ChargeUp EUROPE

A methodology for minimum capacity targets for EV Charging Infrastructure

In collaboration with

ADL Arthur D Little

(technical support & analysis)

ChargeUp EUROPE

Approach

1 **Calculating minimal threshold**

Main Assumptions

2 **Alternative scenarios**

Divergent approaches regarding public v private and AC v DC

Calculating minimal threshold

We consider a market-driven scenario to project fleet size and electricity demand from EVs to 2025 and 2030

- **Market driven EV uptake** based on **current policies and EV strategies** of major European Automotive OEMs (VW Group, Stellantis, Renault, Daimler, BMW, Volvo, JLR)
- **EV Forecast** based on existing **production forecasts** of market intelligence companies (IHS, LMC, Bloomberg) and **manufacturer´s target** announcements

Source: Arthur D. Little

Calculating minimal threshold

EV uptake will drive infrastructure deployment, technology needs to be adapted to charging use cases

Approach to infrastructure planning

Logic	The **EV fleet** is the **main driver for charging infrastructure** → Infrastructure **targets** should always be **set relative to EV targets**
Distinction technology & use case	**Different charging use cases** require **different charging technology** → Infrastructure targets should distinguish between AC, DC (50 - 149kW) and HPC (≥150kW) to account for diff. use cases
Metric	**AC, DC and HPC Charging Points/ 100 BEVs**
Roadmap	***Status-Quo*** (2020): Existing infrastructure as starting point → ***"Overbuild"*** (2025): Release consumer fears, enabling breakthrough of BEVs in EU → ***"New normal"*** (2030): Sufficient infrastructure for convenient and economic use

Main data inputs and validations

Home Charging	■ Housing statistics (share of family homes and semi-houses) ■ Today majority of EV drivers are homeowners → 2030 assumption: EV drivers evenly distributed among all housing use-case
Workplace Charging	■ Commuting statistics (proportion of employees that drive to work by car) ■ Assumption: Employees only drive to work by car if they have a parking possibility at their employer
Public Charging	■ Assumption: Investment-heavy HPC use-case will reach minimum threshold ■ Validation with Charging Point Utilization (Benchmark data provided by member companies) ■ Validation with mature EV market countries (e.g. Norway)

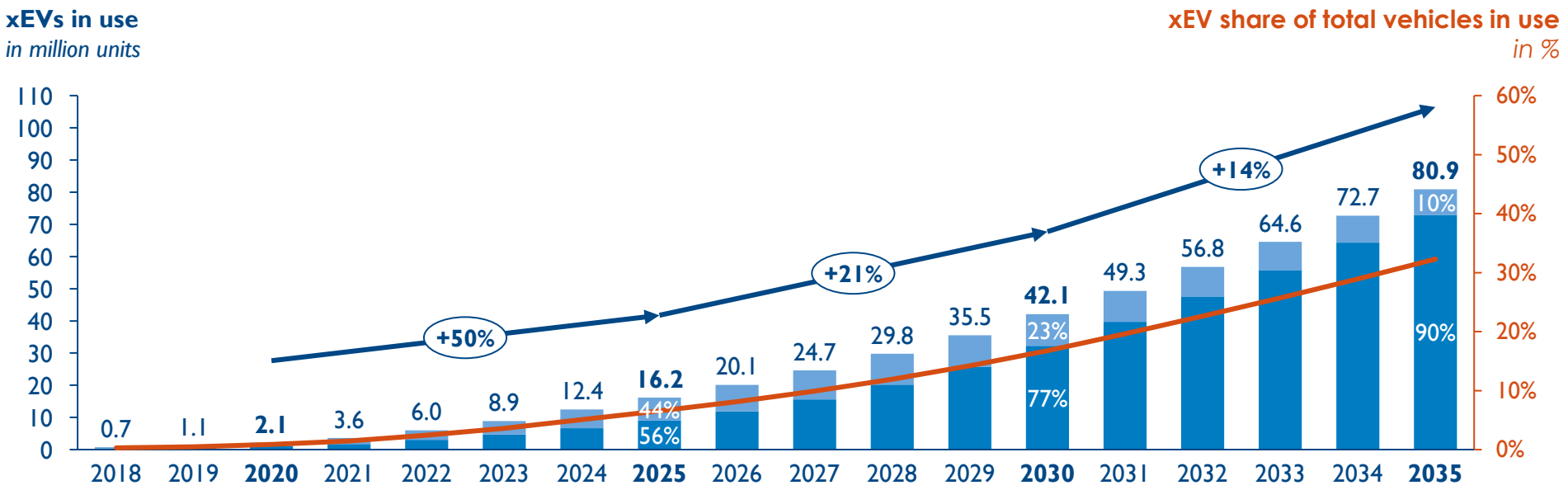
Source: Arthur D. Little

Calculating minimal threshold

In a market-driven scenario we expect that 65% of all new vehicles sold will be electrified and the xEV fleet will grow to 42 million vehicles by 2030

xEVs in use EU-27 2018 – 2035 – Market-Driven Scenario

ONLY PASSENGER CARS



*xEV share of **new vehicle** registrations*	11%	34%	65%	90%
*xEV share of **total vehicles** in use*	1%	7%	17%	32%

Source: Arthur D. Little Analysis based on vehicle sales forecast from IHS, EVVolumes.com, Bloomberg and manufacturer Sales Targets

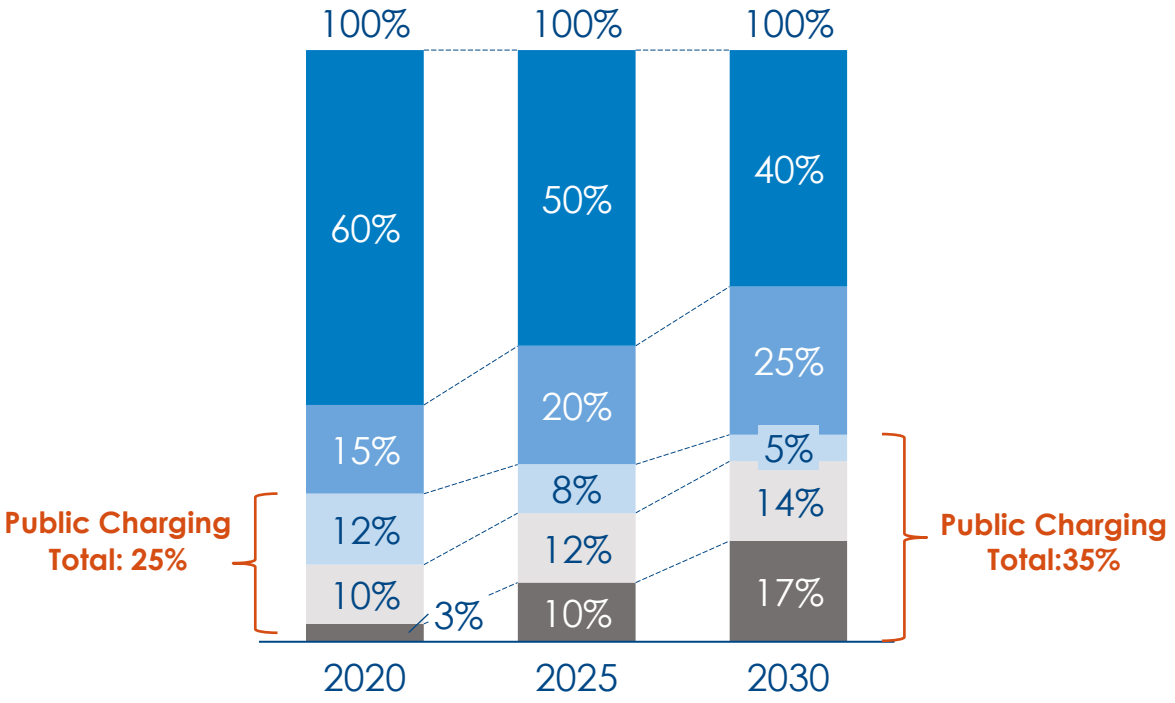
xEV Share BEV PHEV

Calculating minimal threshold

EV adoption of urban EV drivers will increase share of public charging use cases to 35% in 2030

Charging Behavior Forecast – Charging Use Cases

Distribution per consumed electricity



Source: Transport & Environment, Expert Interviews, ADL project Experience

Comments

- **Today** most EV drivers **charge** their **vehicle at home**
- Increasing EV **adoption of urban EV drivers** without charging possibility at home will **shift charging behavior** from Home charging **to Workplace and Public charging**
- **Home Charging** will **remain** the **most important** charging use case

Calculating minimal threshold

The total electricity demand by EVs is calculated by multiplying vehicles, annual mileage and average electricity consumption

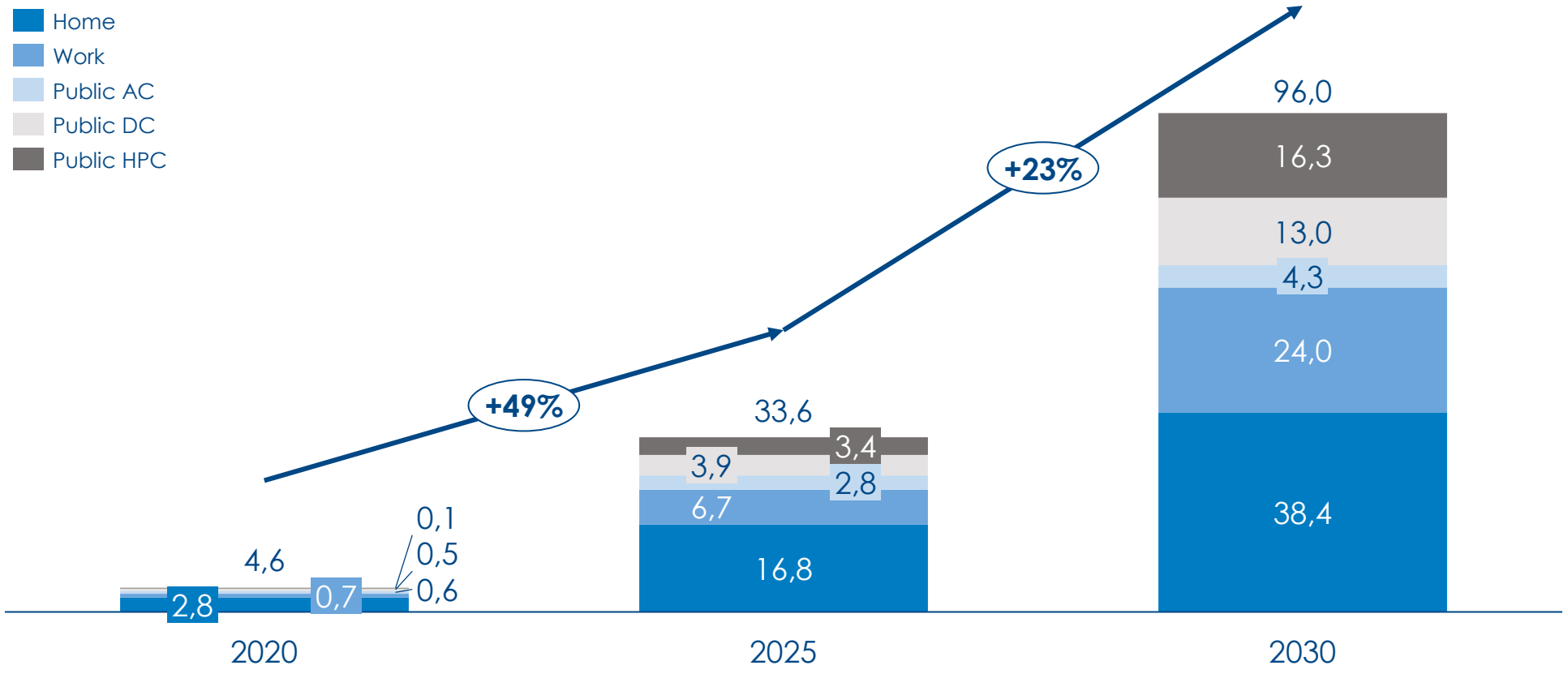
Main Assumptions market scenario

	2020	2025	2030
New Vehicle and xEV Forecast	**Source Vehicle Forecast:** IHS **Source xEV Forecast:** LMC, EVVolumes.com, Bloomberg, Manufacturer announcements, expert interviews		
Annual Electric Mileage	**BEV: 15.000 km**	**BEV: 15.000 km**	**BEV: 15.000 km**
	PHEV: 5.000 km	**PHEV: 5.000 km**	**PHEV: 5.000 km**
	Mileage of PVs historically between 14.000 and 15.000 km in EU		
Electricity Consumption	**21,3 kWh**/100 km	**19,7kWh**/100km	**18kWh**/100km
	Based on most sold EVs in EU 2018-2019 with additional real-world mark-up → average consumption expected to decreased due to shift towards smaller vehicles and efficiency gains; PHEVs expected to have the same electricity consumption as BEVs		

Source: Arthur D. Little

Calculating minimal threshold

Based on our assumptions public charging will generate a total electricity demand of 10.1 TWh by 2025 and 33.6 TWh by 2030



Source: Arthur D. Little Analysis

Calculating minimal threshold

The electricity demand is divided over indicative numbers of charging points per 100 BEVs across different use cases

Density of Charging Network

Charging points per 100 BEVs*

Assumptions

CPs/ 100 BEVs	2020	2025	2030
Home	80	70***	60***
Work	15,0	17,5***	20,0***
Public AC	12,4**	7,0***	3,0***
Public DC	1,7**	2,5	1,3
Public HPC	0,52**	0,43	0,28

The **ratio of publicly accessible charging points to EVs will reduce over time as the market matures** and utilization of the infrastructure improves

Validation (Utilization)

The utilization period assumes a 24 hr day

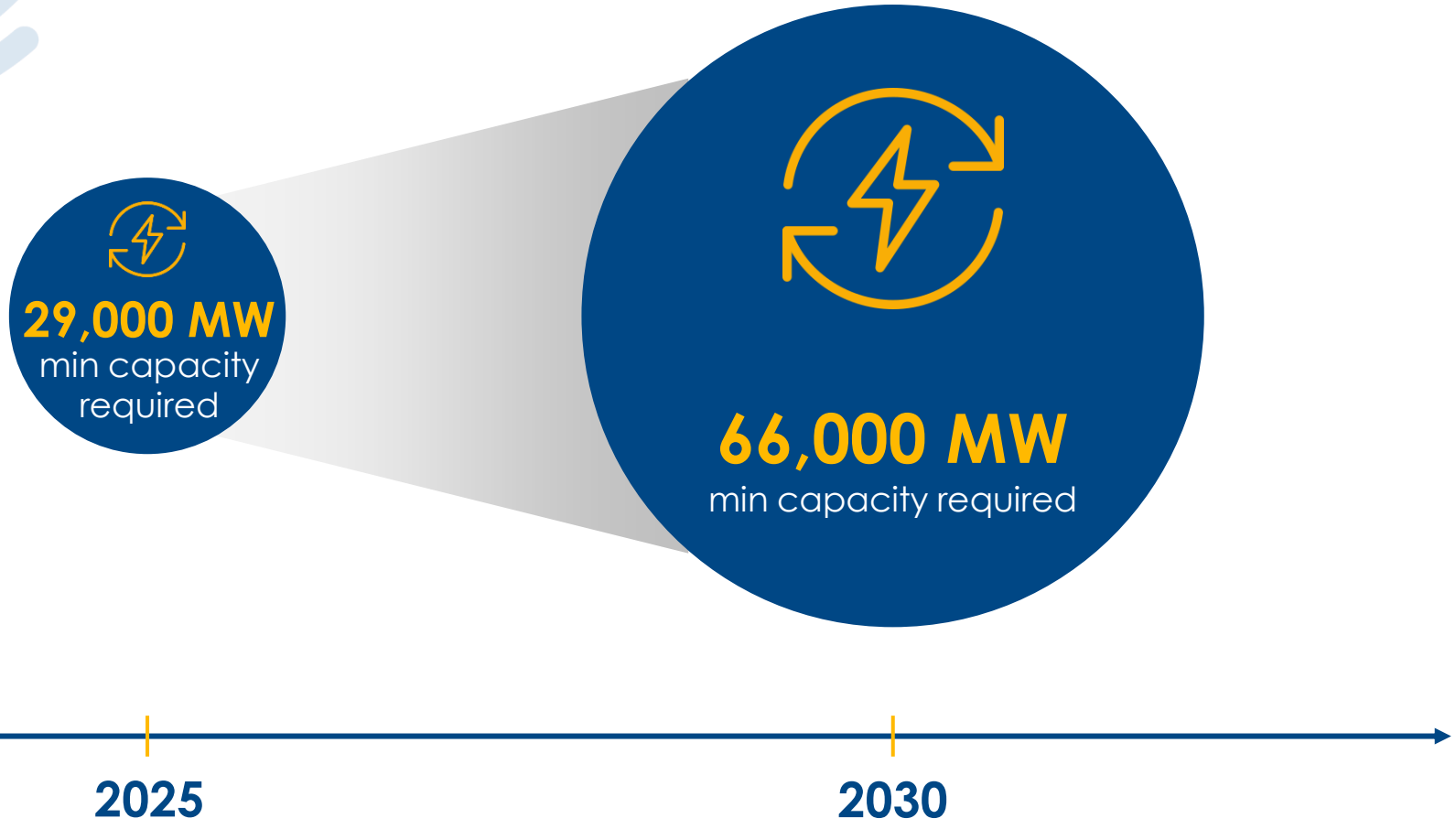
CP Utilization	2020	2025	2030
Public AC	7,4%	6,7%	7,2%
Public DC	8,4%	5,1%	7,2%
Public HPC	11,3%	13,1%	17,6%

Utilization rates will vary, depending on factors such as: network size of CPOs, economies of scale, changing charging behaviors; HPC markets becoming larger compared to AC

Source: Arthur D. Little *) charge point = EVSE **)validated with actual data from EAFO ***)50% of ratio applied for PHEVs

Note: This is an indicative model for split of AC-DC-HPC which would also depend on key factors such as use-cases, market maturity and country specifics, amongst others

Overall minimum European capacity threshold required to serve AC, DC and HPC charging points in 2025 and 2030

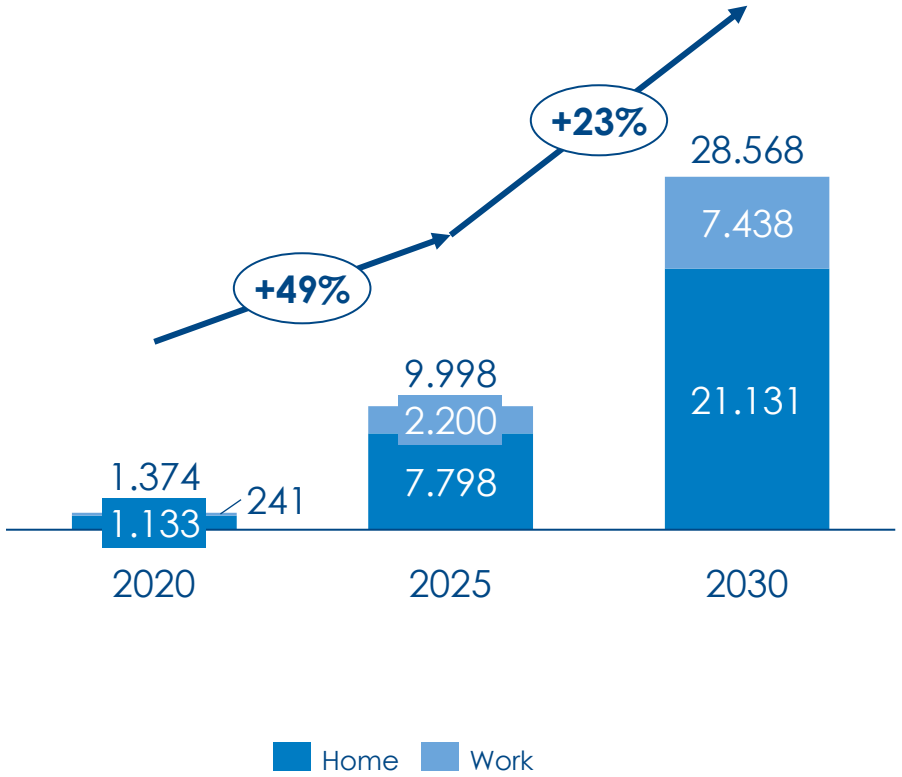


Source: Arthur D. Little

Translating minimum capacity threshold into indicative AC-DC charging point split

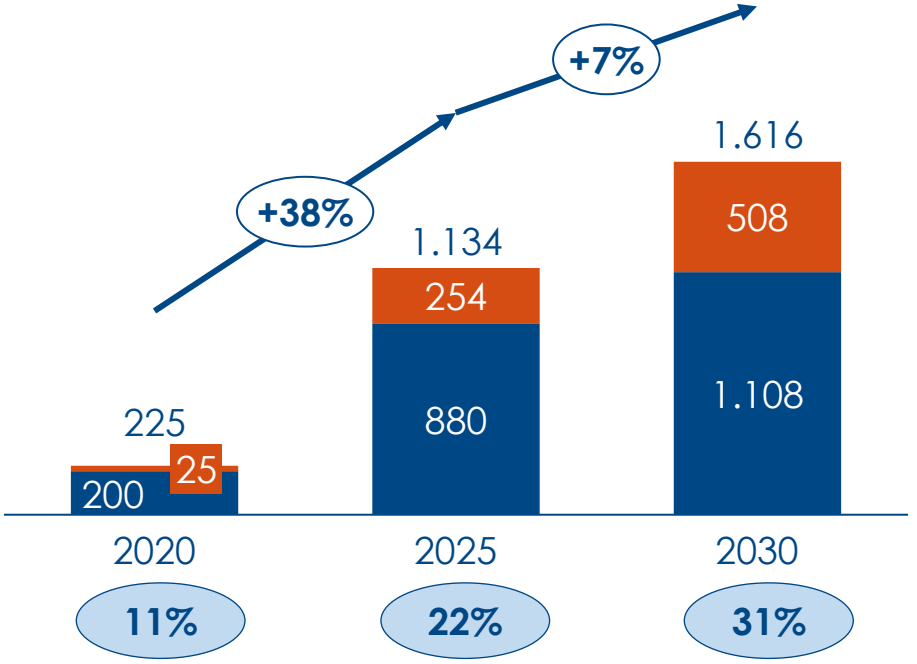
Private Charging EU

# of thousand charging points



Public Charging EU

# of thousand charging points



Source: Arthur D. Little

x% **DC Share of total charging points**

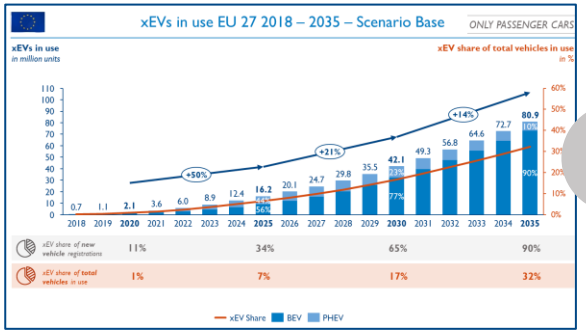
Calculating minimal threshold

Minimum threshold targets need to be linked to level of EV uptake in different countries with balancing factors

Breakdown of EV uptake on national level

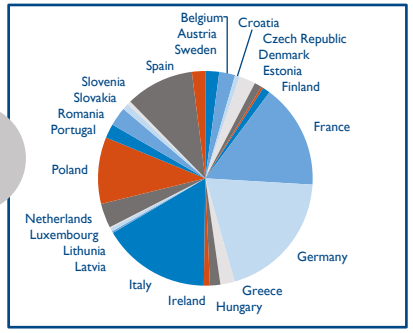
1 **Breakdown of EU EV uptake on national level**

Electric Fleet Forecast EU



x

Total Passenger Car Fleet EU
2019: **242,7 m vehicles**



# of xEVs in Use **2025**

# of xEVs in Use **2030**

on country level

2 **Apply balancing factors to consider current state of EV adoption**

Status-Quo EV Adoption
(xEV fleet and new registration share of fleet)

Country Classification	xEV maturity index 2020*	Balancing Factor 2025	Balancing Factor 2030
Pioneers	> 250%	150%	125%
Frontrunners	> 125% - 250%	120%	110%
Average	>75% - 125%	100%	100%
Developing	>10% - 75%	80%	90%
Beginning	< 10%	50%	75%

x

# of xEVs in Use **2025**

# of xEVs in Use **2030**

on country level

Source: Arthur D. Little

*Index based on xEV share of fleet and new car registrations (100% = EU average 2020)

ChargeUp EUROPE

1 Calculating minimal threshold

Main Assumptions for minimum threshold

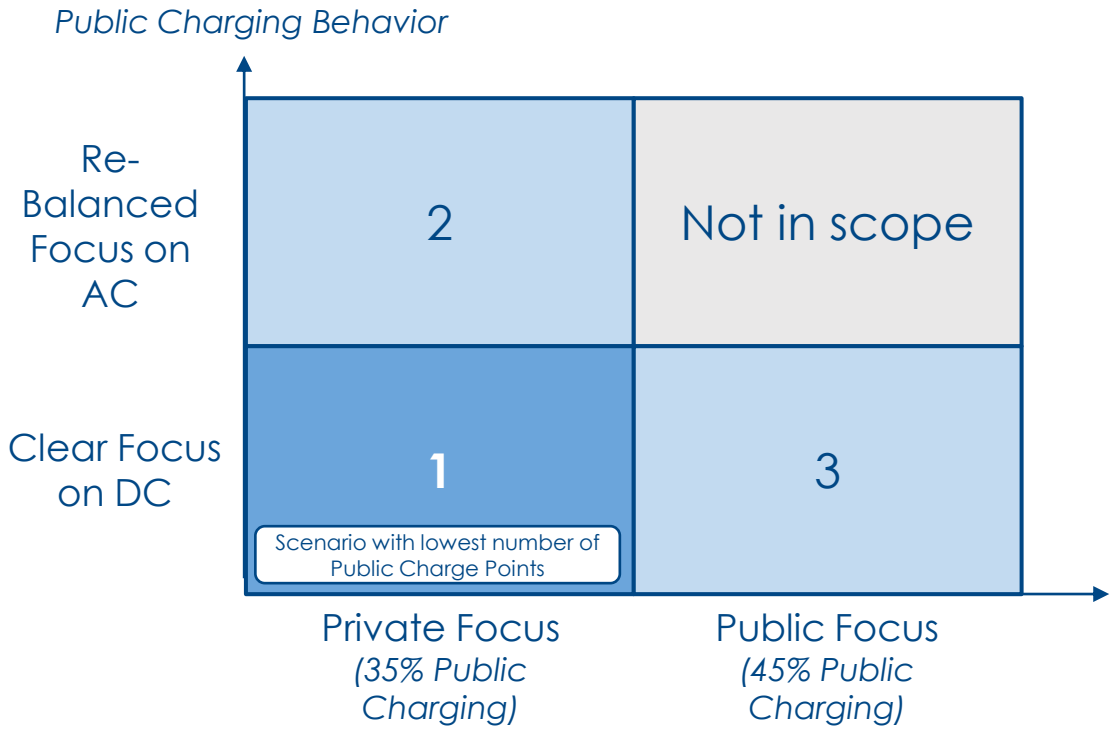
2 **Alternative scenarios**

Divergent approaches regarding public vs private and AC vs DC

Alternative scenarios

In addition to min. threshold scenario, we have analyzed two alternative scenarios based on share of public charging and AC-DC balance

Charging Behavior Scenarios



Customized EV/Charger Ratios

- AC
- DC (50 -149kW)
- HPC(≥ 150kW)

For each scenario

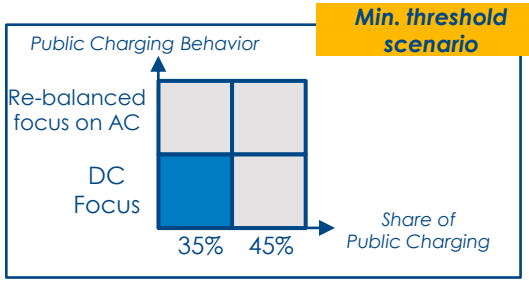
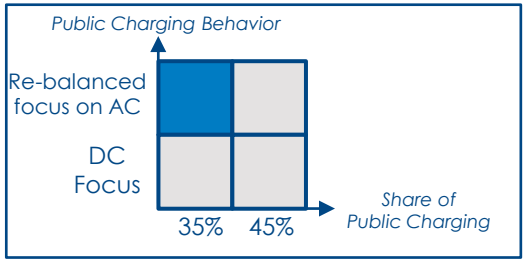
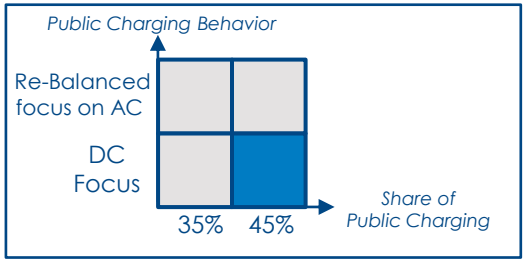
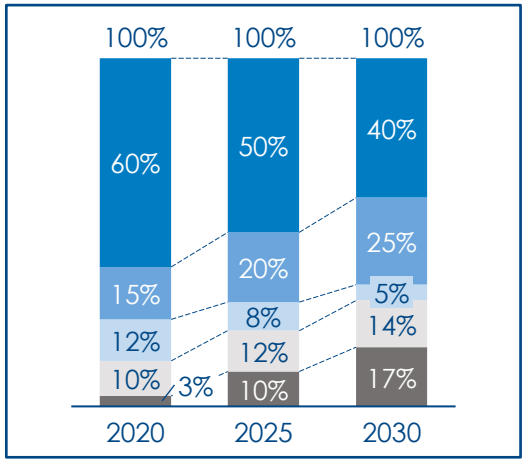
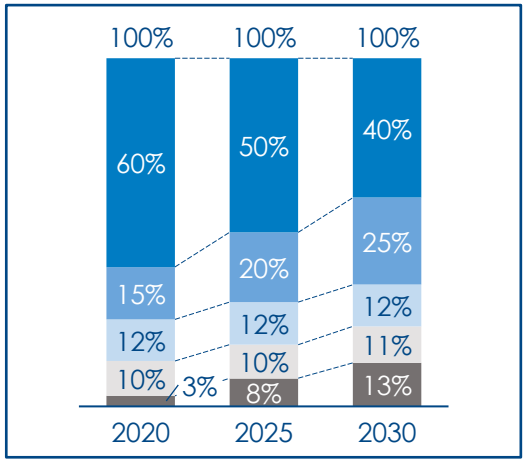
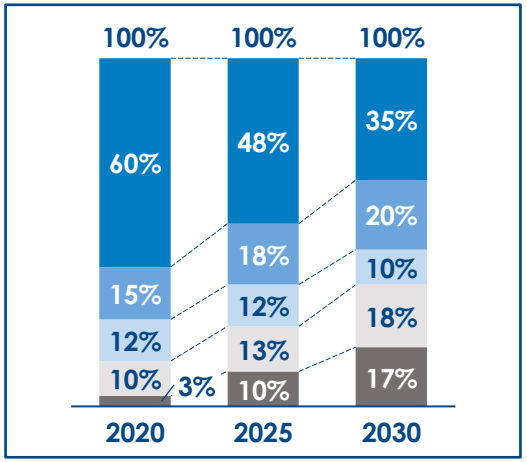
1 Minimum Threshold Scenario

X Alternative Scenario

Source: Arthur D. Little

Alternative scenarios

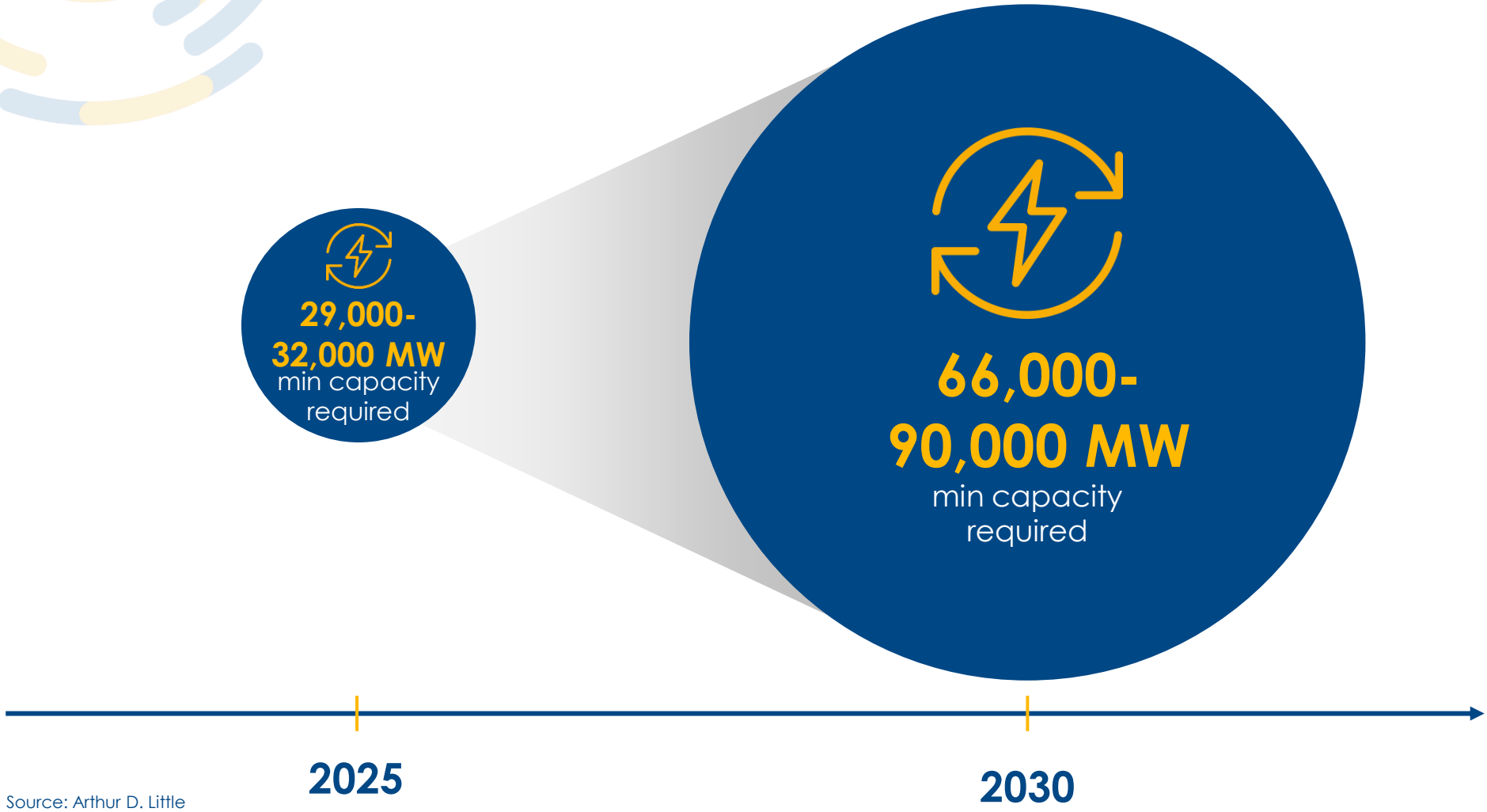
The alternative scenarios consider either a higher share of public AC charging or a higher share of public charging in general

	Scenario 1	Scenario 2	Scenario 3
Charging Behavior Scenarios			
Charging Behavior			

Source: ChargeUpEurope, Arthur D. Little Analysis

Home Charging
Workplace Charging
Public AC (Street, Destination)
Public DC 50 - 149 (mostly Destination)
Public HPC 150 - 350 (mostly En-Route)

Calculating overall European minimum capacity threshold range based on the alternative scenarios

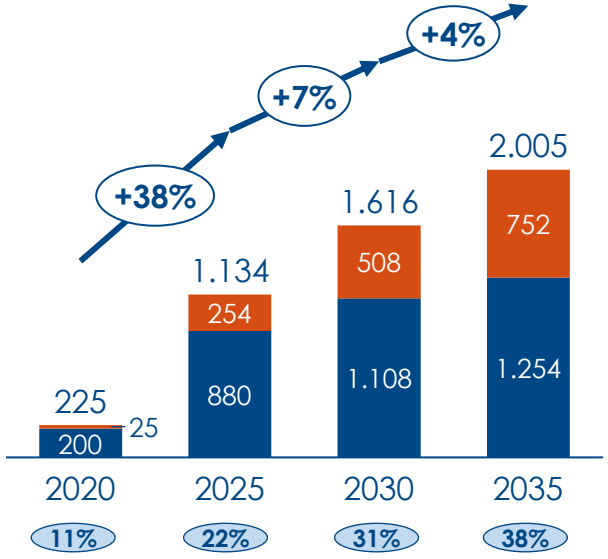


Source: Arthur D. Little

Translating minimum capacity threshold into indicative AC-DC charging point splits for the three scenarios

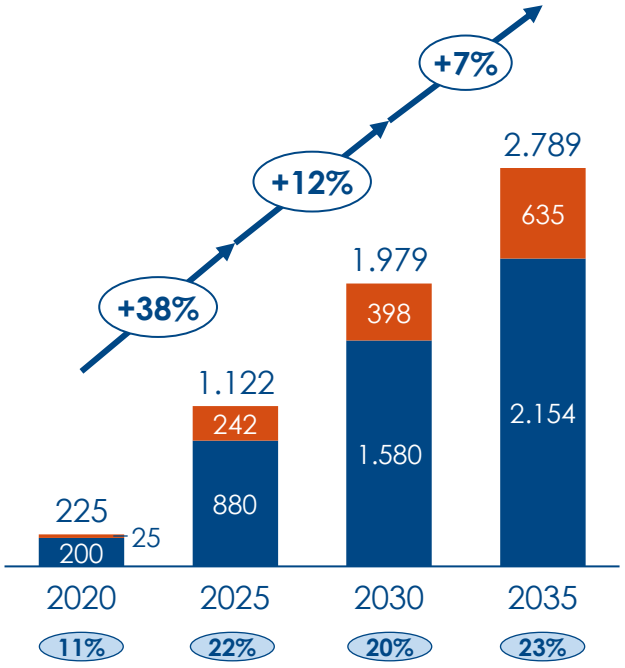
Scenario 1

Private Charging Focus | **DC Charging Focus**



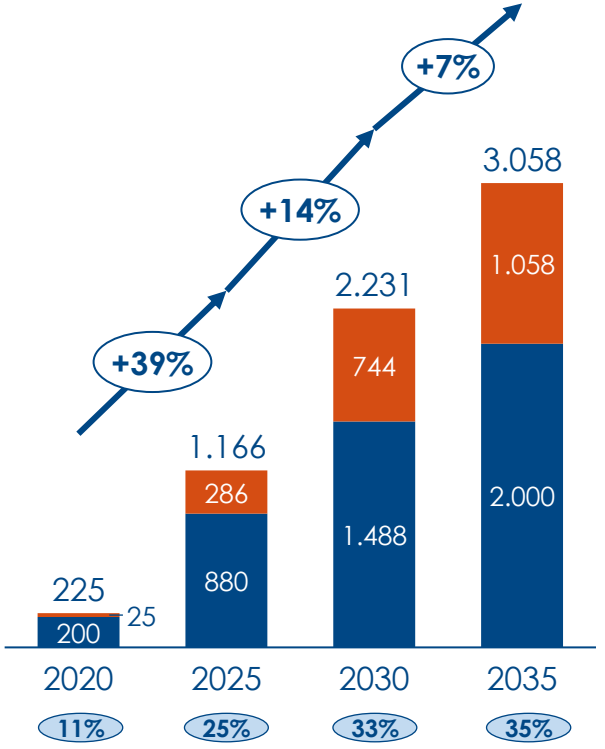
Scenario 2

Private Charging Focus | **AC Re-Balance**



Scenario 3

Public Charging Focus | **DC Charging Focus**



Source: ChargeUpEurope, Arthur D. Little Analysis

AC | DC (including HPC)

x% **DC Share of total charging points**