IHS Markit™

AUTOMOTIVE

Regulation & Electrification in Vehicle Sales Forecast Scenarios

How will Forecasts reflect disruptive Trends?

23 March 2017 | Paris, France

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Preliminary questions

How are disruptive trends impacting your planning processes?

Which transparency and understanding of forecast/planning backgrounds do you require?

Which 'what if' questions do you need to answer?

Do forecast backgrounds and scenarios give answers to these questions?

What are your current and future expectations regarding automotive information, forecasts, or supporting services?

Contents

Scenario concept

1. IHS Markit data and forecasts

- Registration and price-volume data
- Production, powertrain, and sales forecasts

2. Top-down factors

2.1. Market regulation
- Emission compliance
- Taxation, incentives, restrictions

2.2. Market structure
- Charging infrastructure
- Regulated state/city specifics

2.3. Technology and cost
- Battery prices
- Plug-in vehicle (xEV)/internal combustion engine (ICE) development & production cost

2.4. Mobility and others
- Total industry volume (TIV) impact
- Business model

Scenario forecast process

3. Bottom-up factors

3.1. OEM strategies
- Assessment of powertrain/ electrification strategies per OEM

3.2. OEM offerings
- Assessment of vehicle & powertrain/ electrification portfolio per OEM

3.3. Positioning, pricing, and total cost of ownership (TCO)
- xEV positioning
- Target pricing
- TCO analysis per segment

3.4. Sales potential
- xEV trend by price-volume segment

4. Scenario forecast

E.g., Vehicle Sales by Powertrain Scenario Forecast

5. Compliance check

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China—city restrictions are major forecast drivers

Two major types of city restrictions

License plate ban

- First introduced in Shanghai in 1986 to reduce carbon dioxide (CO_2) emissions and traffic in the city center
- Vehicles cannot enter the city center every day and are banned for one day of each week, depending on the number on their license plates
- Exception for neighborhood electric vehicles (NEVs) with special green license plates

Car quota system

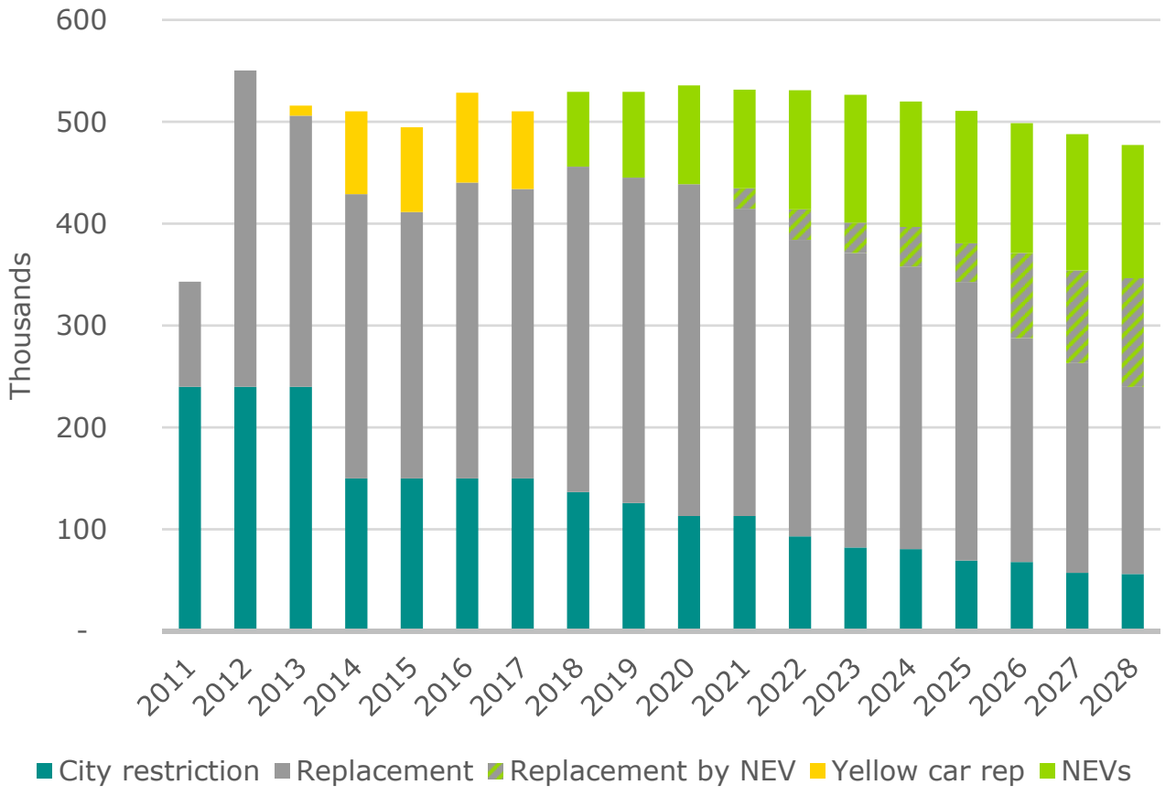
- First introduced in Beijing in 2008 to reduce private vehicle volume and create safer, more livable cities with lower registration rates
- Works like a lottery and includes better chances for NEVs to get a license plate (e.g., gasoline license plate in Shanghai costs CNY90,000)
- Beijing already set a cap to have not more than 6 million registered vehicles in 2017 and 100,000 vehicles a year from 2018–20

Top-30 potentially restricted cities

Restricted cities	Beijing	Shanghai
	Guangzhou	Shenzhen
	Hangzhou	Tianjin
Signs of city restrictions	Changsha	Shenyang
	Chongqing	Suzhou
	Nanjing	Taiyuan
	Ningbo	Zhengzhou
Potential restrictions	Chengdu	Ürümqi
	Donguan	Wenzhou
	Foshan	Wuhan
	Jiaxing	Wuxi
	Jinan	Xi'an
	Kunming	Xiamen
	Qingdao	Zhongshan
	Shijiazhuang	Zhuhai

China—NEV quotas will effect sales significantly

Beijing vehicle registrations by registration type, 2011–28



- Beijing introduced its license plate restriction scheme in 2011. The lottery-based system allowed 240,000 new plates to be issued each year. This limit was reduced to just 150,000 units in the beginning of 2014. IHS Markit assumes that this level will be maintained until the end of 2017 as the regulations have already been put in place.
- The main goal of the controls was to limit road congestion while expanding the Beijing metro system in parallel, increasing its size and coverage by a factor of three or four by 2020.
- In line with new national government guidance (September 2015), NEVs are no longer to be subject to licence plate or circulation restrictions.
- After 2020, NEVs will become common, so that they are assumed to be included in a separate cap (in line with assumptions on other restricted cities at that time).

China—infrastructure will support NEV convenience

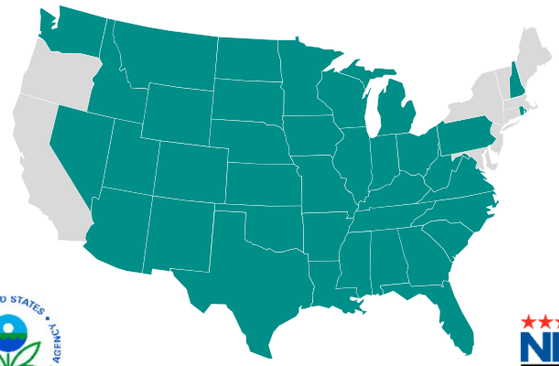
Charging infrastructure development in China

Regional focus	• Main focus on East, North, and South China, including megacities Beijing, Shanghai, Guangzhou, and Qingdao
Charging standard	• New Chinese charging standard from early 2016 supports both DC fast charging and level 2 charging
Infrastructure development	• About 81,000 public charging stations and more than 50,000 private charging stations • USD600 million investment in 2016
Ambitious target	• Government aims to build 12,000 charging stations, 4.8 million charging points by 2020 • Investment of up to USD19 billion

United States—a market differentiated by two regulations

Section 177 of Clean Air Act allows states to choose from:

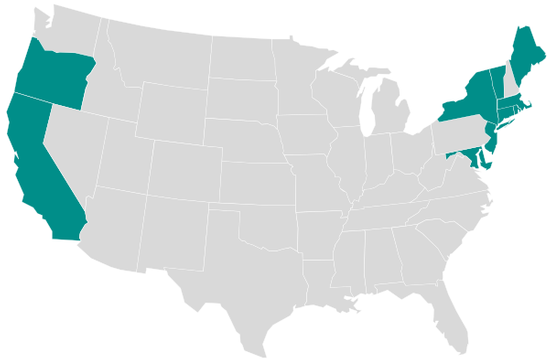
National regulations



- The US Environmental Protection Agency (EPA) has established national greenhouse gas emission standards.
- National Highway Traffic Safety Administration (NHTSA) has established Corporate Average Fuel Economy standards.
- Parallel standards are combined in nationwide standards until 2025, mandatory for all states not using section 177.

or

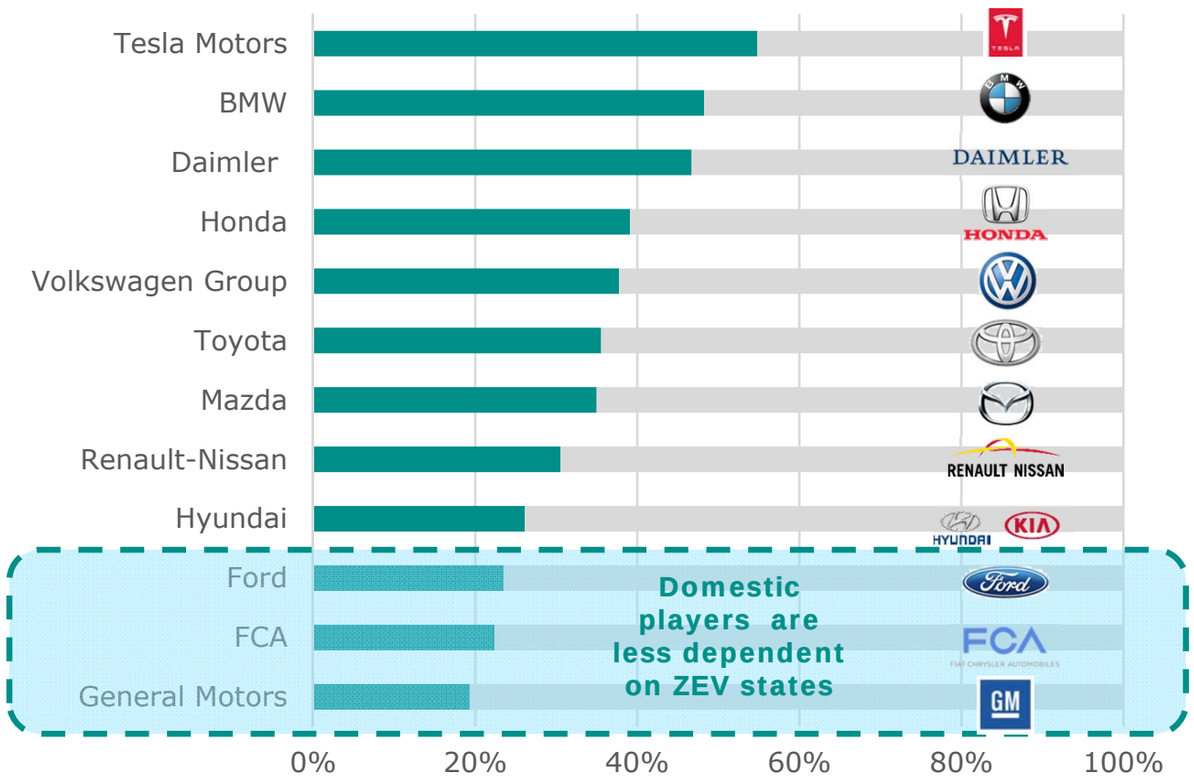
California zero-emissions vehicle (ZEV) mandate

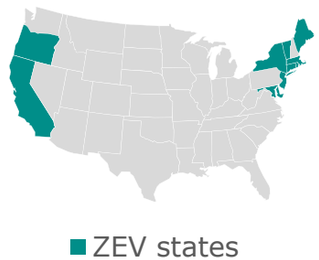


- California is allowed to set own (stricter) emission standards owing to special provisions in the Clean Air Act.
- ZEV mandate forces OEMs to sell increasing percentages of transitional ZEVs, i.e., battery electric vehicles (BEVs), fuel-cell electric vehicles (FCEVs), and plug-in hybrid electric vehicles (PHEVs) until 2025.
- As other states are not allowed to set own regulations, nine so-called Section 177 states have chosen to follow the ZEV mandate instead of national regulations.

United States—domestic OEMs are less dependent on ZEV states than European or Asian competitors

Passenger vehicle sales share by OEM and regulation region, 2015

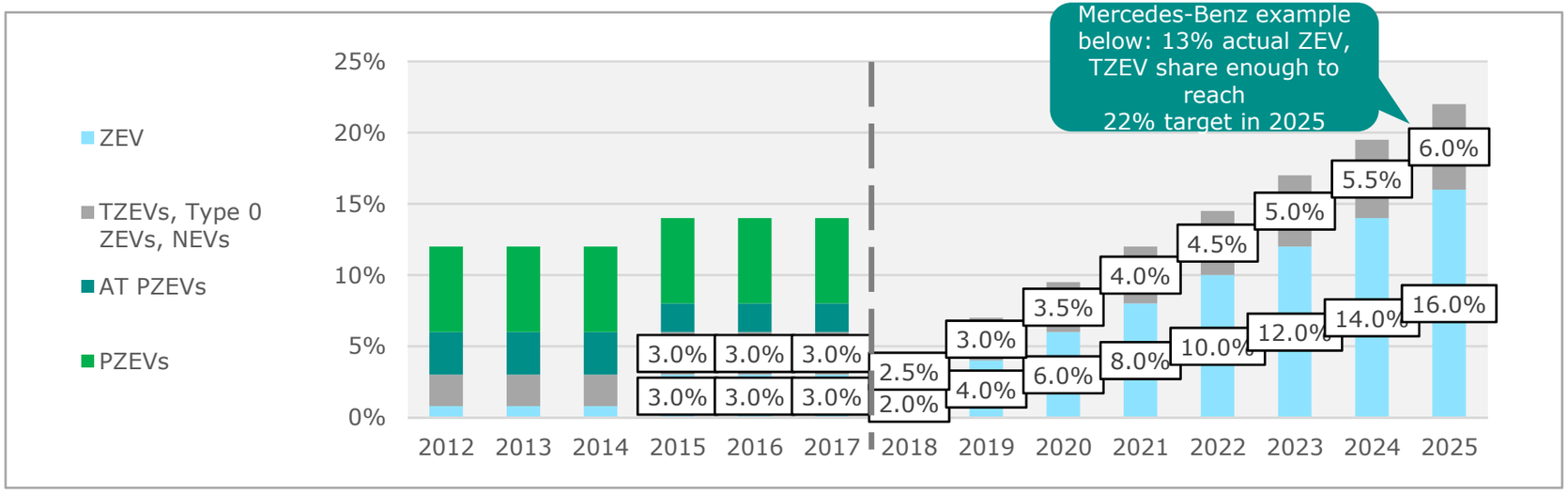




Sources: US registration data by state Note: incl. passenger vehicles, excl. pickups, trucks, utility cars, vans

United States—ZEV states drive the powertrain electrification

ZEV mandate vehicle classifications and credits



Example: Mercedes-Benz	2018	2019	2020	2021	2022	2023	2024	2025
Credits needed for 100,000 sales	4,500	7,000	9,500	12,000	14,500	17,000	19,500	22,000
 Mercedes-Benz GLC PHEV: **0.7 credits** (20 miles range assumed)	Max. units: **3,570**	**4,290**	**5,000**	**5,710**	**6,430**	**7,140**	**7,860**	**8,570**
 Mercedes-Benz EQ BEV: **3.6 credits** (310 miles range assumed)	Min. units: **560**	**1,110**	**1,670**	**2,220**	**2,780**	**3,330**	**3,890**	**4,440**

-13%

ZEV: Zero emission vehicle
TZEV: Transitional zero emission vehicle
NEV: Neighborhood electric vehicle

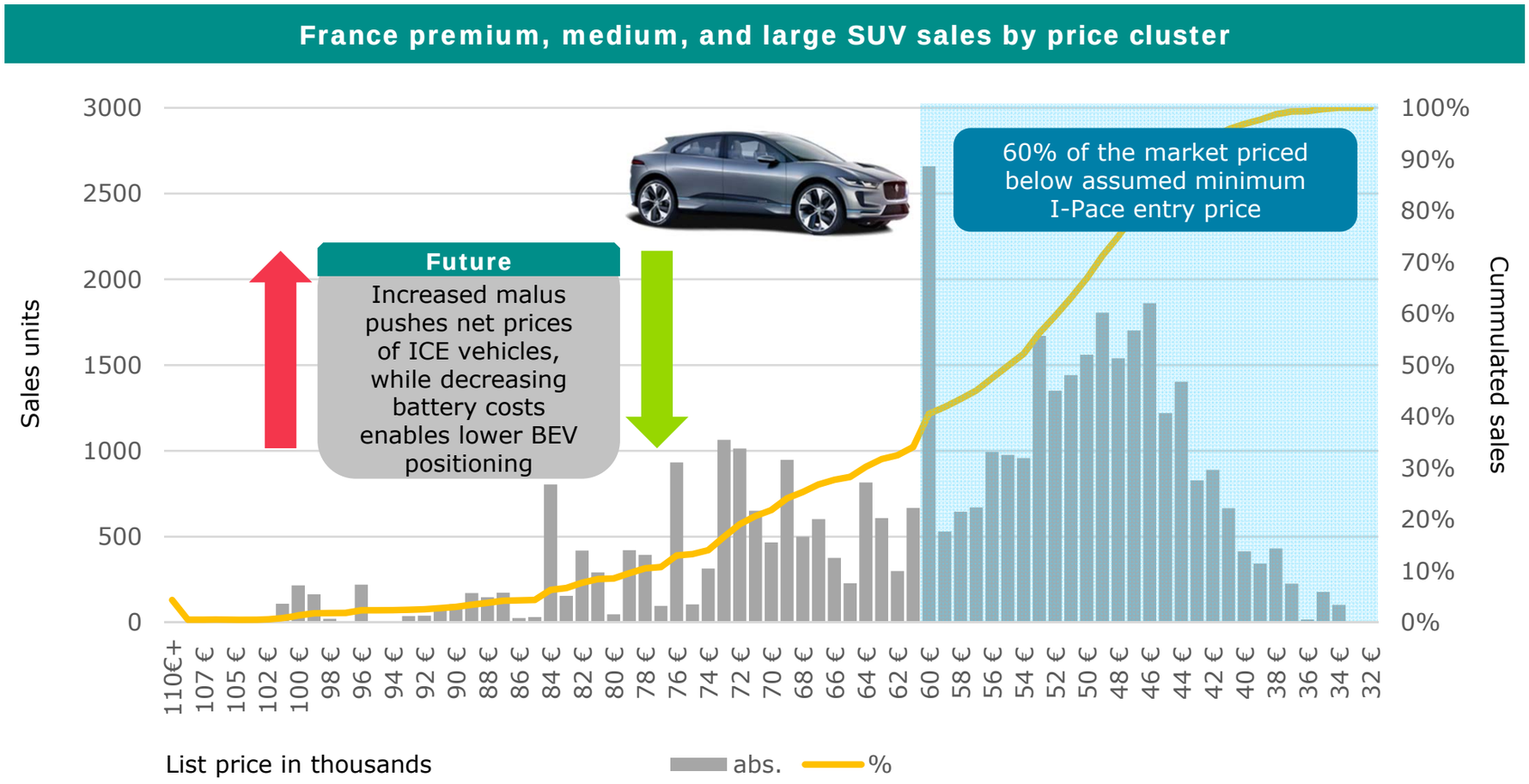
AT PZEV: Advanced technology partial zero emission vehicle
PZEV: Partial zero emission vehicle

Europe—a common emission regulation, but different market frameworks

Forecast drivers		France	United Kingdom	Spain	Italy	Germany
Market frameworks	Incentives					
	Taxation					
	City restrictions					
	Infrastructure					
TCO	Small segments					
	Larger segments					
OEM offerings	Industry wide					

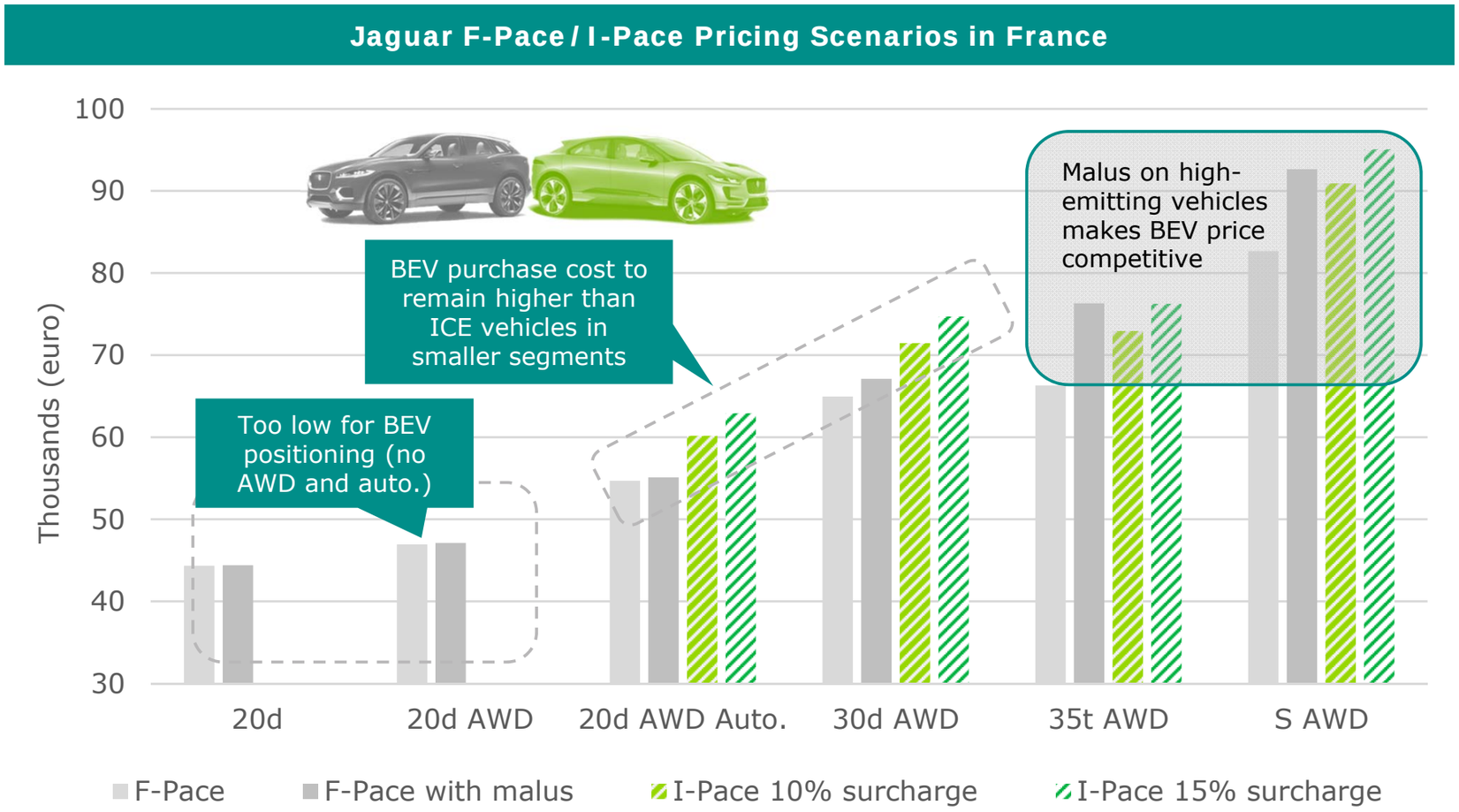
Left: until 2021 Right: 2021–26

France—BEVs target limited market volumes owing to high price positioning



Source: Registration data of France premium, medium, and large SUVs

France—the malus system makes BEVs attractive at a high price positioning



Source: Jaguar France, malus assumption for 2017

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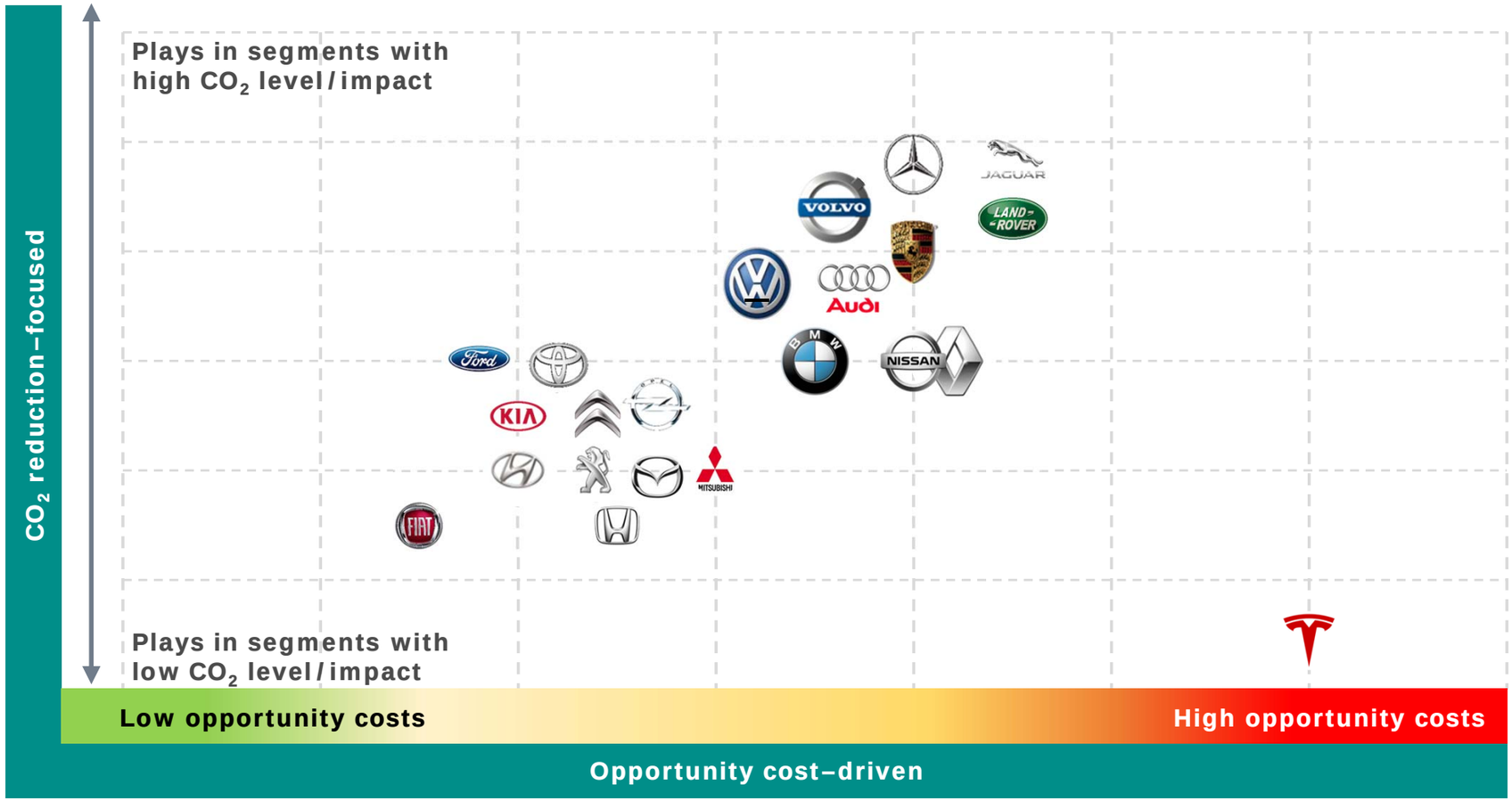
OEM strategies—OEMs react differently to the challenges of regulation and electrification



OEM strategies—Jaguar Land Rover (JLR) starts a BEV offensive

Current strategic steps

PHEV

- PHEVs mostly use diesel engine. Land Rover, especially, will not use gasoline engine for its PHEVs.

BEV

- Jaguar I-Pace is the first BEV in 2017. Luxury EV (I-Type) – Formula E engagement is to promote BEV.
- JLR rumored to open battery plant in cooperation with BMW and Ford

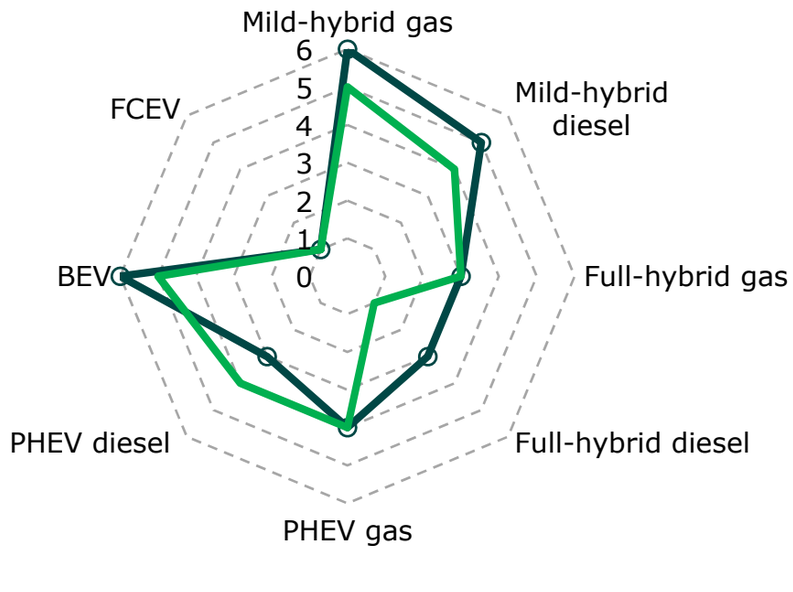
Mild hybrid electric vehicle (MHEV)

- In 2026, MHEVs will dominate the market of JLR vehicles and will help the OEM to reach future compliance targets.

Ian Callum (Head of Design, Jaguar)

"I'm clear in my mind that an electric Jaguar would be suitable for the brand. You have to move with the times."

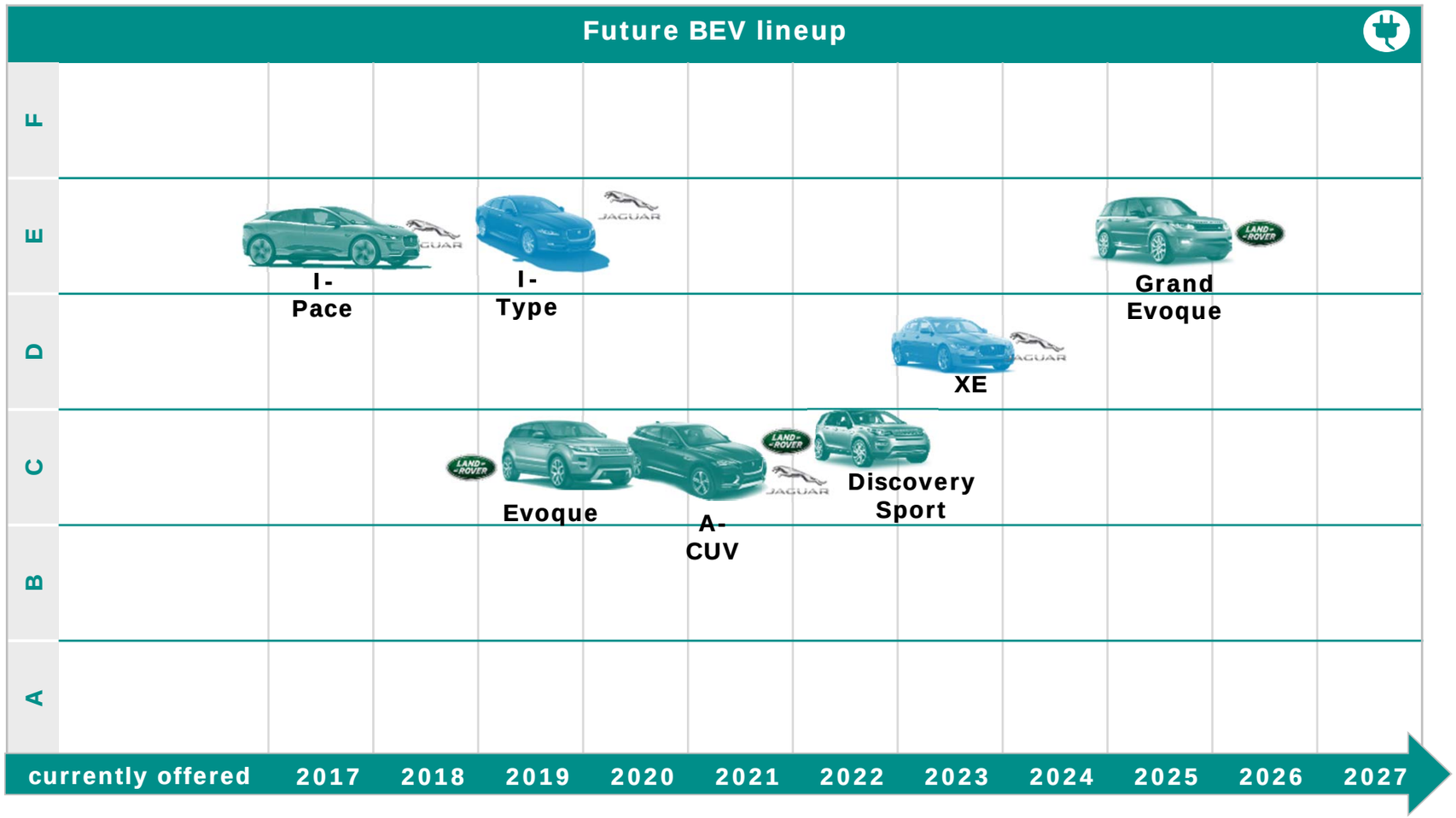
Alternative powertrain strategic relevance, 2026*



Category	1	2	3	4	5	6
% of total sales	0%	0–<1%	1–<5%	5–<10 %	10–<20 %	>20 %

Source: IHS Sales by Powertrain Scenario Forecast
Note: *Sales shares across EU28, China, and United States

OEM strategies—JLR BEV lineup assumption



Source: IHS Sales by Powertrain Scenario Forecast
Note: Nameplates only placeholders

SUV Sedan
Hatch Others

OEM strategies—BMW rolls out PHEVs, followed by BEVs, while mild-hybridization almost becomes a standard

Current strategic steps

BMW i

- Portfolio expansion of the i brand focuses on technologies, rather than on BEVs.
- iNEXT is focusing on autonomous driving and connectivity.

Performance

- PHEV rollout across most model ranges, starting from 2 Series to 7 Series, branded as iPerformance.
- BMW vehicles to be launched with BEV powertain (MINI, X3, 3 Series).

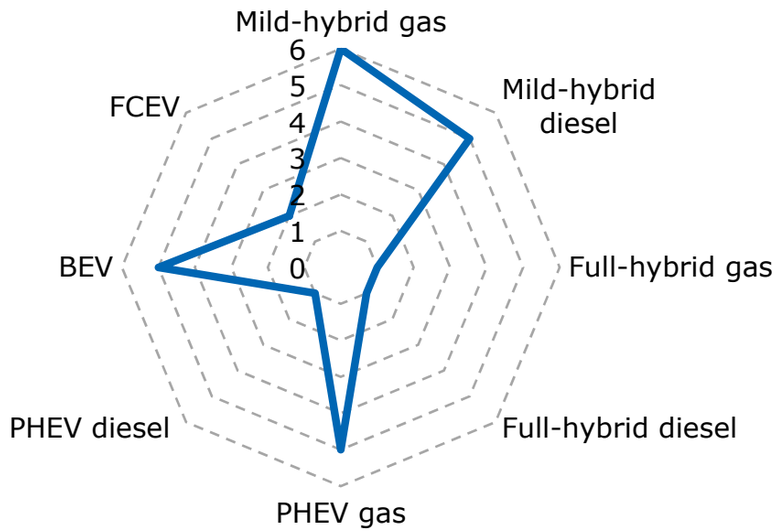
Fuel cell research

- Fuel cell research in cooperation with Toyota
- Limited production volumes only due to costs and infrastructure hurdles

MHEV

- In 2026, MHEV will dominate the offerings of BMW vehicle.

Alternative powertrain strategic relevance, 2026*



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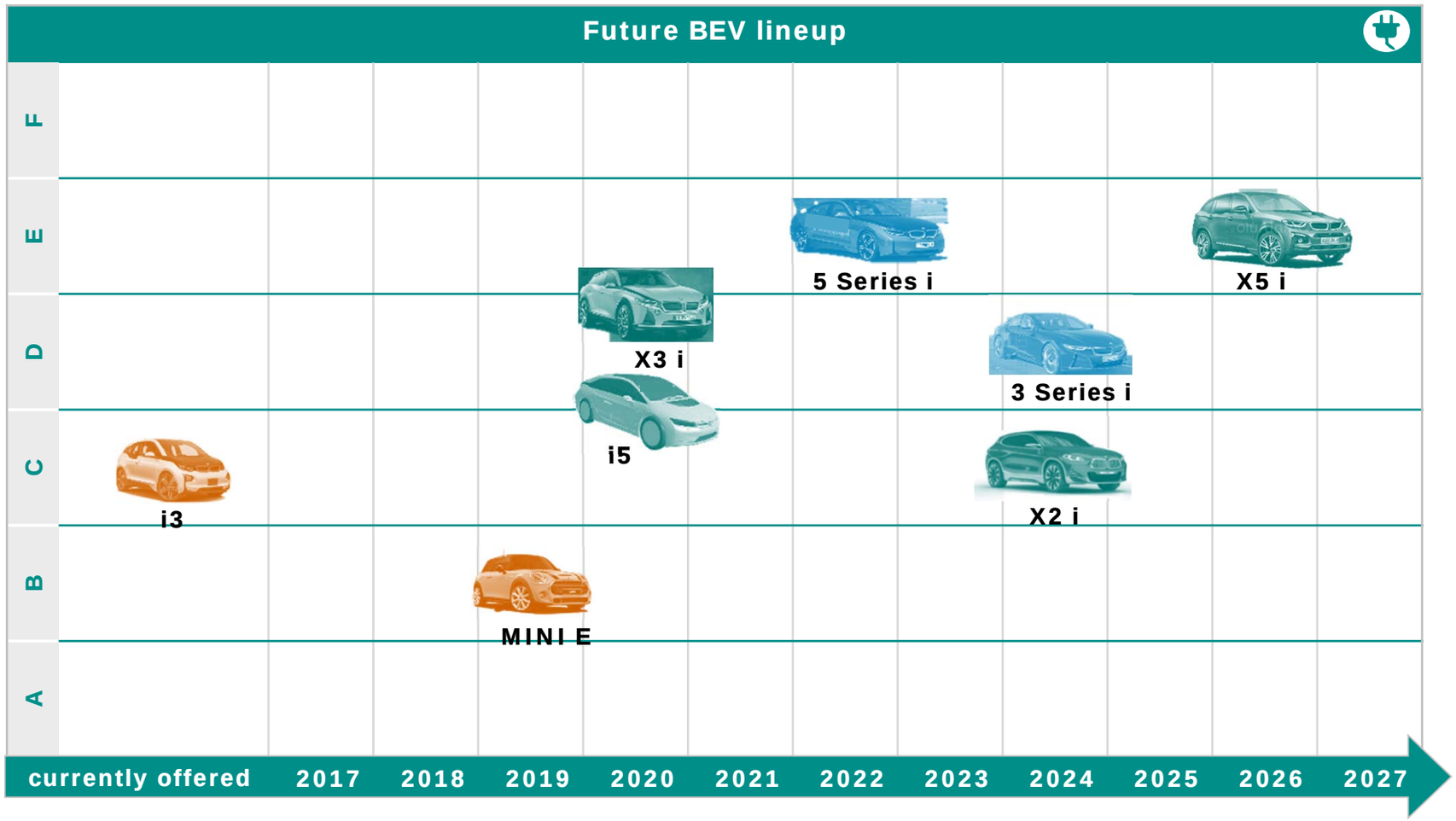
OEM strategies—BMW BEV lineup assumption



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Note: Nameplates only placeholders

SUV
Hatch
Sedan
Others

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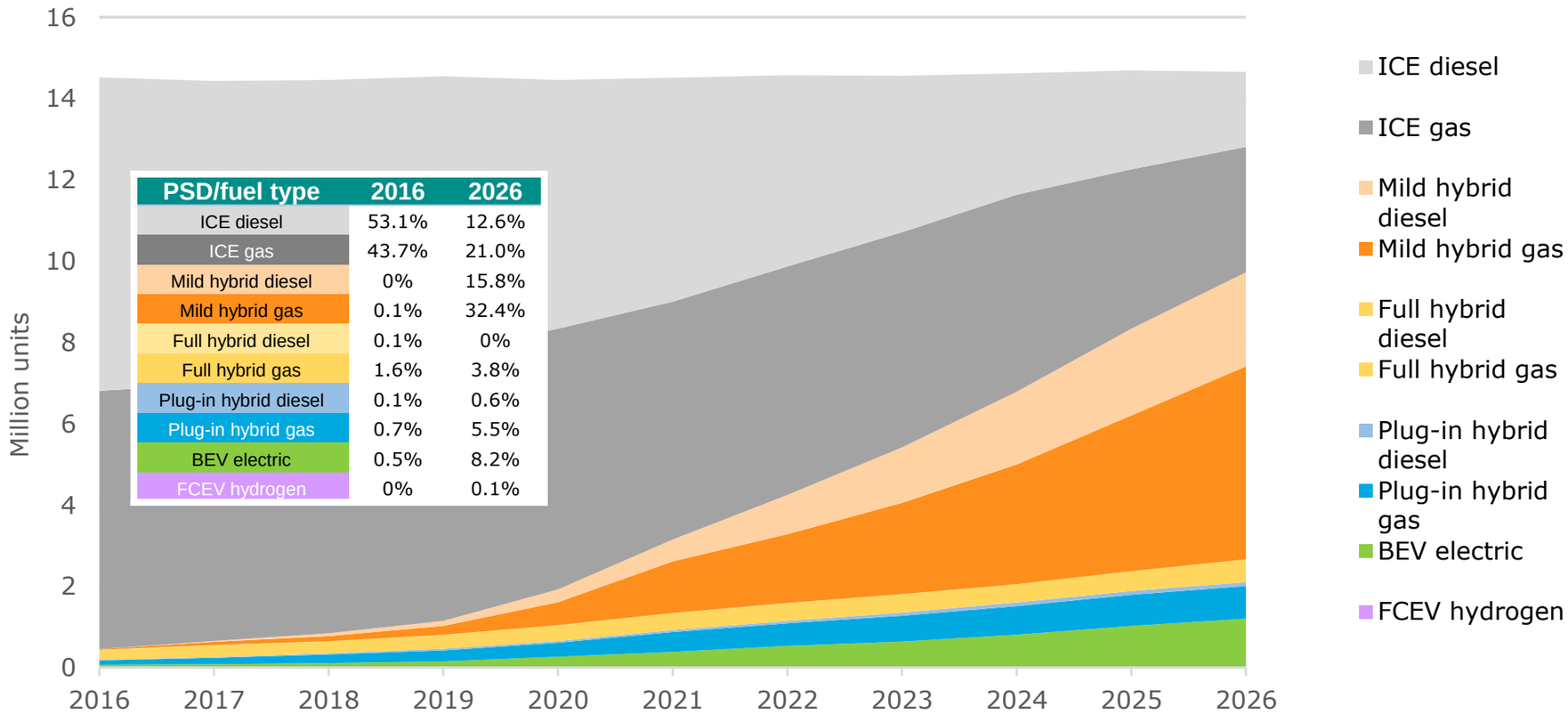
Electrification trends—EU28 emission regulations and OEM offerings lead to BEV & PHEV scenarios with >14% sales share

TIV light vehicle sales by propulsion system design and fuel type, 2016–26*

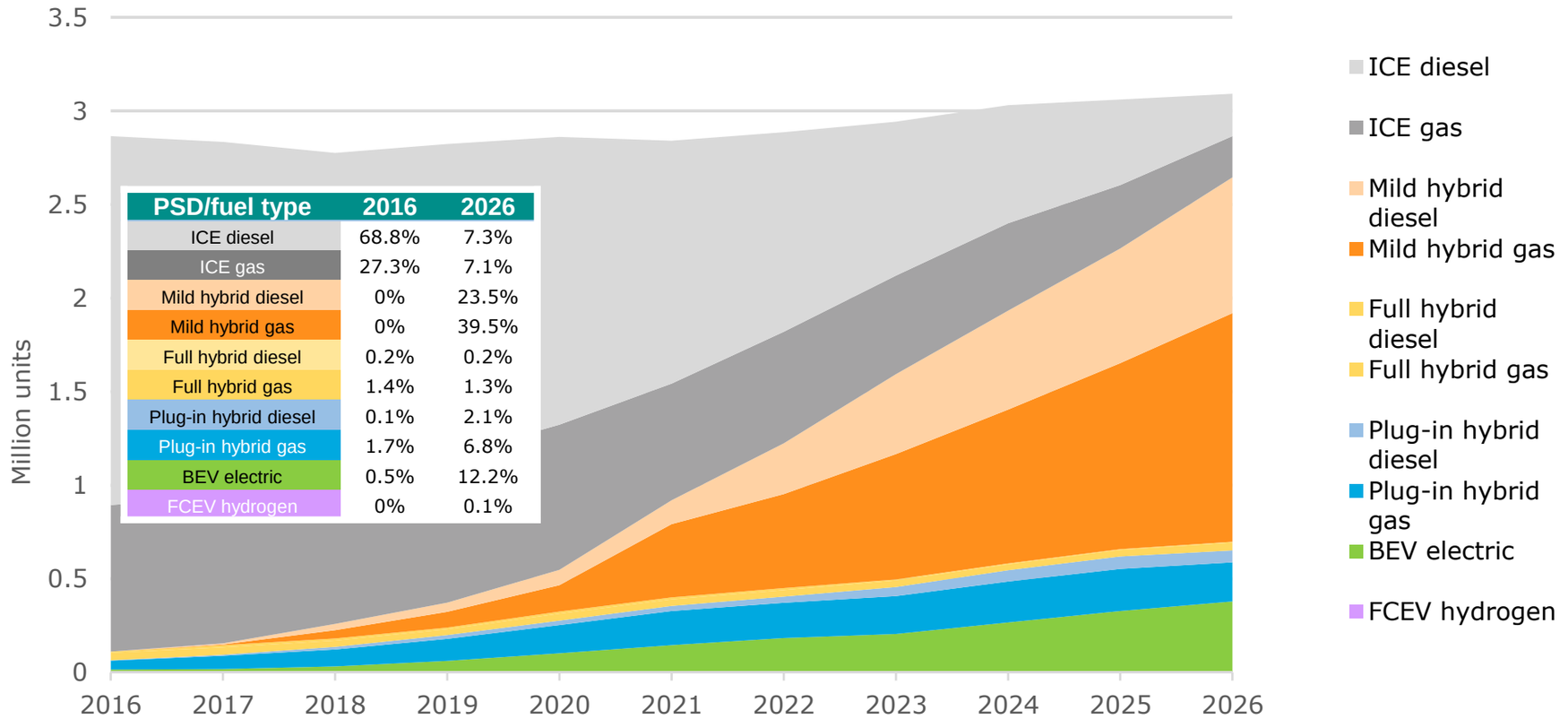


PSD/fuel type	2016	2026
ICE diesel	53.1%	12.6%
ICE gas	43.7%	21.0%
Mild hybrid diesel	0%	15.8%
Mild hybrid gas	0.1%	32.4%
Full hybrid diesel	0.1%	0%
Full hybrid gas	1.6%	3.8%
Plug-in hybrid diesel	0.1%	0.6%
Plug-in hybrid gas	0.7%	5.5%
BEV electric	0.5%	8.2%
FCEV hydrogen	0%	0.1%

Notes: Gas includes gas, natural gas, LPG, and ethanol-petrol, RE included in PHEV, mild hybrid = 48V
*Passenger cars incl. SUVs and excl. pickups

Electrification trends—BEV & PHEV scenarios reach >20% sales share in the European premium vehicle market

Premium light vehicle sales by propulsion system design and fuel type, 2016–26*



PSD/fuel type	2016	2026
ICE diesel	68.8%	7.3%
ICE gas	27.3%	7.1%
Mild hybrid diesel	0%	23.5%
Mild hybrid gas	0%	39.5%
Full hybrid diesel	0.2%	0.2%
Full hybrid gas	1.4%	1.3%
Plug-in hybrid diesel	0.1%	2.1%
Plug-in hybrid gas	1.7%	6.8%
BEV electric	0.5%	12.2%
FCEV hydrogen	0%	0.1%

Note: Gas includes gas, natural gas, LPG, and ethanol-petrol, RE included in PHEV, mild hybrid = 48V
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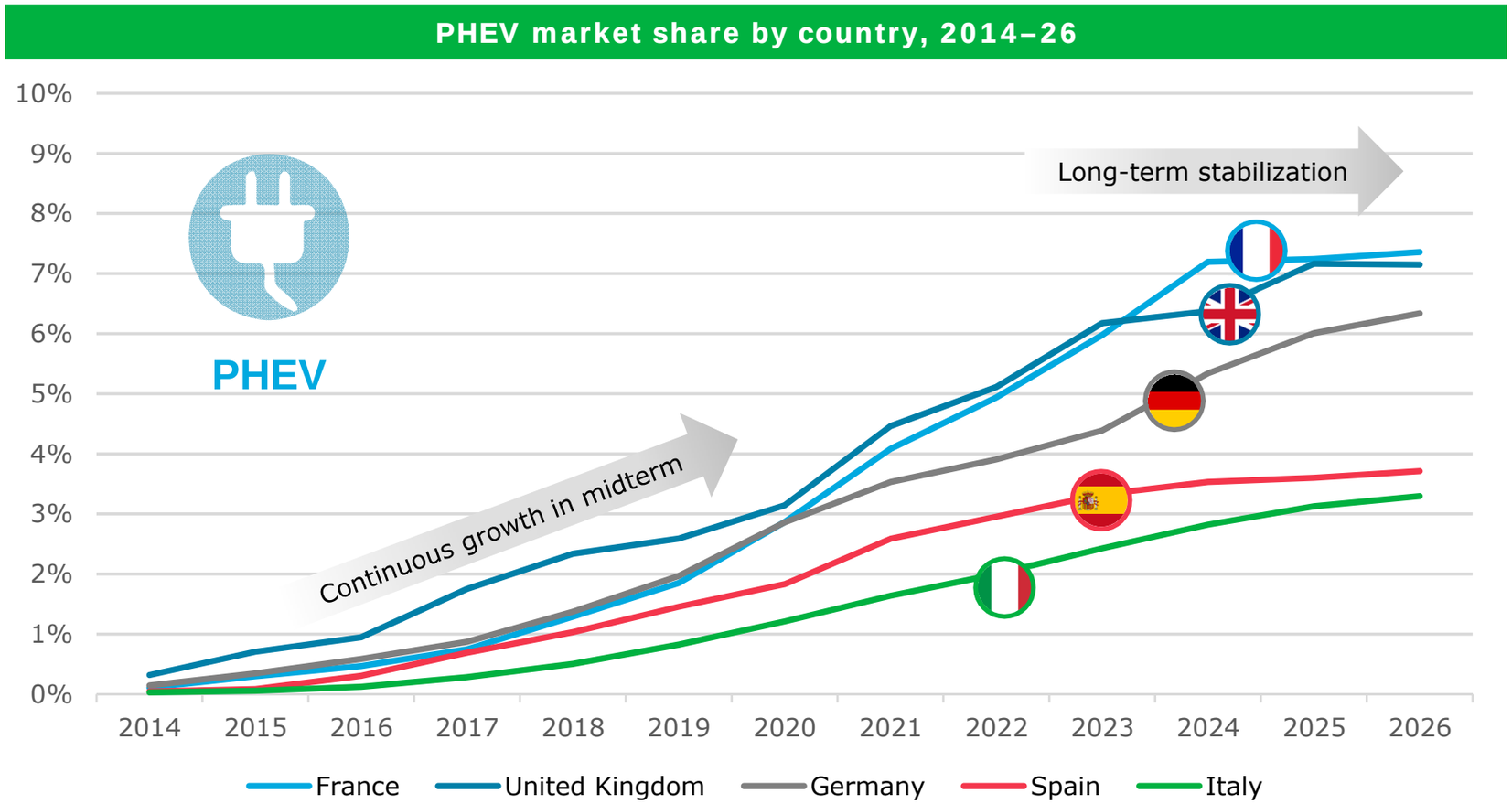
Electrification trends—market frameworks in United Kingdom and France support growth of PHEV sales



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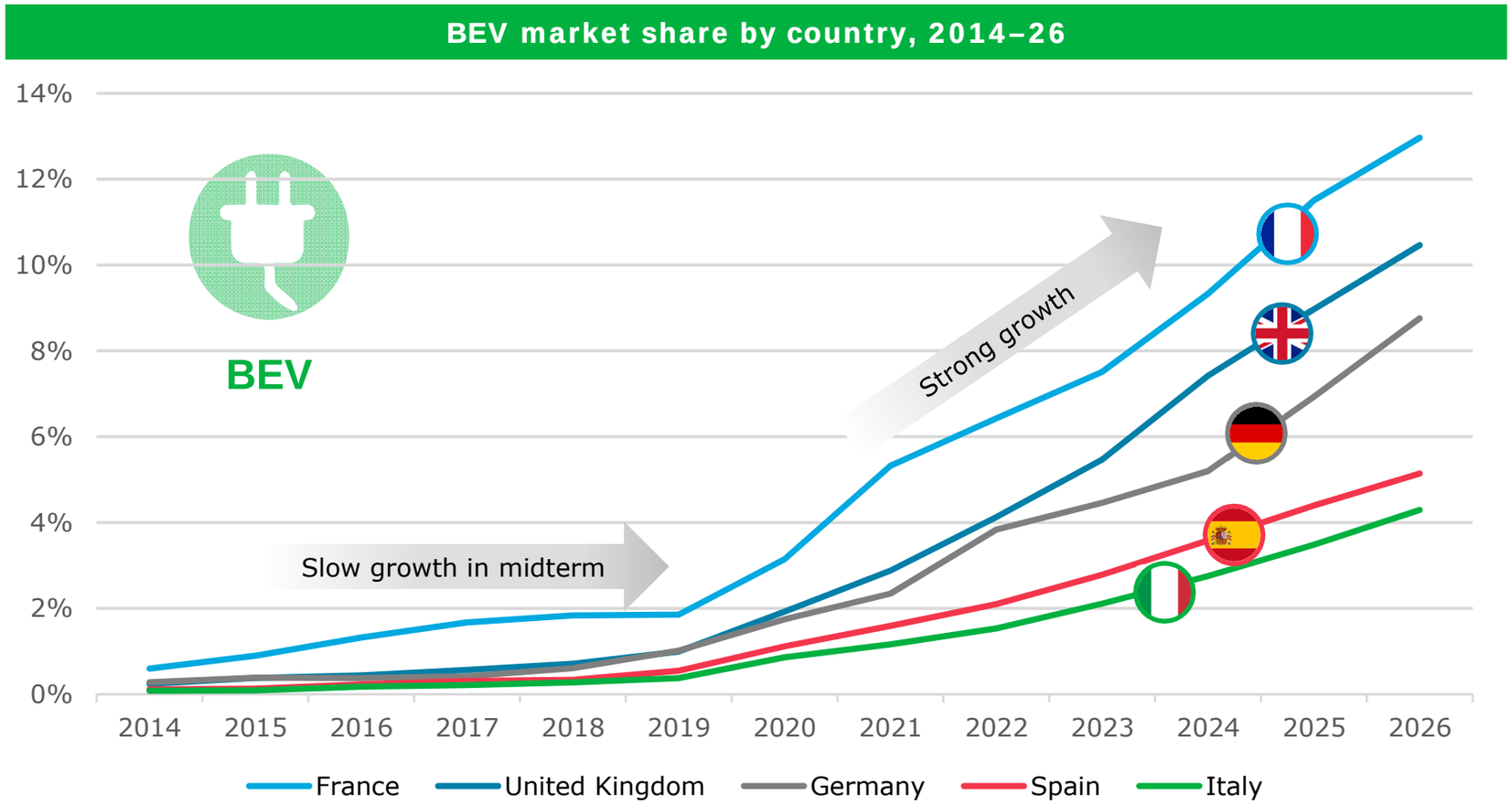
Electrification trends—significant growth of BEV sales is expected after 2019



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Summary

- **Markets require individual forecast approaches** including anticipations of future regulations.
- **OEM strategies and vehicle portfolios require individual assessments** including anticipations of future emission compliance.
- Powertrain electrification is in progress. Customer acceptance and speed of xEV penetration trend depend on the **closure of price and convenience gaps**.
- Overall, **the complexity of the forecast process increases significantly**, along with your questions regarding the **assumptions** and their **sensitivity regarding scenarios. We look forward to discuss them with you.**

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