INNOVATE · ACCELERATE · CHALLENGE

Mobility Electrification

WEBINAR

March 4th, 2021

Agenda & Presenter

PRESENTER

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MODERATED BY

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AGENDA

1. Introduction
2. EV sales forecast and key challenges
3. Trends for the e-powertrain and value chain
4. The charging station landscape
5. The 6 success factors to succeed in the EV market
6. Q&A

The Automotive industry faces 4 megatrends during 2020-2030
The most mature of which is Electrification

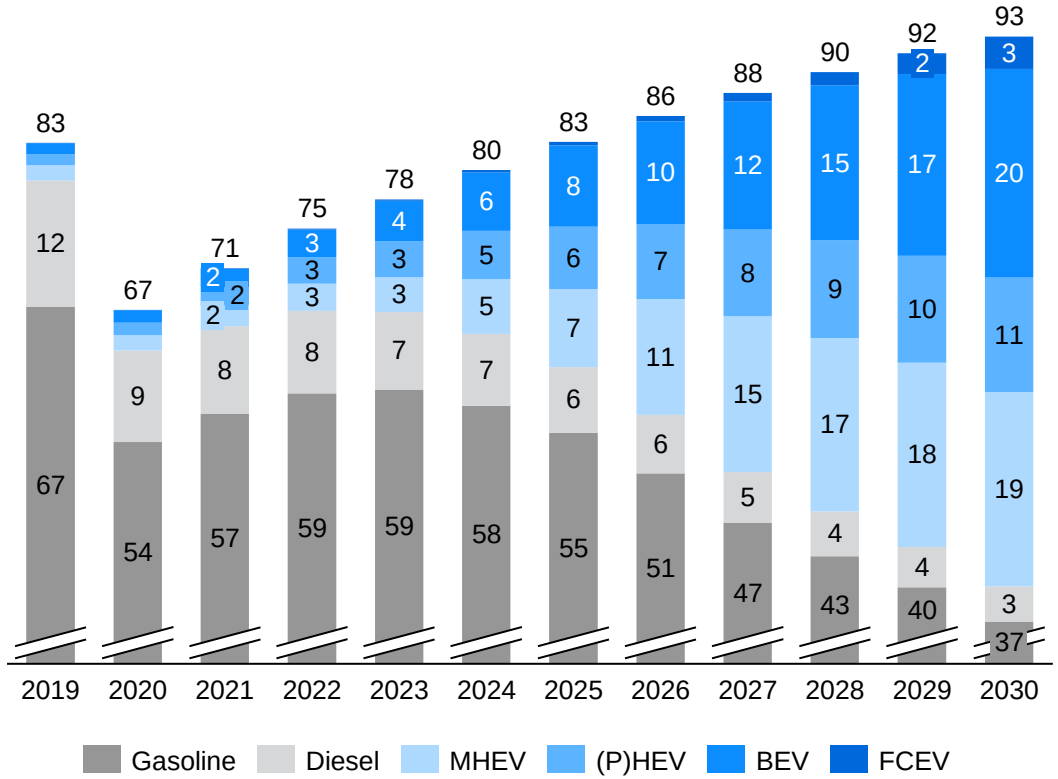
The vehicle of the future will be:	**Electrified**	**Shared**	**Connected**	**Autonomous – L4&5**
Maturity level	*R&D — Commercial* *Market share 2019: 4.4% sales* *Market share 2030: 57%*	*R&D — Commercial* *Market share 2020: 2% trips* *Market share 2030: 38%*	*R&D — Commercial* *Global revenue 2020: 67 bn $* *Global revenue 2030: 420 bn $*	*R&D — Commercial* *Market share 2020: 0% sales* *Market share 2030: 4.5%*
Key features	*CO_2-free – Potentially* *Electric plug* *H_2*	*Corporate fleets* *Smart dispatching*	*Entertainment* *Tracking* *Services*	*Hands-off* *Mind-off*
Drivers	*Oil peak* *Climate change and CO_2 regulation* *Government incentives & investments* *Technological pull*	*Customer demand* *Governmental incentives* *Cost-effectiveness*	*Customer demand* *High perceived added value*	*Customer demand* *Almost technological readiness*
Key challenges	*Range & weight* *Cost* *Charging : speed & availability (E&H_2)* *Standardization* *H_2 safety*	*Public adoption*	*Inter-vehicle communication*	*Infrastructure* *Regulation* *Safety* *Real-time certification*

Electrification is the most mature megatrend in the passenger car market

Electrification splits into 4 sub-trends. New sales EV market share is expected to grow from 4% in 2019 to 57% in 2030, with a +27% CAGR over the period

Vehicle type	Example	Motorization	Battery capacity	Key features	Electric range
MHEV	 *Volkswagen Golf 8 2020*	ICE only	NA	Start/stop Boost mode Recuperation	NA
(P)HEV	 *Volvo SUV XC40 recharge T4/5 - 2020*	Dual ICE & electric motor	6-12 kWh	Small battery charged by ICE	30-200 km
BEV	 *Renault Zoe 2020*	E-motor only	20-90 kWh	Large battery capacity Only charging from the grid	240-560 km
FCEV	 *Toyota Mirai 2021*	E-motor only	NA	Fuel cell stack (PEM tech) Buffer battery H2 tank	500 km

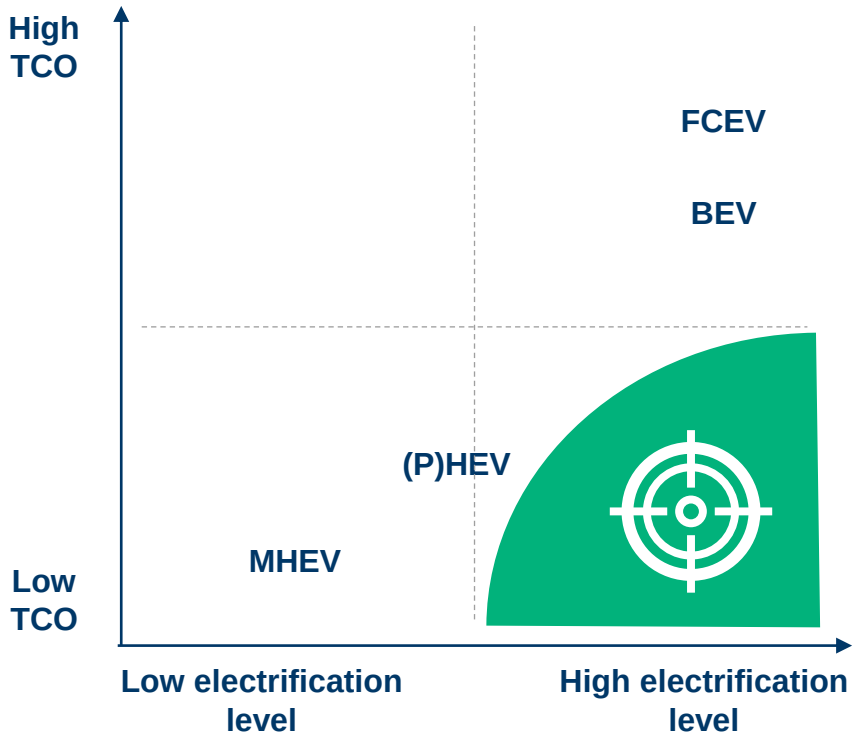
Market forecast - passenger cars, incl. SUV: # yearly sales, in millions



Passenger car market is to be dominated by XEVs by 2030

For Electrification to become mainstream, range, cost and charging speed must improve by optimizing multiple sub-features

Challenges for XEVs lead to functional improvements …



Increase range

- Utilization losses
- Energy recuperation
- "Fuel" capacity
- Energy density
- Parts weight and number

Improve charging speed and efficiency

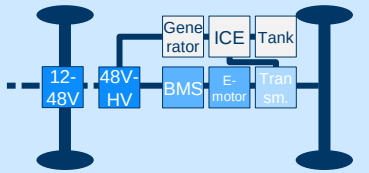
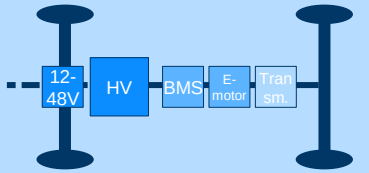
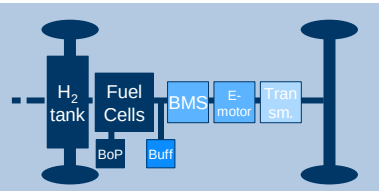
- Charging infrastructure availability
- Intermittent charging
- Charging speed
- Charging losses
- Bi-directional charging
- Wireless charging

Reduce TCO

- Battery pack cost
- "Fuel" cost
- Standardization and Modularity
- Recycling
- Maintenance
- Battery lifespan

… that impact vehicle layout, standards and unitary components

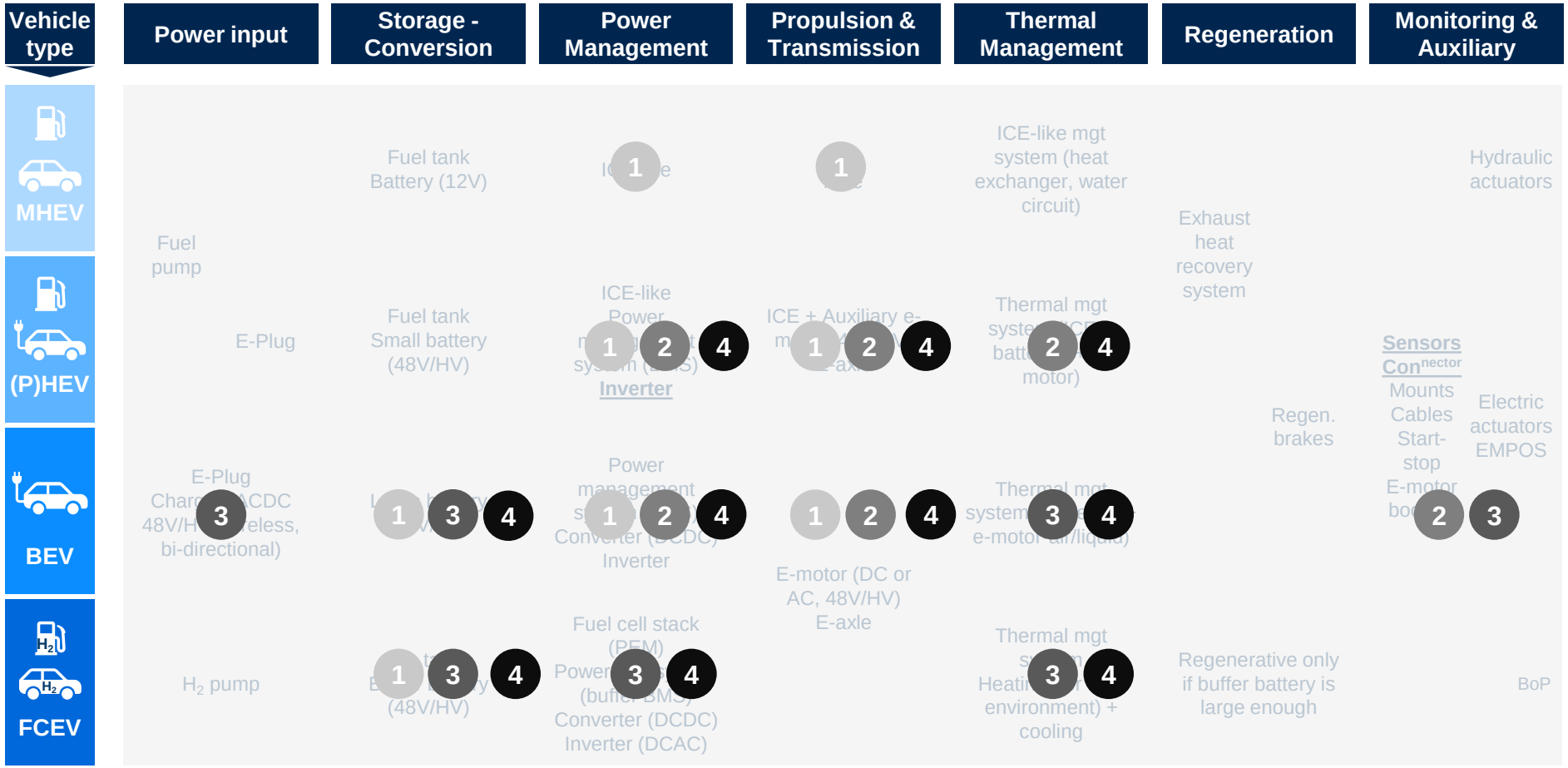
Components in the e-powertrain will go through technological changes by volume increase

Vehicle type	Power input	Storage - Conversion	Power Management	Propulsion & Transmission	Thermal Management	Regeneration	Monitoring & Auxiliary	Architecture
MHEV	Fuel pump	Fuel tank Battery (48V)	ICE-like	ICE Axle	ICE-like mgt system (heat exchanger, water circuit)	Exhaust heat recovery system	Hydraulic actuators	
(P)HEV	E-Plug	Fuel tank Small battery (500V)	ICE-like Power management system (BMS) **Inverter**	ICE + Auxiliary e-motor (48V/HV) E-axle	Thermal mgt system (ICE + batteries + e-motor)	Regen. brakes	**Sensors** **Connector** Mounts Cables Start-stop E-motor booster	Electric actuators EMPOS	
BEV	E-Plug Charger (ACDC 48V/HV, wireless, bi-directional)	Large battery (500V/1000V)	Power management system (BMS) Converter (DCDC) Inverter	E-motor (DC or AC, 48V/HV) E-axle	Thermal mgt system (Batteries + e-motor-air/liquid)				
FCEV	H_2 pump	H_2 tank Buffer battery (48V/HV)	Fuel cell stack (PEM) Power mgt system (buffer BMS) Converter (DCDC) Inverter (DCAC)		Thermal mgt system Heating (for cold environment) + cooling	Regenerative only if buffer battery is large enough		BoP	

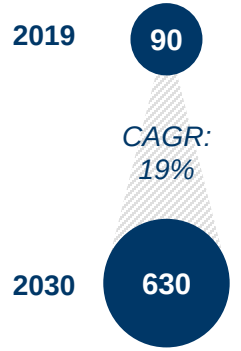
TCO and Range challenges drive each component's technological roadmap

*The next slides show a detailed focus on the technological trends that apply to the components in **bold blue***

The overall e-powertrain is undergoing key changes driven by 4 main technical trends



Market size, in bn $ XEV e-powertrain



Overall technical trends

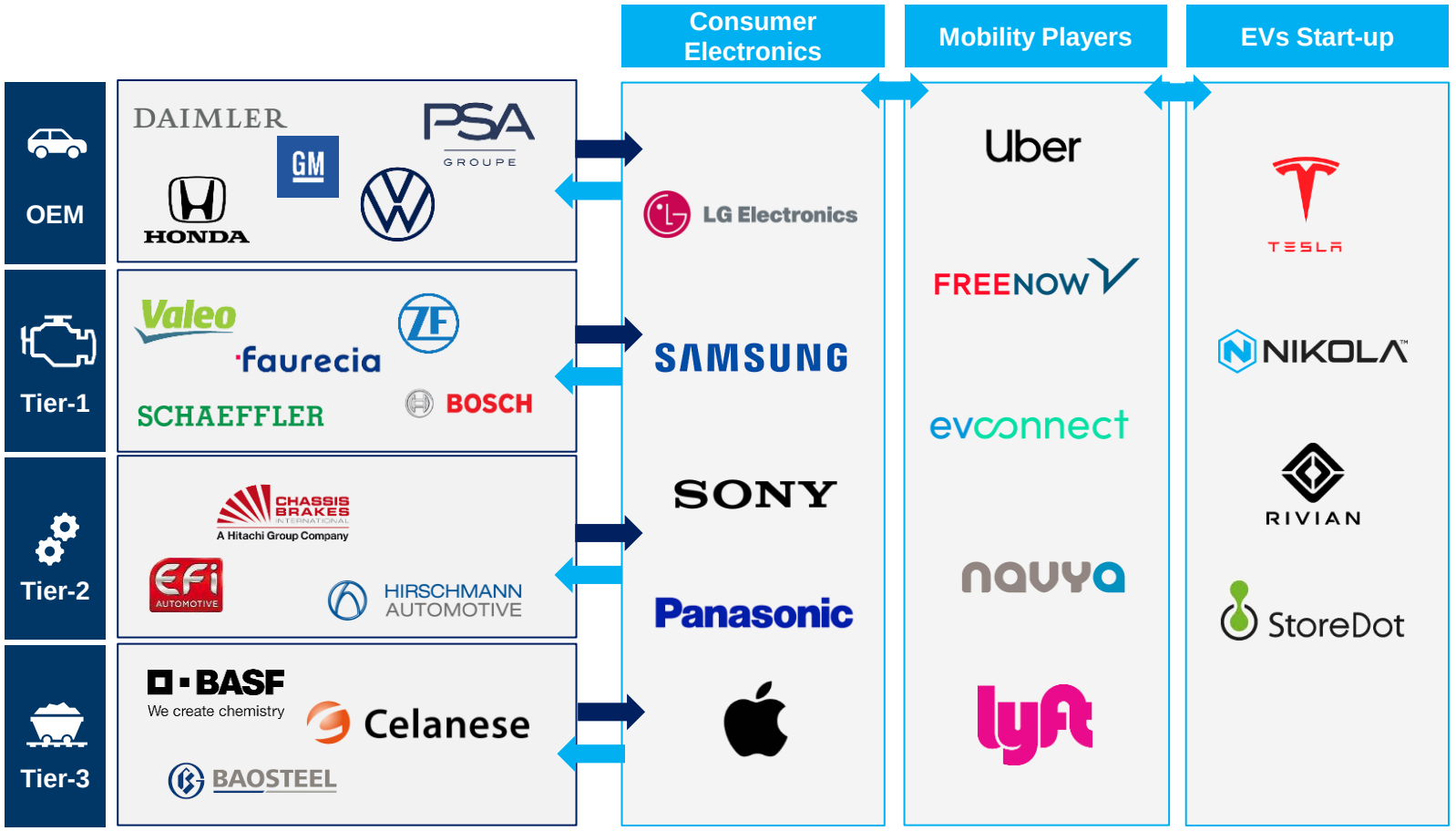
1. **Modular design** to answer wide range of needs & optimize ROI
2. **Merge components** and mutualize auxiliary systems (e.g skateboards)
3. **Develop new technologies** to answer new needs
4. **Software reconfigurable vehicle** (SaaS, auto update, predictive maintenance,etc.)

Overall trends for each component translate into key moves across the value chain

The e-powertrain requires new technologies and capabilities bringing new players in the value chain

Legacy Powertrain Value chain

E-Powertrain Value chain

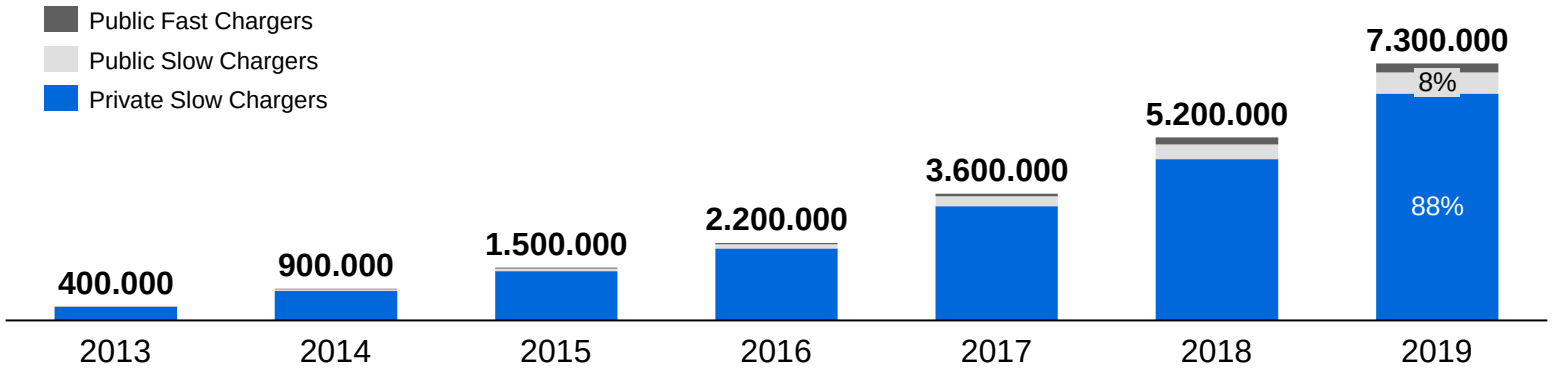


Key findings

- **OEMs value proposition is expected to adapt to the changing landscape:**
- **Seeking strategic alliances** will enable co-opetition between legacy suppliers and new players in order to fill competence gaps
- To **differentiate themselves**, **suppliers** will either have to:
  - Offer **technical differentiation**
  - Provide **cost competitive products** leveraging platforming and economies of scale

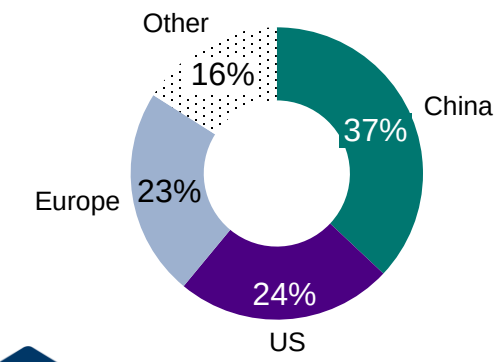
In 2019, total number of public charging station reached 862 000 units, of which 60% are in China

Number of charging stations for Light Duty Vehicles, worldwide

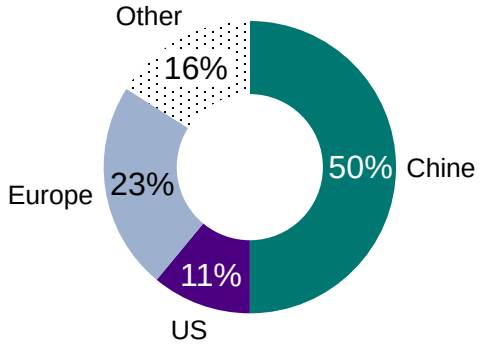


Number of private and public charging stations by country

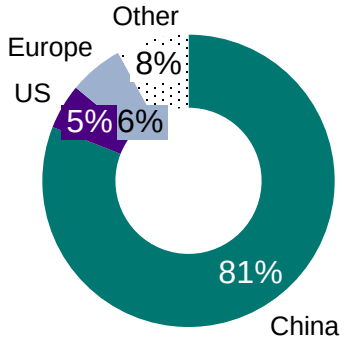
Private Slow Chargers



Public Slow Chargers



Public Fast Chargers



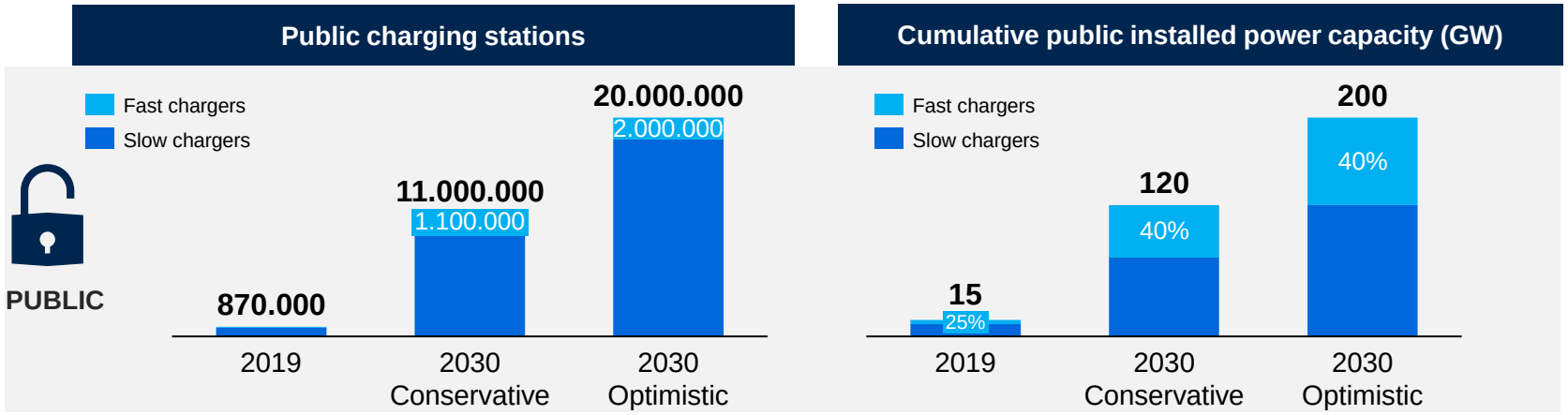
Key findings

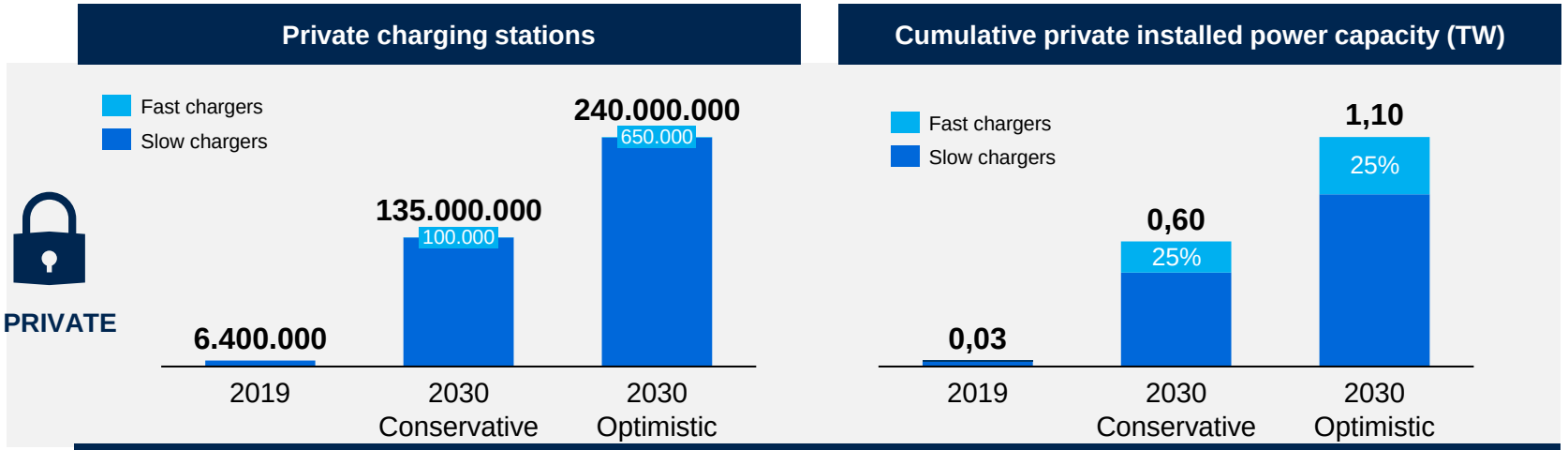
Light Duty Vehicles (LDV):

- **Private chargers** accounted for ~90% of the worldwide LDV chargers in 2019
- **Publicly accessible charging spot reached 862 000 units** globally in 2019:
  - 598 000 were **slow chargers** (charging power <22 kW)
  - 263 000 were **fast chargers**
- **China** accounts for:
  - **60% of worldwide public chargers**
  - **80% of public fast chargers** compared to 47% of the world's electric light-duty vehicle stock.

Source: IEA Global EV Outlook 2020

The number of private charging stations is expected to grow between 135 M and 240 M units by 2030





→ Fast chargers market represent a total market potential of 2,6 million chargers by 2030

Key findings

Public chargers:

- **Slow chargers** are more than **90%** of the total publicly installations (10 million)
- **Could substitute private charger**

Private chargers:

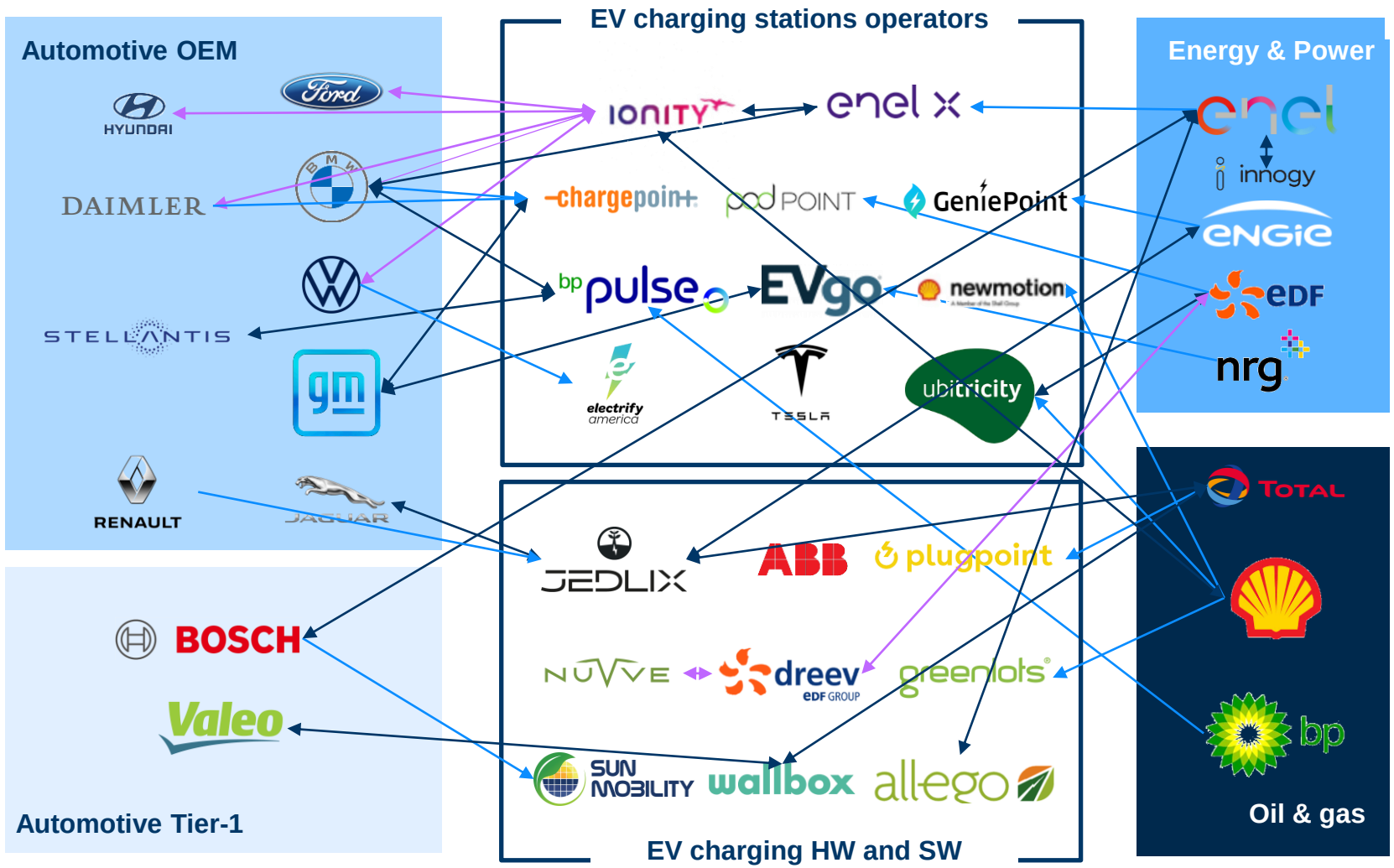
- **Almost the entire stock** of private chargers is for **LDVs**
- By 2030, **buses and trucks** will together account for about one-fourth of total installed charging capacity.

Conservative = Stated Policies Scenario

Optimistic = Sustainable Development Scenario

Source: IEA Global EV Outlook 2020

EV charging stations networks development is driving multiple partnerships and M&A across the automotive & energy industries

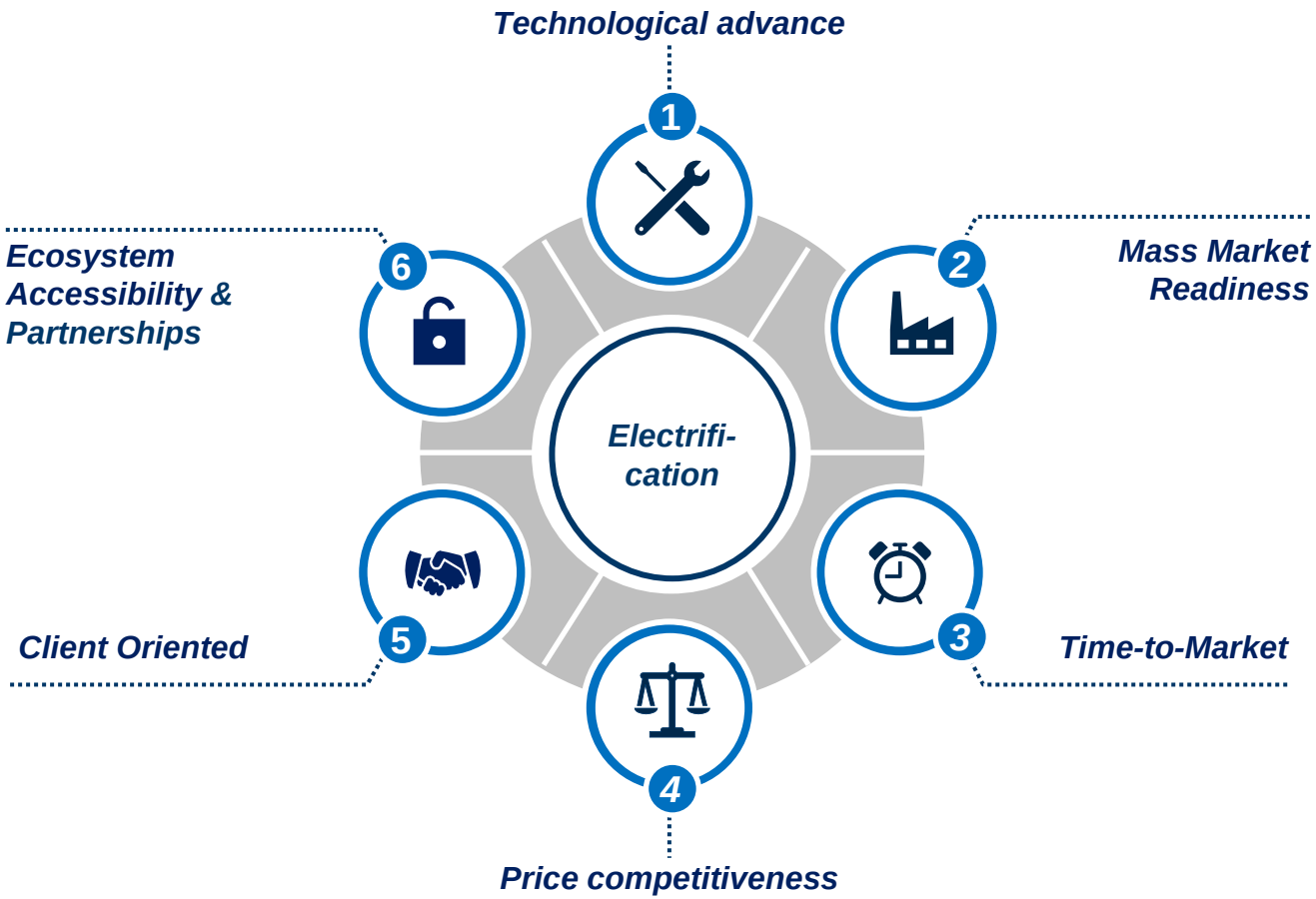


Key findings

- EV charging network creation is boosting **collaboration** between **automotive and energy / oil & gas players**
- Multiple **partnerships and JV** have been created among **directly competing automakers**
- Collaborations are mainly performed to:
  - ✓ Give access to **customers to a larger charging stations network**
  - ✓ Propose **vertically integrated solutions** for customers
  - ✓ **Develop EV technical solutions** and system

6 key success capabilities to ensure a strong position in the X-EV ecosystem

Success Capabilities for "Electrification"



Description

1. **Capability to offer an innovative solution**
2. **Financial capacity** to invest in R&D and large-scale production capabilities
3. **Operational effectiveness** to develop solutions in time as market is ramping up
4. Fulfilling existing functions at a more **competitive price**
5. **OEM pain points** at the center of product development
6. **Ability to on-board both suppliers and clients** in the new solution development

Take-aways, Q&A

1. **City policies play a growing role in the development of both XEVs and charging networks.**

2. **Technical innovations are expected on the short to medium term.**

3. **Modular design** will enable to answer wide range of needs & optimize ROI

4. **Automotive anchor players have to adapt to a new ecosystem** and **adapt their supply chain.**

Q & A

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