previous research have been combined with data on the EV parc to give daily demand curves

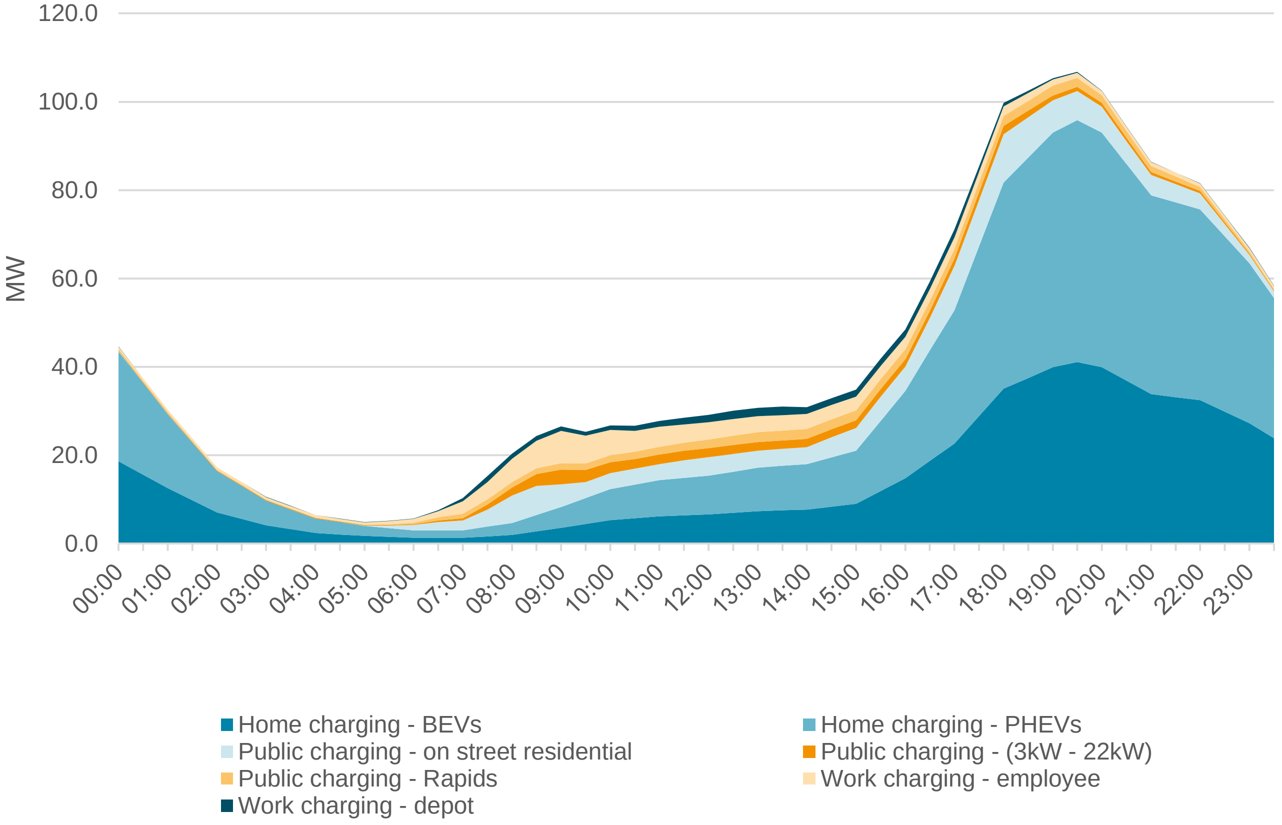
The demand curve for home and work CPs was calculated by working out the daily energy consumption required from the average daily mileage and an efficiency factor for EVs (0.3 kWh/mile)

The public charging demand profile was calculated using utilisation rates of different chargepoint types. (Source)

Daily demand profile

- EV demand profiles was taken from trial data. The trial was UK based, we have assumed EV driver behaviour is similar between the UK and BE.
- Home charging (both BEV and PHEV followed the same curve) shows a large peak between 6pm and 9pm.
- On street residential shows a similar curve to home charging, with a slight increase in the morning due to commuters charging in residential areas.
- Public charging (3 – 22kW) shows a larger peak in the morning followed by a gradual decrease and smaller peak around 5 – 7pm.
- Public charging rapids show an increase throughout the day to a steady point at midday before quickly decreasing from 8pm.
- Workplace employee charging shows a peak in the morning and a gradual decrease throughout the day
- Workplace depot shows a peak in the morning and larger peak after lunch before a slight drop and third peak after working hours (5pm)

EV demand Belgium



Electric vehicles and chargepoints

Diversity and variability

Diversity has been built into the demand curves by making assumptions on daily mileage and utilisation rates.

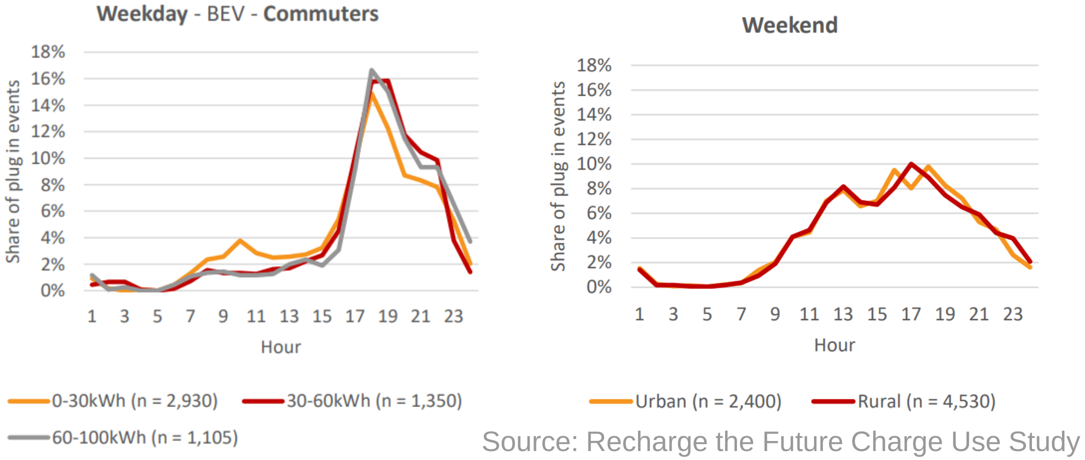
There comes the risk of even higher peaks due to variability in EV driver behaviour.

Weekend vs weekday

- Home chargepoints: Plug in events occur more spread out on a weekend with an earlier evening peak. Energy demand is lower on a weekend and there are fewer plug-in events
- Work chargepoints: Daily demand is 73% lower on a weekend than an average weekday. Plug in events are ~ 80% less.
- On-street chargepoints: Limited information available although some studies note a normal distribution of charging events between 7am and 11pm on a weekend – similar change to home.
- Slow/Fast public: Smoother charging profile throughout the day during a weekend and fewer charging events (~75% less).
- Rapids: Similar charging profiles between weekend and weekdays. There is minimal difference in the number of charging events during a weekend.

Throughout the year

- Demand per day for home chargepoints is on average 16% higher in January and 21% lower in august (source). Daily demand increases by 1.6% for every 1°C decrease in temperature. This figure accounts for efficiency of the battery as well as reduced trips during summer.
- Variation of demand for slow/fast public is similar to home, with January being 20% higher than the average and August 12% lower.



Source: Recharge the Future Charge Use Study

Share of plug-in events at different times of the day

Diversity

- Most home charge points are 7-11kW peak rated power, but the average peak demand will typically be much lower. The **after diversity maximum demand (ADMD)** provides an estimate of this, accounting for the fact the EVs are not expected to be charged every day or at the same time.
- The analysis presented here provides an **ADMD of 0.57 kW** for home charge points.
- However, considering the large difference between the ADMD and the individual home rating, there is potential for this value to be significantly higher in some circumstances and regions.
- The ADMD of public charging infrastructure is more complex due to the large variety of charging speed.

Heating technologies

Unmanaged demand from residential heat pumps

Heat pump demand curves depend on building insulation levels, comfort requirements and outdoor temperatures. On average, each residential heat pump will add about 1 kW peak demand.

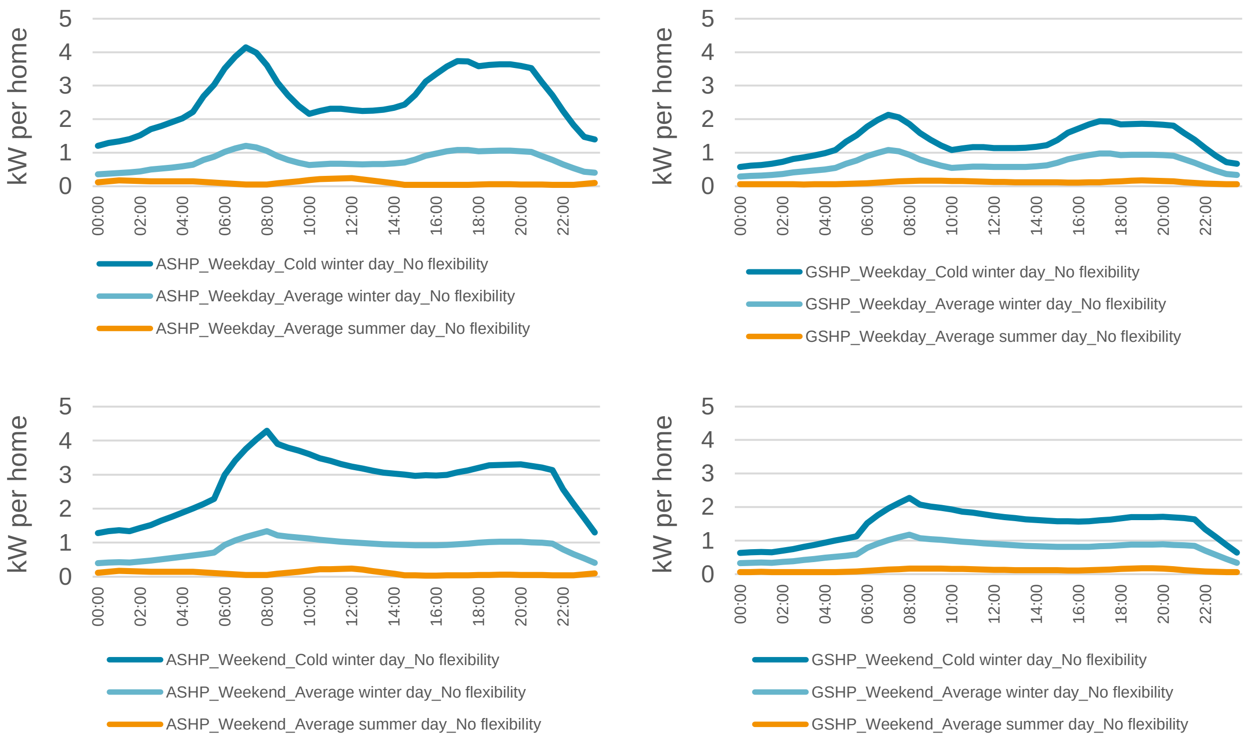
After diversity peak demands of around 1 kW during average winter weather and 4 kW in very cold winter weather align with findings in studies and trials by [Northern Powergrid], [Western Power Distribution], [Ecofys], and the [UK Government].

The unmanaged after diversity demand profiles of residential heat pumps are shown in the adjacent charts. Annex 1 explains how these profiles were derived.

The shape of the demand profiles is influenced by when homes are occupied. On weekdays demand peaks in the mornings and evenings. On weekends heat is needed throughout the day.

Heat pump electricity demand is strongly correlated with outdoor temperature. On colder days, buildings lose heat at a faster rate, and ASHPs are less efficient. ASHP demands can therefore be almost four times higher on a very cold winter day (> -6°C) compared to an average winter day (~ 6°C). GSHP efficiencies are more consistent. Heat pump demands in the summer are much lower as heat is only required for hot water generation.

After diversity demand profiles for air source (ASHP) and ground source (GSHP) heat pumps on weekdays and weekends under different weather conditions



Source: Calculated by Delta-EE

Annex 4 – Flexible profiles

Heating technologies

Heating technologies

What are the key factors determining potential flexibility

While the capability of heating technologies is highly sensitive to the season and local assets, the enabling technologies and customer barriers will be critical, with impact on consumer and complexity important barriers to overcome for widespread uptake.

Asset Volume
- Subsidies
- Building regulation
- Asset installation cost and running cost vs. gas
- Industry annual installation capacity
- “Retrofit-ability”

Asset flexibility
- Building insulation
- Thermal storage
- Season(external temperature)

Control signal
- Time of use tariffs
- Capacity tariffs
- TSO/DSO signal
- PV consumption signal

Control capability
- In built smart control
- Home energy management
- Retrofit controls

Appropriate metering
- Smart meters

Customer barriers
- Complexity for consumer
- Impact on consumer

Heating technologies

Heat pumps - potential for flexibility

Type	Potential for flexibility	Constraints	Typical unit size	Maximum load shifting period
Air-water heat pump – Space heating	Potentially can pre-heat home for 2-3 hours ahead of the time needed.	The three main factors enabling heat pump flexibility are the building's insulation, its thermal mass, the capacity of any existing buffer tanks and the intelligence level of its control system and the temperature profile required in the house.	5-16 kW	
Ground source heat pump - Space heating	Potentially can pre-heat home up to 2-3 hours ahead of the time needed.		> 8 kW	
Hybrid heat pump – space heating	Can be used for flexibility, as gas boiler can take over from heat pump unit when needed.	Intelligence level of control system. Price of gas and willingness of customers to use the gas boiler unit instead of the heat pump.	3-15 kW	No time limit, as gas boiler can operate during flexibility requirement
Heat pump water heater	Heat pump water heaters can be used in a flexible way and due to their better COP, it is more economical to use than electric hot water tanks. They can be heated up during off-peak hours and can keep energy in hot water form for several hours.	Domestic users' lifestyle is the main constraint, which determines hot water demand	1.5 kW (typically 5-7 per home)	If charged up previously, hot water tanks can be disconnected for a few hours without discomfort to the user
Air-air heat pump - Space heating	Potentially can pre-heat home up to 2-3 hours ahead of the time needed.	Thermal inertia of the air and building is the main constraint	1.3 – c. 10.2 kW	

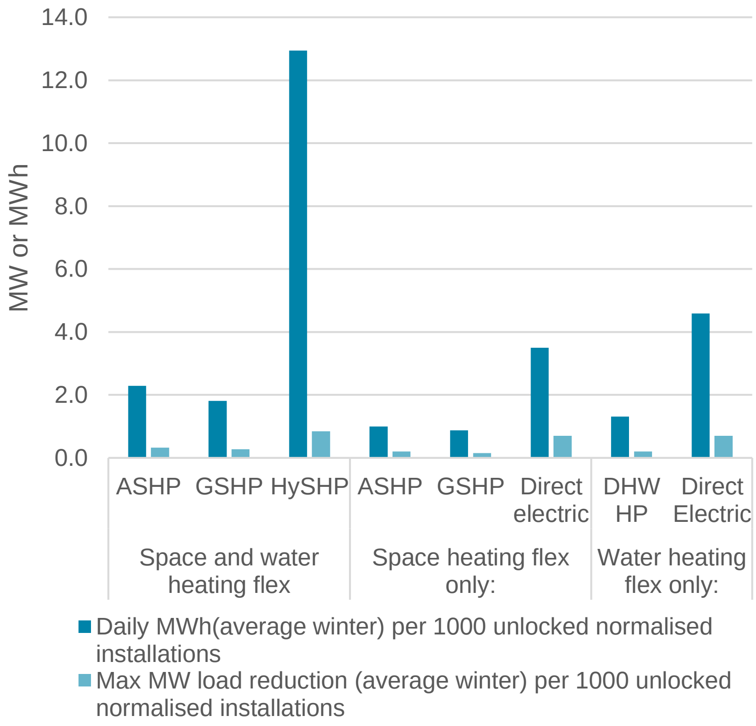
Summary of heating technology technical flexibility

Daily MWh and Max MW per 1000 installations

Electric heating technologies can provide 1-2 MWh of flexibility per day per 1000 households, however the maximum load is limited.

Flexibility type	Asset	Daily MWh (average winter) per 1000 unlocked normalised installations	Max MW load reduction (average winter) per 1000 unlocked normalised installations
Space and hot water flex	ASHP	2.3	0.32
	GSHP	1.8	0.27
	HySHP	12.9	0.84
Space heating only	ASHP	1.0	0.20
	GSHP	0.9	0.15

Flexibility of heating technologies
(Average winter day – 6 ºC)



Source: Calculated by Delta-EE

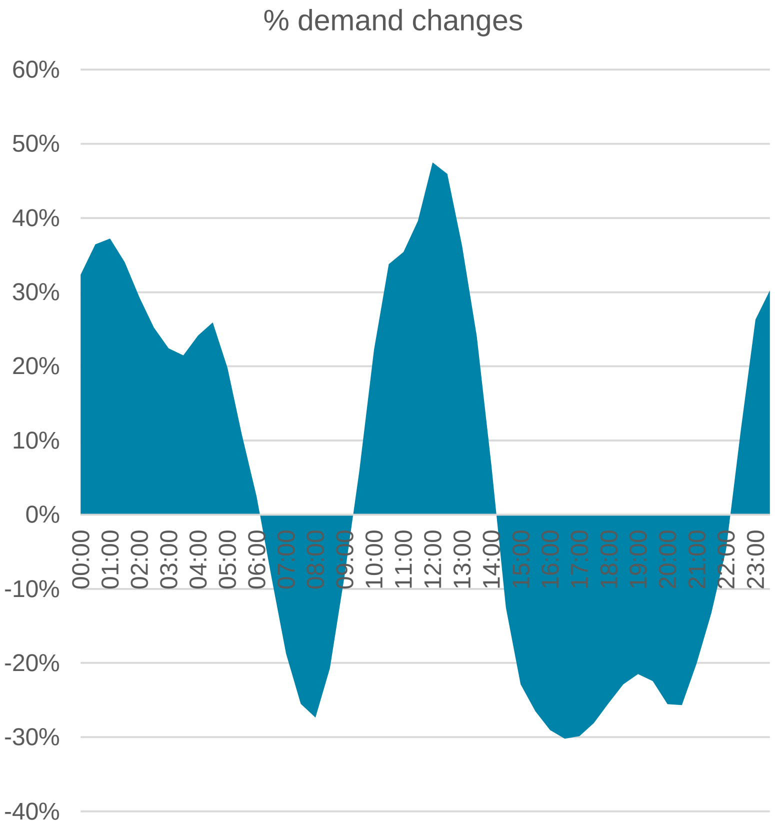
Heating technologies

Heat pump flexibility dual function HP

Heat pumps can shift up to 30% of demand if required by pre-heating homes and generating hot water outside of peak periods.

Many heat pump heating systems will provide both hot water and space heating.

Enabling flexibility in both demand, provides the greatest potential flexibility, up to 30% reduction in demand.



Source: Calculated by Delta-EE

Space heating flexibility

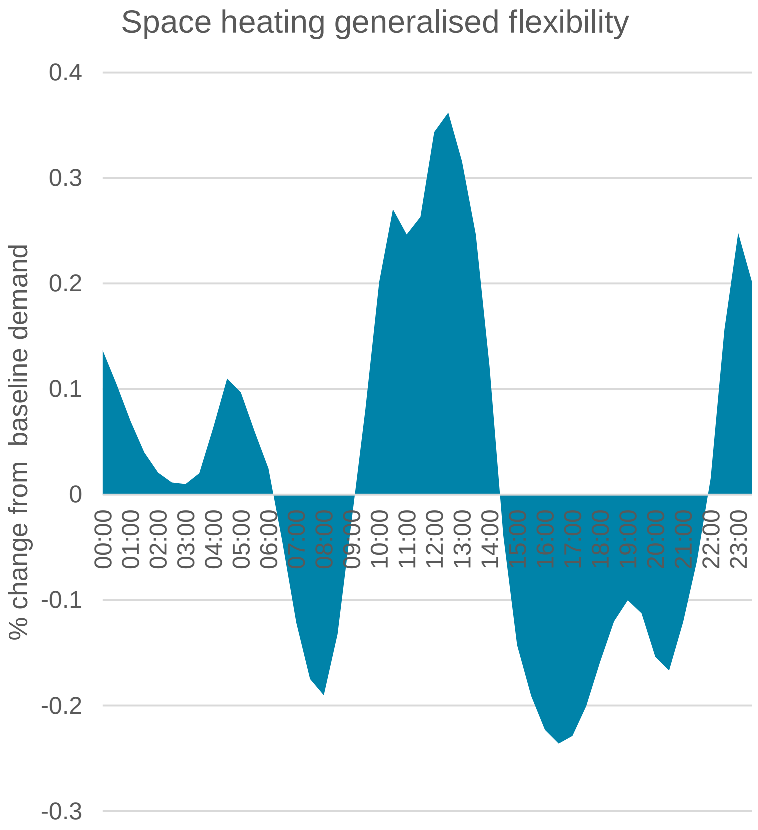
Flexibility of flexible temperature set point

Space heating flexibility can deliver ~20% reduction in heating demand in the morning and evening, but requires increased customer flexibility.

The after diversity demand of heat pumps is typically 1kW through winter but on colder days (e.g. -6 C), can reach as high as 4kW.

Maximum demand reduction therefore varies from 200-800W per unit.

- Homes were assumed to be heated to 21°C on average when occupied during the day. A 16°C setback temperature was applied overnight. A flexibility of +/- 2C is assumed, allowing preheating to 23C and cooling to 19C.
- A three hour ramp up period is allowed to prevent HP demand from peaking sharply at the beginning of the heating period. Overheating was not allowed in the mornings, as preliminary customer research findings suggested this was unacceptable to most households.
- The average flexibility as % of the baseline demand shows potential reduction in demand by ~20%, but requires ~35% increase in demand to pre-heat home in middle of the day.
- The exact impact of heat flexibility will vary based on weather conditions of the day, e.g. the specific temperature profile, wind conditions, flexibility during extreme cold weather events may be lower due to increased temperature losses.



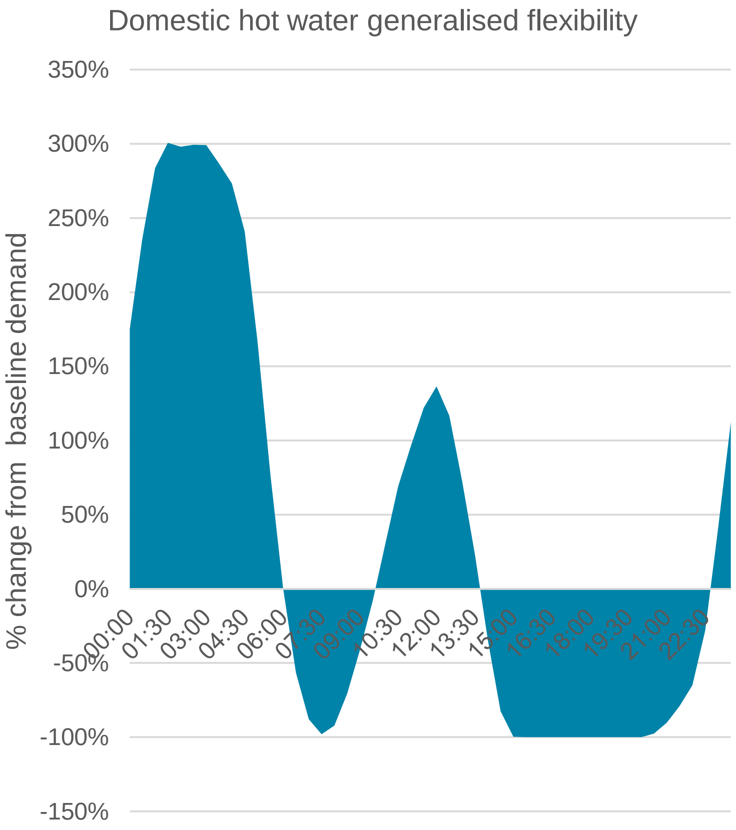
Domestic hot water flexibility

Flexibility of hot water energy storage

Domestic hot water can provide accessible but limited flexibility for most households.

Domestic hot water energy demand is not significantly impacted by outside temperature. After diversity peak normalised demand is 0.2-0.3 kW for heat pumps and 0.5-0.7kW for electric water heaters.

- Domestic hot water systems are natural energy storage system in residential homes, which can be pre-heated ahead of demand, particularly in mornings and evenings.
- In theory domestic hot water systems can be fully switch off for short duration, leading too reduction in demand of 100% as is modelled in the generalised profile. Not this requires a significant increase in demand in early morning and middle of the day.
- However, it should be noted, that while domestic hot water demand can be generalised, it can be highly variable per household per day depending on specific household needs, therefore 100% reduction of demand on aggregate may not be feasible, however this level of stochastic complexity was not included in this assessment.
- Hot water is typically 10-15% of heating demand through winter.



Hybrid heat pumps & direct electric

Potential flexibility

Hybrid heat pumps can provide very high electrical flexibility, but at the cost of higher gas consumption.

In very cold conditions the gas boiler may be the primary heat source, reducing the value of flexibility.

Hybrid Heat pumps

- Hybrid heat pumps are sized with a relatively small heat pump ~ 5kW and a typical sized gas boiler that can deliver sufficient heating and hot water to the household alone if needed
- The heat pump is designed to provide high efficiency heating
- The electric heat pump component can therefore theoretically be completely switch off at anytime and for even the full duration of the day, eliminating the need for any electrical demand. This was demonstrated in the Freedom project https://www.nationalgrid.co.uk/projects/freedom
- However, the costs of this flexibility may be high, switching electricity for gas, optimum operation will depend significantly on spark spreads while gas plays a major role in peak electricity generation.

Electric Vehicles

Electric vehicle charging

Key factors to unlock flexibility

For electric vehicles, EV and charger capabilities will be critical in determining the types of vehicle charging available the ultimate unlocked capacity.

Complexity and customer impact will determine how much customers enable their assets for flexibility.

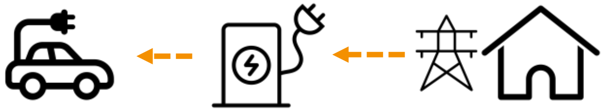
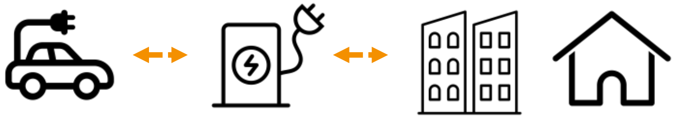
Asset Volume	Asset flexibility	Control signal	Control capability	Appropriate metering	Barriers
Subsidies	Vehicle type	Time of use tariffs	Charger type – basic, smart, bidirectional	Smart meters	Complexity for consumer
Value vs. ICE	Charger segment	Capacity Tariffs	Home energy management		Impact on consumer
	Season(external temperature)	TSO/DSO signal	EV charging capability – in built smart, bi-directional(built in or compatible with charger)		
		PV consumption signal			

Electric vehicles

Smart and bi-directional charging options

Smart charging provides most straight forward option for EV flexibility, only requiring unidirectional charging.

Vehicle-2-home (V2H) or vehicle-2-grid (V2G) approach have similar enablers, requiring more expensive charging equipment. Market arrangements are key for V2G.

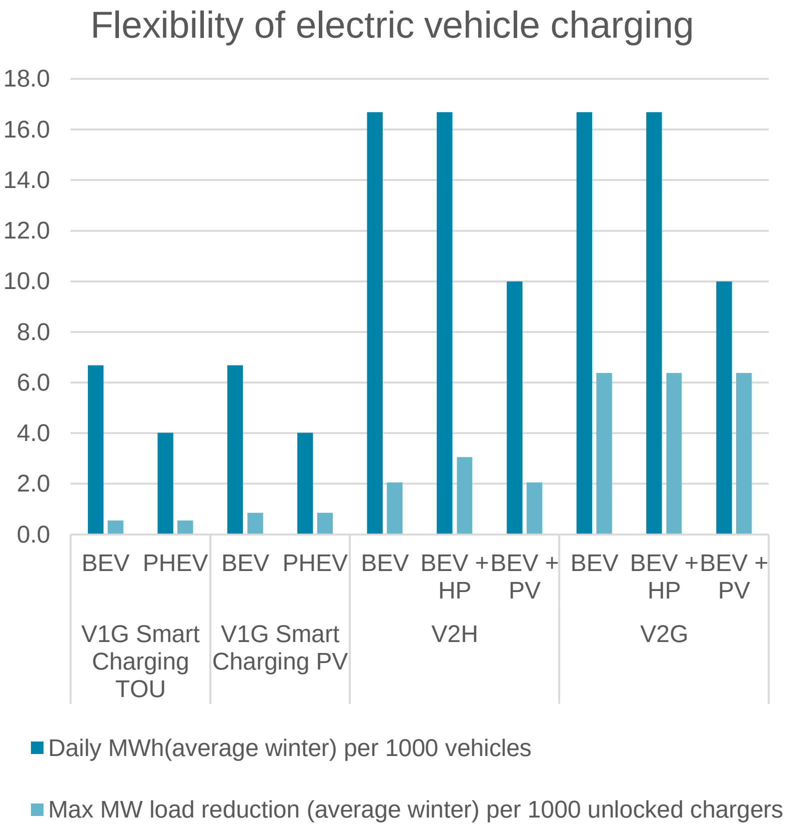
Vehicle 2 X - Types	Key enablers
Smart Charging (V1G) The ability to optimise the time and rate of charging against time of use tariffs, solar PV self consumption, or other control signals.	▪ Smart chargers or in vehicle smart charging capability including connectivity ▪ Increasing plug in time. ▪ Smart meter (for tariff driven flexibility) 
Vehicle2Home (V2H) & Vehicle2Building (V2B) The ability to optimise self consumption from domestic PV and/or use the vehicle battery to optimise time of use tariffs provides the customer with **cheaper, greener electricity**. When referring to V2H for residential, single family homes, V2B for commercial (fleets) or residential (multi family homes).	As V1G plus: ▪ Bi-directional inverter (in charger or vehicle) cost and deployments ▪ Interoperable communication protocols and standards 
Vehicle2Grid (V2G) The ability of the vehicle to respond to signals from a network company (usually via an aggregator) to discharge electricity to the grid at a set time. There are different value streams available for EVs to take advantage of (see value streams slide). To be defined as V2G, the vehicle must be discharging / exporting electricity	As V2H plus: ▪ **Market arrangements for aggregation and access.** ▪ Business models providing sufficient annual return 

Summary of electric vehicle technical flexibility

Daily MWh and Max MW per 1000 installations

Electric vehicles can provide 4-16.7 MWh per day per 1000 vehicles, depending on charging capability. Max MW is highly dependant on charging capabilities.

Flexibility type	Asset(s)	Daily MWh(average winter) per 1000 vehicles	Max MW load reduction (average winter) per 1000 unlocked chargers
V1G Smart Charging TOU	BEV	6.7	0.54
	PHEV	4.0	0.55
V1G Smart Charging PV	BEV	6.7	0.85
	PHEV	4.0	0.85
V2H	BEV	16.7	2.05
	BEV + HP	16.7	3.05
	BEV + PV	10	2.05
V2G	BEV	16.7	6.38
	BEV + HP	16.7	6.38
	BEV + PV	10	6.38



Source: Calculated by Delta-EE

Electric vehicle charging

Smart charging – Time of use tariff

Home chargers and work depot charging have potential to respond to price/market signals to changing charging time.

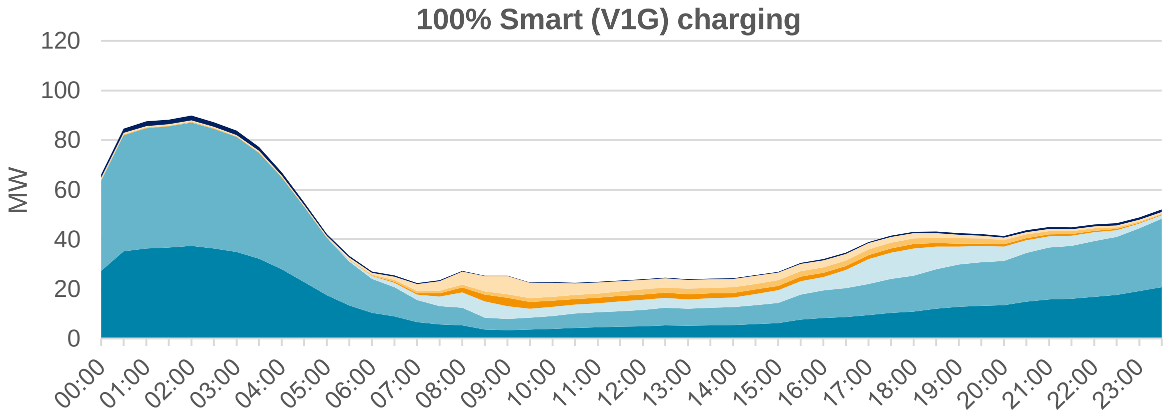
Peak demand is shifted to 2:00 and ~10% lower.

Public charging and employee charging not suitable for load shifting

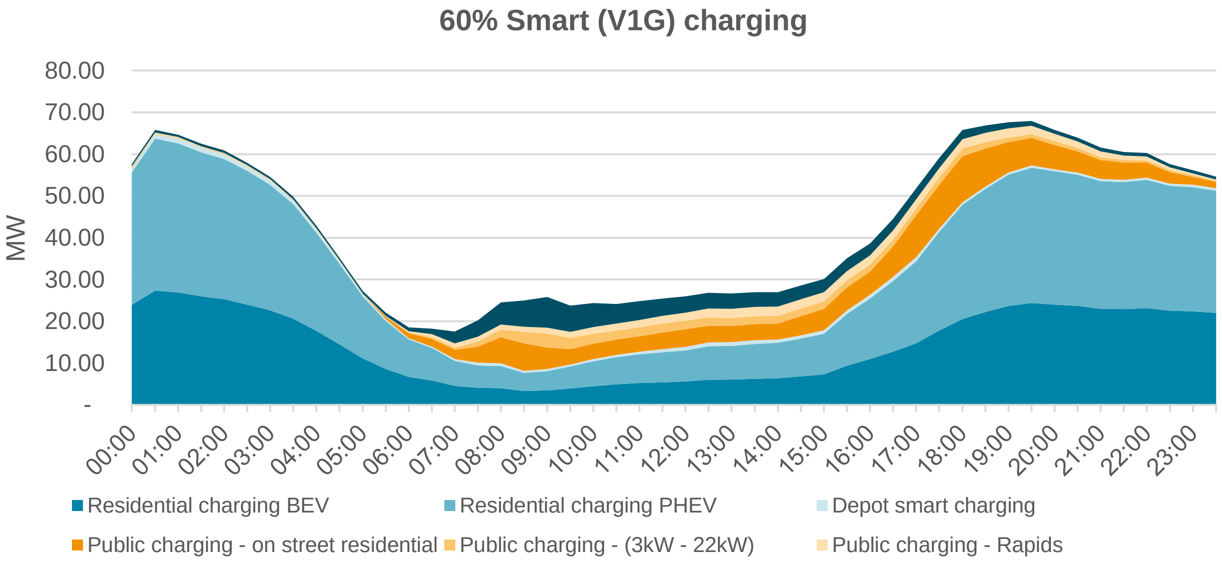
Chargepoints with internet connectivity can respond to signals and programme charging to optimum times

- A typical normalised smart charging profile will look like the top graph on the right, however this assumes 100% of residential chargepoints in Belgium are internet connected.
- More realistically only around 60%* are smart, meaning the EV demand profile of Belgium will look more like the bottom right graph
- Only specific chargepoint segments are suitable for smart charging: residential and workplace depot. Other segments either require quicker speeds of charge so can’t be shifted or are commercially difficult to scale e.g. on street residential.
- Unlike V2G/H, there is no need for the vehicle to have upgraded technology for smart charging to take place.

*Average based on Delta-EE customer research



Source: Calculated by Delta-EE



Source: Calculated by Delta-EE

Electric vehicle charging

Residential V2G/H availability

An average EV availability of 72% has been observed in V2G specific trials. This figure is important to calculating the flexibility potential from V2G/H.

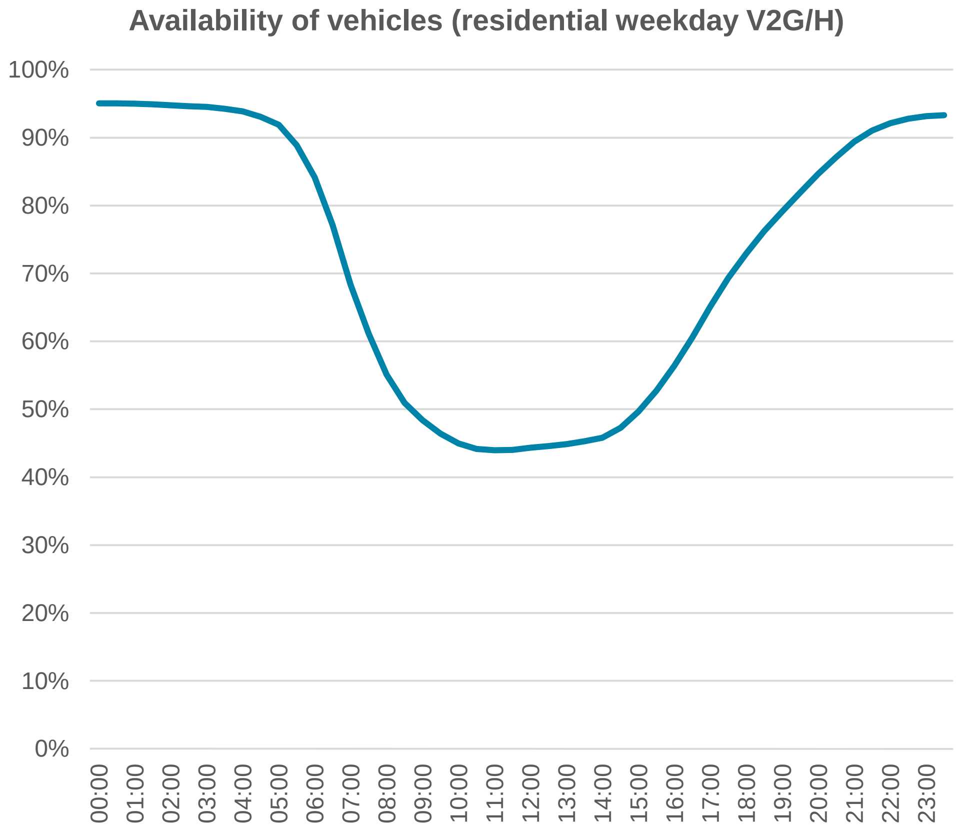
Availability of EVs is highly dependent on driver behaviour. Incentives would need to be offered to increase plug in time of drivers.

The trial mentioned here incentivized drivers to plug in more, meaning in a mass market it could be lower

By using the EV availability curve, we can provide estimations on how flexibility potential of V2G/H varies throughout the day

- EV availability at 00:00 is ~95%. The vast majority of EV drivers with a bidirectional chargepoint at home will plug in at home after their last trip of the day*
- Throughout the morning this dips to a low of 44% at midday
- Availability then increases gradually back up to 95% by 22:00
- Should there be a need for flexibility at 18:00 for example, the capacity available would be 73% of the entire installed base. In 2023 this would be 200 x 7kW x 73% = 1022kW. Additional turn down capacity would be available if the EVs were charging however this hasn't been included here. It is likely that EV drivers with a bidirectional chargepoint are on a smart / dynamic tariff, meaning many would delay charging to off peak (after 18:00).

*Project Sciurus



Source: Project Sciurus

Heating technologies

Demand profiles of heat pumps providing flexibility

Heat pumps can shift up to 15% of demand if required by pre-heating homes and generating hot water outside of peak periods.

Installing additional storage with heat pumps would allow more demand to be shifted from peak periods.

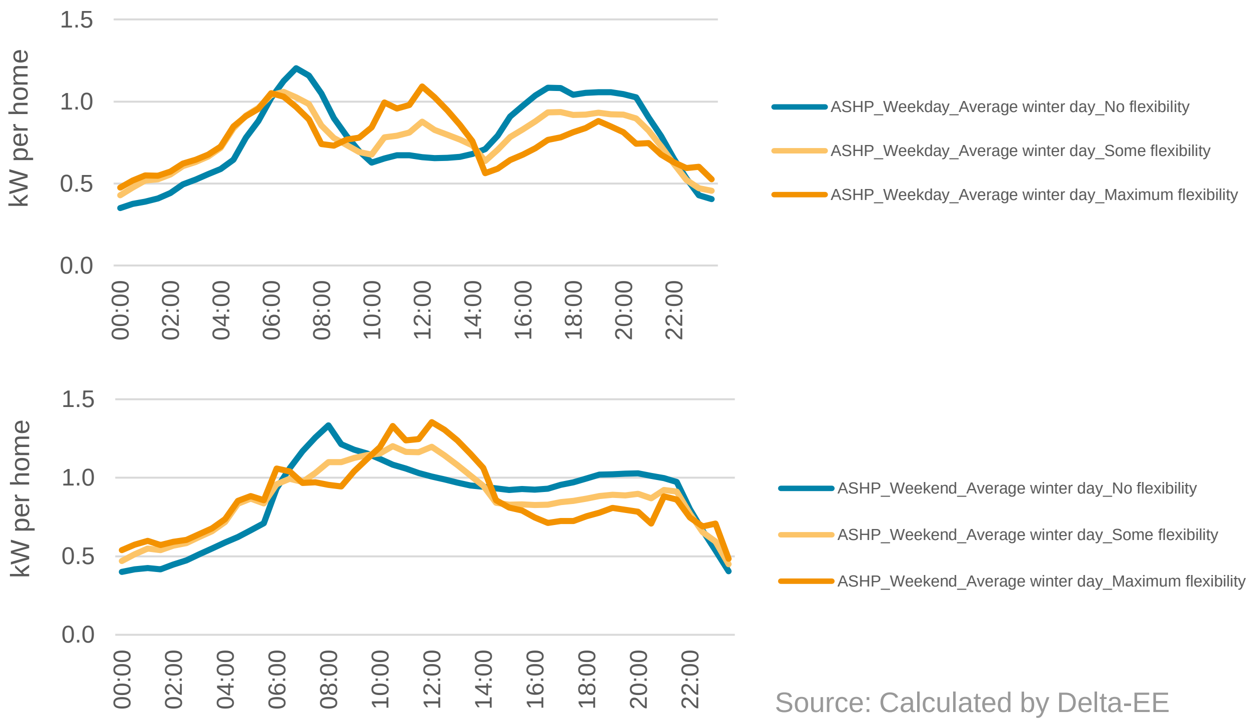
The adjacent charts show the demand profiles of heat pumps optimised to a time of use tariff with lower overnight prices and high evening peak prices.

In the example of heat pumps providing some flexibility, hot water generation is allowed to occur at any time, provided demand can always be met. Indoor temperatures are allowed to deviate by ±0.5°C from the set temperature profile.

In the example with heat pumps providing maximum flexibility, indoor temperatures are allowed to deviate by ±2°C from the set temperature profile.

This helps to reduce demand during the morning and evening peak periods by pre-heating homes overnight and in the afternoon when the electricity grid is less constrained.

After diversity demand profiles for air source (ASHP) and ground source (GSHP) heat pumps on weekdays and weekends providing different levels of flexibility



Source: Calculated by Delta-EE

Annex 5

Unlocked Inventory

Annual factors for generating unlocked flex

Heading Technologies

Home chargepoints	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
% HP Smart	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	32%	34%	36%	37%	39%
% households with smart thermostats	5.5%	7.5%	9.8%	12.2%	14.9%	17.7%	20.7%	23.7%	26.9%	30.1%	33.4%	36.8%	40.3%	43.9%	47.5%	51.2%
% households with HEM	0.1%	0.2%	0.3%	0.4%	0.6%	0.8%	1.0%	1.3%	1.7%	2.1%	2.6%	3.2%	3.9%	5.0%	6.2%	7.9%
% Smart HWT	2%	4%	6%	8%	10%	12%	14%	16%	18%	20%	22%	24%	26%	28%	30%	32%
% of homes with smart meters	8%	18%	22%	37%	53%	58%	63%	69%	74%	79%	82%	85%	88%	91%	93%	96%

This is linked to the methodology described on slide 37

Heating technologies customer barriers

How do customer barriers limit potential uptake?

Different types of flexibility for heat have greater customer impact and therefore are expected to have lower uptake.

The maximum uptake based on these factors is described here.

This is linked to the Methodology described on slide 37

Technology and flexibility type	Customer impact	Maximum uptake	Reasoning
ASHP - Water only	V. Low	90%	For a relatively high value asset, this small change can provide significant flexibility and reduce costs without customer impact
ASHP - Water & space	High	25%	Flexing space heating requires more compromises for customers, allowing a wider range of internal house temperatures which will reduce uptake.
GSHP - Water only	Low	75%	Similar to ASHP, but as GSHP is more efficient there is lower value in providing flexibility as overall energy demand is lower
GSHP - Water & space	V. high	5%	Similar to ASHP, but as GSHP efficiency is less affected by temperature the benefits of flexing during the winter are lower.
HyHP - Water only	Low	75%	Hybrid heat pumps vary but electric HP can be used primarily for pre-heating water and therefore could operate flexible quite easily, however where switch to gas is required, flexing to use gas instead of electric power may be increasingly expensive in the future.
HyHP - Water & space	V. High	5%	As limited amount of capacity is generated through the electric heat pump, especially during winters the benefits for providing flex and the costs are lower, therefore limited impact is likely.
Direct electric - space heating	V. High	5%	Electric space heating has a large existing stock, with multiple disconnected assets per house, in addition space heating has low thermal inertia therefore customers would be required to expect a high range of temperature. Electric heating is often fitted in older buildings with lower insulation levels, making them less suitable for flexibility.
Direct electric – domestic hot water	Low	75%	There is a large existing stock of electric hot water tanks that would require retrofit to participate. While relatively cheap to retrofit, EHW are generally installed to keep costs as low possible, some tanks may also be too small to be effectively utilised for energy storage, therefore low impact instead of very low.
Heat pump – domestic hot water	V. Low	90%	DHW stock is relatively new and as higher value assets are more likely to include smart controls enabling increased efficiency, hot water flexibility has low impact on the customer.

Flexibility type	Offering complexity	Maximum uptake	Reasoning
H1H – Implicit flexibility	Low	75%	While it has low customer impact to optimise self-consumption according to tariffs, some resistance and disinterest is likely while tariffs are a free choice.
H1M – Explicit flexibility	High	25%	The offering for grid services and potential loss of asset control can be difficult for some customers to understand and it is harder to quantify the customer benefit, therefore we would expect uptake to be significantly lower.

Annual factors for generating unlocked flex

Home chargepoints

Home chargepoints	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
% of new home chargepoints which are smart			90%	90%	90%	95%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Smart meter penetration	8%	18%	22%	37%	53%	58%	63%	69%	74%	79%	82%	85%	88%	91%	93%	96%
% of EV drivers with a smart meter and smart chargepoint participating in V1H	60%	62%	64%	66%	68%	70%	72%	74%	76%	78%	80%	82%	84%	86%	88%	90%
% of EV drivers with a smart meter and smart chargepoint participating in V1M				5%	20%	22%	24%	26%	28%	30%	32%	34%	36%	38%	40%	42%
% of EV drivers with a bidirectional chargepoint participating in V2H			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
% of EV drivers with a bidirectional chargepoint participating in V2M as well as V2H									10%	20%	30%	40%	50%	50%	50%	50%

This is linked to the methodology described on slide 41

Annual factors for generating unlocked flex

Workplace charging

Workplace chargepoints	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
% of depot chargepoints smart	70%	75%	80%	85%	90%	95%	95%	95%	95%	99%	99%	99%	99%	99%	99%	99%
% of employee chargepoints smart	70%	75%	77%	78%	80%	82%	83%	85%	87%	88%	90%	90%	90%	90%	90%	95%
% depot smart chargepoints V1H	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
% of depot smart chargepoints V1M				5%	20%	22%	24%	26%	28%	30%	32%	34%	36%	38%	40%	42%
% of depot bidirectional chargepoints V2H			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
% of depot bidirectional chargepoints V2M as well as V2H				10%	20%	30%	40%	40%	50%	60%	60%	60%	60%	60%	60%	60%

This is linked to the methodology described on slide 41

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