WG Adequacy #11

13 October 2022

Agenda

- Welcome
- Minutes of Meeting WG Adequacy #10 (13.09.2022)
- Presentation Results Afry study [AFRY]
- Presentation study on the quantification of Belgian residential and tertiary future consumer flexibility [DELTA EE]
- CRM design changes [Elia]
- LCT design note [Elia]
- Next meetings

Minutes of Meetings

Minutes of Meeting

- **WG Adequacy #10 – 13.09.2022 : To be approved**
- *The MoM were sent on 06.10.2022. No comments were received.*

Presentation Results Afry study

Update to the review of annual fixed O&M cost

October 2022

SEAN DALY, ALEXANDER ARCH AND MATTHIEU MOLLARD

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ABOUT AFRY

Sector specific engineering, design, and advisory services around the world

EMPLOYEES GLOBALLY

~ 17,000

(2021)

NET SALES

€ 2 bn

(2021)

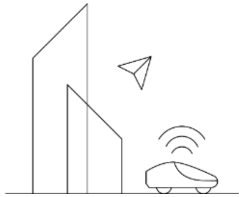
NUMBER OF COUNTRIES WITH OFFICES

> 50

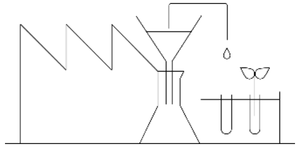
NUMBER OF COUNTRIES WITH PROJECTS

> 100

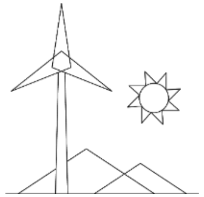
AFRY TRANSFORMING SEGMENTS



INFRASTRUCTURE



FOOD AND LIFE SCIENCE



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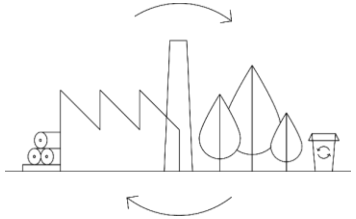
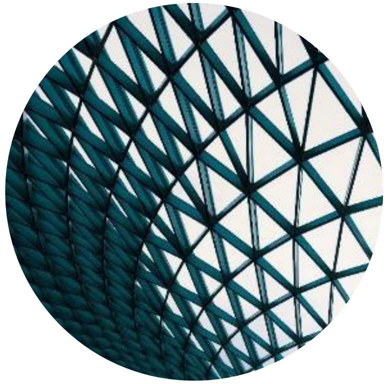


BIOINDUSTRY

AFRY CORE EXPERTISE



ENGINEERING

DESIGN

DIGITALISATION

ADVISORY SERVICES

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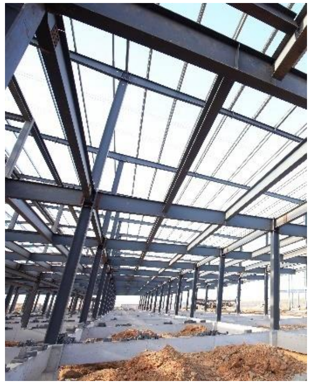
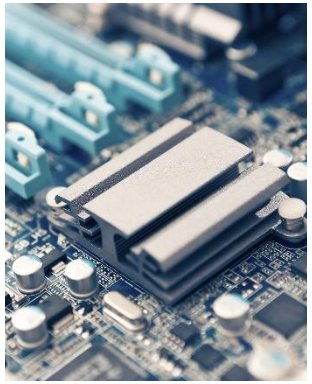
AFRY is organised in six divisions



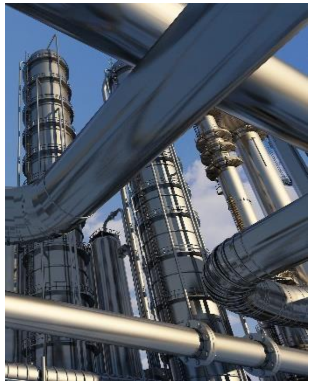
INFRASTRUCTURE

- Transportation
- Buildings
- Water
- Environment
- Architecture & Design



INDUSTRIAL & DIGITAL SOLUTIONS

- Advanced Automation
- Automotive R&D
- Experience Design
- Food & Pharma
- Specialised Tech Services
- Systems Management



PROCESS INDUSTRIES

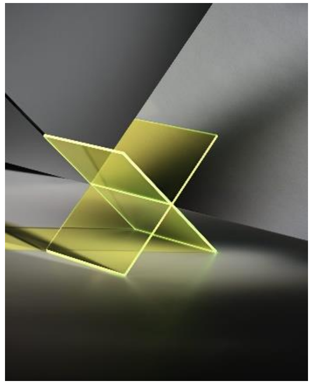
- Pulp and Paper
- Chemicals
- Metal & Mining
- Smart Site TM & Digitalisation

ENERGY

- Thermal
- Renewables
- Hydro
- T&D
- Nuclear
- Contracting

MANAGEMENT CONSULTING

- Energy Sector
- Bioindustry Sector
- Market Analysis
- Strategic Advice
- Operational & digital transformation
- M&A and Transactions



AFRY X

- IT and SaaS Solutions
- AI and data analytics
- Cyber security
- Digital design

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Leading advisor for the transition of the energy and bioindustry sectors

Presence	Revenue	Projects	Staff	Backed by
4	90 million	>100	500+	17,000
continents	EUR in 2021	countries	management consultants	experts at AFRY

Energy transition

- Global transition towards decarbonised energy system
- Sector integration due to decarbonisation and electrification (e.g. mobility, industries, cities)
- Need for smart infrastructure to enable transition and new decentralised business models

\+

Transition to Bioeconomy

- Growing sustainability awareness and commitment
- Global shift in demand and products
- Need for green carbon to ensure full decarbonisation
- Resource scarcity

Agenda

Agenda

The main objective is to provide an updated review of fixed O&M costs for CCGTs, OCGTs and a typical pumped storage plant in Belgium

OBJECTIVES

– To provide an update to AFRY's fixed O&M costs peer review analysis undertaken during summer 2020 for OCGTs, CCGTs and a typical pumped storage plant in Belgium
– Those annual fixed O&M costs will be used by Elia as part of the calibration of the Intermediate Price Cap and other parameters in the Belgian Capacity Remuneration Mechanism

SCOPE

– The scope of the study is:
    – To review the assessment carried out during summer 2020 and update our review where cost items have changed
    – To clarify the definition and cost items assumed in the various fixed O&M categories identified in the study

Agenda




Compared to our 2020 review, we estimate fixed O&M costs for OCGTs to have increased by 25% on average

Unit	Capacity (MW)	Type	COD	Specific fixed O&M cost (€/kW/a)			
				AFRY 2020 Report	AFRY 2020 (excl. grid charge)	AFRY 2022 Report	AFRY 2022 (excl. grid charge)
Angleur 3 - TG31	25	Frame type	1978	40.68	40.19	50.41	49.92
Angleur 3 - TG32	25	Frame type	1978	40.68	40.19	50.41	49.92
Angleur 4 - TG41	63	Aero	2012	19.08	18.59	24.69	24.19
Angleur 4 - TG42	63	Aero	2012	19.08	18.59	24.69	24.19
Ham - HAM31	56	Aero	2006	19.08	18.59	24.69	24.19
Ham - HAM32	56	Aero	2006	19.08	18.59	24.69	24.19
Cierreux	18	Turbojet	1960s	29.49	29.00	37.00	36.51
Beerse	32	Turbojet	1960s	23.07	22.58	28.94	28.45
Zelzate	18	Turbojet	1960s	29.49	29.00	37.00	36.51
Aalter	18	Turbojet	1960s	29.49	29.00	37.00	36.51
Zedelgem	18	Turbojet	1960s	29.49	29.00	37.00	36.51
Noordschote	18	Turbojet	1960s	29.49	29.00	37.00	36.51
Zeebrugge	18	Turbojet	1960s	29.49	29.00	37.00	36.51

Our updated review has highlighted the following:

- No change in assumed % of EPC cost for annual operating, insurance and fixed maintenance
- EPC cost however are estimated to have increased by 25% based on in house and real life project information;
- Specific Major Maintenance Costs through LTSAs are expected to have increased by 20% based on materials and labour costs indexation estimates given known indexation formulas in such contracts;
- the resulting increase in specific O&M cost appears to be 25% on average (accounting for appropriate weighting between materials/labour costs within EPC/LTSA costs and the share of EPC/LTSA within the overall fixed O&M costs)

Our estimates are based on an assumed 800h of operation and 150 starts per annum. More restricted operation would most likely mean lower maintenance costs and the fixed O&M would be lower than that presented in the table.

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Compared to our 2020 review, we estimate fixed O&M costs for CCGTs to have increased by 23-27% on average

Unit	Capacity (MW)	Type	COD	Specific fixed O&M cost (€/kW/a)			
				AFRY 2020 Report (8,000h)	AFRY 2020 Report (4,000h)	AFRY 2022 Report (8,000h)	AFRY 2022 Report (4,000h)
T-Power	425	1x1	2011	41.39	32.08	50.97	40.21
Seraing	485	2x1	1994	42.10	32.06	51.81	40.16
Amercoeur	451	1x1	2010	40.26	31.34	49.59	39.31
Marcinelle	405	1x1	2011	42.36	32.71	52.15	40.98
Saint-Ghislain	350	1x1	2000	45.52	34.74	56.01	43.47
Drogenbos	460	2x1	1993	43.22	32.77	53.17	41.03
Knippergroen	315	1x1	2010	48.06	36.36	59.11	45.45
Ringvaart	357	1x1	1998	45.07	34.46	55.46	43.12
Herdersbrug	480	2x1	1998	42.31	32.19	52.07	40.33
Zandvliet	384	1x1	2005	43.47	33.43	53.50	41.86
Inesco	138	1x1	2007	56.46	43.88	69.48	54.77

Our updated review has led to a similar cost increases, in percentage terms, as for OCGTs

- EPC costs are estimated to have increased by ~23% on average, primarily driven by the rise in equipment and materials cost, but also by labour costs
- LTSA costs are estimated to have risen by ~20%, the largest share coming from materials

Similar to the 2020 review, fixed O&M costs have been provided on a baseload (8,000h) and mid-merit (4,000h) operating assumption to illustrate the potential change in total fixed O&M through reduced need for major maintenance. This would also mean lower grid transmission costs.

Assuming a 4,000h of operation, we expect the annual O&M to be €10-15/kW lower.

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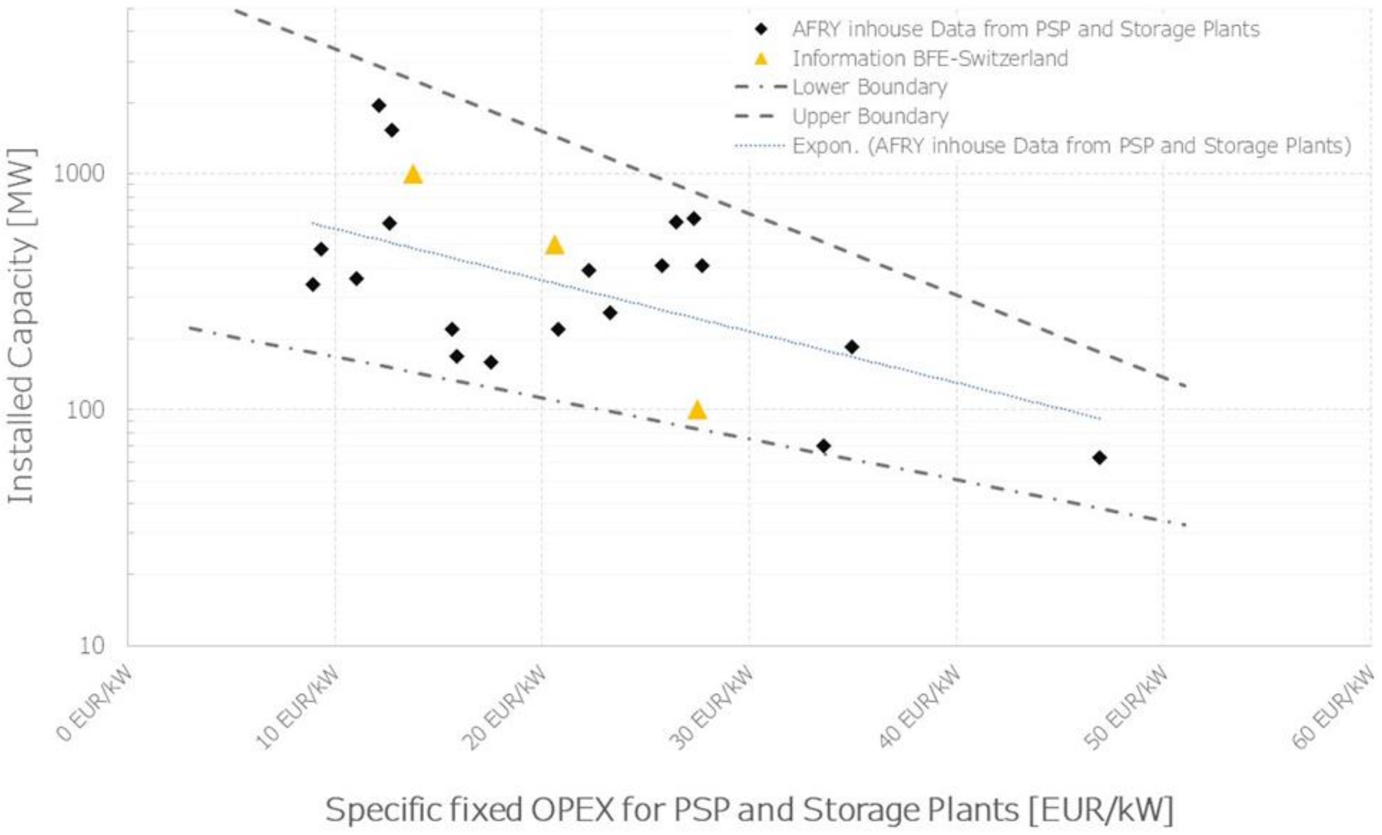
Compared to our 2020 review, we estimate fixed O&M costs for CCGTs to have increased by 23-27% on average

Unit	Capacity (MW)	Type	COD	Specific fixed O&M cost (€/kW/a)			
				AFRY 2020 Report (8,000h, no elec)	AFRY 2020 Report (4,000h, no elec)	AFRY 2022 Report (8,000h, no elec)	AFRY 2022 Report (4,000h, no elec)
T-Power	425	1x1	2011	36.46	29.62	46.04	37.75
Seraing	485	2x1	1994	37.16	29.59	46.87	37.69
Amercoeur	451	1x1	2010	35.32	28.88	44.65	36.84
Marcinelle	405	1x1	2011	37.42	30.24	47.21	38.51
Saint-Ghislain	350	1x1	2000	40.59	32.28	51.08	41.01
Drogenbos	460	2x1	1993	38.28	30.30	48.24	38.56
Knippergroen	315	1x1	2010	43.12	33.89	54.17	42.98
Ringvaart	357	1x1	1998	40.13	31.99	50.52	40.65
Herdersbrug	480	2x1	1998	37.38	29.73	47.13	37.86
Zandvliet	384	1x1	2005	38.53	30.96	48.57	39.39
Inesco	138	1x1	2007	51.52	41.42	64.54	52.30

Part of the grid costs are incurred on a variable cost basis – therefore such costs can be considered as variable and recoverable from the energy market. Excluding those would further reduce the specific O&M cost.

We have revised upward our fixed O&M estimates to €22/kW, keeping in mind there is a strong degree of variation in pumped storage annual O&M costs



Although there were no new publicly available study to review cost increase since 2020, we feel the range of €10-30/kW for annual fixed O&M cost for PSP remains valid and applicable

According for cost increase through relevant materials and labour costs indices resulted in a recommendation to use an average cost of **€22/kW** for the purposes of defining a typical fixed O&M value for a pumped storage plant in Belgium. This is a **~17.5% overall increase** compared to the 2020 review (€19/kW)

The lower end of the range is more representative of pumped storage integrated in a pool of hydropower plants allowing the utility to optimise resources – most notably manpower. On the other end of the spectrum, smaller PSP plants tend to have a higher O&M cost – a similar sized team is needed to operate the plant when compared to larger plants

Agenda

Our cost review is limited to annual O&M costs for OCGTs, CCGTs and pumped storage

DEFINITION OF FIXED O&M COSTS

The fixed O&M cost is assumed to include the following components:
- fixed operating costs including personnel costs, administrative costs, electricity and gas transmission charges (where applicable);
- the O&M insurance for general liability, machine breakdown and interruption of operation of a power plant;
- fixed maintenance costs including intra-year maintenance and a provision for major overhauls that do not necessarily take place on an annual basis.

TECHNOLOGIES

We have focused on the following technologies:
- Open Cycle Gas Turbines;
- Combined Cycle Gas Turbines; and
- Pumped Storage.

Items considered in the assessment of fixed O&M costs for OCGTs and CCGTs

Details around costs considered under the fixed O&M assessment
Personnel costs
Those assume the plant is operated and maintained by a third-party O&M company and cover salary and wages, bonus payments, shift premiums, pension contributions, social security contributions and O&M company profit.
Regular maintenance
The regular maintenance cost covers routine and preventative maintenance activities including consumables (filters, fuses, bulbs, gaskets, pump mechanical seals, pump / motor bearings, lubricating oil changes, etc.). The routine or regular maintenance cost typically covers routine maintenance on the GT, generator, compressed air systems, cooling systems, fire protection, electrical equipment, C&I, site facilities and site support services. The gas turbine routine maintenance cost is expected to be the largest component and includes the cost associated with periodically replacing the gas turbine air intake filters.
Trading and admin
Those include trading and settlement overhead costs, bank fees, security expenses, public relations, legal fees, freight and import duties, auditing fees, safety equipment, office equipment expenses, and other miscellaneous expenses.
Fixed electricity and gas transmission charges
The electricity transmission charge is highly country-specific and has been calculated based on tariff data published by Elia. For the OCGTs, the gas transmission charge has been set to zero on the basis that short-term gas capacity products are available and peaking units treat these as variable costs.
Plant operating insurance
The annual insurance covers the O&M period insurances for general liability, machinery breakdown and business interruption for the power plant.
Annual accrual for future major overhauls
This covers the annual accrual for future gas turbine major maintenance (often referred to as hot gas path inspections or major inspections). The trigger for carrying out such inspections is generally based on the gas turbine reaching the manufacturer's defined threshold in terms of operating hours or starts (e.g. 24,000 operating hours or 900 starts). As such the timing of inspections depends to a large extent on the plant running regime and consecutive inspections can be separated by many years.

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The list of costs below are not considered as part of fixed O&M costs but those are rather seen as variable costs for OCGTs and CCGTs

Details around costs NOT considered under the fixed O&M assessment
Property taxes and land lease costs
Those are not considered in this assessment
Chemicals cost
The chemical cost covers chemicals for demineralised water production, water steam cycle chemical dosing, wastewater treatment (neutralisation) and any necessary cooling water treatment (anti-scalant, biocide).
Raw water cost
The raw water will be used to satisfy the process water demands of the plant. In the case of a CCGT plant the municipal water will be treated on site to provide the high quality make up water that is required by the heat recovery steam generator when the plant is operating. For an OCGT plant the raw water consumption is relatively modest.
Imported power
Electricity is imported from the grid whenever a plant is shutdown (for planned maintenance or due to a forced outage). Given the strong correlation between the import amount and the plant running hours this is generally treated as a variable cost.
Contingency for unplanned maintenance
The contingency for unplanned maintenance is an allowance to cover the cost of repairing unexpected equipment breakdowns which are not covered either by manufacturer’s warranty or are below the threshold of the deductible under the insurance policy. Given the strong correlation between this cost and the amount of plant running hours / starts, this is generally treated as a variable cost.
Fuel for plant starts (i.e. after plant trips or maintenance)
Fuel for plant starts covers the cost of natural gas consumed during plant start-ups not requested by the transmission system operator (e.g. after a plant trip or after a shutdown for scheduled maintenance).
CO_2 emission costs
The CO_2 emissions cost in any period depends on the amount of CO_2 emitted by the plant in that period (depending on fuel use) and the prevailing CO_2 price level.

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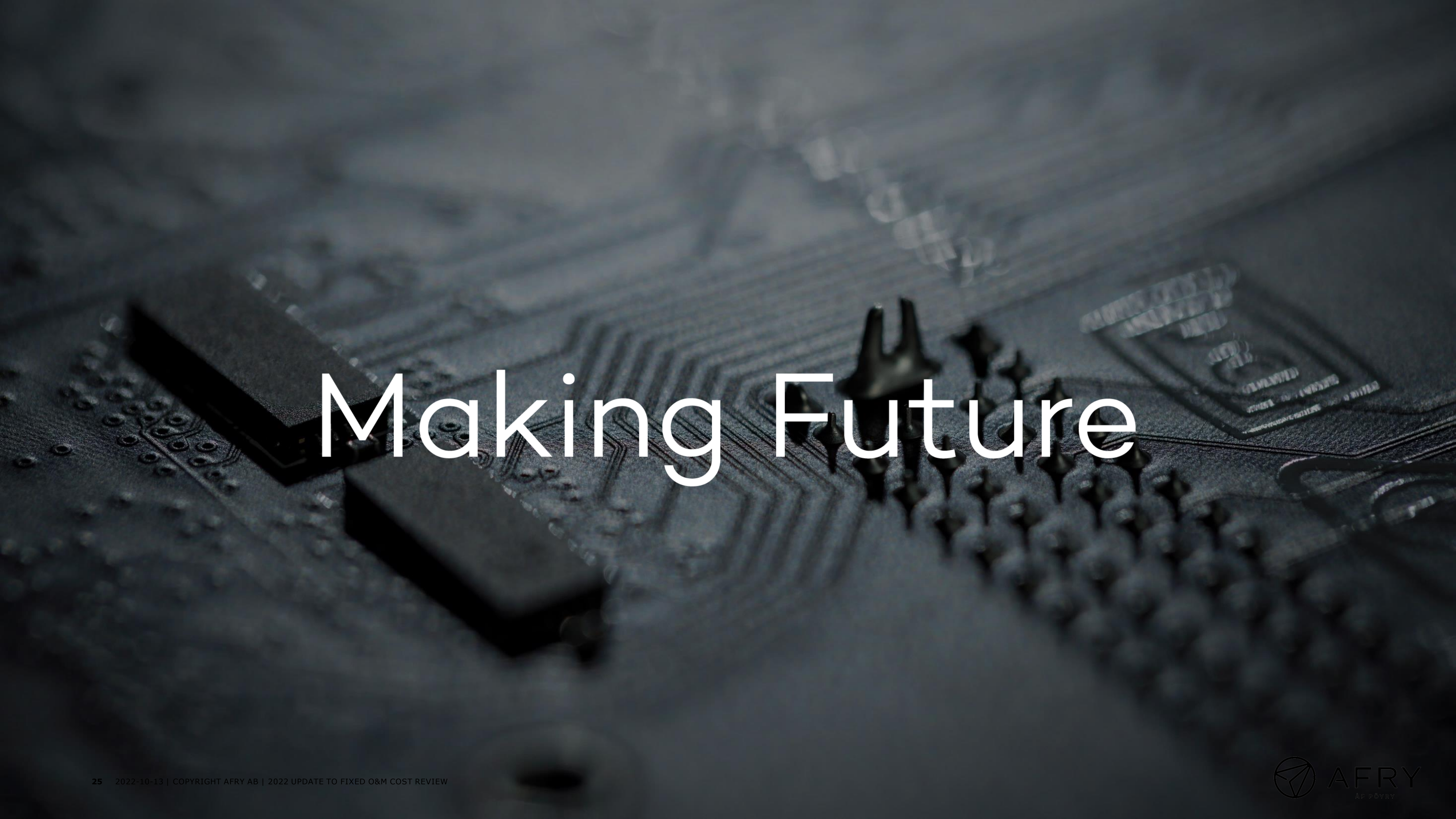
Agenda




INDICATOR

Despite no public information, fixed O&M costs have indeed increased and those are estimated through use of relevant materials and labour indices

Items	Key comments
Annual Operating, Insurance and Fixed Maintenance costs	– No change in assumption since 2020 review in terms of % of EPC costs – Annual Operating Cost: 1.9% / 3.0% of EPC cost for OCGTs and CCGTs respectively – Annual Insurance Cost: 0.6% / 0.6% of EPC cost for OCGTs and CCGTs respectively – Annual Fixed Maintenance Cost: 0.5% / 0.75% of EPC cost for OCGTs and CCGTs respectively
EPC costs	– Recent energy market developments have not yet been reported in public studies or GT World 2022 – Through in-house market intelligence and projects, it is clear EPC costs have noticeably increased (tensions on energy markets, situation in Ukraine and resulting impacts on costs of metals and raw materials – EPC cost increase assessed through evolution of relevant Producer Price Index for Industrial Products and STABEL labour costs
Specific Major Maintenance costs	– Energy market developments since mid-2021 have not yet been reported in public studies but market participants are – LTSA contracts have indexation parameters embedded in them to account for the evolution of economic conditions – Evolution in the Producer Price Index for “fabricated steel plate” for materials (60%) and STATBEL for labour cost (40%) are used to estimate the increase in LTSA costs between 2019 and 2022.



Making Future

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Presentation study on the quantification of Belgian residential and tertiary future consumer flexibility

DELTA-EE

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

WG - ADEQUACY

CONTACT:

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13 October 2022

Why this study?
Important preliminary remarks

- In the past, Elia received several comments during public consultations on the lack of consideration of the residential & tertiary flexibility. It is the goal to improve it in the next AdFlex23 thanks to this study;
- This study will be submitted to public consultation from 28/10 (as part of the AdFlex23 consultation);
- The scope of the study is:
    - The Belgian perimeter
    - Residential & tertiary sector (industrial flexibility is not assessed)
    - Years up to 2035

Agenda

- **Overview of technologies reviewed**
- Focus on Electric Vehicles
- Focus on Heat pumps
- Next steps

About LCP Delta

Expertise in generation, networks and demand in a single integrated energy transition practice

Our mission is to enable a better, faster energy transition for all by supporting the energy sector to drive the transition.

Founded in 2004 and based across the UK, France, Norway, the Netherlands and beyond, LCP Delta provide data-driven research, consultancy, technology products and training services to companies investing in and navigating the energy transition.

We are a diverse team from a variety of backgrounds including engineers, data analysts, environmentalists and more.

LCP Delta is a mission driven organisation - all of us want to make a difference to the energy transition and accelerate the path to a low carbon future.

The energy market is becoming increasingly complex. As consumers become more empowered and as energy systems around the world decarbonise, there is a need to understand both the generation and demand side to effectively navigate the rapid changes occurring.

LCP Delta was formed through the merger of Delta-EE and LCP Energy to bring together deep generation and consumer-side expertise, to provide our clients with a single partner to help them on their journey and provide them with a 360° view across the energy spectrum.

Goal of the study

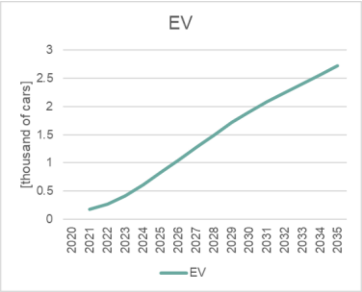
Determine the amount of MW & MWh available for flexibility each hour

An **illustrative** example for EVs:

Asset Volume + Asset Flexibility + Enablers = Forecast

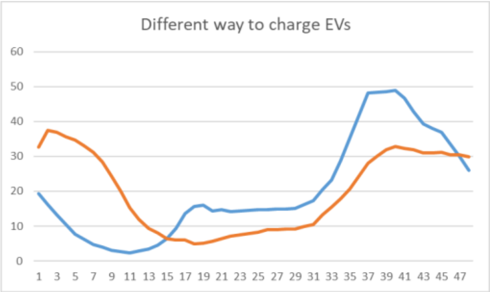
Asset Volume

A fleet of EVs
for each scoped year



Asset Flexibility

natural charging (V0)
Or
smart charging (V1)



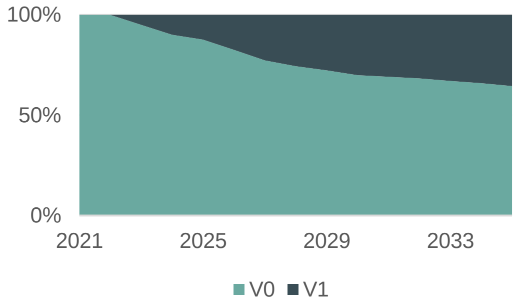
Enablers

Control signal
Control capability
Relevant metering
Customer Engagement

Forecast

Forecast of unlocked flexibility

Share of vehicle in natural or smart charging



DISCLAIMER: Not actual figures, present for illustrative purpose

Agenda

- Overview of technologies reviewed
- Focus on Electric Vehicles
- Focus on Heat pumps
- Next steps

Technologies

EV, HP & batteries are the most relevant technologies to deliver flexibility in scope sector

Air conditioning, commercial refrigeration and residential appliances have been excluded from further analysis (see next slide)

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 Direct electric heating Electric hot water systems	Air & ground source heat pumps Hybrid heat pumps Direct electric heating Electric hot water systems
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	

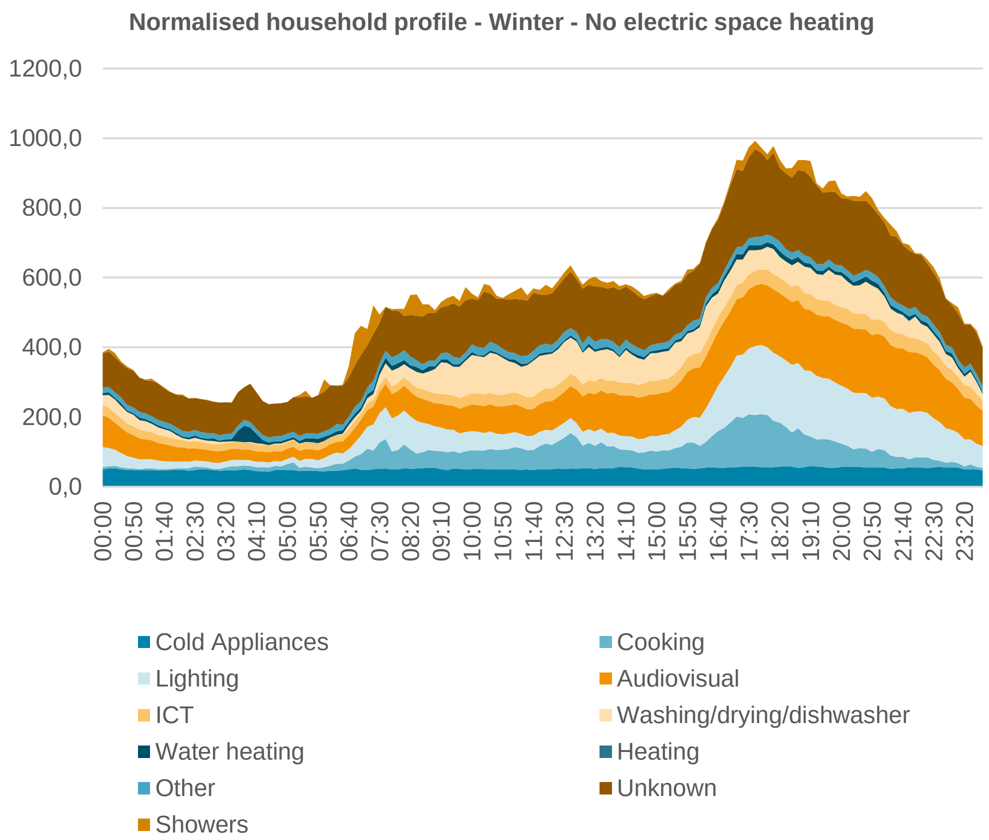
Flexible miscellaneous loads representing a negligible share of household peak load

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

Key factors

What is needed to unlock demand side flexibility?

A – Asset Volume
Load of installed base of flexible assets

B – Asset flexibility
Capability of assets to provide flexibility around demand

C – Control signal
Market or local need that provides signal for when and how flexibility is required

D – Control capability
Capability to receive and respond to market signal

E – Appropriate metering
Ability to accurately measure the energy usage in timeframes relevant to flexible services

F – Customer barriers
Degree of engagement and participation

Long list of enablers

Factors considered

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

Agenda

- Overview of technologies reviewed
- **Focus on Electric Vehicles**
- Focus on Heat pumps
- Next steps

EVs

Profiles categories for EVs

EV can lever different type of flexibility

Management of EVs can happen either uni- or bidirectionaly, & based on a local or market signal.

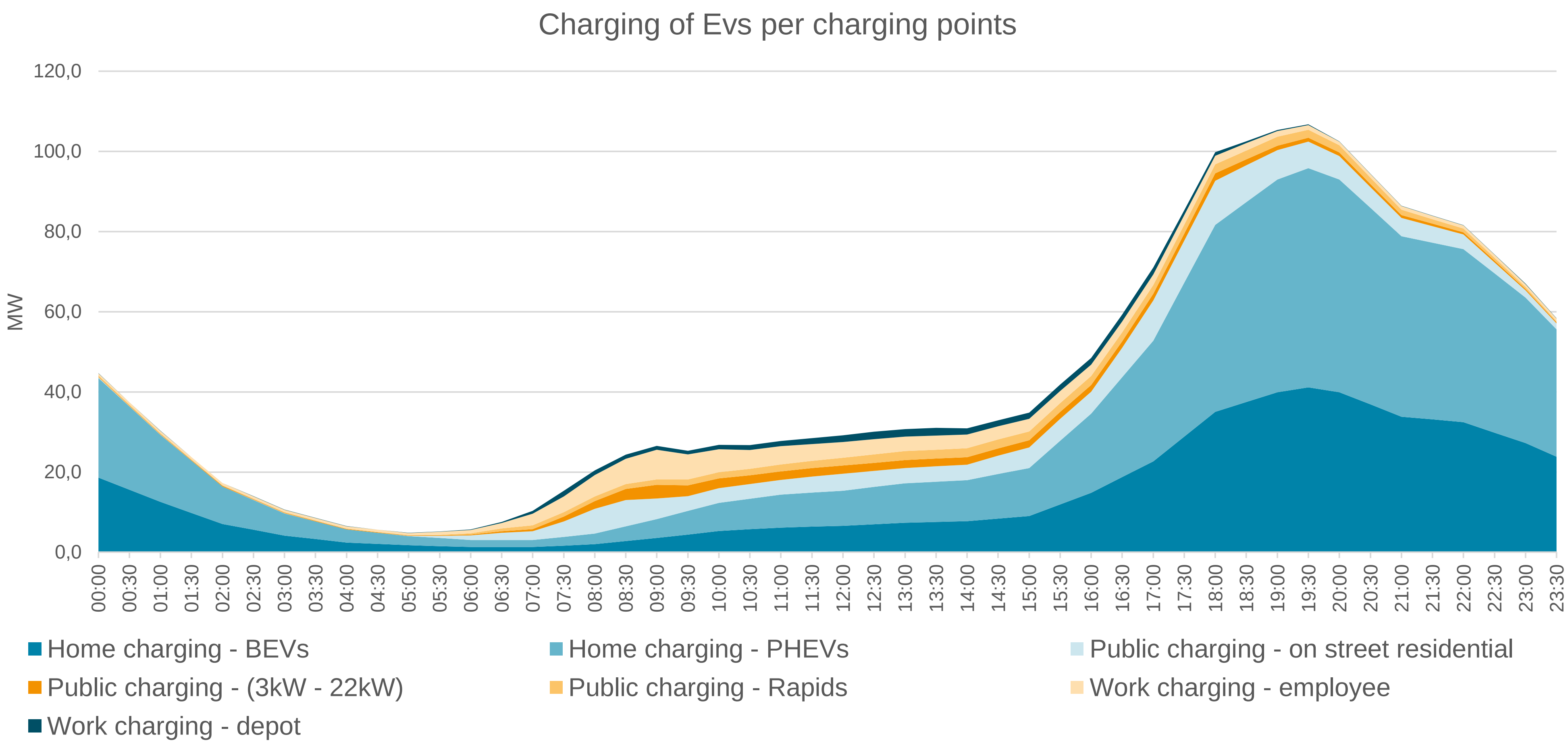
Technology	Profile name	Description	Enablers
Electric Vehicles (EV)	V0	Natural Charging : charges as soon as plugged-in	/
	V1**H**	Smart charging based on local signal (**H**ome)	Smart meter Smart charger & communication capability Appropriate tariff
	V1**M**	Smart charging based on **M**arket signal	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

Natural charging of electric vehicle

Charging depends on charging point

EV	V0
	V1H
	V1M
	V2H
	V2M

This profile represents charging of EVs as soon as they plug-in

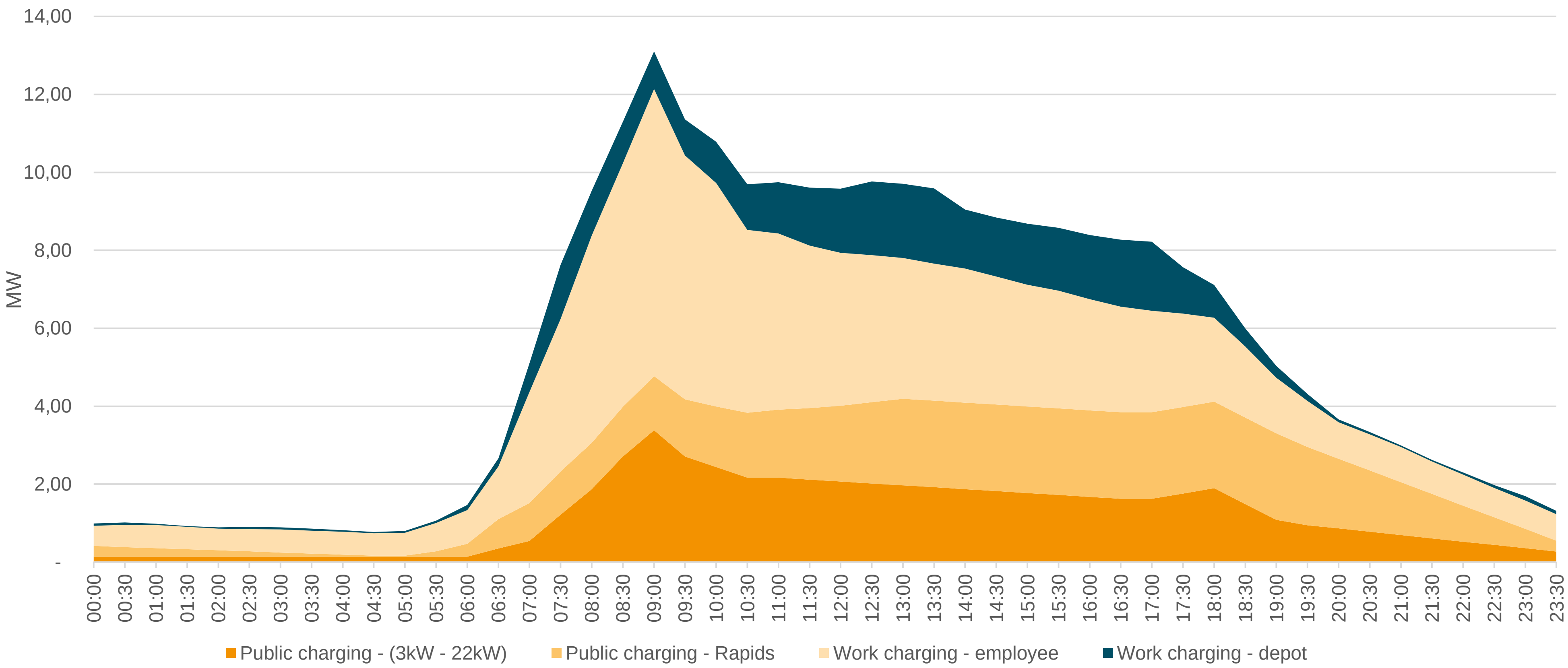


Natural charging of EVs

Zoom on work and public chargepoints

EV	V0
	V1H
	V1M
	V2H
	V2M

Public charging shows a larger peak in the morning.



How were the flexible profiles optimised?

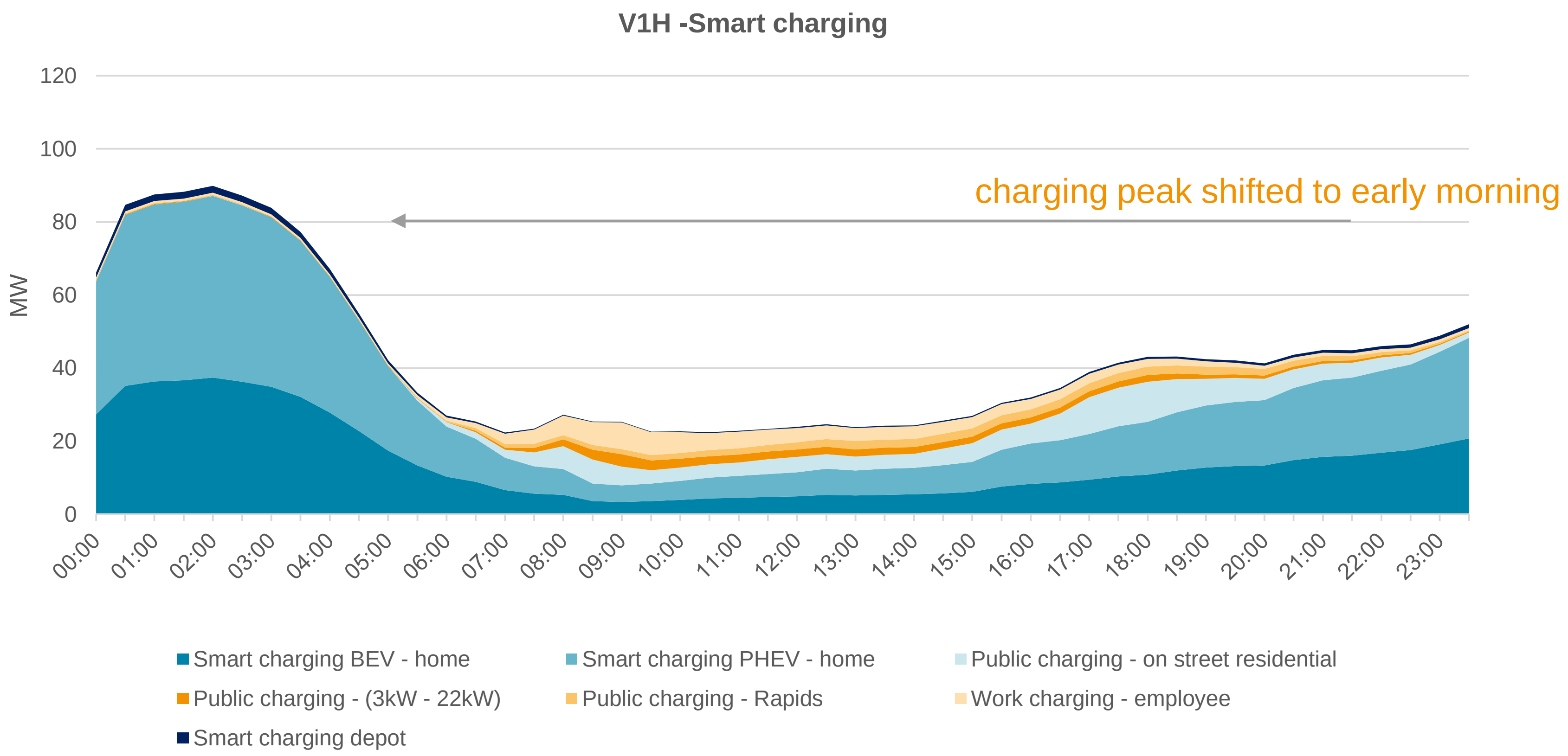
Technology	Profile name	Description	Profile optimisation
Electric Vehicles (EV)	V1**H**	Smart charging based on local signal (**H**ome)	Optimised by time of use tariff providing incentive to shift load from daytime, particularly evening to night/morning.
	V2**H**	Smart management based on local signal (**H**ome)	Includes V1H charging on time of use tariff (as above). V2H discharge is optimised against peak day time loads, while additional V2H charging load is optimised to minimise maximum load.
	V2**M**	Smart management based on **M**arket signal	V2M is optimised with same approach as V2H, but with higher maximum discharge. Note - illustrative profile only as flexibility time and volume will be driven by market signal.

Smart charging of electric vehicle

DELTA-EE

EV	V0
	V1H
	V1M
	V2H
	V2M

V1H allows to shift the load from evening peak to early morning

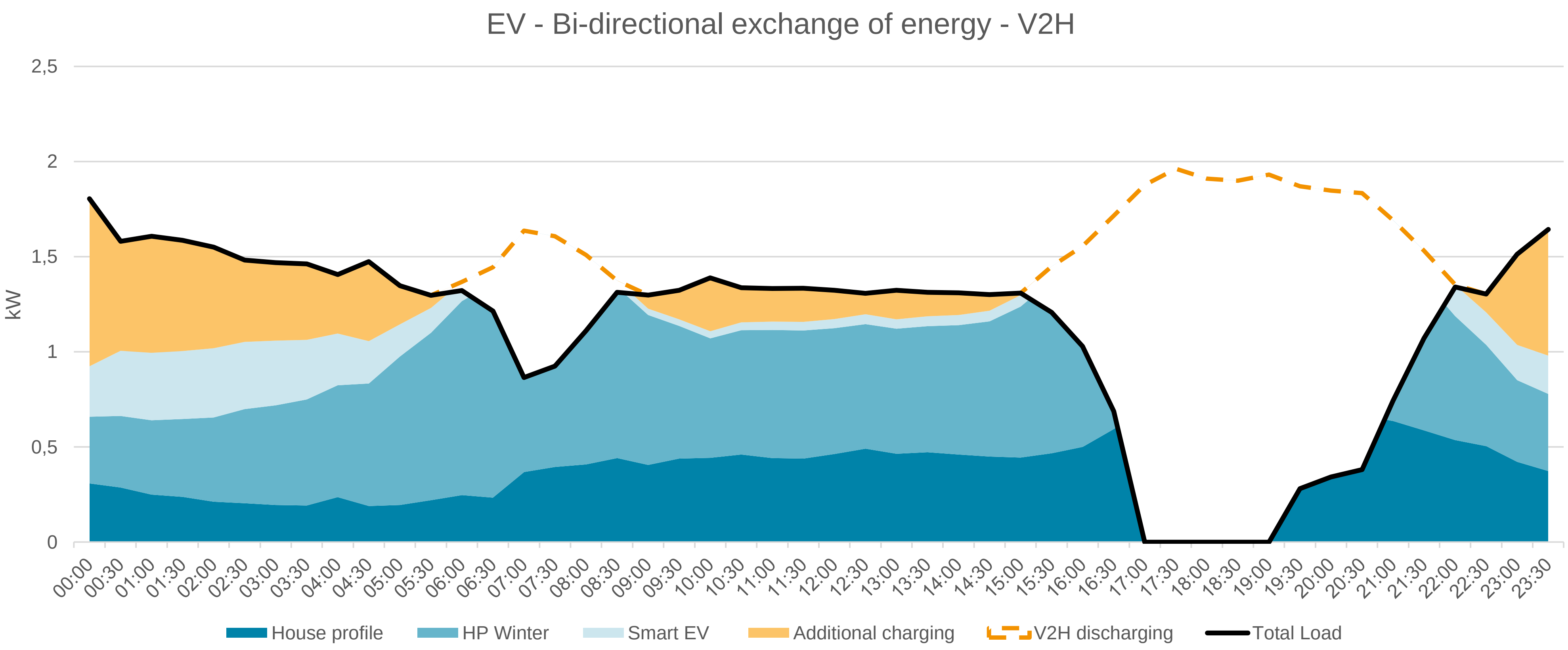


Beyond smart charging of electric vehicle

Vehicle to home: netting the house load

EV	V0
	V1H
	V1M
	V2H
	V2M

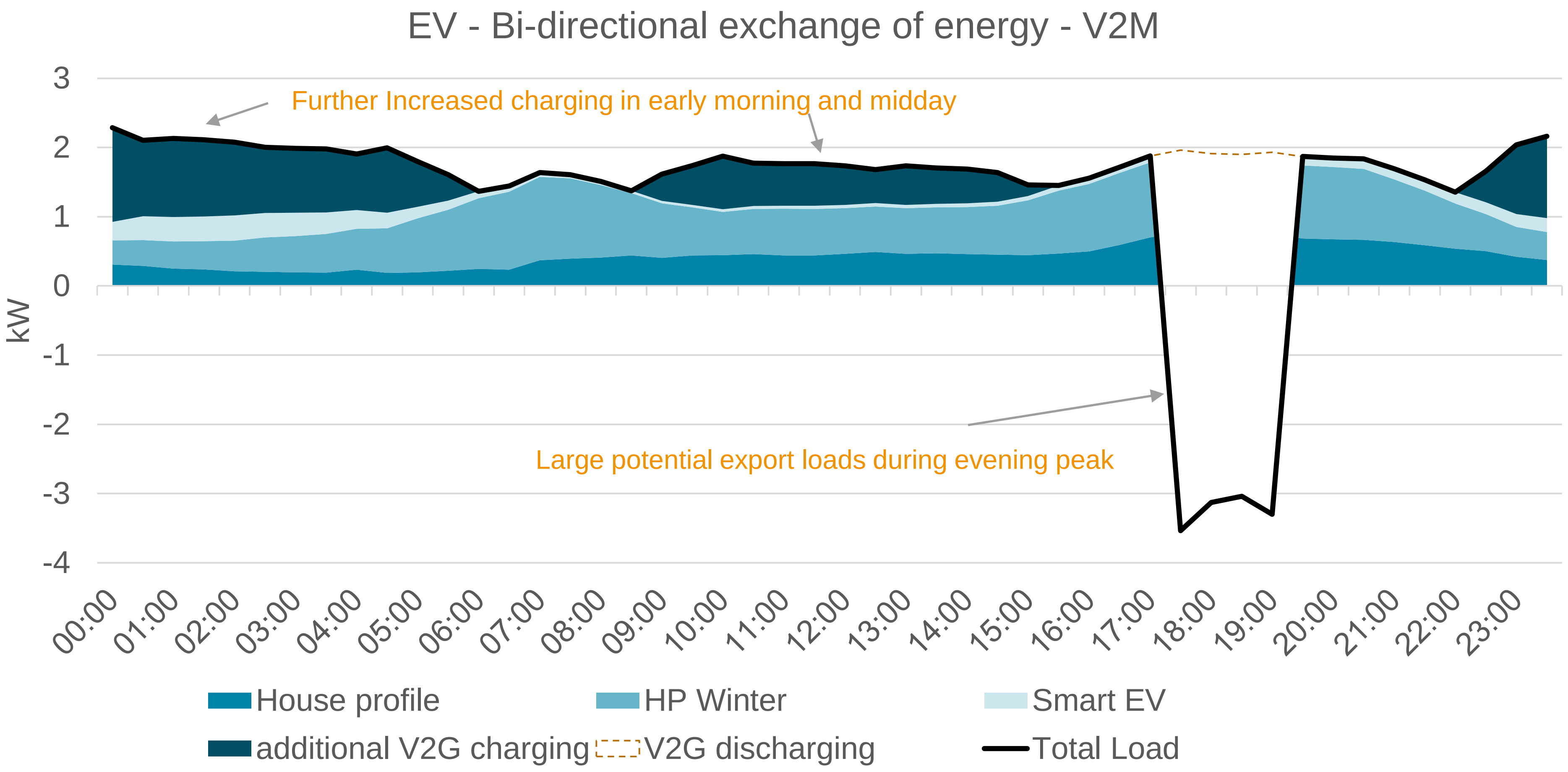
V2H allows to reduce the house load during morning & evening peaks. This increases charging in between.



Vehicle to market – illustrative profile

EV	V0
	V1H
	V1M
	V2H
	V2M

V2M has can potentially provide export to the grid, as it is optimized based on market signal



Heat pumps

Profiles categories for HPs

HP can shift the load based on different signals

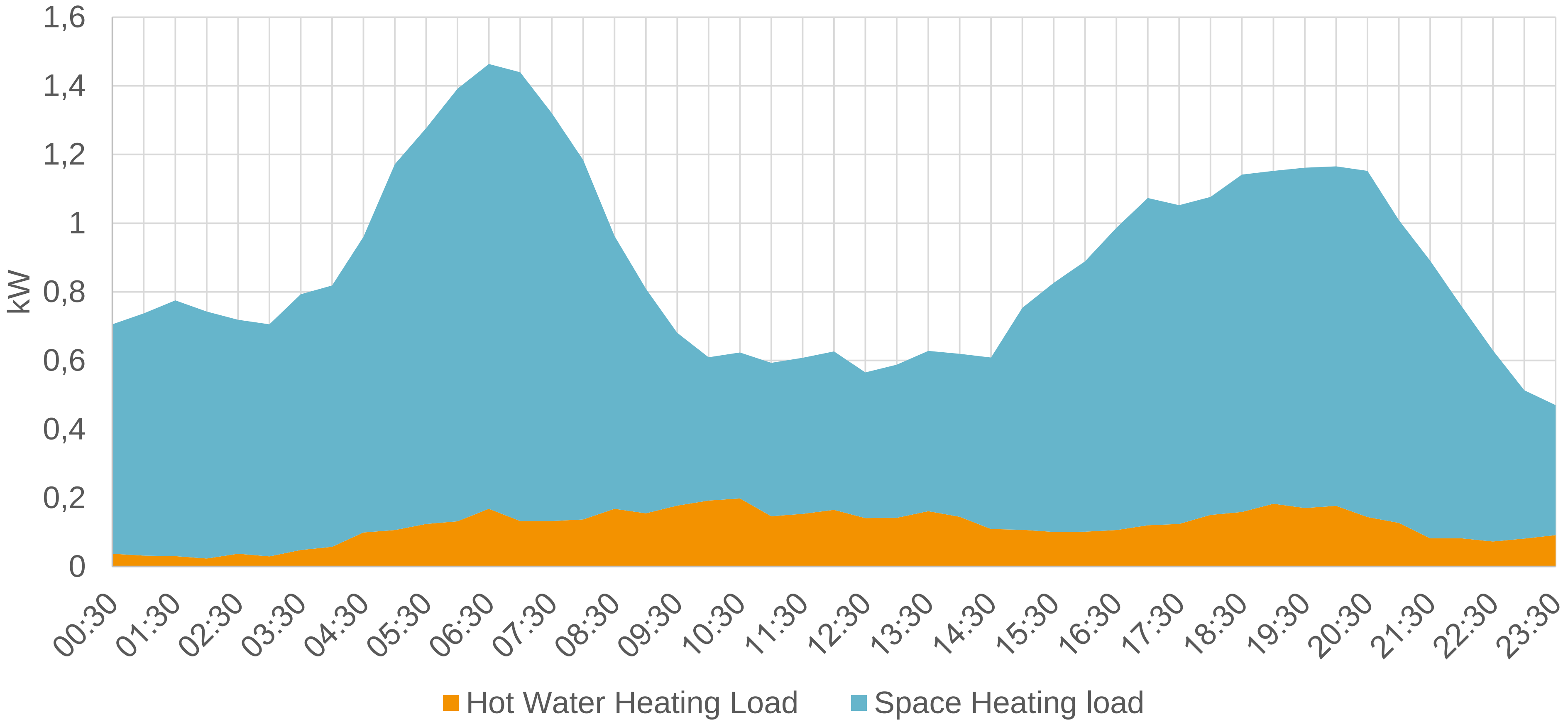
Heat Pumps are essentially a load which you can shift outside of peak hours

Technology	Profile name	Description	Enablers
Electric heating loads (Heat pump, electric heating)	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)

Natural load for a heat pump

HP	HP0
	HP1H
	HP1M

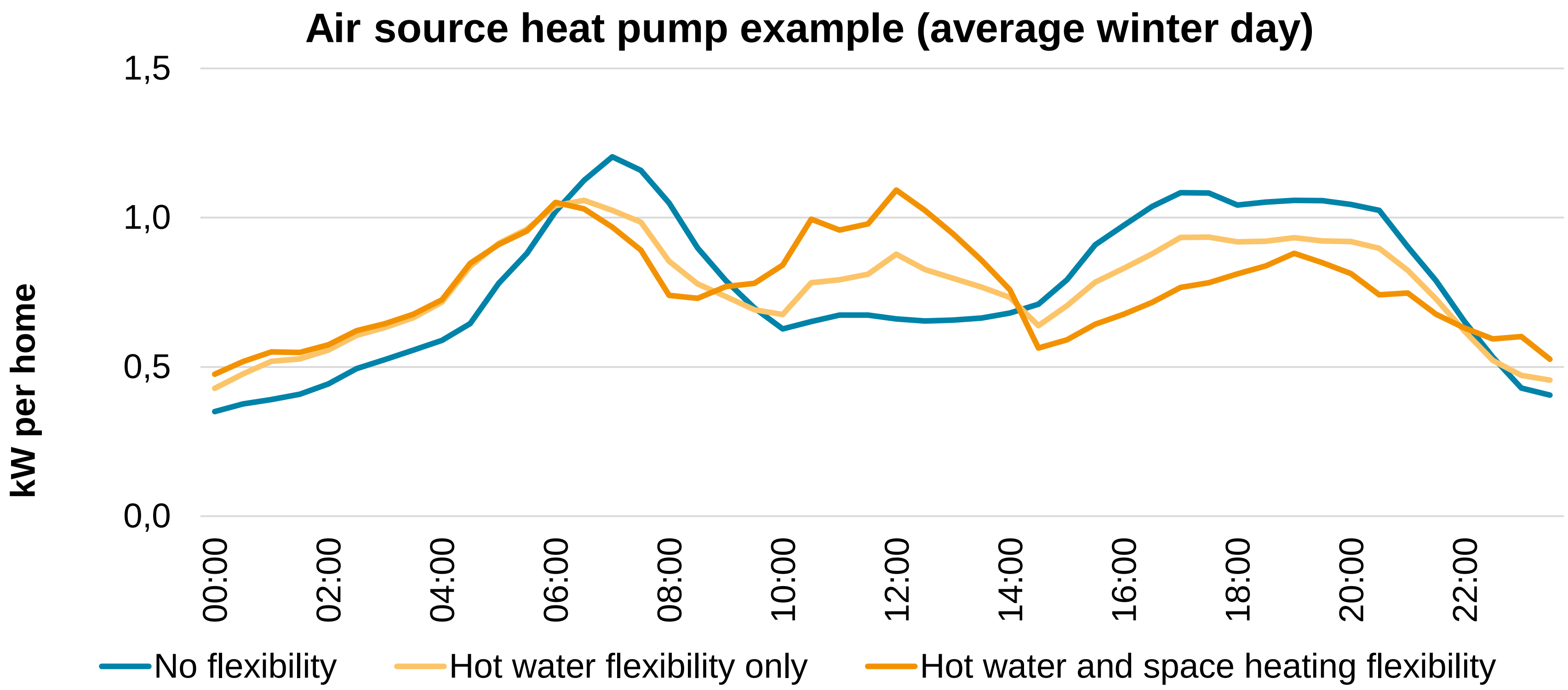
Space heating is significantly larger load than hot water, however space heating is more difficult to flex than hot water



Flexibility delivered by heat pump

HP	HP0
	HP1H
	HP1M

Evening peak can be reduced by pre-heating either the water or space heating. But pre-heating space heating would have a greater impact on consumers.



Residential Batteries

Profiles categories for Residential Batteries

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)

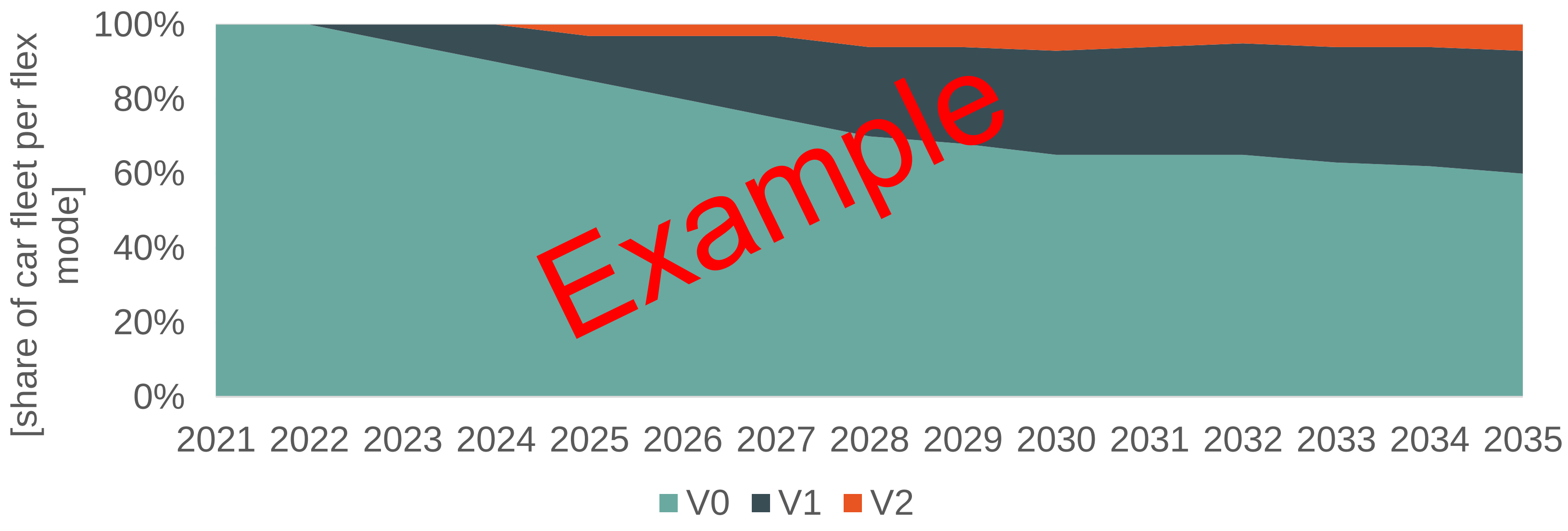
Next Steps

Flexibility penetration forecast & typical profiles will be available for public consultation

For AdFlex23 public consultation, the following information will be submitted to consultation

- **Typical profile of load for each flexibility option (e.g. V0, V1H/M, V2H/M)**
- **Flexibility characteristics for the flexibility study**

Example for Evs:



Appendix

Annex 1

Residential heat pump demand profile assumptions

Methodology and key assumptions used to estimate after diversity demand profiles of residential heat pumps under different weather conditions with different levels of flexibility

Home heating demands

Heat pump demand profiles were estimated using results of building energy modelling done in previous Delta-EE analysis. In this previous analysis, IESVE software was used to estimate the half-hourly heating requirements of several home archetypes based on weather conditions and comfort requirements. Stochastic simulations were performed to determine after-diversity demand profiles.

For this analysis it was assumed that ASHPs will be installed in similar numbers across detached, semi-detached and terraced homes in Belgium. Fewer ASHPs are expected to be installed in flats due to the lack of space for outdoor units. On this basis, the average annual heat demand for a residential ASHP system was taken to be around 14,000 kWh per year.

GSHPs are expected to be installed primarily in larger detached homes with outdoor space for boreholes or trenches. The average annual heat demand for a residential GSHP system was taken to be around 17,000 kWh per year.

Comfort requirements

Homes were assumed to be heated to 21°C on average when occupied during the day. A 16°C setback temperature was applied overnight.

Energy efficiency improvements

Homes are expected to be reasonably well insulated before heat pumps are installed (e.g. cavity wall insulation, loft insulation and double glazed windows). Further improving insulation levels might reduce heating demands by around 5-20%.

Heat pump performance

The coefficient of performance (COP) for ASHPs was estimated as an exponential function of outdoor temperature ($COP=2.63e^{0.05*T}$). This was calculated based on performance data reported for various heat pump models. GSHPs were assumed to have a relatively constant COP between about 4-5.

Hot water

Hot water demands were estimated based on measurements reported in a UK study. Hot water storage cylinders installed with heat pumps were assumed to have a capacity of 180 litres on average. In the baseline scenario with no flexibility it was assumed that cylinders are required to maintain a minimum state of charge of approximately 80%.

Electric Vehicles and chargepoints

Unmanaged charging load from Belgium’s EV fleet

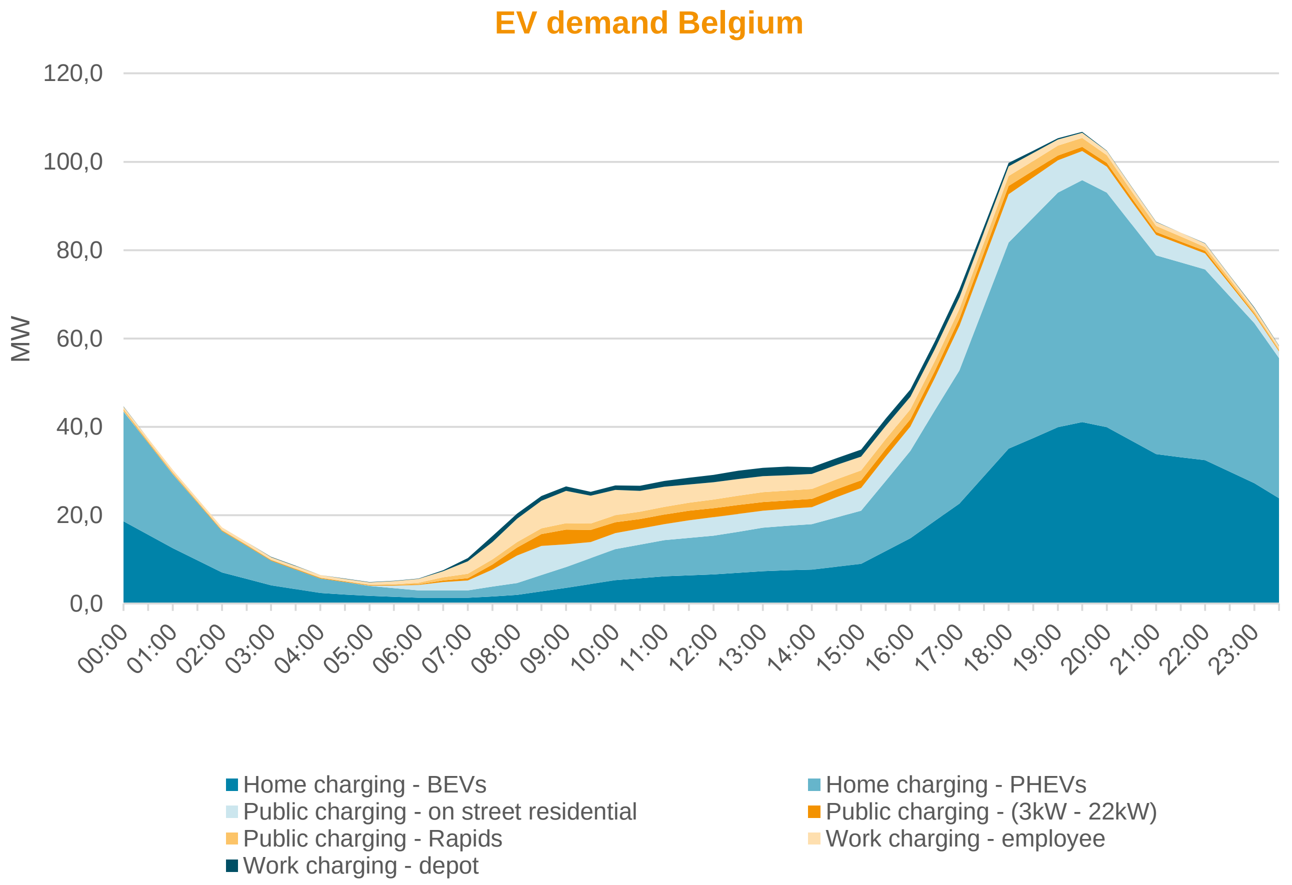
Demand profiles from previous research have been combined with data on the EV parc to give daily demand curves

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)



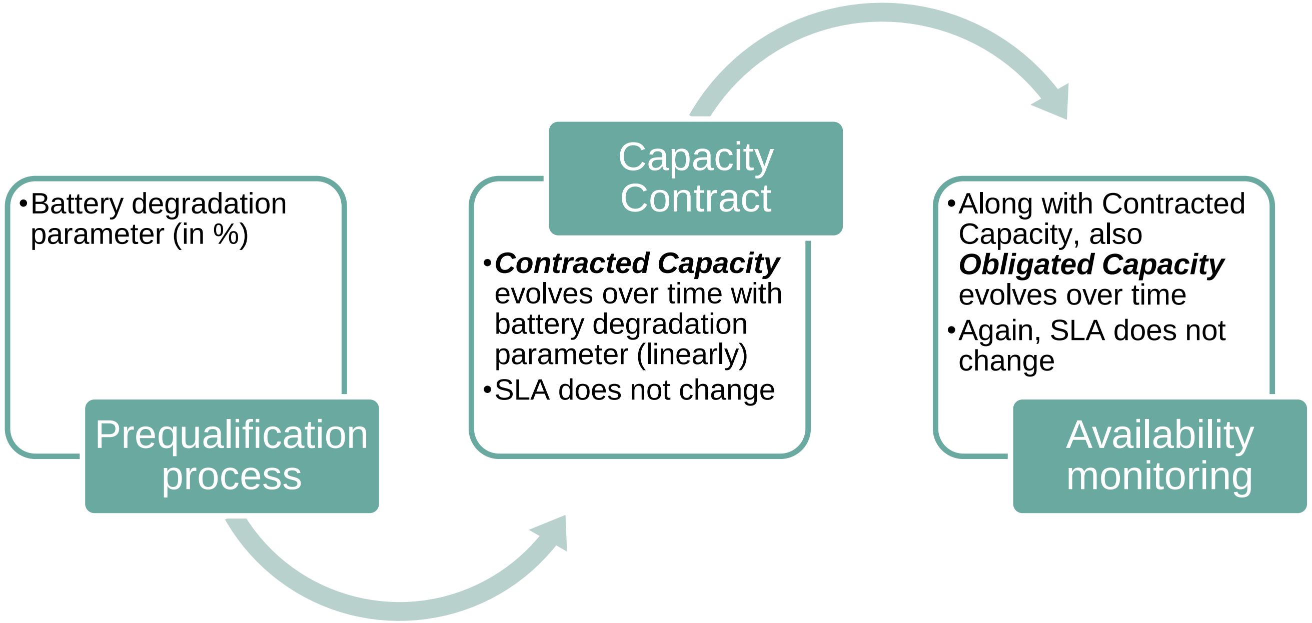
CRM design changes

CRM design elements

	Evaluation
1) Review of **payback obligation** modalities : evolution of the payback obligation indexation mechanism (NEW update)	➢ Addressed
2) Review **NRP** determination	➢ Addressed
3) CRM should be **"winter" product**	➢ Addressed
4) **Tests for demand response** are too strict (in line with SLA, e.g. testing full nominal capacity for 6 hours)	➢ Addressed
5) Facilitate participation of **low voltage flexibility**	➢ (will be) addressed (together with DSOs)
6) **Administrative simplification** (grid user declaration (DP ID), CO_2, renunciation of operating aid, …)	➢ (will be) addressed
7) **Battery degradation** could be better considered in CRM design (NEW update)	➢ Addressed
8) **Permit request** too strict for battery projects 4 years ahead of delivery period. There is still sufficient time for such projects to get the necessary permits after the auction.	➢ Not addressed
9) Impact of **derating factor improvement/reduction**	➢ Addressed

Battery degradation

More and more (large) batteries are being connected to the grid and show interest to participate in the CRM. Therefore, it becomes relevant to introduce a specific **battery degradation parameter** to allow ***batteries*** that go for a ***multi-year contract*** to ***maximize the capacity offered in the CRM, without them needing to resort to opt-out***.



Note that towards the next Auctions (for Delivery Period 2 and following), the battery degradation volume is reconsidered each time during the Prequalification Process:

- *The Remaining Eligible Volume is each time calculated as: (NRP – opt-out) * Derating Factor* ***– Contracted Capacity****;*
- *Hence, the* ***volume related to the degradation will be part of the Remaining Eligible Volume*** *and so should be offered in the Auction or part of an upfront opt-out notification.*

NEW update:

- ➢ Degradation parameter will be made ***technology neutral***, such that each CMU going for a multi-year Capacity Contract can make use of this parameter if desired;
- ➢ Other modalities remain the same, as described on this slide.

Evolution of the indexation mechanism for the payback obligation

Recap

In the previous working group, Elia presented several options for **the evolution of the payback obligation indexation mechanism** (see recap next slide):

- The current indexation mechanism only applies for multi-year contracts starting from the second delivery year.
- In light of the current market circumstances, the indexation mechanisms is deemed to be not fit for purpose anymore by some market parties.
- After discussion in the working group and further assessment, Elia has worked further on an **updated proposal of indexation mechanism** capturing short term evolution of the market while keeping in mind other important principles
  - Technology neutrality
  - Technology openness
  - Windfall profit avoidance
  - Least cost principles

➔ The focus of today's working group is on the indexation mechanism, not on the retroactive application of such mechanism as the analysis is still ongoing.

This leads to different options for the uniform strike price redesign

This overview of proposed solutions aims at summarizing considered options

Recap:
New option discussed in the next slides

	Option A: As Is	Option B: Haulogy proposal	Option C: Ex-post indexation DA	Option D: Ex-post indexation based on fuel and CO_2 prices	Option E: Combination of max (B & D)	granul
What	- Only ex-ante indexation from 2nd Delivery Period - No ex-ante indexation for 1s Delivery Period - DAM driven	- Ex-ante indexation from 1st Delivery Period (cf. Haulogy) - DAM driven - Complemented with finetuned indexation formula	- DAM driven. - On a monthly basis	- Gas prices and CO_2 prices driven - On a monthly basis	- Ex ante indexation with a back-stop mechanism in case of price shocks in fuel markets	- Monthly or weekly stop-loss
+	- Simple - Fixed strike price, lower uncertainty for the delivery period	- Simple - Relieves some concerns on LT market trends	- Takes into account ST evolution. - Technology neutral. - Captures windfall profits	- Takes into account ST evolution of underlying price drivers.	- Addresses current concerns of high prices - Impact of fuel prices in extreme situations covered	- Simple - Further decreases risk in case of temporary market trends.
-	- Does not solve lag between historical and current prices. - Does not address concerns raised by stakeholders	- Unable to capture ST changes. - Indexation based on DAM might not consider evolution of specific drivers such as changes in merit order.	- Indexation based on DAM might not consider evolution of specific drivers such as changes in merit order.	- Complex determination of indexation formula - Selected fuel sources might not determine DAM in the long term.	- Decrease of market prices lags (hence longer time with high strike price)	- Not a solution when prices remain above strike price structurally. - Risk of reducing the efficiency of the Payback Obligation

Evolution of the indexation mechanism for the payback obligation
New proposal

Elia has worked out additional possible option for the indexation of the strike price:

- A **monthly** ex-post indexation of the strike price based on monthly DA prices (i.e. strike price of September is set by DA prices of September). **This indexation would apply from the first delivery year**.
- It consists in adding a **variable component** following the DA evolution to a fixed component on which the strike price was initially calibrated.

Making the split between a variable and a fixed component for the monthly indexation of the strike price allows to:

- **Capture a dynamic evolution of the electricity prices** and avoid time lag issues. Hence the indexed strike price follows **increasing but also decreasing market prices**.
- Avoids a disproportional indexation factor, hence **no need for a cap and floor**.
- Have **the right time granularity** to capture sudden market changes.
- Avoiding windfall profits whilst still ensuring the possibility to capture some inframarginal rents.

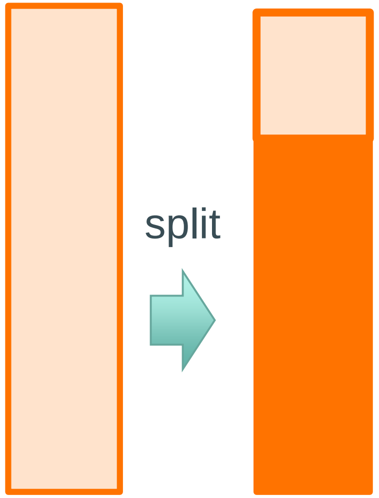
Evolution of the indexation mechanism for the payback obligation

New proposal

At the time of the auction

$$\begin{aligned}&Fixed\ component\\&= calibrated\ strike\ price\\&-\ \ average\ DA\ prices\ for\ the\ calibration\ period\end{aligned}$$

Strike price set as auction parameter (eg. 300€/MWh)



Av. DA market price observed in the same period as used for the calibration of the strike price*/**

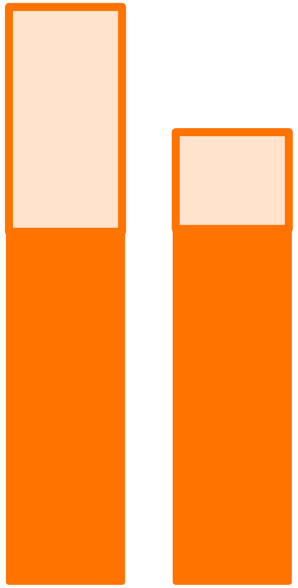
Fixed component = calibrated strike price – Av. DA price for the calibration period

During delivery

$$Ex-post\ indexed\ Calibrated\ Strike\ Price\ =\ (fixed\ component + Max(0; average\ DA\ price\ for\ month\ m)$$

Av. DA price for each delivery month (all year)

Fixed component

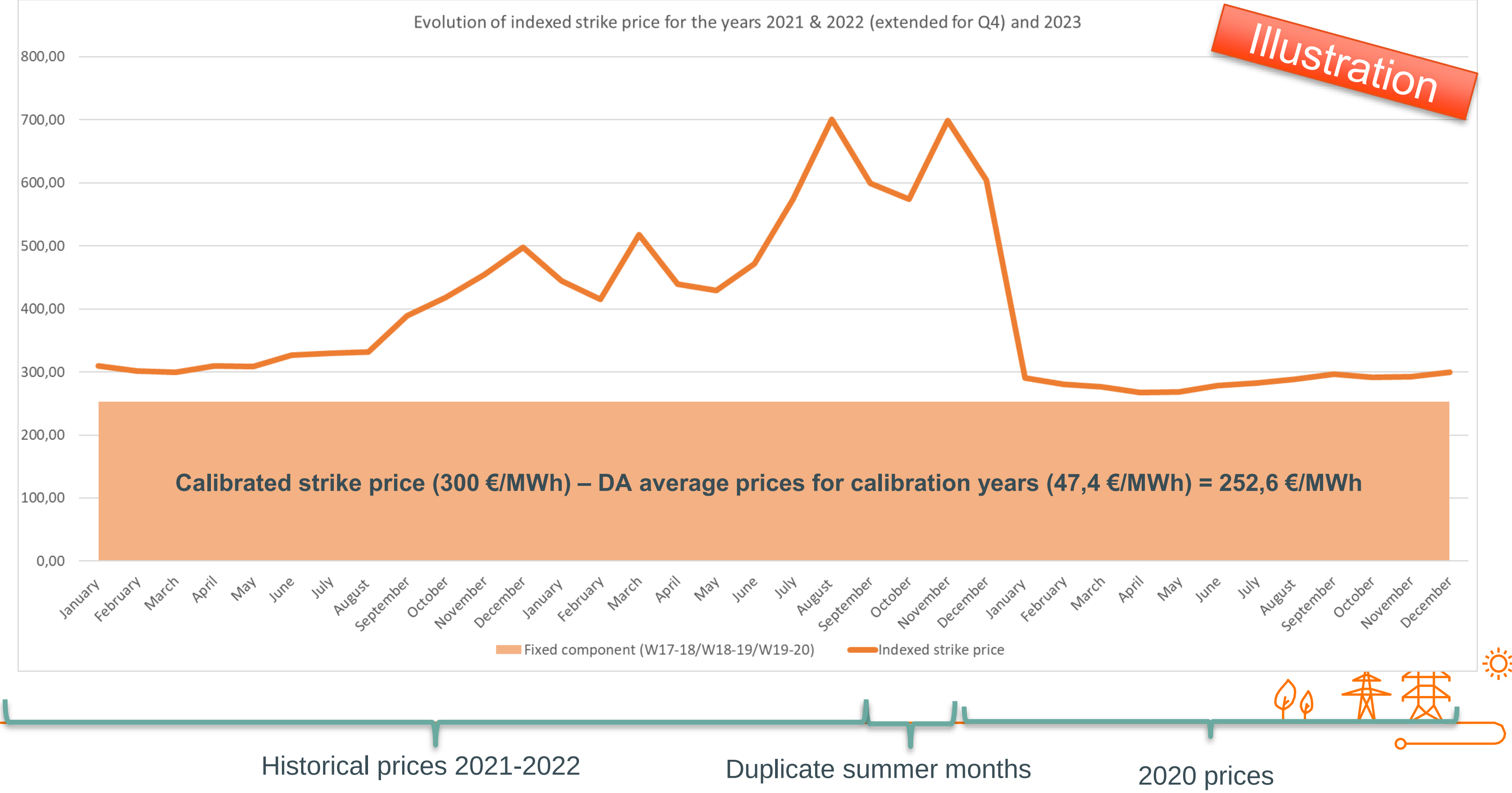


*It may be relevant to reduce the observed DA prices by only considering the week days / peak hours.
** For the calibration, only the winter periods are considered

Evolution of the indexation mechanism for the payback obligation

Example (1/2)

- We use the strike price calibrated for the 1st Delivery Year 2025-26: 300 €/MWh -> calibrated based on winters 2017/18, 2018/19, 2019/20
- From this calibrated strike price, we withdraw the average of the DA prices for the same winters : 47,4 €/MWh
- Then, we add for every month of the period investigated the **average DA monthly price**



Year	# of Payback occurrences
2021	14 (13/14 events show a higher CSS* > Payback amount)
2022 (Q4 '22 replicates prices from July/Aug/Sept '22)	132 (More than 90% of events show a higher CSS* > Payback amount)
2023 (prices from 2020 were taken for illustrative purpose)	0

*CSS is based on an average efficiency rate of 50% for a CCGT

Evolution of the indexation mechanism for the payback obligation

Example (2/2) : Payback amount

- The equivalent amount of Payback Obligation (€/MW) that a Daily Schedule capacity provider would have had to pay back during the simulated period is the following :

Year	# of Payback occurrences
2021	14 (13/14 events show a higher CSS* > Payback amount)
2022 (Q4 '22 replicates prices from July/Aug/Sept)	132 (More than 90% of events show a higher CSS* > Payback amount)
2023 (prices from 2020 were taken for illustrative purpose)	0

Year	Pay-back obligation amount [€/MW]
2021	458 €/MW
2022 (Q4 '22 replicates prices from July/Aug/Sept)	7611 €/MW
2023 (prices from 2020 were taken for illustrative purpose)	0

Evolution of the indexation mechanism for the payback obligation

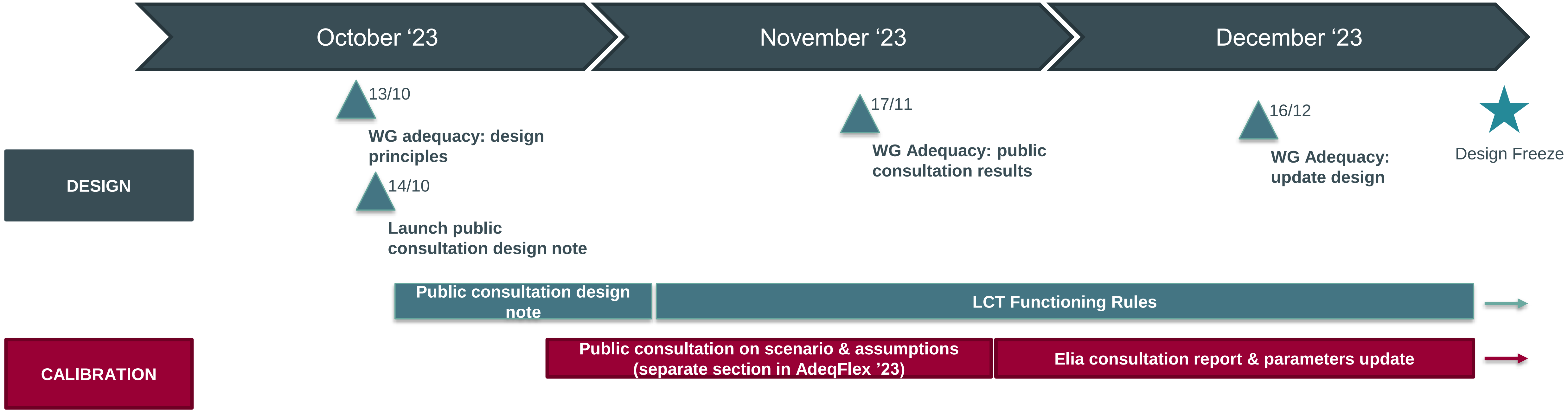
Focus on the fixed component

	Calibrated value	Average DA prices used for calibration	Fixed component
Calibrated Strike price for Y-4 linked to DY 2025-26	300 €/MWh	47,4 €/MWh	252,6 €/MWh
Calibrated Strike price for Y-4 linked to DY 2026-27	300 €/MWh	46,3 €/MWh	253,7 €/MWh
Calibrated Strike price for Y-4 linked to DY 2027-28	417 €/MWh (if we assume that P85 is the value retained from the calibration curve)	98,5 €/MWh	318,5 €/MWh
Winter 2021-2022	494 €/MWh (assuming we would have three identical winters)	213,4 €/MWh	280,6 €/MWh

- The strike price is set on the tail of the offer curve, hence there will always be a significant difference between the average prices and the strike prices
- The fixed component of the indexed strike price (being the maximum inframarginal rent “expected” at the time of bidding in the CRM auction) remains steady throughout the considered scenarios.
- Doing so could reduce the uncertainty/risk to factor in at the time of bidding in the CRM auction, and henceforth lead to a more competitive outcome

LCT design note

Overview of short term milestones for the Low Carbon Tender



Design: eligibility

Recap of the general eligibility principles

Eligibility criteria

1) Only additional “new build” is allowed to ensure procurement of new MWs, but with exception for demand response (see further).

2) Existing demand response can participate, as long as it was not yet “contributing to adequacy” (see further)

3) Only participation of low-carbon technologies will be allowed (cf. Winter Plan), so only a limited set of technologies will be eligible or CO_2 restrictions will apply (exact rules to be determined by the Belgian Authorities).

Only capacities that haven’t been accounted for in adequacy calculations are eligible for this low-carbon tender

New **storage assets** are eligible if the conditions below are satisfied :

- “Additional - New Build” capacities are eligible
  if they comply to the emission threshold and/or are within the set of eligible technologies.

  ➔ New build capacities are defined as not “in service” at the moment of the auction.

  ➔ This approach might imply a volume correction in the demand curve if capacities become ‘in service’ between the volume determination and the auction.

  ➔ If the capacity has already a capacity contract under the CRM (for a different Delivery Period), an intermediate price cap will apply.

New **demand response** : capacity is eligible if it’s considered **Non-contributing to adequacy:**

& Has not contributed to the Belgian adequacy by participating in the Ancillary Services or in Transfer of Energy in the last 2 years.

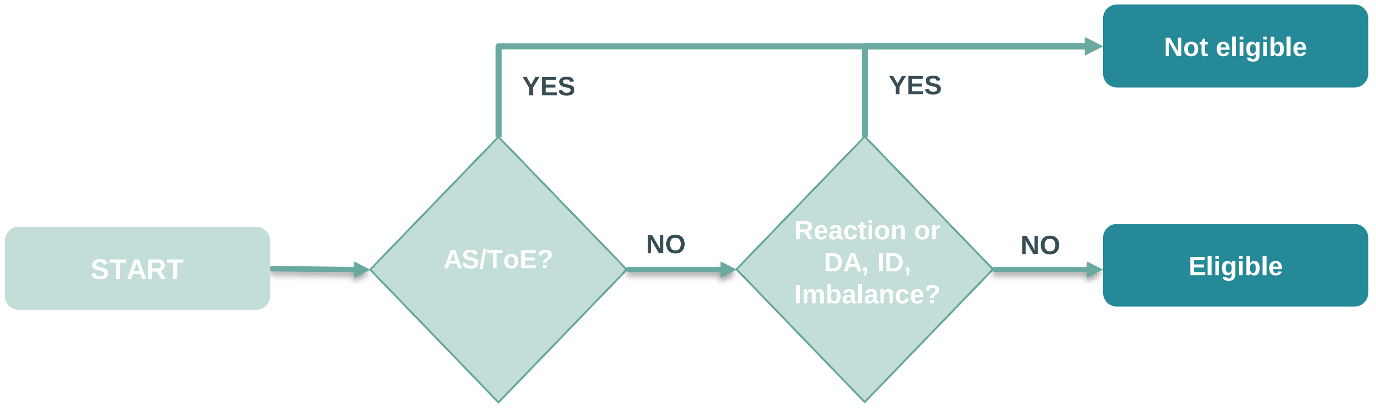
& Has not contributed to the Belgian adequacy by reacting to real-time price signals or participated in the Day-Ahead, Balancing or Intraday Market in the last 2 Winters.

How to define “non-contributing to adequacy” in case of demand response

	Additional “New Build”	Additional “Other”	Existing
	At moment of PQ, not connected to the grid	At PQ, no quarterly measurements available	At PQ, quarterly measurements available
Providing ancillary services to Elia or having participated in Transfer of Energy	N/A	N/A (measurements would be available)	**To be checked at PQ**
DSR as a reaction to high prices or DSR offered in DA/ID/Imbalance market	N/A	**To be checked at PQ***	**To be checked at PQ**

*If no measurements are available at **DP level**, **AP level** is also allowed, while allowing for an “equation” to filter out other DPs which could distort the signal.

Eligibility of “new” Demand Response is determined in two steps



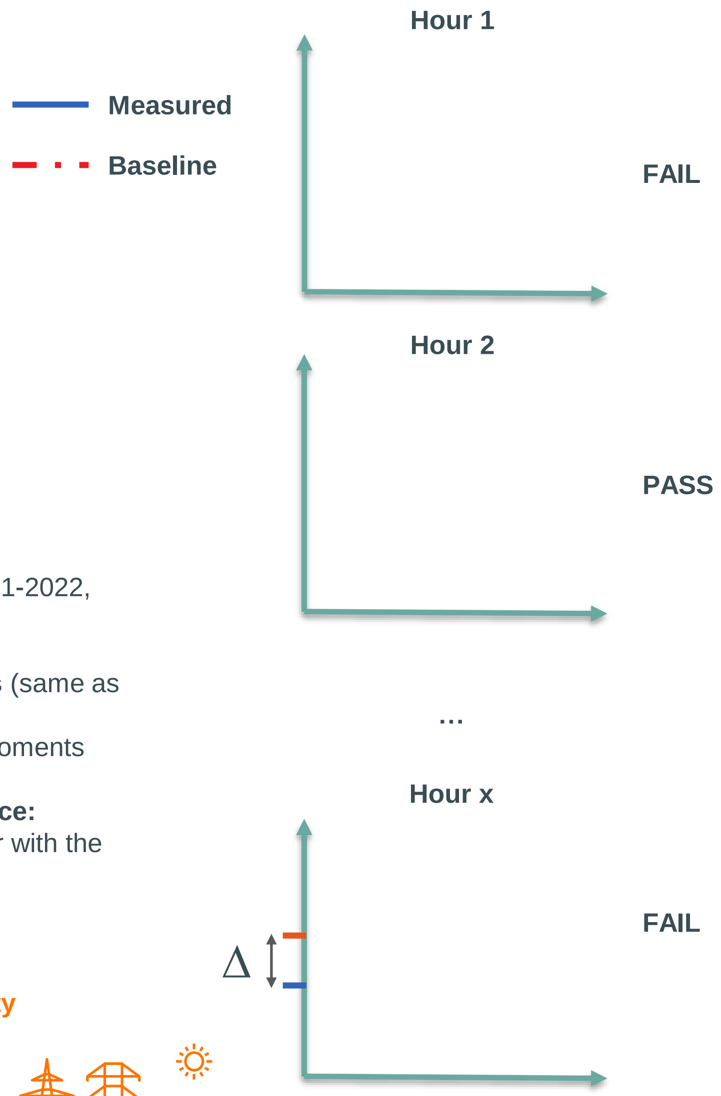
Has the DP taken part in AS or ToE since 31st of October 2021

Has the DP provided any other Demand Response?

1. Determine relevant **high price hours** over Winter 2021-2022, Winter 2022-2023**
2. Perform **baselining on each of the high price hours** (same as Availability Monitoring baselining)
   → determine their “delivered capacity” during these moments
3. Determine **for each hour if a reaction has taken place:** compare the average power during the high price hour with the baseline
   → If Δ < 15%: classified as PASS
4. If >85% of the **high price hours** PASS
   → **DP does not provide implicit capacity**

***** Determining "high price hours"***
Determine price thresholds for ID, DA, Imbalance (hourly prices, in Winter: 1/11 – 31/03, for Winter 2021-22, Winter 2022-23:
- *If DAM > 95th percentile of prices*
- *If ID reference > 95th percentile of prices*
- *If imbalance price > 95th percentile of prices*

*→ Identified as a “**high price hour**”*



**Exact percentages and cut-offs are still under review*

Next meetings

Foreseen timeslots for next meetings

- Friday 28th October 2022 **pm**
- Thursday 17th November 2022 **pm**
- Friday 16th December 2022 **pm**
- NEW Friday 27th January 2023 **am**
- NEW Friday 17th February 2023 **am**

Thank you !