Slow, fast, rapid EV charging

What’s best

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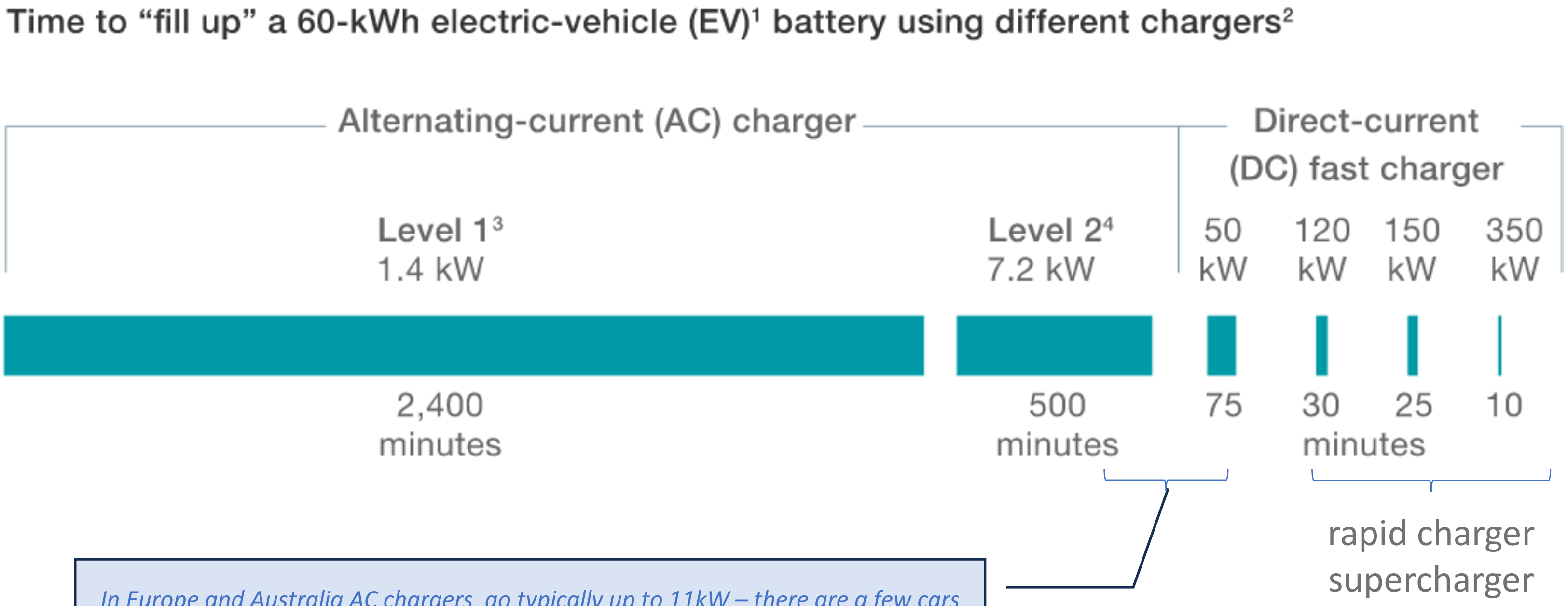
PARTNER FORUM 2023

Battery and charger must go together like horse and carriage; one party does not deliver without the other.

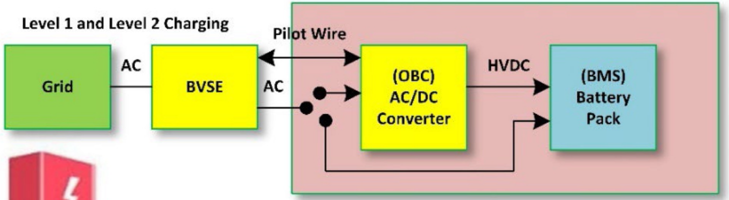
DEFINITION

Slow, **Fast, Rapid** Charger and more

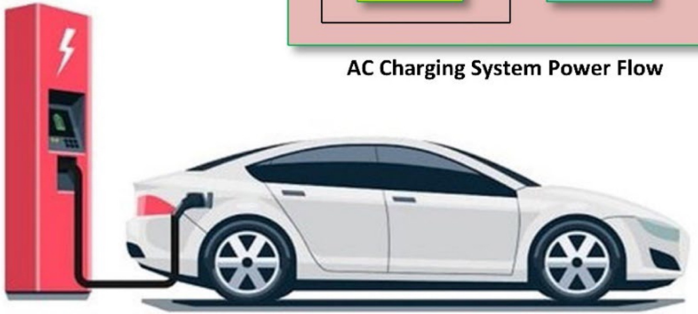


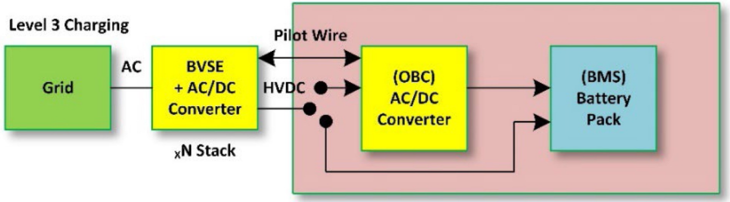
In Europe and Australia AC chargers go typically up to 11kW – there are a few cars (like the Renault Zoé and BMW i3) going up to 43kW [mode-3].
Vans and trucks usually accept 43kW charging.

EV Charging Infrastructure



AC Charging System Power Flow





DC Charging System Power Flow

Level 1 and Level 2
Residential Charging

Level 2
Work and Public place Charging

Level 3
DC Fast Charging

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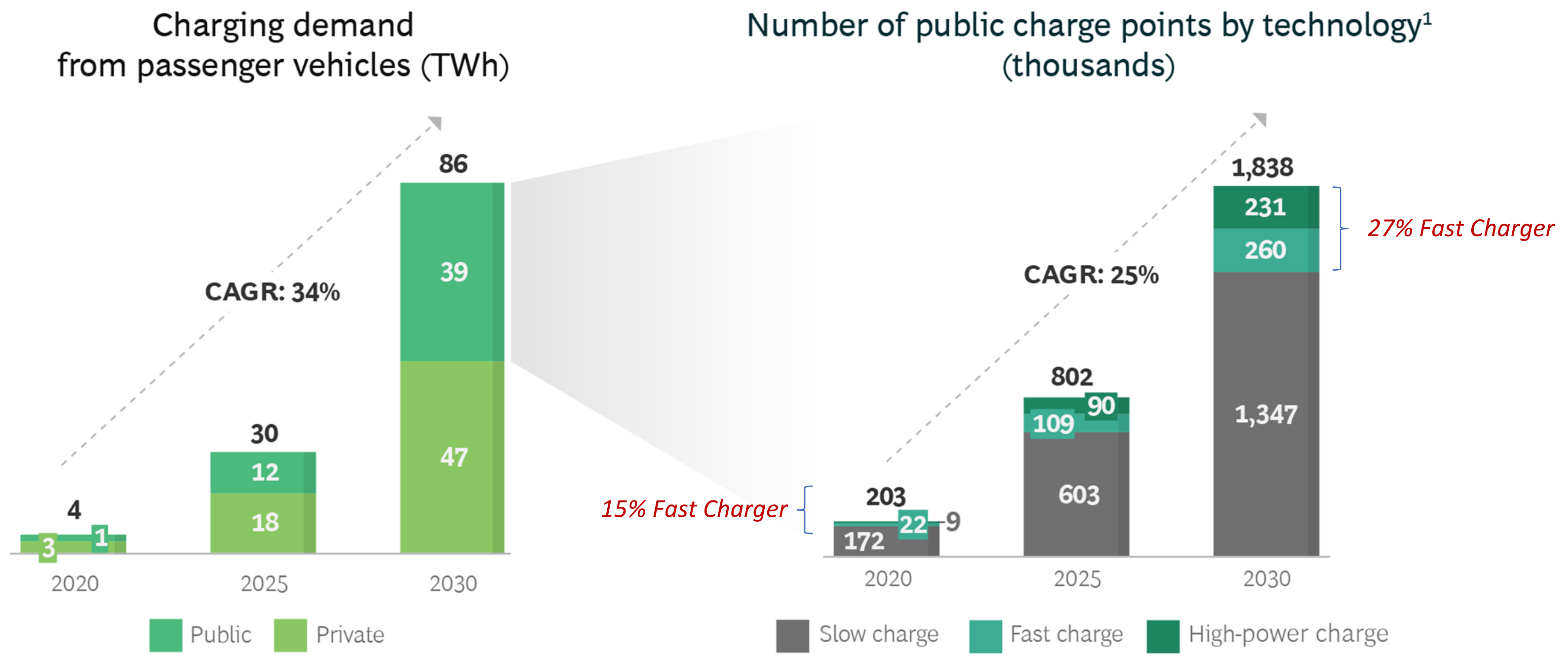
MARKET

Europe’s EV charging demand



Source: BCG EV forecast, 2021; BCG analysis.

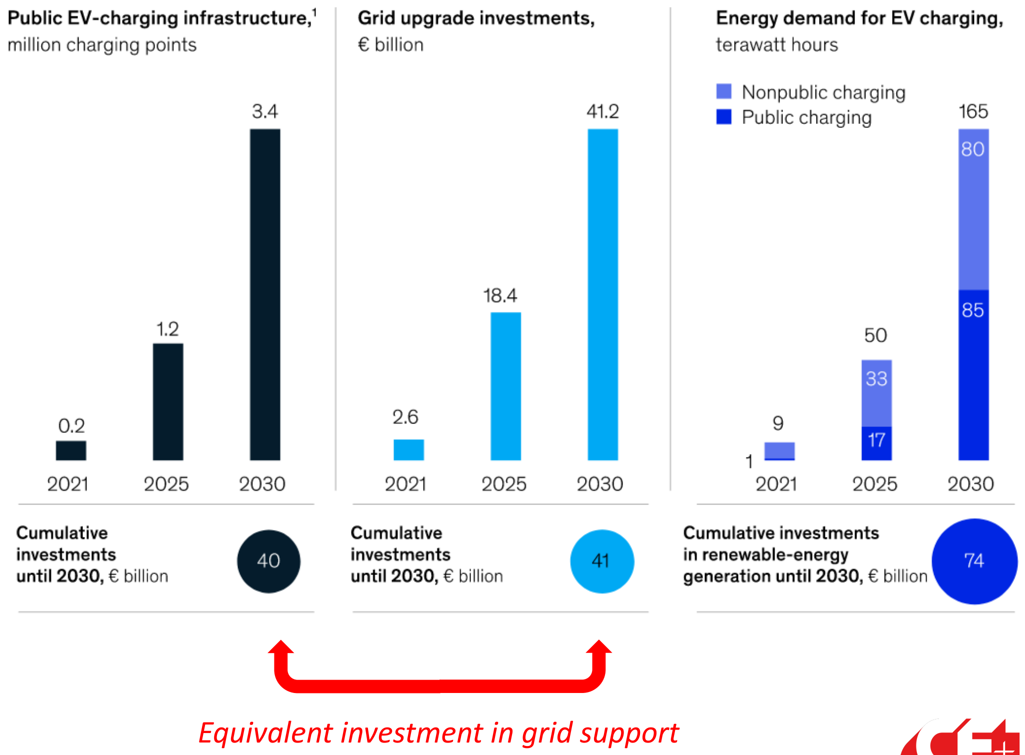
[1]Public slow chargers are under 22kW, while public fast chargers are between 22kW and 149kW; public high-power chargers are more than 149kW.

Europe's EV charging demand

The EU-27 will need at least **3.4 million** operational public charging points by 2030.

Passenger cars:	2.9 million
Light commercial vehicles:	0.4 million
Trucks and buses:	0.1 million

Not included: 29 million private charging stations



Source :
Mc Kinsey & Company
"The EV Charging Infrastructure Masterplan"
November 2022

Deployment bottlenecks

High / Medium

Bottleneck	Severity	Example	
~3- to 18-month lead times for construction work permits for DC 150+ kW chargers, due to approvals from city planning and highway bodies and local energy/geology authorities, and performance of archaeological studies	High	EVCI setup for DC 150+ kW highway chargers takes ~14 months, of which ~8 months are for acquiring the required planning permissions from the Ministry of Infrastructure and Water Management	NL
~5- to 8-month lead times for DSO approvals for network extension and substation creation for approvals from city planning, transport/environmental ministries, and authorities dealing with archeological discoveries	High	It takes ~3 months for the project to be assessed and queued by an engineer, then ~3 months for the DSO to secure planning permissions	NL
Up to 20 months time to get access to grid, also due to shortage and long delivery times of transformers	High	Lead time for delivery and installation of new transformers is 20 months when new substation is required	PT
+1 month waiting time for installation, due to lack of experienced electricians	High	Electricians are overbooked due to PV and EVCI installations, often waiting +3 weeks	DE
6+ months to deliver EVCI hardware	Medium	DC 150 kW chargers have lead time of 6-8 months for hardware delivery	EU
Limited visibility of user load profiles hinders deployment of smart charging solutions	Medium	With 5% smart meter penetration rate, DSOs have limited opportunities to predict and evaluate alternative solutions to grid reinforcements (eg, ToU, decentral power solutions)	SK
Capped investments of DSOs (fixed percentage of revenues) lag behind investment needs for modernization	Medium	In Poland, DSOs have an obligation to invest each year 10-30% of annual profits, this is insufficient to upgrade grid built in the 1970s and 1980s	PL
Significant effort by CPOs to coordinate with multiple DSOs across Europe and within countries	Medium	850+ DSOs throughout Germany require CPOs to follow different processes for deploying EVCI	DE

- *Construction Work Permit*
- *Utility Approval*
- *Grid capacity*
- *Workforce shortages*
- *Hardware delivery*
- *Grid capacity strategy*
- *Grid capacity investment*
- *No unified rules*

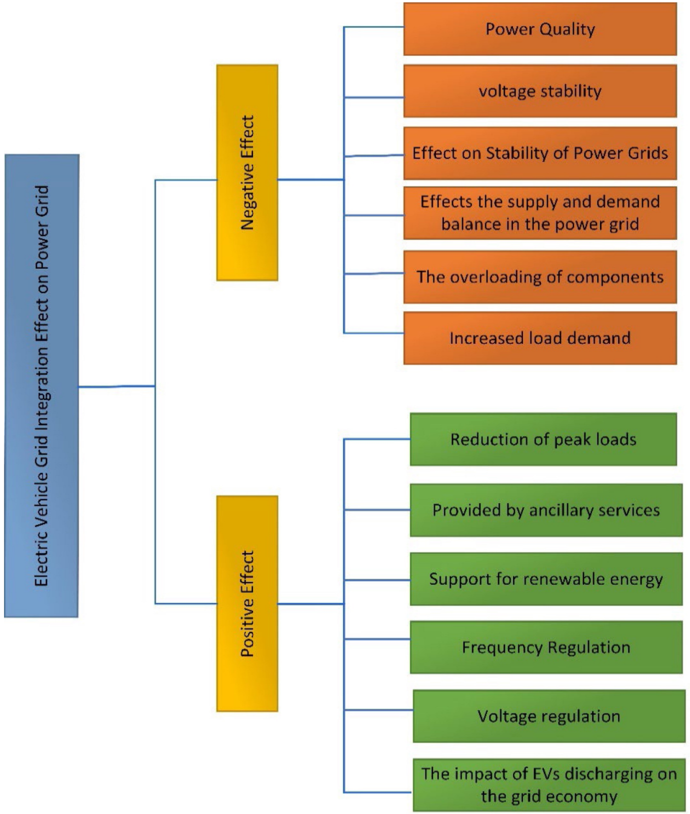
Impact on the grid (Europe)

KEY INSIGHTS	
Electricity generation in Europe	3,901 TWh
Leading source of electricity generation in Europe	Nuclear
Electricity demand in the EU	2,794 TWh

BCG 86TWh – 3%
McK 165TWh – 5.5%

The demand/supply question is thus less about meeting total volume and more about preventing local bottlenecks during peak load times—for example, when the residents of a neighborhood are all charging their cars at the same time on a Friday night in preparation for the weekend.

Impact on the grid



- Overvoltage in the grid, deterioration of power quality, increased line damage, and higher current faults (Godina et al., 2016).
- Due to high-frequency converters, the grid is subject to harmonics, resulting in poor quality power (Karmaker et al., 2019).
- Distribution transformers become overloaded due to harmonics, causing their life expectancy to decrease (Meyer et al., 2011).

- Instability is caused by nonlinear EV loads that draw large amounts of power over short periods (Dharmakeerthi et al., 2013).
- Electric vehicles increase the likelihood of disruptions, and they take longer to return to a steady-state (Ul-Haq et al., 2015).
- An adequately managed EVGI system can improve the grid's reliability (Ma et al., 2017).

- Before adding new EV loads to an electrical system that has been unstable, a stability analysis must be conducted (Onar and Khaligh, 2010).

- The charging architecture influences the variations in total harmonic distortion (Habib et al., 2015).
- Harmonic distortion variability ranges from 7% to 99% for EV chargers (Mahalik et al., 2010).

- Congestions in transmission nodes can be expected due to uncontrolled EV charging (Hadley and Tsvetkova, 2009).

- Using time-of-use (TOU) tariffs and coordinated charging strategies makes the grid more energy-efficient without adding more generating capacity (Kristoffersen et al., 2011).
- Several bidirectional grid-connected EVs are used here as part of the industrial power grid. Battery management systems may provide limitations regarding the type and extent of usage-driven charge and discharge signals. The penetration of EVs into the grid system is adversely affected (Hofmann et al., 2015).
- 96 percent of the peak demand on the power system can be reduced in practical circumstances. Whenever the electric vehicle battery has a large capacity, it will significantly benefit from reducing peak domestic and grid demand. Ultimately, this could lead to better use of the power system (Garwa and Niazi, 2019).

- Services ancillary ensure reliability, demand, supply, and grid stability (White and Zhang, 2011) (Guille and Gross, 2009).
- Grid frequency deviation is corrected by frequency regulation (Garwa and Niazi, 2019) (ur Rehman and Riaz, 2017) (Tian et al., 2012).

- Voltage regulation is fundamental to ensuring the supply and demand of reactive power are stable. Electric vehicles can react quickly to regulatory signals (Qiangqiang et al., 2012).
- EV charging is halted when the system voltage drops below a certain level and resumes when the system voltage reaches a certain level (Donadee and Ilić, 2012).

BEHAVIOR

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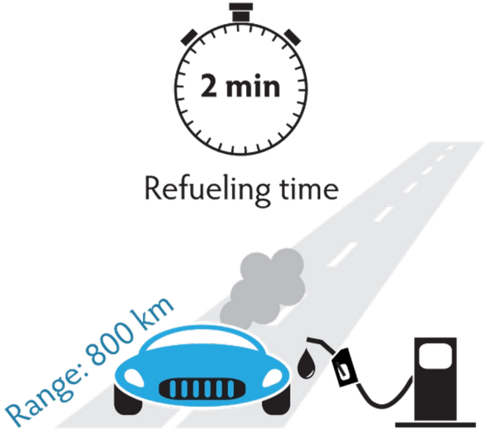
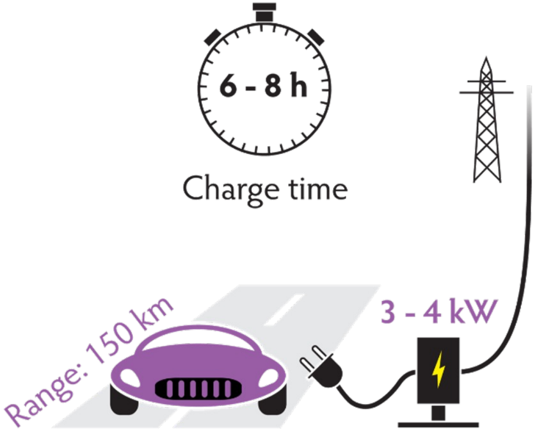
Charge your EV in 15 minutes



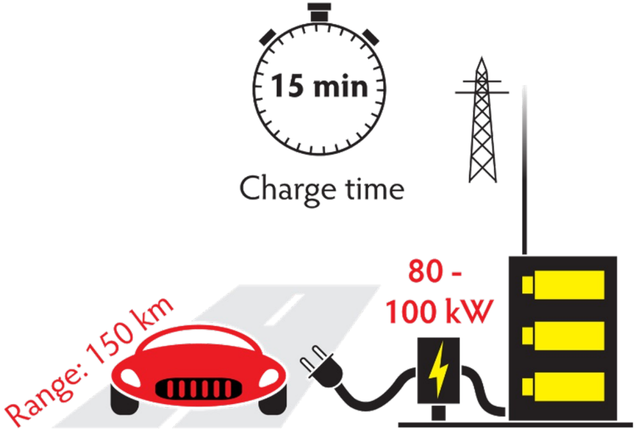
Gasoline and diesel

96% of today's cars. Rapid refueling and long range, but harmful for the environment.



Electricity, home charging

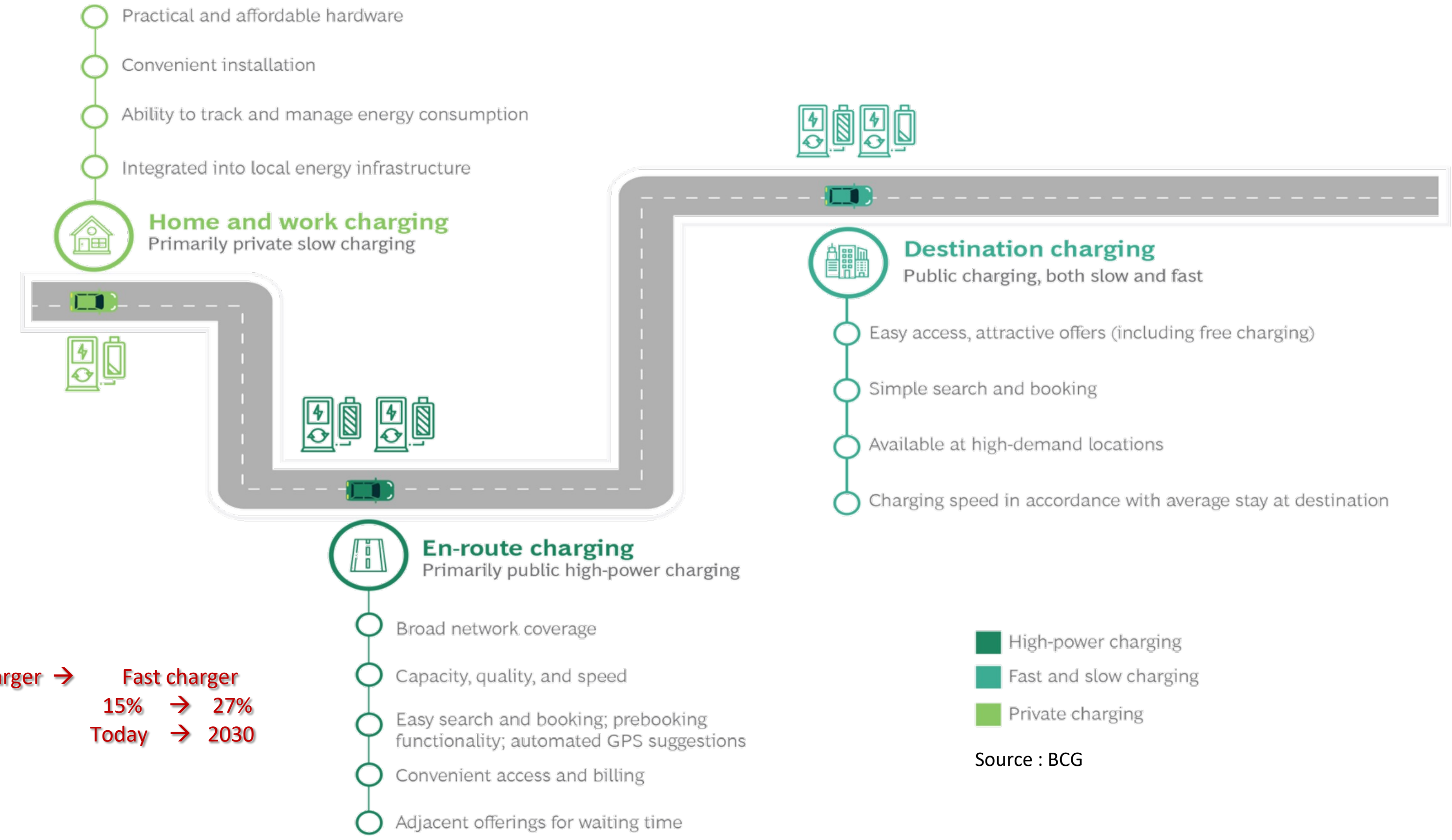
Most common charging method for today's electric cars. Growing risk of overloading the electric grid due to increasing popularity and power requirements.



Electricity, ultrafast charging

Buffering allows for rapid charging of hundreds of cars without overloading the electric grid.

From Private to Public

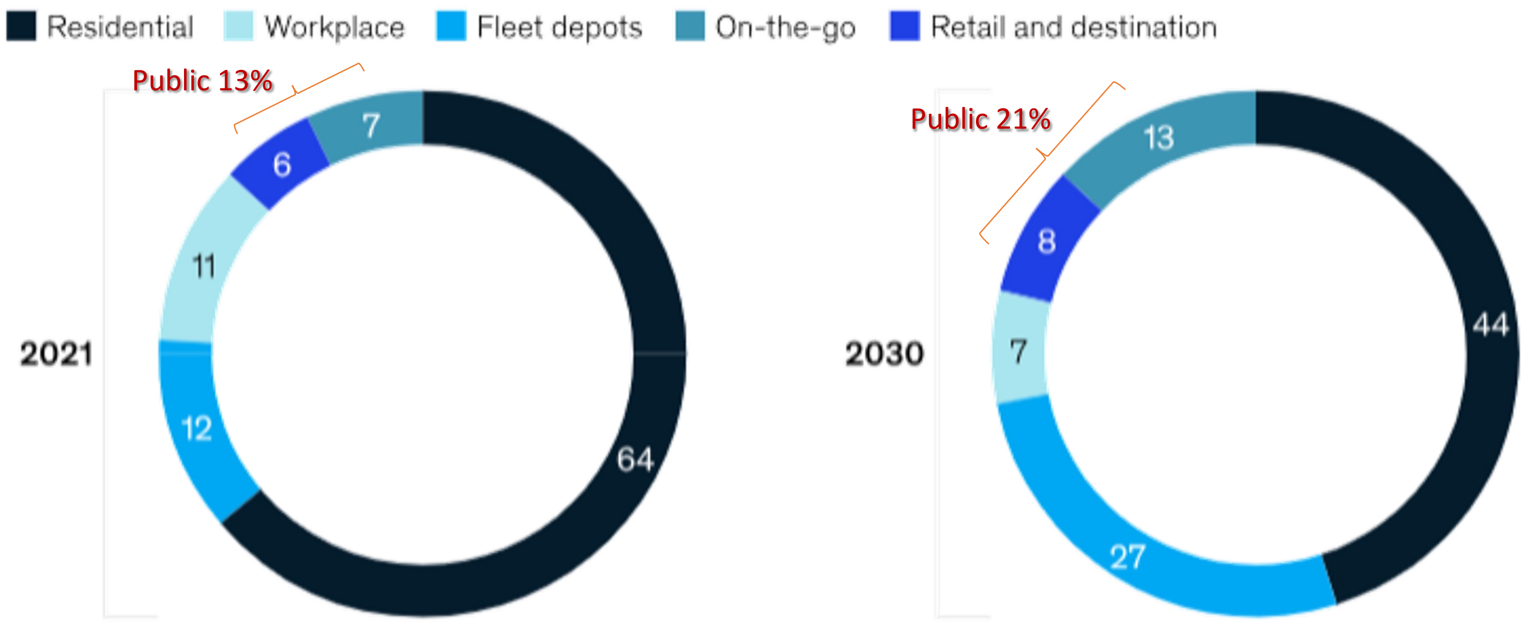


Slow charger → Fast charger
15% → 27%
Today → 2030

Source : BCG

Public Chargers duty increase

Electricity demand by charging use case,[1] %



Note: Figures may not sum to 100%, because of rounding.

[1] Based on a scenario where zero-emissions vehicles (battery-electric vehicles, plug-in hybrid electric vehicles, fuel-cell electric vehicles) account for half the vehicles sold in the United States in 2030, in line with a federal target.

Source: McKinsey Center for Future Mobility

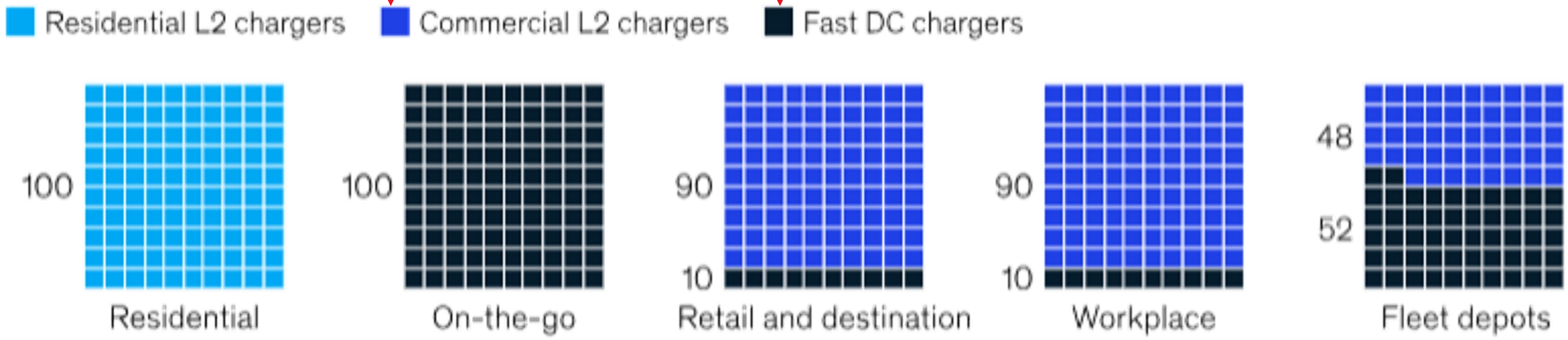
Fast chargers and use case

MOB ENERGY

Both require Dynamic Load Balancing
But not with the same strategy

EVONITY
ELEGANT POWER

Distribution of chargers in 2030 by use case and technology,[1] %



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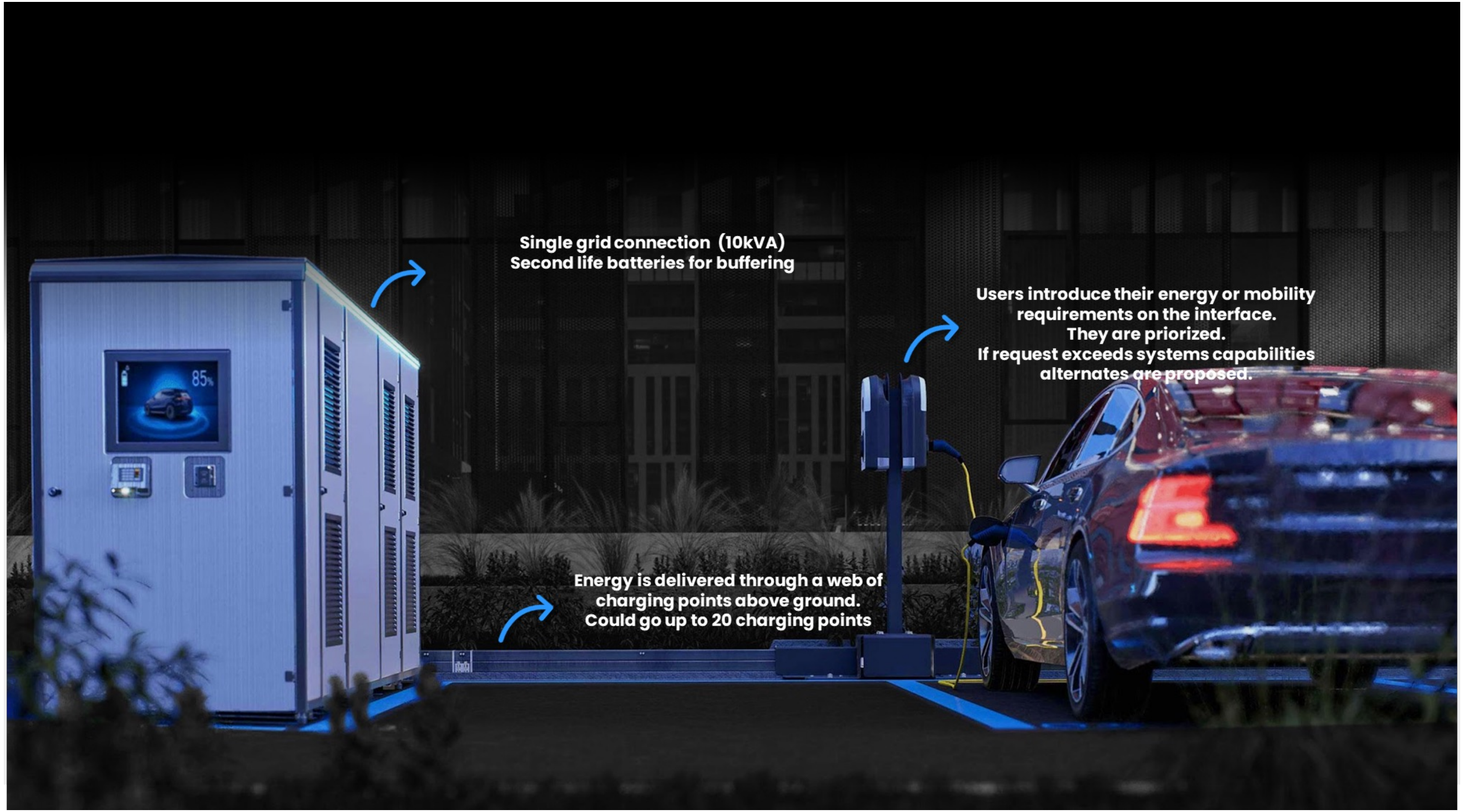
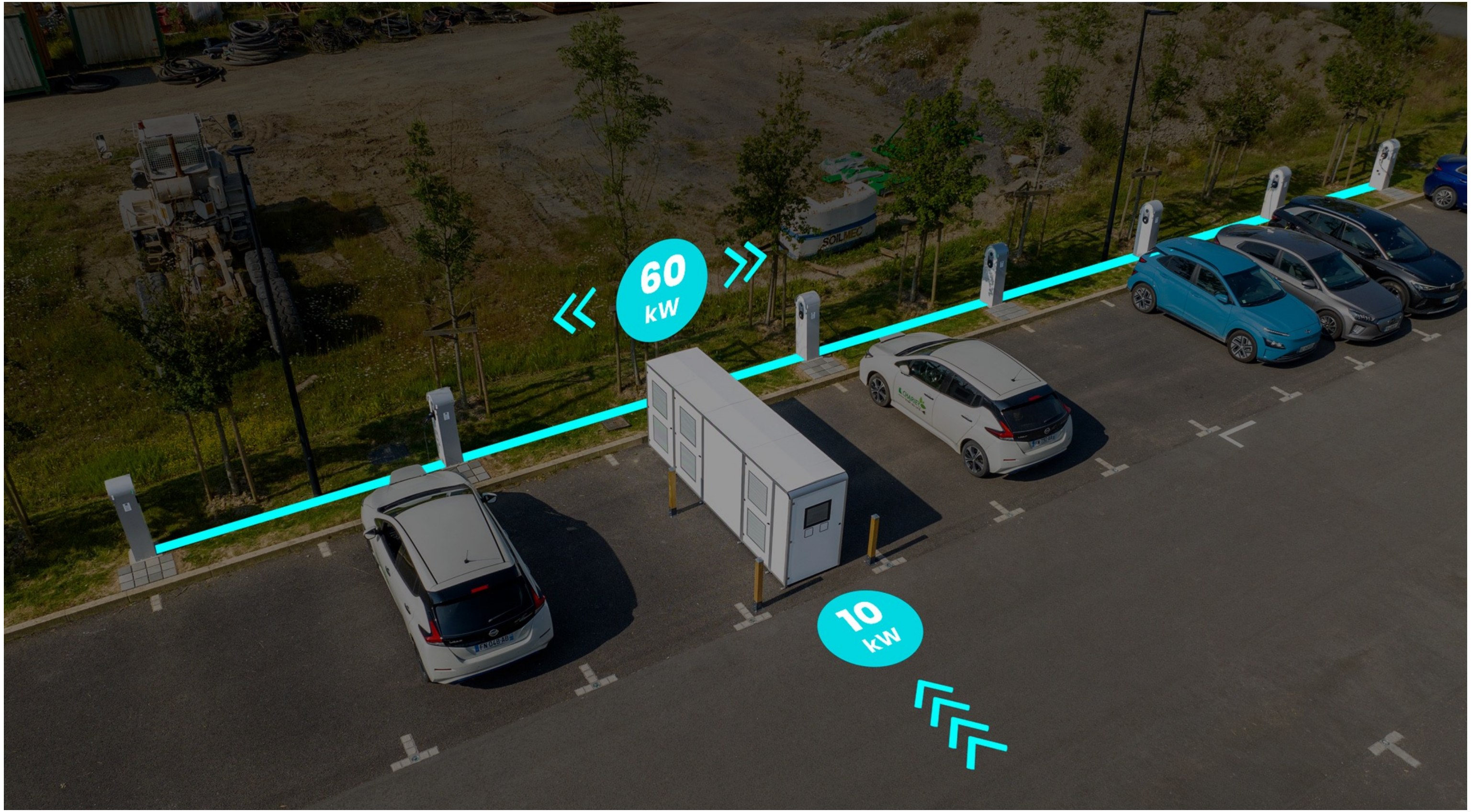
SOLUTIONS BY CE+T

EIKO by Mob Energy



Sierra inside



Leveraging CE+T expertises

haulogy
IT ENERGY LEADER
AMEO
OptiFlex

- (AI based) charge optimization
- Grid flexibility & trading

WATT4EVER
BATTERIES FOR LIFE

- (repurposed) Battery
- Container & acc.

CE+T POWER

- All-in-1 conversion
- Charge/discharge control

EVONITY
ELEGANT POWER

- DC (Ultra) Fast Chargers
- Control and monetization

1. Buffering electricity for (fast) EV chargers
2. Reduce civil works, container with skid

E-Mobility Container by CE+T

Battery container with fast chargers

Grid support: battery as “power boost” for limited grid connection
Drop shipment : easy and fast to deploy, minimal electric and civil works
Flexible asset: battery controllable and connected to any EMS through APIs
Energy efficient : DC-DC to minimize conversion losses
Fully modular: multiple containers can be deployed step by step on multiple sites, and managed in pool

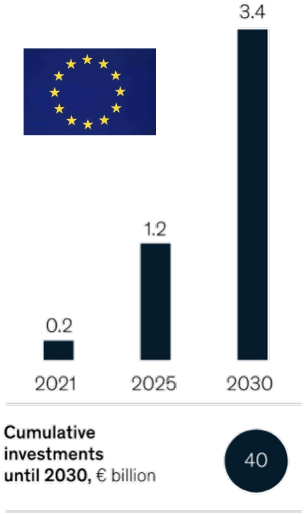
Also, in our portfolio

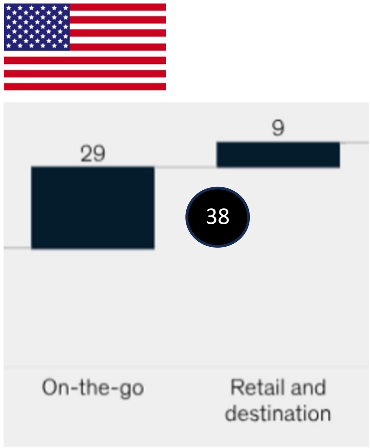
Grid Flexibility: play Demand Response, explicit or implicit
V2G ready: extend flexibility thanks to the battery of the vehicle
DER ready: made compatible with solar arrays or wind turbines thru MPPT
Financing solutions : enables leasing options and third party invest

CE+T POSITIONING

Creating viable businesses

CAPEX Public Charging



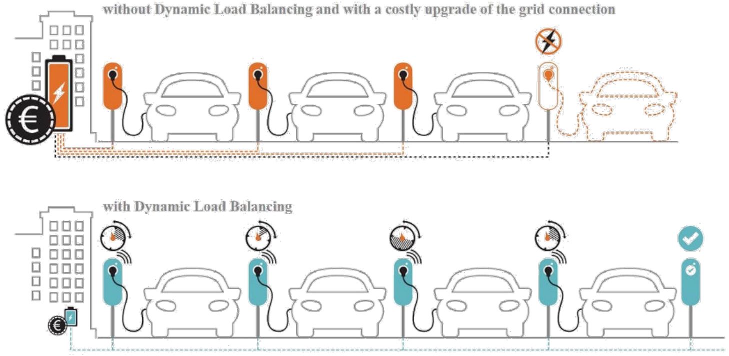


Source : MacKinsey & Company

Currently, most EV charging business are not or barely profitable

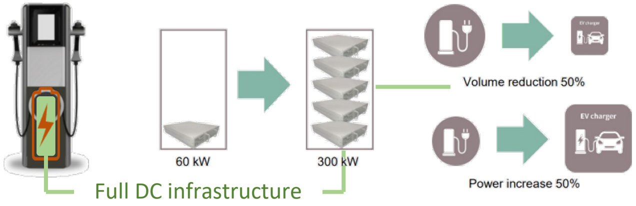
Slow charging strategy

cope with EV blockers (charge hogs)
minimize the cost of the bay



Fast charging strategy

typically, no EV blockers, optimize infra for charging time
maximize the power capacity



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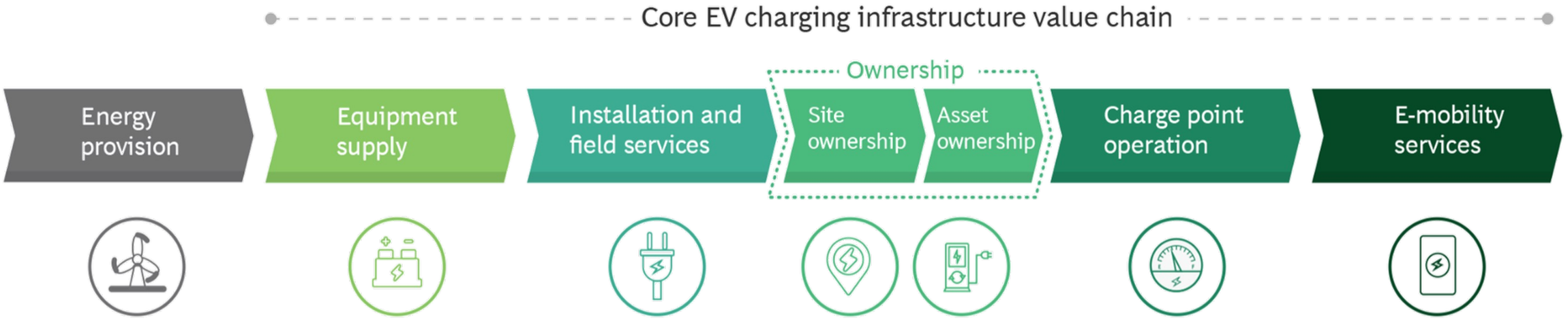
The EV charging value chain



Energy provision: Generating, storing, managing, and retailing electricity

Equipment supply: Engineering, manufacturing, and selling AC and DC chargers

Packaged with battery & Control equipment

Installation and field services: Preparing sites, installing and maintaining chargers once in operation

Integrated solutions Belgium only

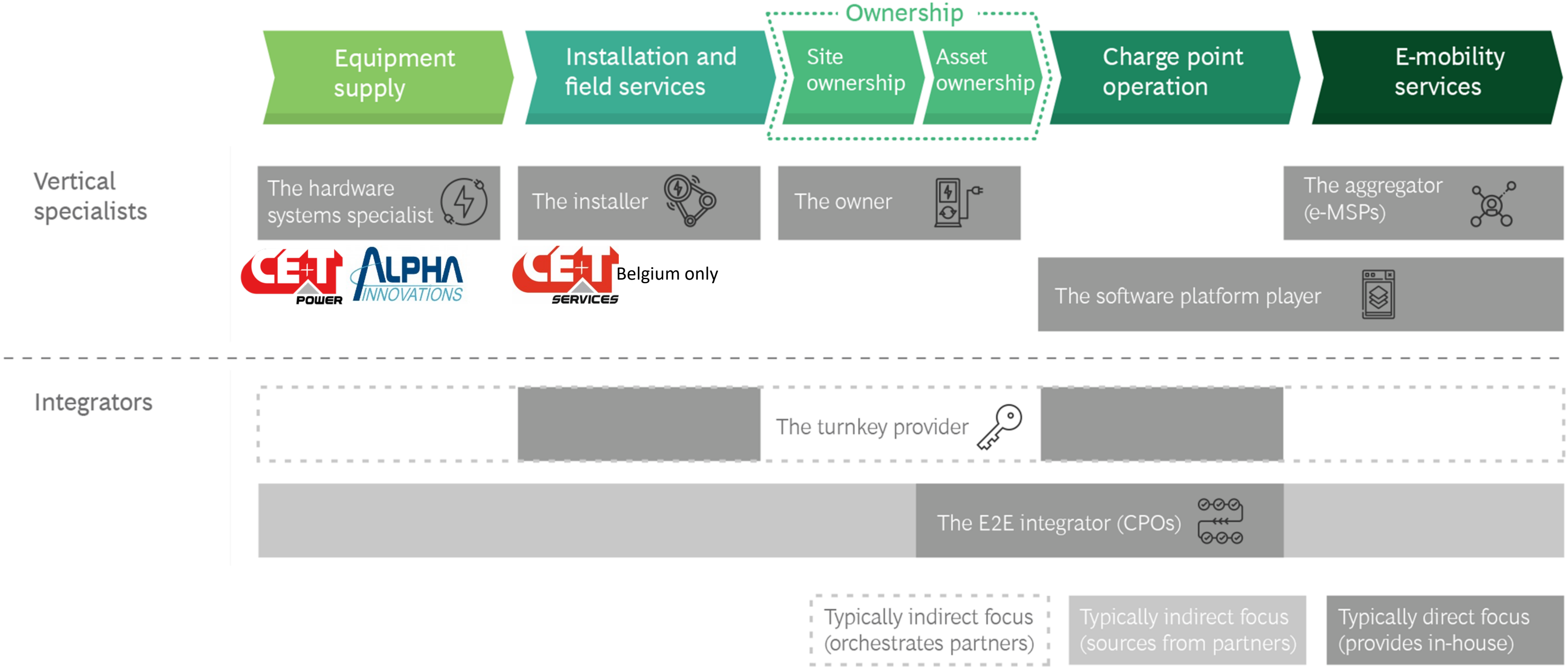
Ownership: Investing in sites and chargers, sourcing electricity from utilities, and selling it to end users at a markup

Charge point operation: Running the charge points at stations, including monitoring charger status and coordinating maintenance

E-mobility services: Providing charging and other mobility services to end users; app- or charge-card-based

Source: BCG analysis.

The strategic play



Source: BCG analysis.

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