STUDY ON THE QUANTIFICATION OF BELGIAN RESIDENTIAL AND TERTIARY FUTURE CONSUMER FLEXIBILITY

Draft report: version of 27/10/2022
An update and more elaborated will be available
beginning of November.

CONTACT:
Laurence.Robinson@delta-ee.com
Stephen.harking@delta-ee.com
Oliver.McHugh@delta-ee.com

Disclaimer

This slide deck is a collection of all slides sent by DELTA-EE so far as part of their study on “the quantification of Belgian residential & tertiary future consumer flexibility” for Elia.

Their final slide deck will be delivered for the 4th of November latest.

This slide deck contains information on the

1. relevant technologies to deliver flexibility in the next 10 years
2. enablers needed to unlock this flexibility
3. further details on flexible profiles for the technologies considered relevant
4. development of flexibility options for the said technologies

The full report will complete the presented data with information on the methodology & assumptions

Demand side flexibility technology list

Initial capability scoring

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

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.

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

Technologies list

Technologies considered for demand side flexibility

Out of all initially considered technologies: Air conditioning, commercial refrigeration and residential appliances have been excluded from further analysis

Category	Residential Technologies	Commercial Technologies
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
Electric heating loads	Air & ground source heat pumps Hybrid heat pumps	Air & ground source heat pumps Hybrid heat pumps
Cooling Loads	Air conditioning systems	Air conditioning systems Commercial refrigeration
Energy Storage	Home batteries Hot water storage(covered in heating)	Commercial batteries
Misc. loads	Lighting Appliances & white goods	

Miscellaneous loads – lighting and appliances etc.

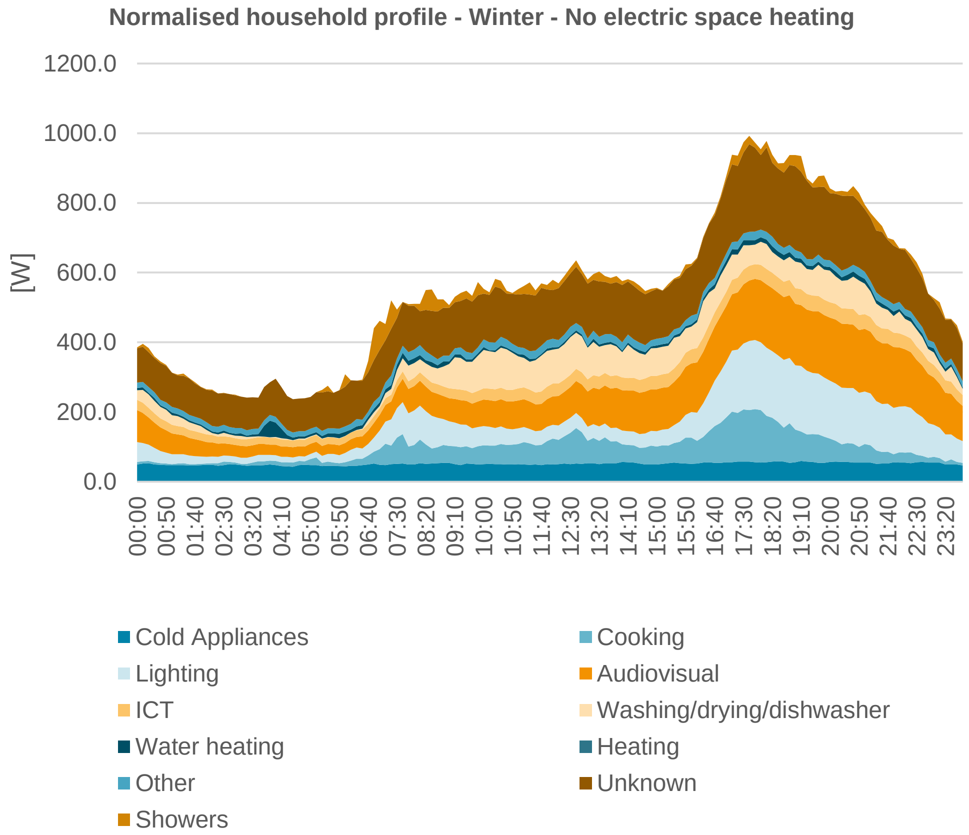
Normalised household profile in winter without electric space heat

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 → unclear – believed to be mostly lighting and 24/7 appliances

The **capacity accessible for flexibility amounts to <15% of peak load at 17:40.**



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

Miscellaneous loads – appliances etc.

Normalised flexibility for misc. loads across 3 household examples

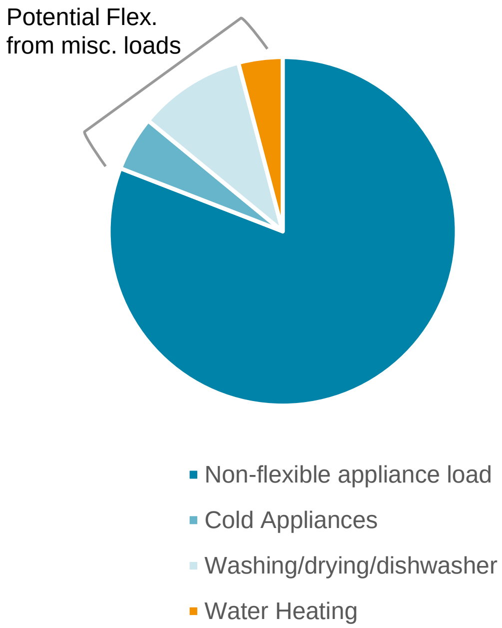
Flexibility potential from misc. loads is not significant, especially as adoption will be challenging to encourage and manage.

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 **~1000W.**

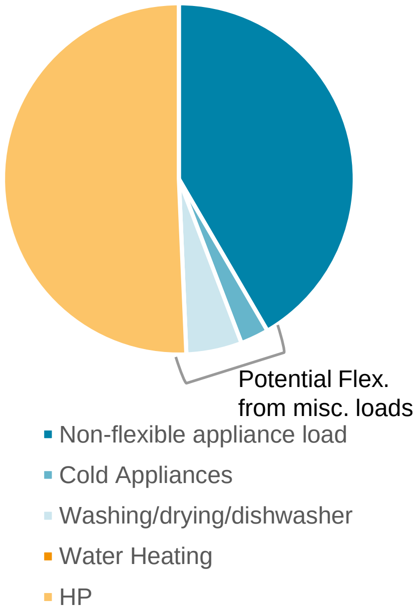
Normalised flexibility from the miscellaneous loads amounts to **~15%** (131W)



Home with air source HP

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

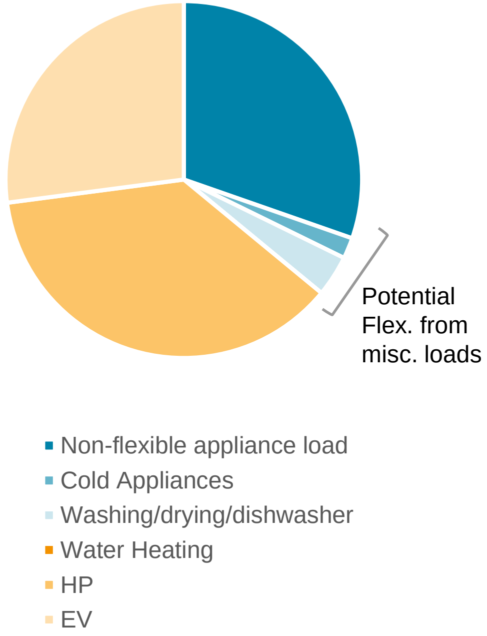
Normalised flexibility from the miscellaneous loads amounts to **~5%** (116W) (flex load is slightly lower as water heating is delivered by heat pump)



Home with air source HP & EV

Normalised peak demand across households amounts to electric HP and EV **~3,000W.**

Normalised flexibility from the miscellaneous loads amounts to **~4%** (116W) (flex load is slightly lower as water heating is delivered by heat pump)

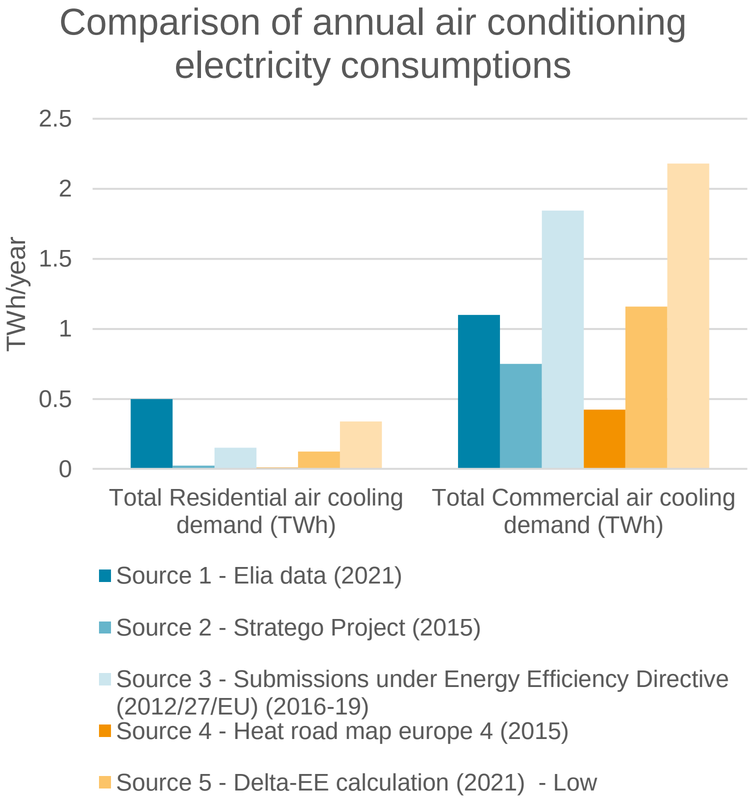


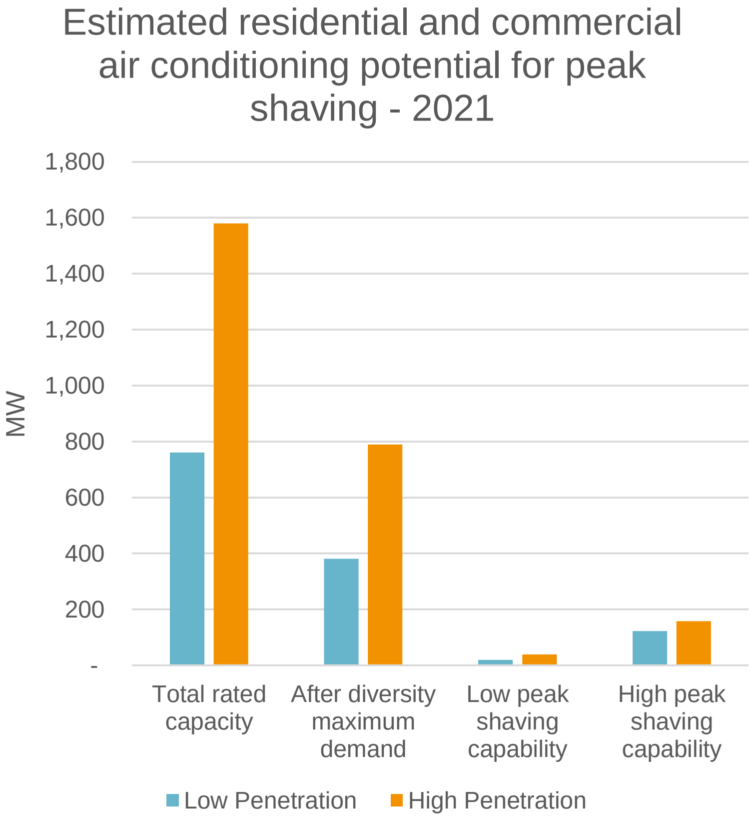
Air conditioning demand side flexibility assessment

Estimate for ~20-150MW flexibility, with high uncertainty

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

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


Comparison of annual air conditioning electricity consumptions


Estimated residential and commercial air conditioning potential for peak shaving - 2021

Commercial refrigeration demand side flexibility assessment

Estimates peak shaving potential of 10-102MW, with high uncertainty

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

Qualitative assessment summary

Outcome of investigations

Air conditioning and residential appliances and lighting are unlikely to have provide significant capacity for DSF, 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 expect 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.

DELTA-EE

Key factors

What is needed to unlock demand side flexibility?

Control signal	Control capability	Asset flexibility	Accurate metering	Participation
Market or local need that provides signal for when and how flexibility is required	Capability to receive and respond to market signal	Capability of assets to provide flexibility around demand	Ability to accurately measure the energy usage in timeframes relevant to flexible services	Degree of engagement and participation
A	B	C	D	E

This framework outlines that flexibility can encounter technical barriers (see B), but also soft barriers (see A).

Market reforms could enable as well as accelerate companies ability to develop offerings and generate market signals.

Enablers list

Factors considered & relevance per technology

Enabler	Impact	HP	EV	BAT	Area
Technologies					
Smart capability and connectivity	enables flexible control	●	●		B
Buffer tanks for space heating	asset flexibility and participation.	●			C,E
Smart/digital meters	enables access to smart tariffs, access to financial incentives	●	●	●	D,E
Housing insulation	space heating flexibility and participation	●			C,E
Home energy management products	multi-asset optimisation, control of “dumb” devices.	●	●	●	B,C, E
HP/EV/PV/Battery combination	Multi-asset optimisation opportunity	●	●	●	C
Bi-directional chargers	Enables increase EV charging types		●		C
Market & regulation					
Availability of time of use/capacity tariffs	provides control signal and incentive for participation	●	●	●	A,E
Market arrangement and structure for TSO/balancing/DSO flex services	provides control signal and incentive for participation	●	●	●	A,E
Standards for interoperability	Reduces stranded assets and availability for participation.	●	●	●	B,E
Installation subsidies	Increases number of assets available	●	●	●	
Building regulations	Increases number of assets available	●	●	●	

EV
LOAD PROFILE & FLEX POTENTIAL

Natural load profile

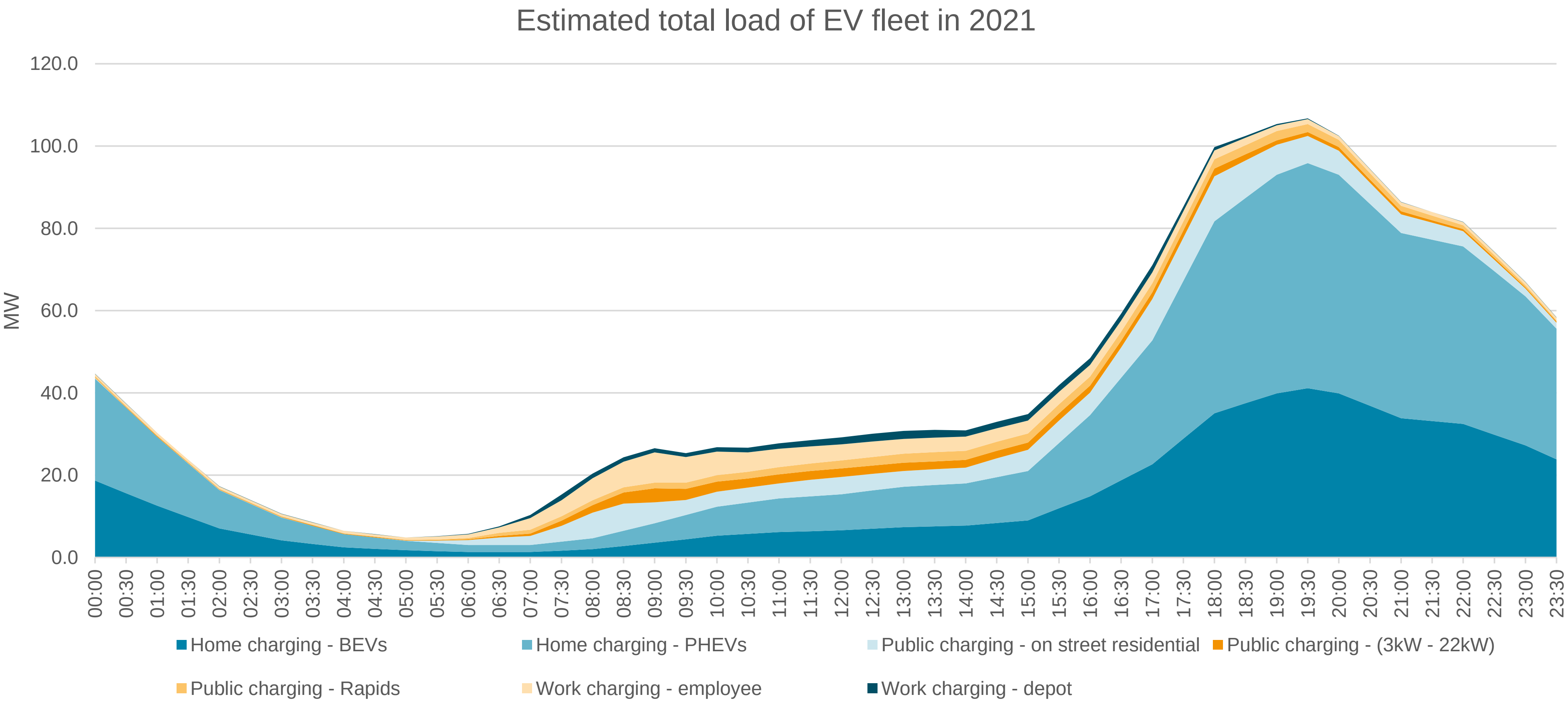
Electric Vehicles and chargepoints

Unmanaged charging load from Belgium’s EV fleet

Key message: Most charging happens through home chargepoints hence, flexibility is not available all the time

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

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

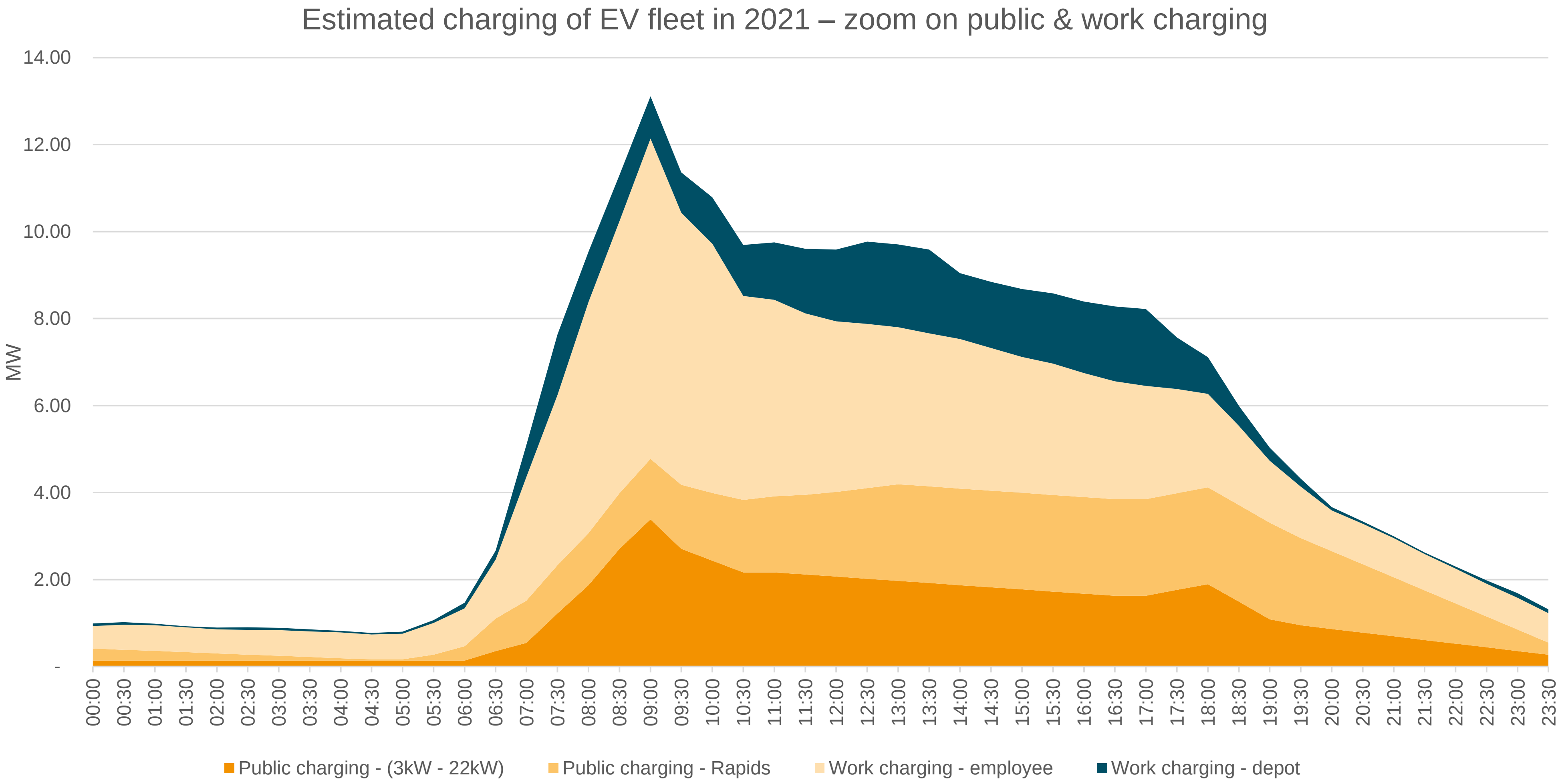


Electric Vehicles and chargepoints

Work and public chargepoints

Public charging (3 – 22kW) shows a larger peak in the morning followed by a gradual decrease and smaller peak around 5 – 7pm.

Workplace employee charging shows a peak in the morning and a gradual decrease throughout the day



Enablers and flexible profiles

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			

Profiles categories for EVs

EV can lever different type of flexibility

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

Vehicle 2 home or vehicle 2 grid approach have similar enablers, requiring more expensive charging assets. **Market arrangements are key for V2M.**

Management of EVs can happen either uni- or bidirectionaly (1 or 2), and based on a local or market signal (H or M).

Technology	Profile name	Description	Enablers
Electric Vehicles (EV)	V0	Natural Charging : charges as soon as plugged-in	/
	V1**H**	Smart charging based on local signal (**H**ome)	Smart meter Smart charger & communication capability Appropriate tariff
	V1**M**	Smart charging based on **M**arket signal	Smart meter Smart charger & communication capability Price signal (e.g.: dynamic tariff)
	V2**H**	Smart management based on local signal (**H**ome)	All V1H enablers, plus: Bi-directional smart charger & EV
	V2**M**	Smart management based on **M**arket signal	All V1M enablers, plus: Bi-directional smart charger & EV

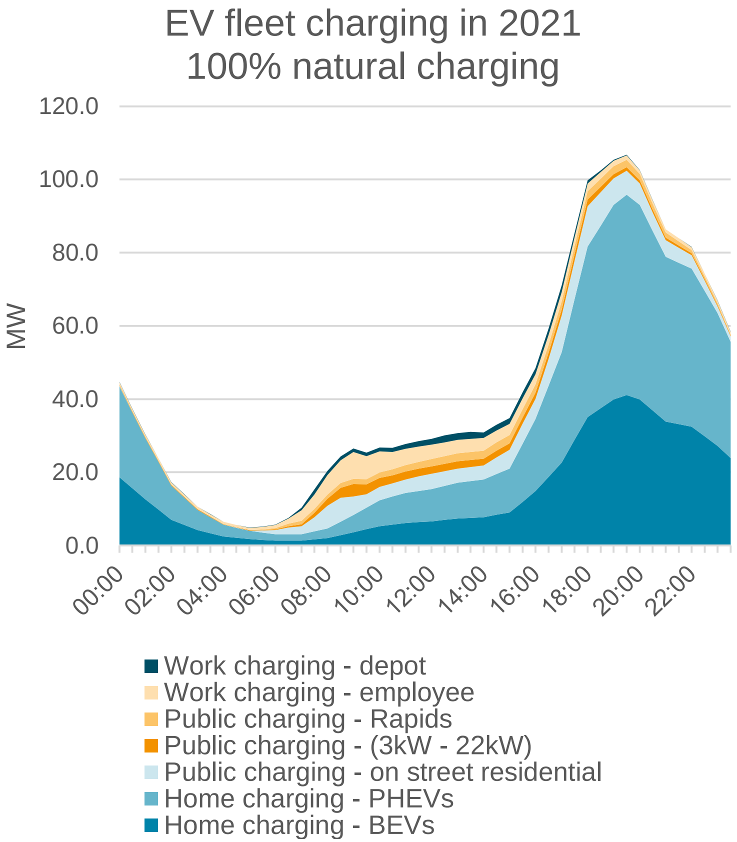
Smart electric vehicle charging

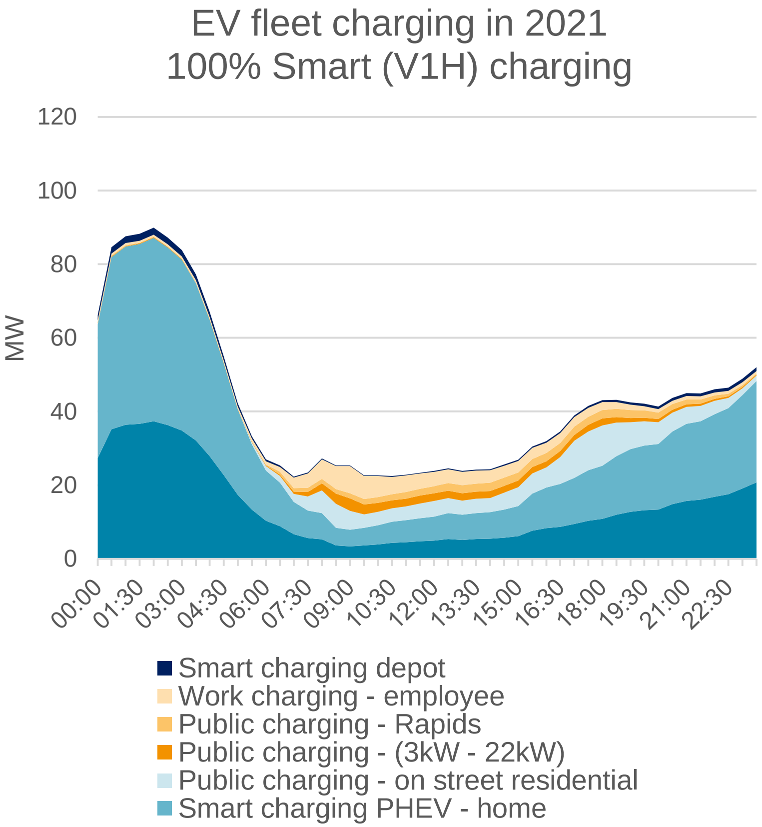
Aggregated load shifted profile

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





Concerning V1M, V1H profile can serve as illustration.
But for V1M, the ANTARES will determine the optimal level of shifting.

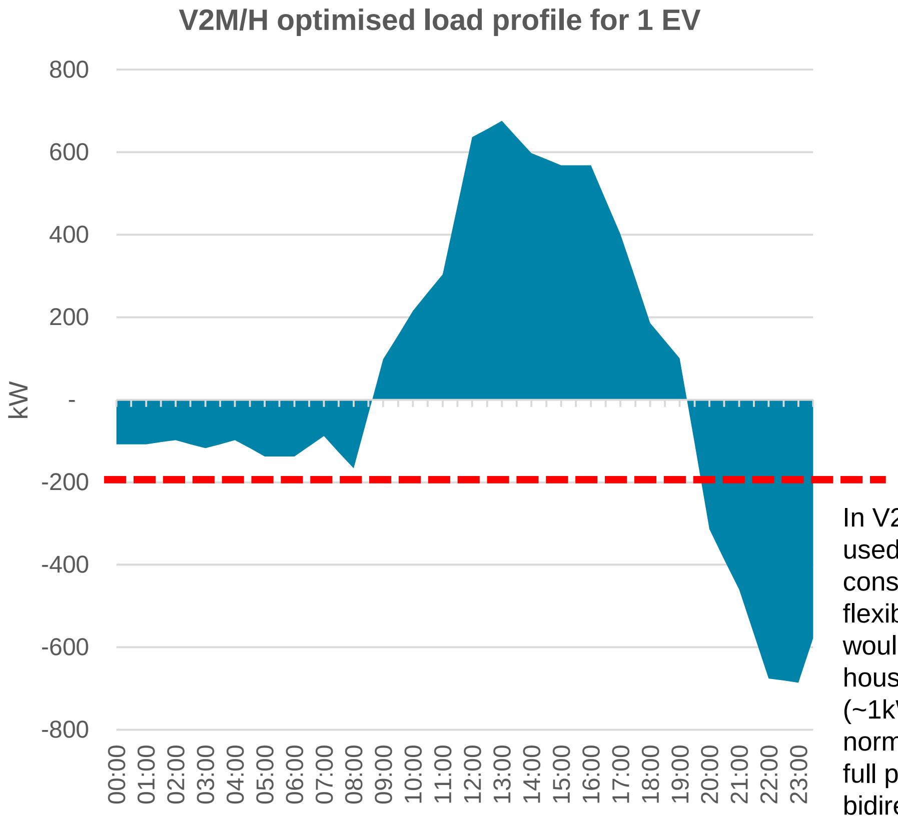
Electric vehicle charging

Residential V2M/H

Residential V2M and V2H will have similar load profiles. Individual uses will vary as different value streams and driving patterns are considered.

The chart opposite shows the ideal optimised charging profile for a V2M/H connected EV

- Low numbers of bidirectional CP units are expected up until 2024 / 2025 so flexibility potential from this segment will be low (~**200** in 2023, mainly in trials).
- As seen in trials, average daily export of energy in a V2M/H session is~**10kWh.**
- Bidirectional CPs are yet to come to mass market, most residential models available now will export at ~**7kW**.
- Combining the figures mentioned above with a higher-than-normal utilisation of **72%** (explained on next slide) gives an export potential of ~1MW
- There is an additional flexibility potential of shifting the demand from charging, currently showing at a peak of ~640kW. Similarly, if this were to be fully utilised it would be equivalent to shifting a maximum of ~1MW.
- In reality, the flexibility contribution available in vehicle-to-home use cases will be limited by household demand. Domestic consumption rarely exceeds 5kW, whereas V2M could comfortably export at 7kW.



In V2H units are only used to limit household consumption, the flexibility available would be limited by household demand (~1kW at peak normalized) and not the full potential of the bidirectional CPs (7kW)

Electric vehicle charging

Residential V2M/H availability

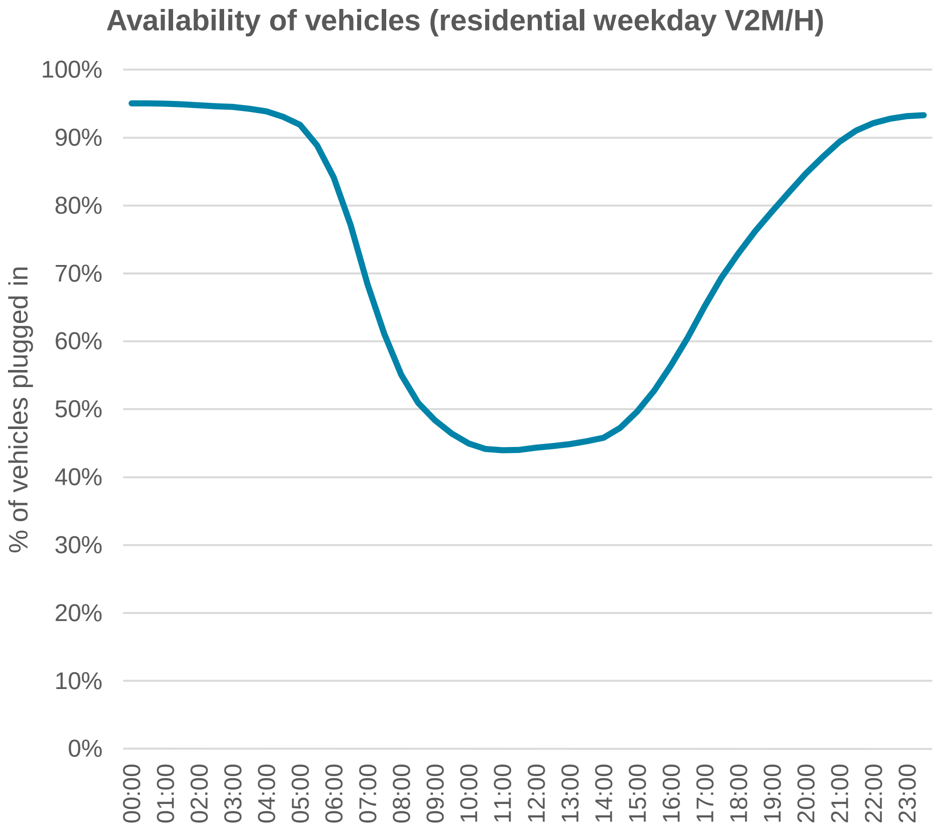
An average EV availability of 72% has been observed in V2M specific trials. This figure is important to calculating the flexibility potential from V2M/H.

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 V2M/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

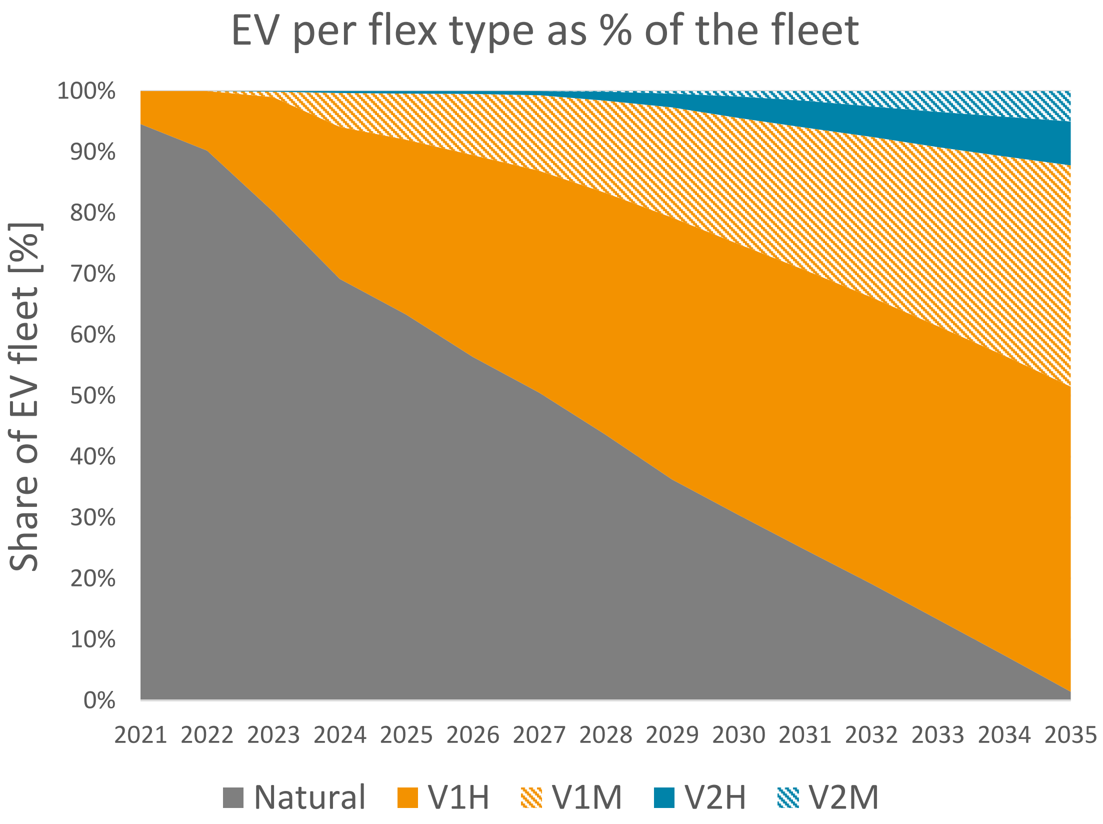
Penetration of flexibility option

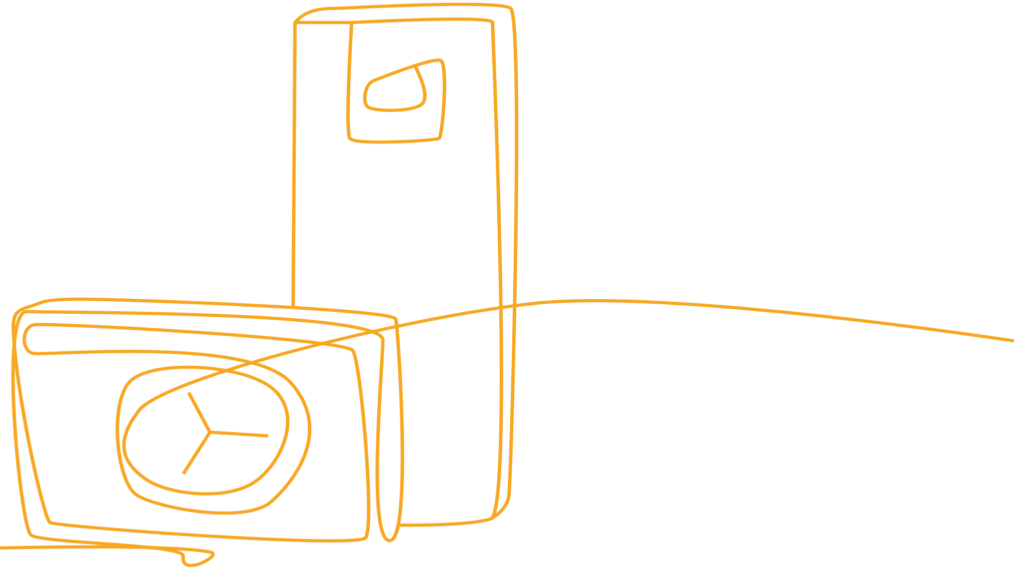
EV flex option penetration

DELTA-EE Best Estimate

Important remarks on forecast:

- BEV owners to buy **smart chargers**
- **“dumb” charger replacement** every 4 years
- **Smart meters uptake** aligned with regional targets
- **No technical barriers** to a maximum V1H smart uptake. This share can be achieved with a minimum of market reforms.
- V2M/H possible in **new sales as of 2025**.
- V2M participation can be **boosted with the right market reforms** (As pushed by the EU through part of its Clean Energy Package)





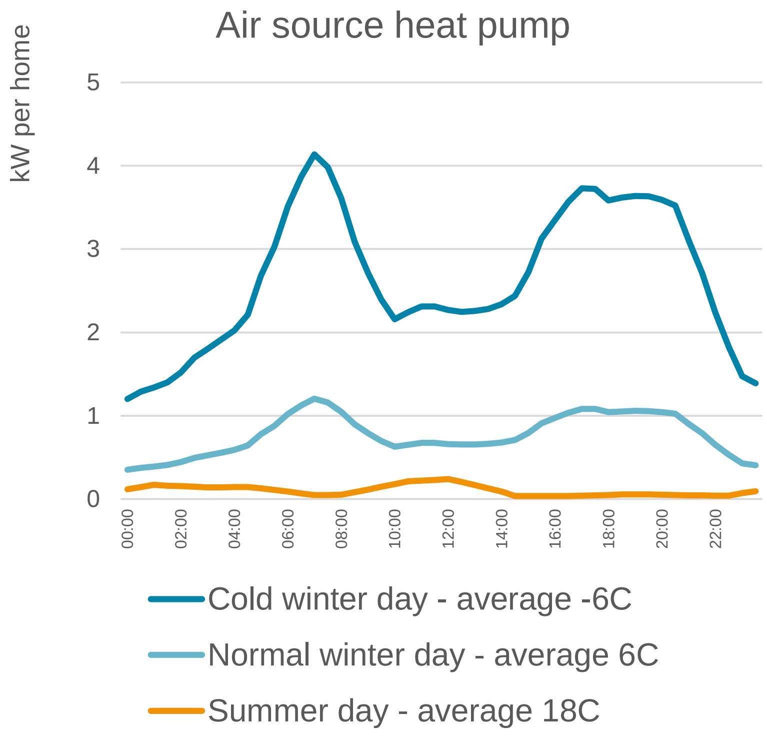
HEAT PUMP
LOAD PROFILE & FLEX POTENTIAL

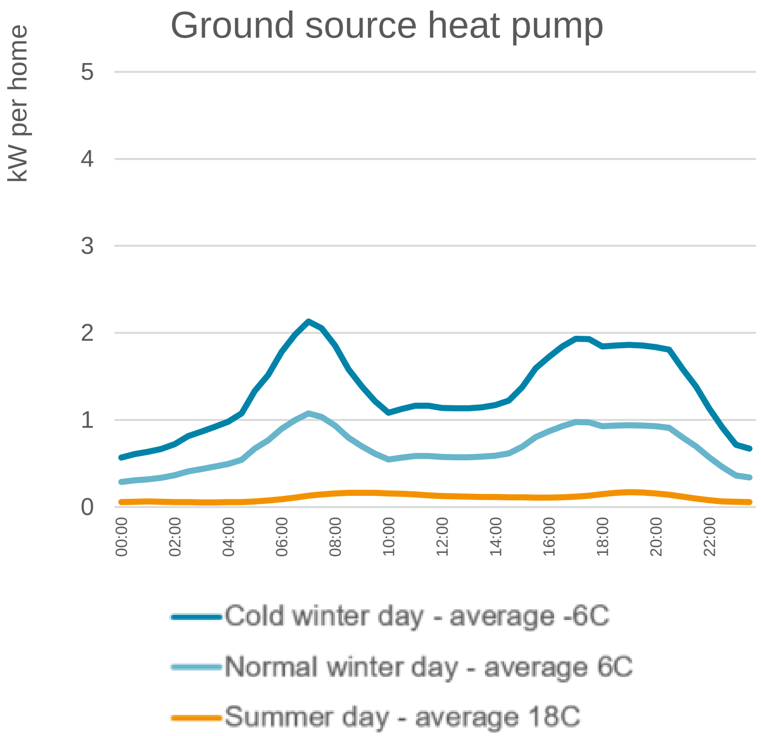
Natural load profile

Heating technologies (week profile)

Unmanaged demand from residential Air and ground source Heat pumps

Load profile peaks are highly sensitive to external temperature, as the load increases and efficiency decreases. Ground source heat pumps are less impacted.





Profiles shown here are indicative to show the thermo-sensitivity of heat pumps; which increases both their loads as their flexibility available.

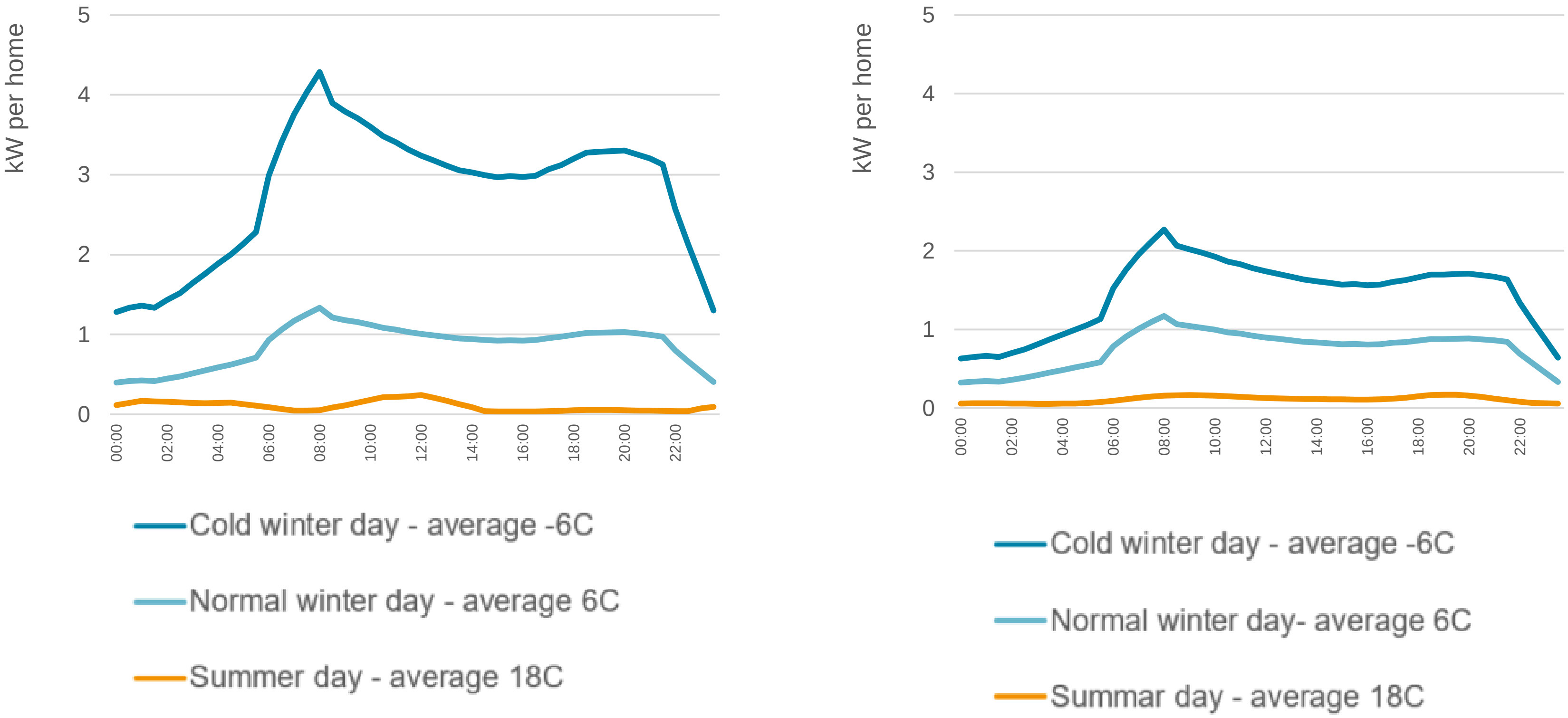
Heating technologies (week-end profile)

Unmanaged demand from residential Air and ground source Heat pumps

Weekend profiles are significantly flatter, peak demand in the morning is similar to weekdays, but evening is lower.

The advantage of GSHP in cold winter day is clear as the increased load is less severe.

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



Profiles shown here are indicative to show the thermo-sensitivity of heat pumps; which increases both their loads as their flexibility available.

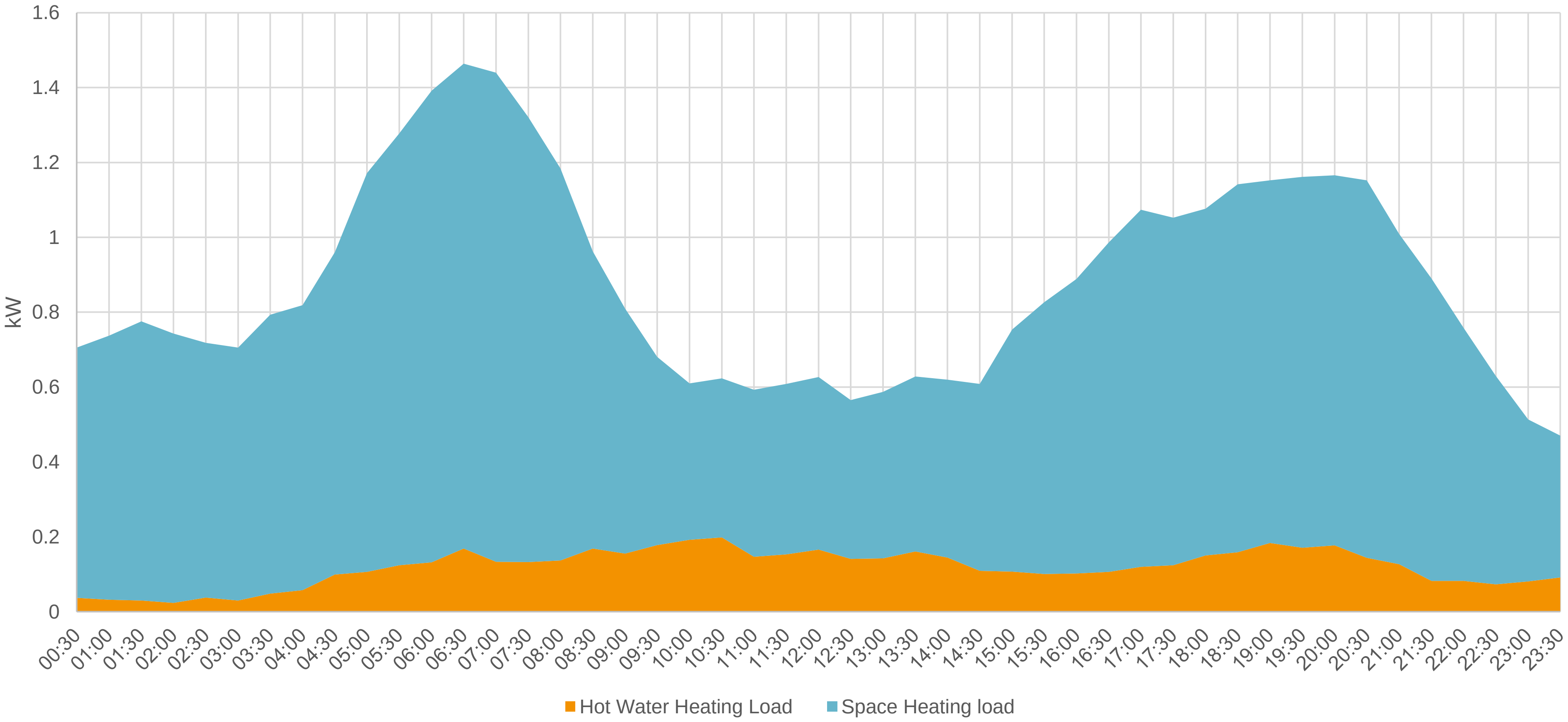
Heating technologies

Space heating and hot water

Profile of a typical winter weekday – air source heat pump energy demand split between hot water and space heating.

Hot water is relatively unaffected by outside temperatures, hot water is maintained at a minimum level through the day.

Key message: Space heating is significantly larger load than hot water, however space heating is more difficult to flex.



Enablers and flexible profiles

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	Asset flexibility	Control signal	Control capability	Appropriate metering	Customer barriers
Subsidies	Building insulation	Time of use tariffs	In built smart control	Smart meters	Complexity for consumer
Building regulation	Thermal storage	Capacity tariffs	Home energy management		Impact on consumer
Asset installation cost and running cost vs. gas	Season(external temperature)	TSO/DSO signal	Retrofit controls		
Industry annual installation capacity		PV consumption signal			
“Retrofit-ability”					

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	

Profiles categories for HPs

HP can shift the load based on different signals

Heat Pumps are essentially a load which you can shift outside of peak hours

Technology	Profile name	Description	Enablers
Electric heating loads (Heat pump)	HP0	Natural load	/
	HP-1**H**	Load shifting based on local signal (**H**ome)	Smart meter Communication capability Appropriate tariff (House insulation)
	HP-1**M**	Load shifting based on **M**arket signal	Smart meter Communication capability Price signal (e.g. : dynamic tariff) (House insulation)

Heating technologies

Flexibility options

Water heating flexibility

Hot water tanks provide inherent energy storage which can be exploited to provide flexibility through pre-heating with **minimal impact on customers**

Key enablers

- Larger hot water tanks or thermal storage device can increase the energy storage potential.
- In-built smart setting or interoperability with smart systems
- Connectivity
- Smart meter(to exploit tariffs)

Space heating flexibility

Space heating can also provide flexibility through pre-heating, however **the impact on customer may limit the effectiveness and adoption**, space heating has limited energy storage, although hydronic system has some thermal inertia

- In-built smart setting or interoperability with smart systems
- Connectivity
- Buffer tank or other energy storage in provide additional energy storage – **reduces impact on the consumer**
- Smart meter (to exploit tariffs)
- Building insulation – slows heat loss and therefore reduces impact on the consumer

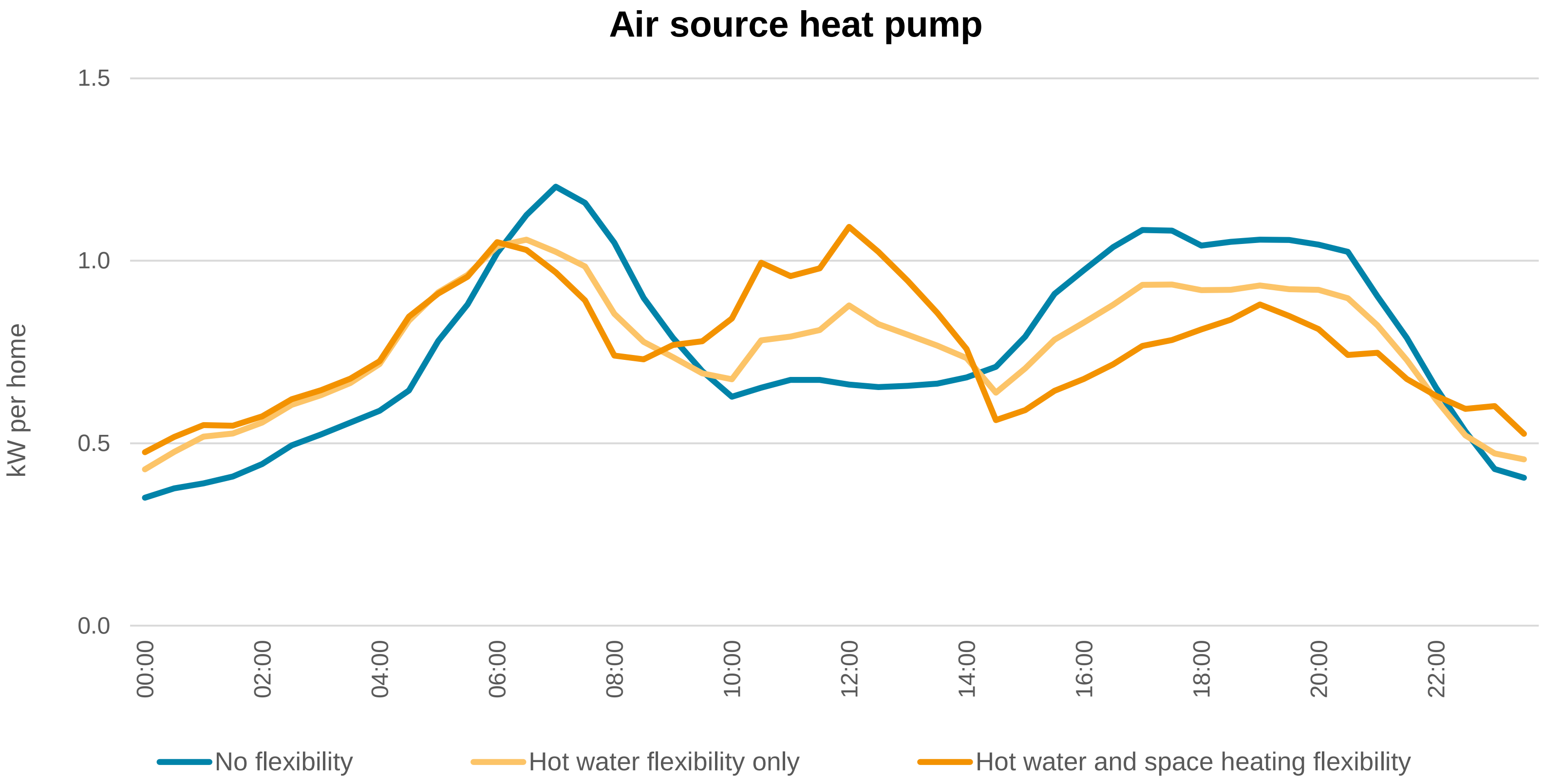
Heat pump flexibility

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.

Some flexibility is based on hot water flexibility alone, where hot water can be pre-heated and utilised later.

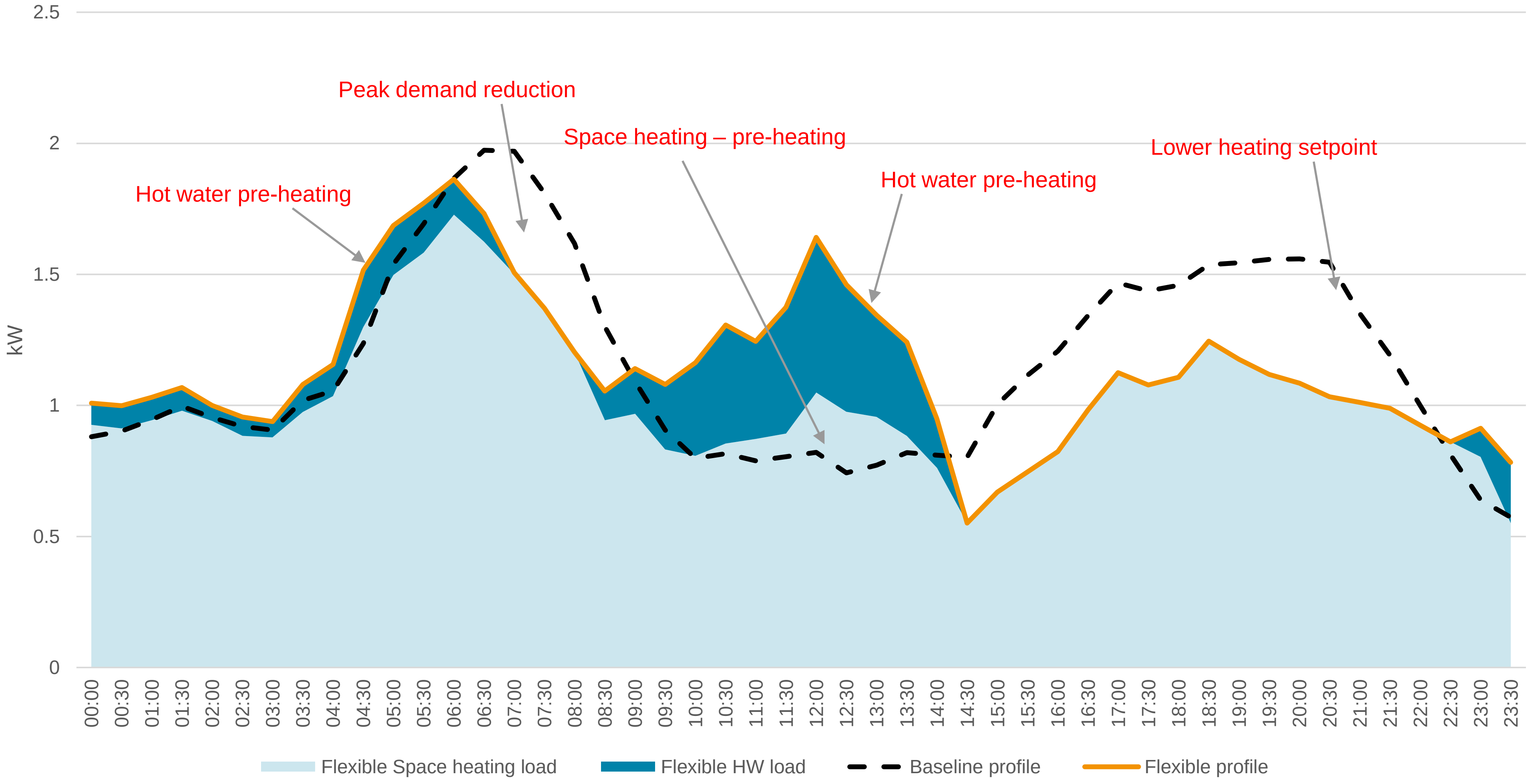
Maximum flexibility includes +/- 2 ^oC around the space heating set point (21 ^oC), providing additional pre-heating



Heat pump flexibility

Hot water vs. space heating flexibility

“Maximum Flexibility” case in more detail – showing the hot water energy demand is off during peaks at 7:00-8:00 and 14:30 – 22:30.



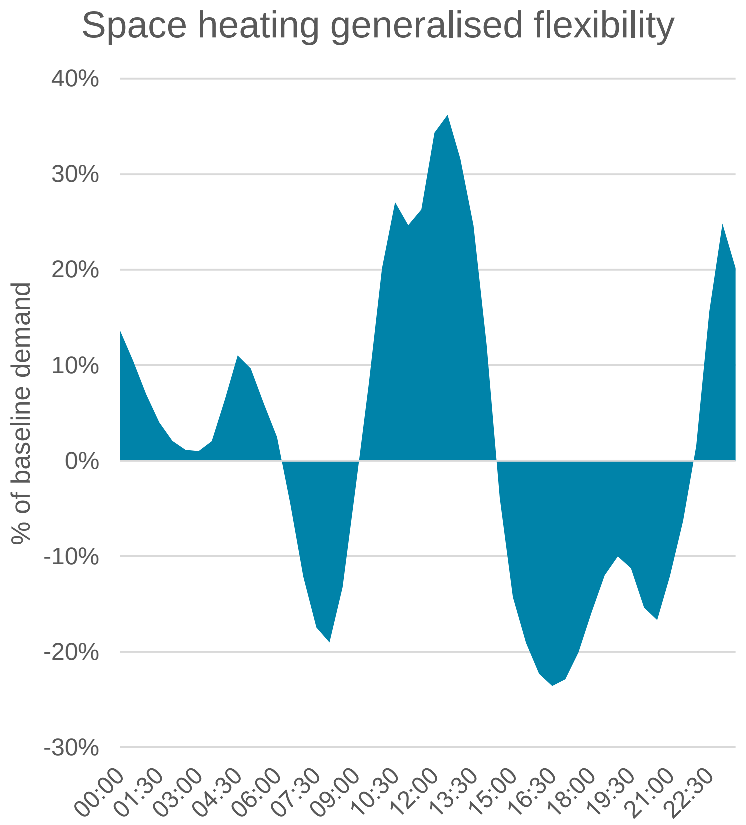
Space heating flexibility

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.

- 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.



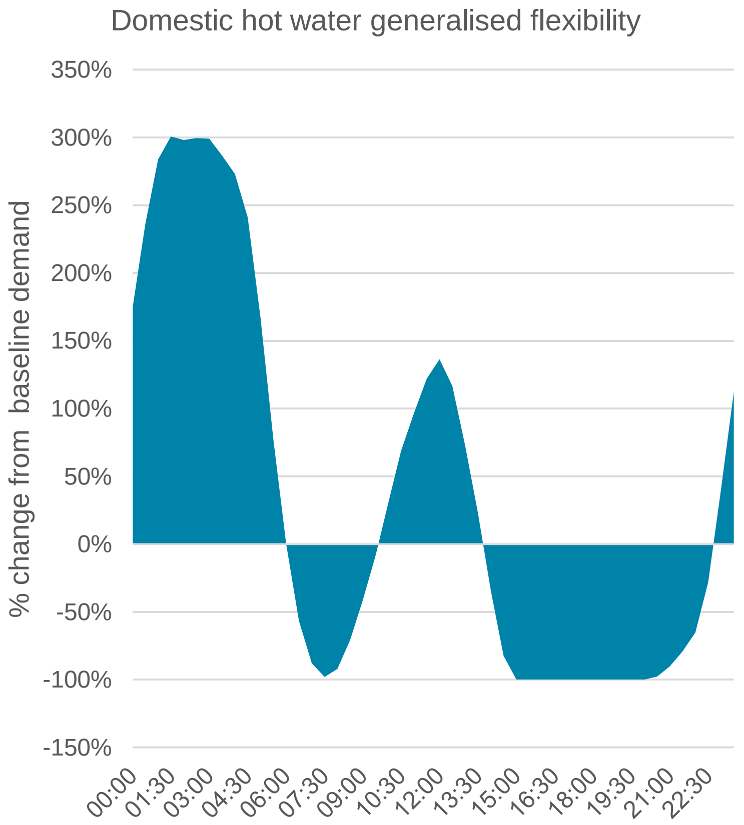
Domestic hot water flexibility

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.

- 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.



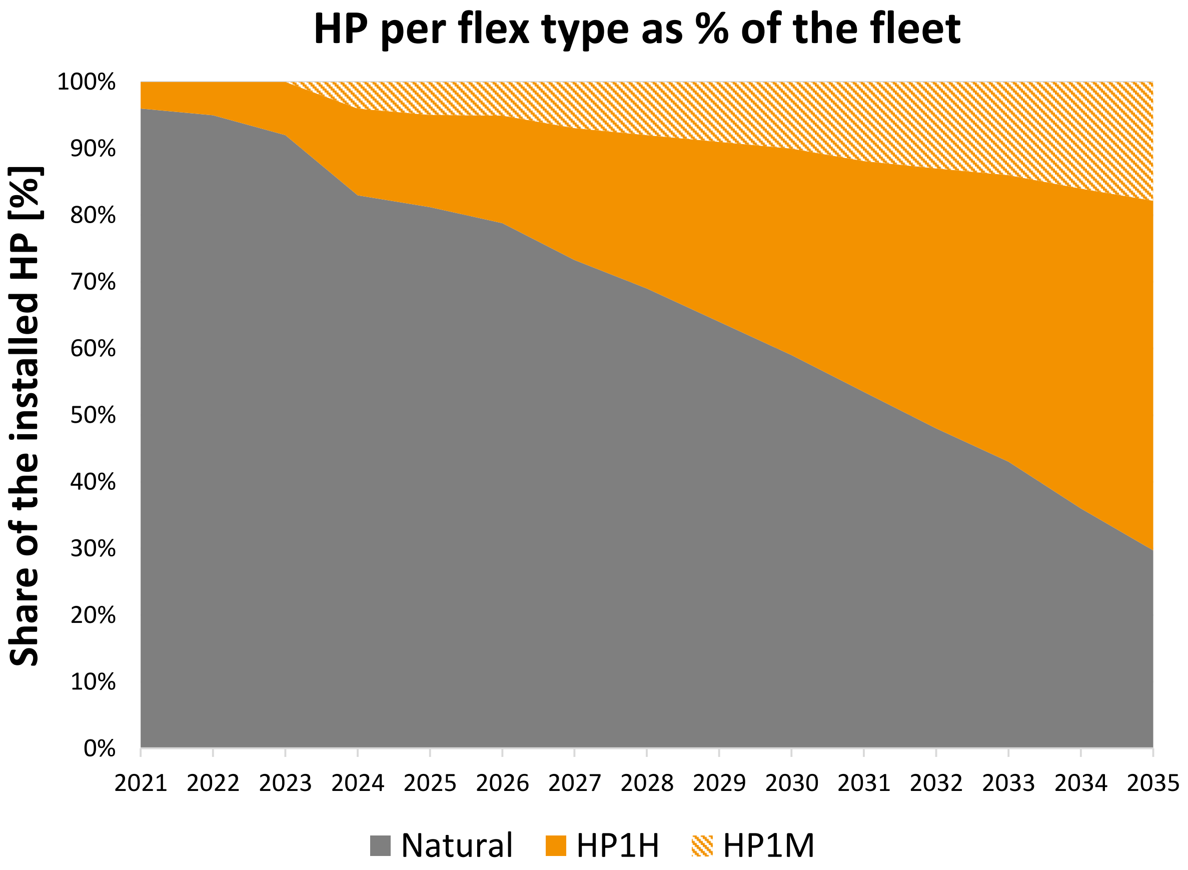
Penetration of flexibility option

HP flex option penetration

DELTA-EE Best Estimate

Important remarks on forecast:

- **Right tariff / price signal will decrease natural charging profile**, and increase HP1H
- Different tariff will change the behaviour/profiles depending on their specific cost structures.
- With smart meters roll out, & with the right market reforms, we could see **market barriers coming down** & **more competition between** flexibility aggregators then **unlocking HP1M** potential. we forecast from 2024 or 2025 a wider spread of offering will be available.



Profiles categories for Residential Batteries

DELTA-EE

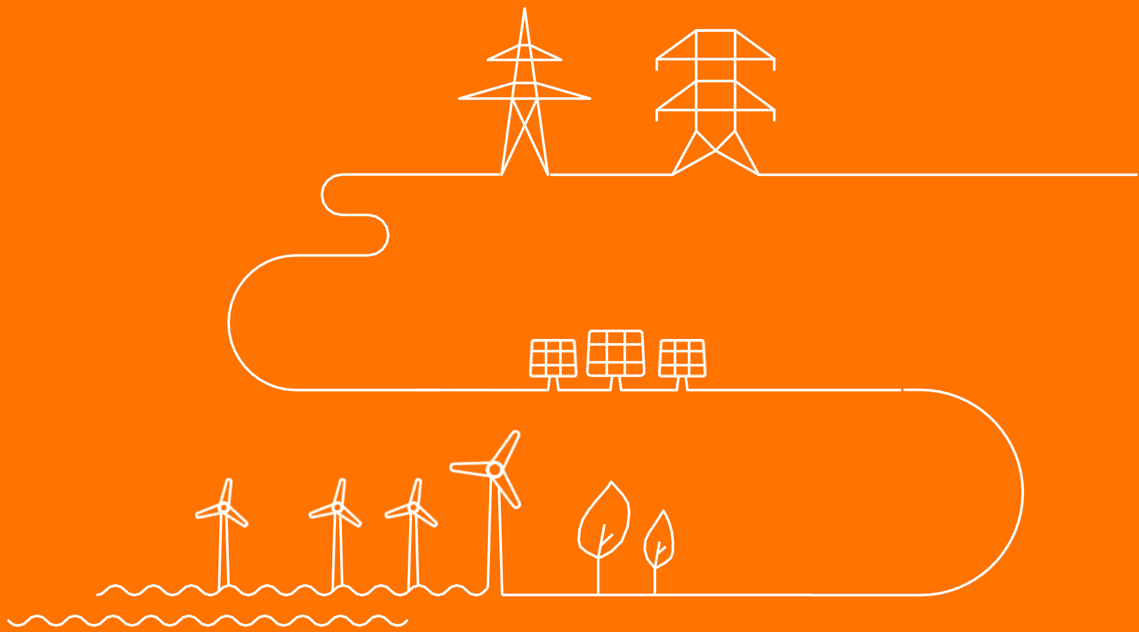
Residential Batteries will either be optimised linked to the house load / PV production or through market signal.

Technology	Profile name	Description	Enablers
Residential Batteries	B-2**H**	Load shifting based on local signal (**H**ome)	Smart meter Communication capability Appropriate tariff
	B-2**M**	Load shifting based on **M**arket signal	Smart meter Communication capability Price signal (e.g. : dynamic tariff)

Without market reforms, all batteries would be assumed to be operated under local signal (B2H)

Thank you

Final report to come 4th November



Appendix

Load profiles

Electric Vehicles and chargepoints

Unmanaged charging load from Belgium’s EV fleet

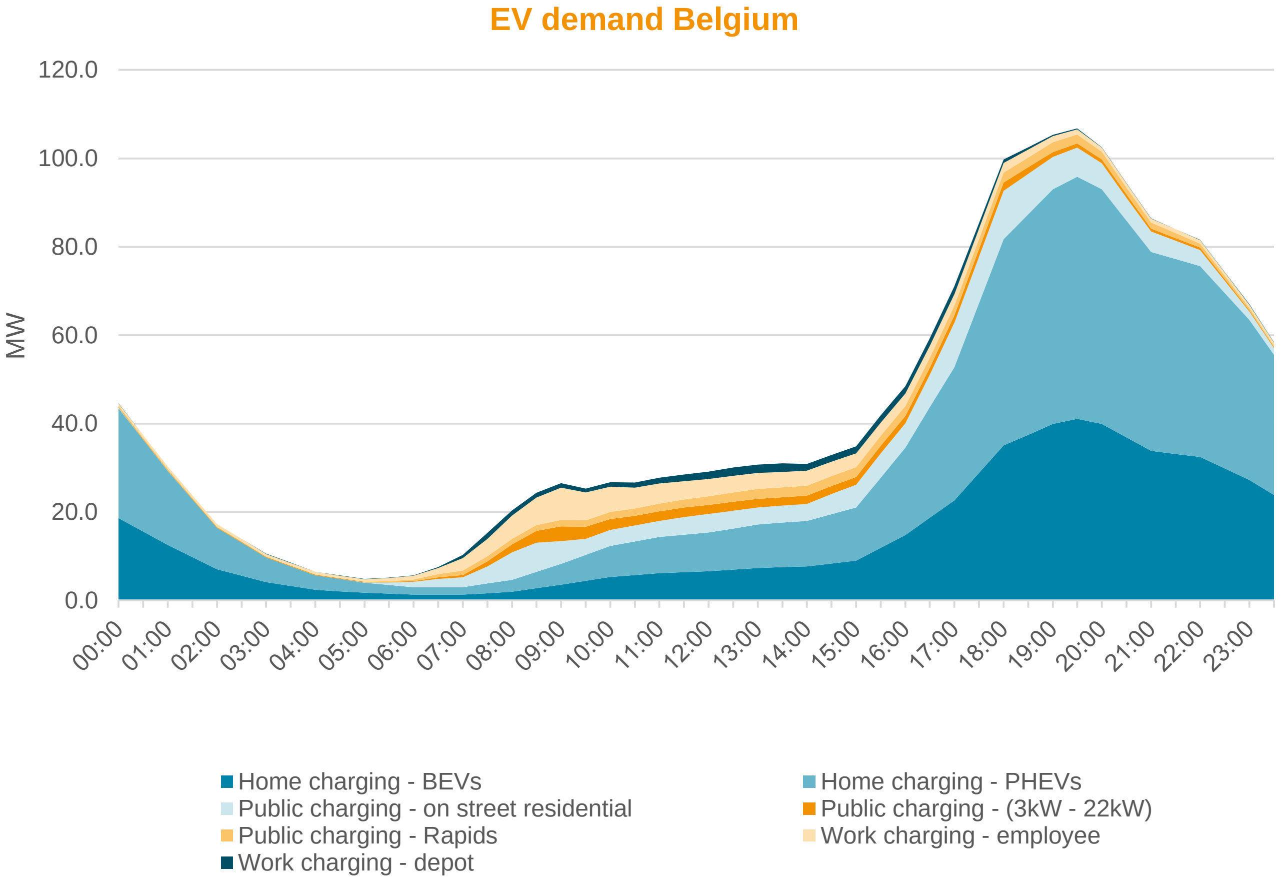
Demand profiles from previous research have been combined with data on the EV parc to give daily demand curves

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)



Inventory

2018-2021

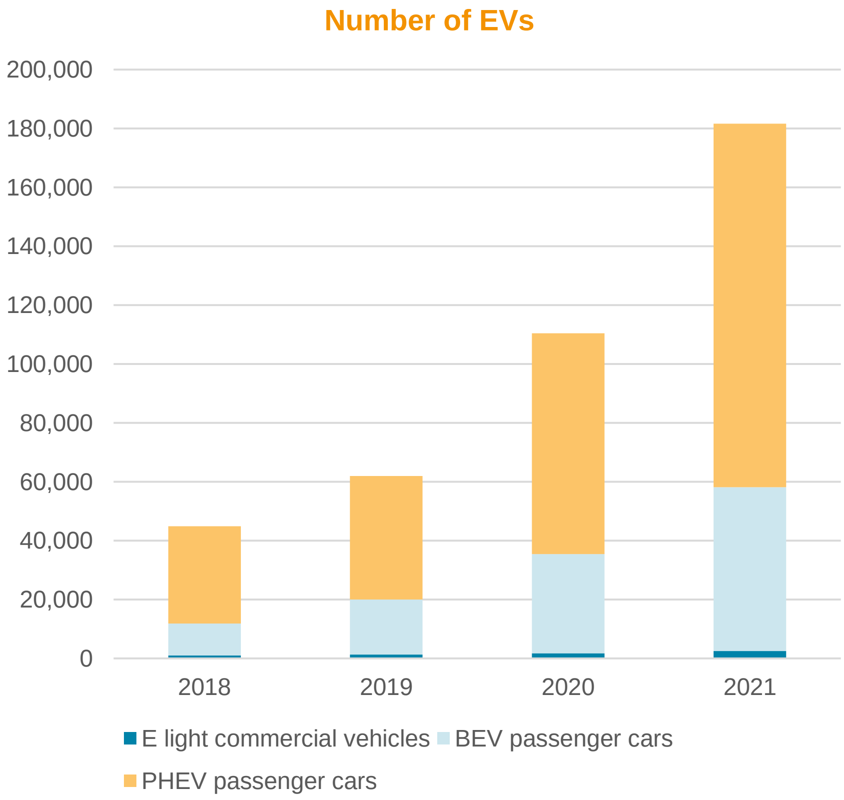
Electric Vehicles and Charging points

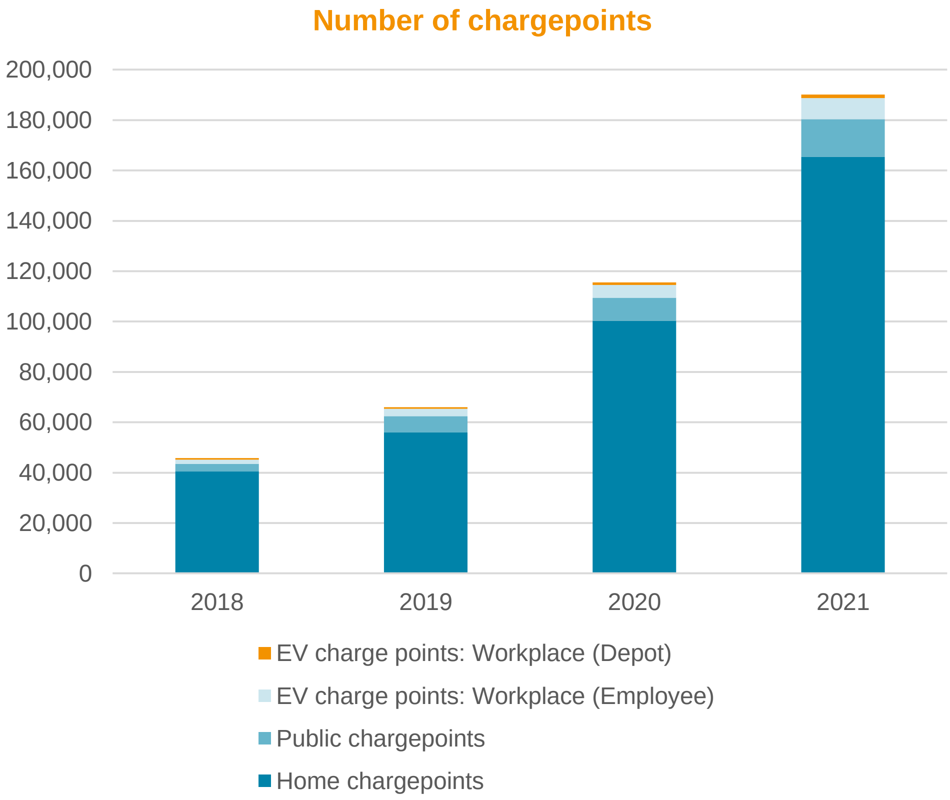
Number of EVs on the road and installed chargepoints in Belgium

PHEVs currently dominate the vehicle parc, it is expected that BEV sales will pick up over the next few years, currently 55,000 in 2021.

Home chargepoints make up the vast majority of the installed base (165,386 in 2021).

Workplace chargepoints are estimated to be low (~8,000 in 2021).





Source: European Alternative Fuels Observatory

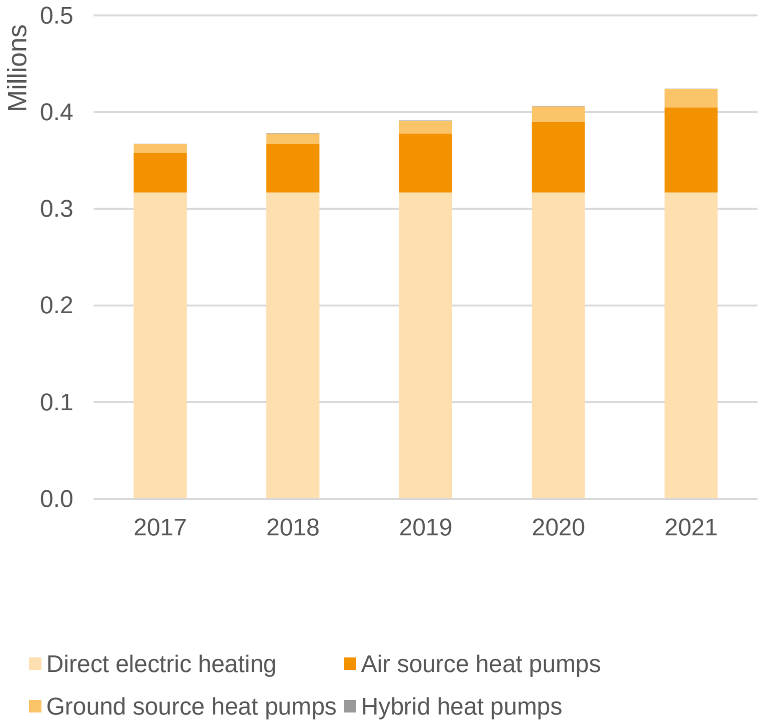
Heating Technologies

Installed base of electric technologies for space and water heating

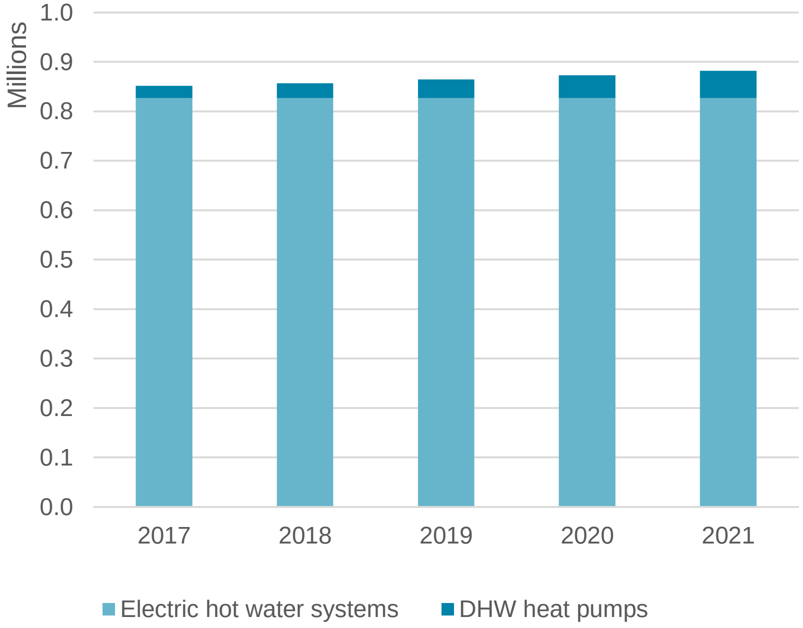
Only a small proportion of homes in Belgium are currently heated by heat pumps, though the installed base is growing steadily as heat pump sales increase year on year. Inefficient direct electric heating is not expected to increase in future years.

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

Installed base of electric space heating systems



Installed base of electric water heating systems

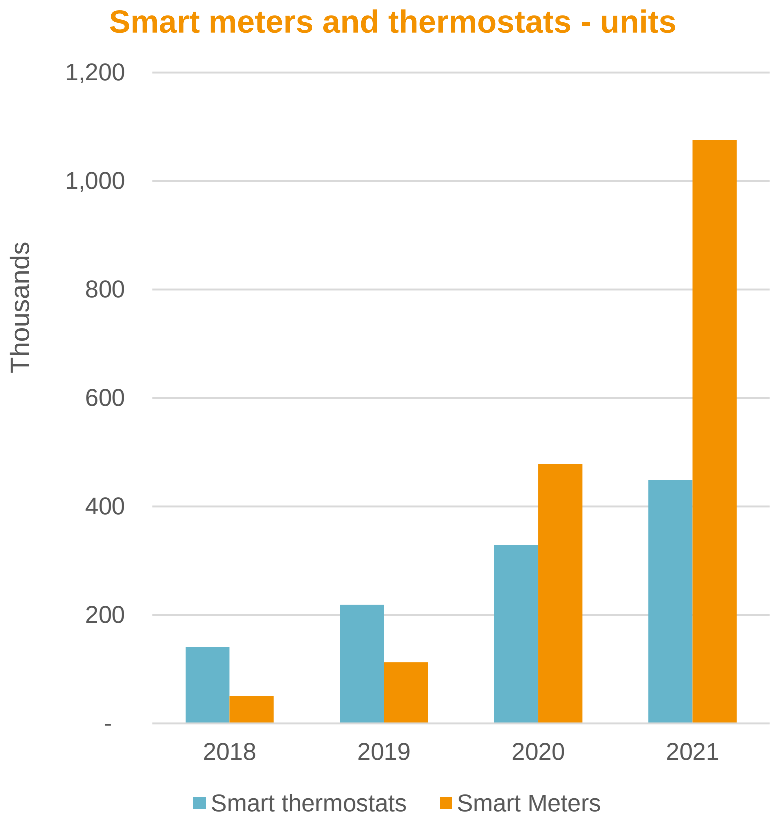


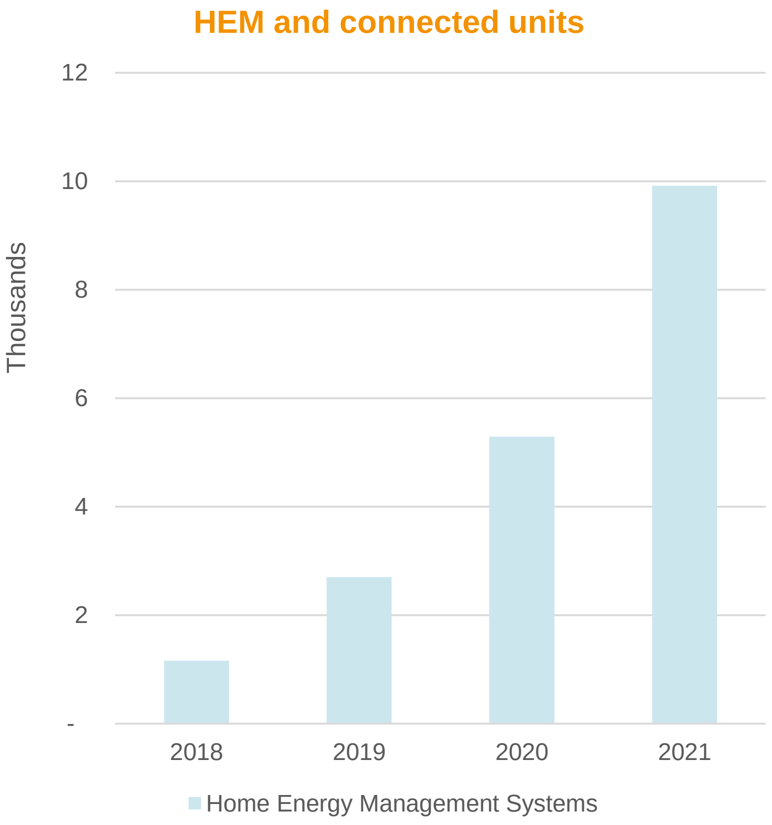
Digital enabling technologies

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.





Disclaimer

Copyright

Unless otherwise credited all diagrams in this report belong to Delta Energy & Environment Ltd.

Important

This document contains confidential and commercially sensitive information. Should any requests for disclosure of information contained in this document be received, we request that we be notified in writing of the details of such request and that we be consulted and our comments taken into account before any action is taken.

Disclaimer

While Delta Energy & Environment Ltd ('Delta-EE') considers that the information and opinions given in this work are sound, all parties must rely upon their own skill and judgement when making use of it. Delta-EE does not make any representation or warranty, expressed or implied, as to the accuracy or completeness of the information contained in the report and assumes no responsibility for the accuracy or completeness of such information. Delta will not assume any liability to anyone for any loss or damage arising out of the provision of this report.

Where this report contains projections, these are based on assumptions that are subject to uncertainties and contingencies. Because of the subjective judgements and inherent uncertainties of projections, and because events frequently do not occur as expected, there can be no assurance that the projections contained herein will be realised and actual events may be difference from projected results. Hence the projections supplied are not to be regarded as firm predictions of the future, but rather as illustrations of what might happen. Parties are advised to base their actions of an awareness of the range of such projections, and to note that the range necessarily broadens in the latter years of the projections.