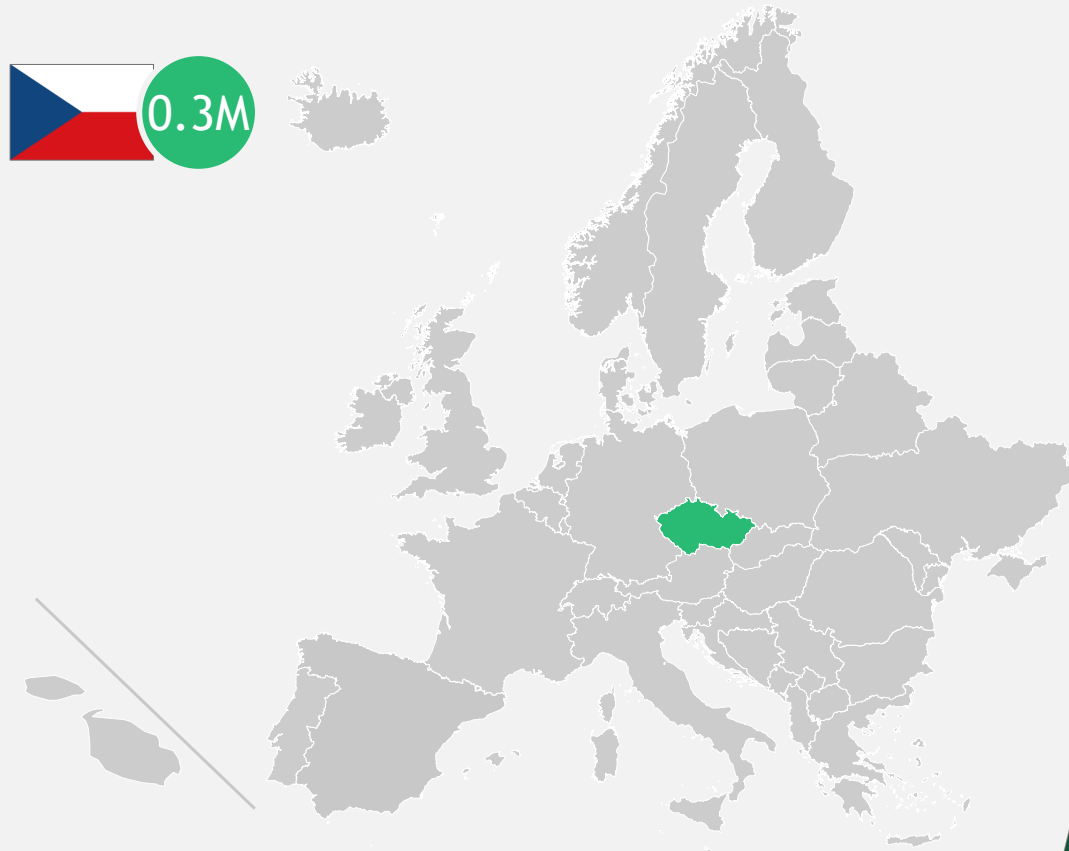




Czech Automotive Industry in Transition

Potential Job Impacts of Electromobility in the Next Decade






Job development in Czech Republic from '20-'30 ...



X.XM Number of employee in scope (Basis 2020)

Source: BCG

... answered in five building blocks

-  **Industry sectors and job families** primarily affected 1
-  **Major trends** influencing job development in Auto industry 2
-  **Net impact** of job development until 2030 3
-  **Transition** over time, across industries, jobs and regions 4
-  **Recommendations** for companies and governments 5

Agenda



Industry sectors and **job families** primarily affected

1



Major trends influencing job development in Auto industry

2



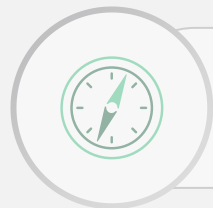
Net impact of job development until 2030

3



Transition over time, across industries, job families, regions

4



Recommendations for companies and governments

5



330k employees in scope for the Czech Republic

Total number of jobs in Czech Republic 2020 [in k]

Job category²

Industry cluster¹



Total 2020

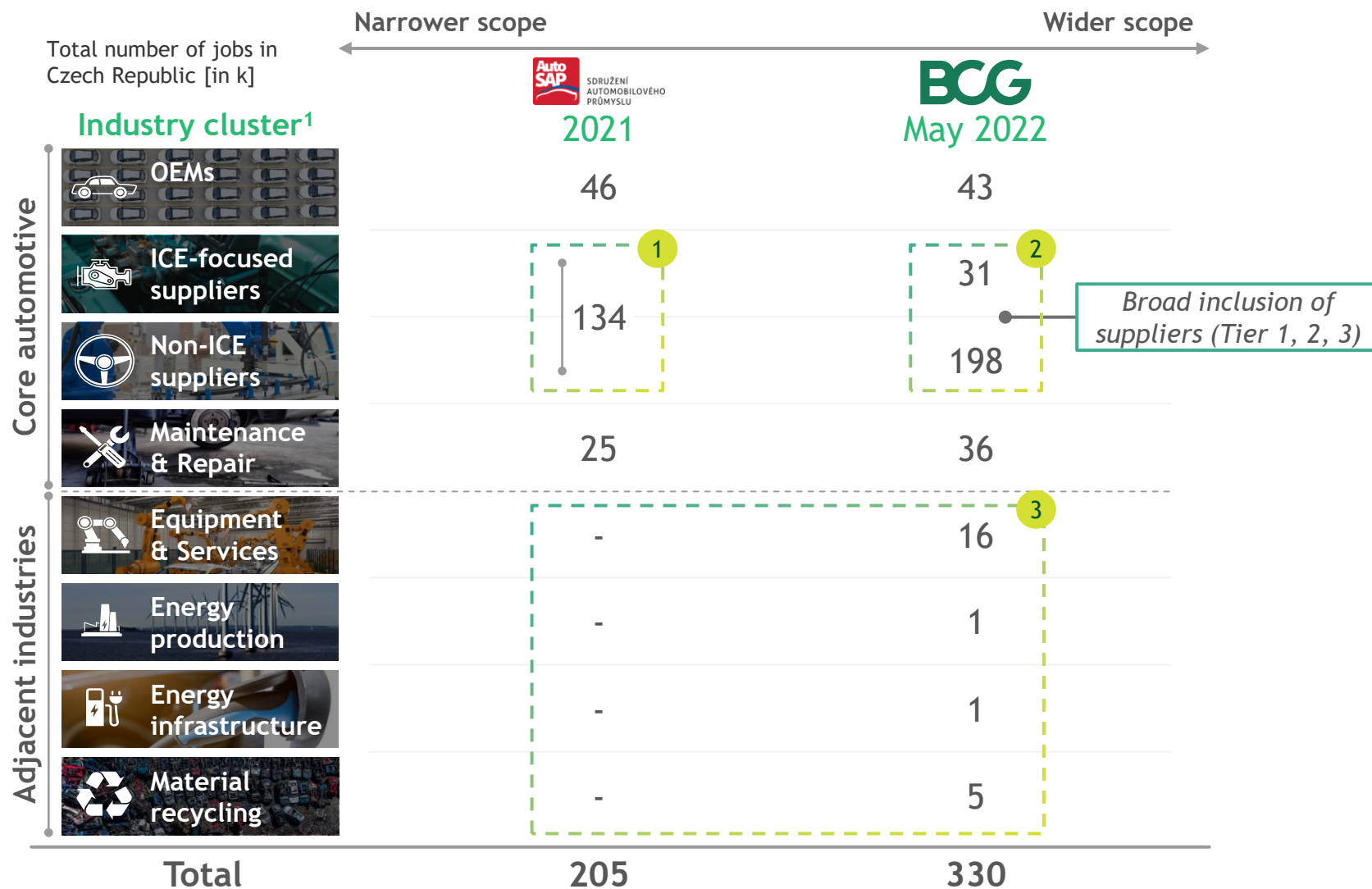
Industry cluster ¹	Engineering	Procurement	Production/Service Ops.	Sales	Other	Total	%
Core automotive							
OEMs	2	1	31	3	6	43	13%
ICE-focused suppliers	3	1	20	2	5	31	9%
Non-ICE suppliers	15	4	147	7	24	197	60%
Maintenance & Repair	0	2	29	3	2	36	11%
Adjacent industries							
Equipment & Services	2	1	9	2	2	16	5%
Energy production	0	0	1	0	0	1	0%
Energy infrastructure	0	0	1	0	0	1	0%
Material recycling	1	1	3	0	0	5	1%

23 7% 10 3% 241 73% 17 5% 39 12% 330

1. Based on 26 industries
 2. Based on 31 jobs families
 Source: EuroStat; BCG



Scope of auto jobs varies, not directly comparable



1. Based on 26 industries
Source: AutoSAP; Eurostat; BCG



Observations

- 1 Only suppliers **directly related** to the automotive industry included, e. g. body/coachwork
- 2 Both, **direct and indirect car industries** covered, e. g. bearings or cooling systems
- 3 BCG & ECF analysis covers **core automotive as well as adjacent industries**, in contrast to scope of AutoSAP

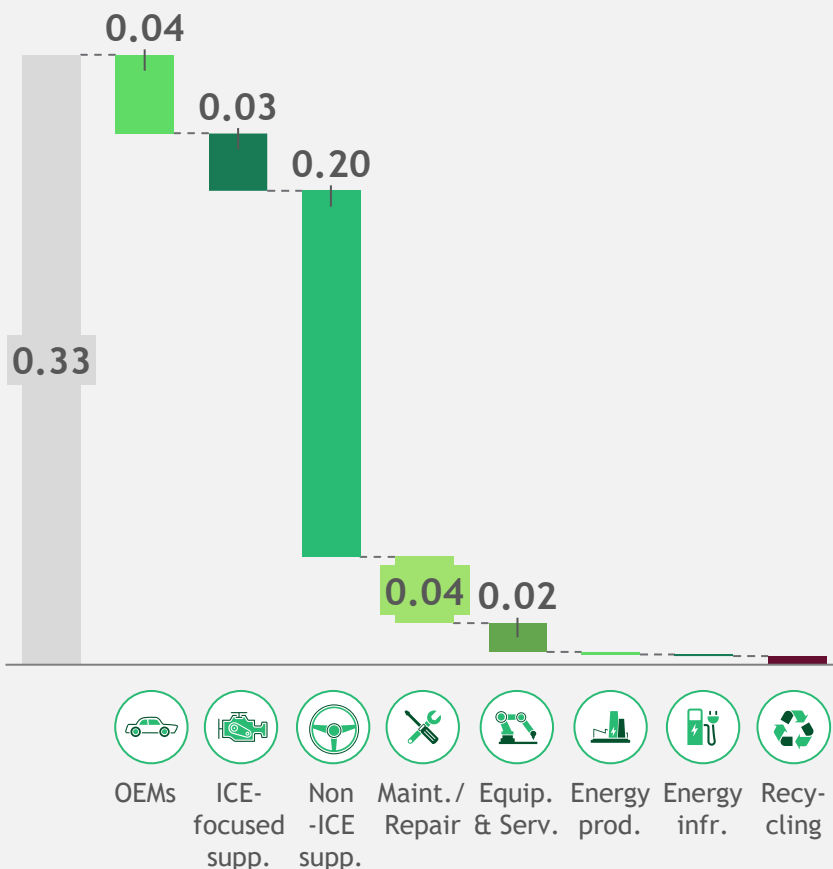


Scopes not directly comparable



Majority of employees in the non-ICE supplier cluster

Total number of jobs with industry split
[Numbers in M]



26 affected sectors grouped in 8 overarching industry clusters ...

- ... whereof, **0.04M (13%)** jobs are associated with **OEMs**
- ... whereof, **0.03M (9%)** jobs are associated with **ICE-focused suppliers**
- ... whereof, **0.20M (60%)** jobs are associated with **Non-ICE suppliers**
- ... whereof, **0.04M (11%)** jobs are associated with **maintenance & repair**
- ... whereof, **0.02M (5%)** jobs are associated with **Equipment & Services**
- ... whereof, **0.001M (0%)** jobs are associated with **Energy production**
- ... whereof, **0.001M (0%)** jobs are associated with **Energy infrastructure**
- ... whereof, **0.005M (1%)** jobs are associated with **Material recovery**

Core automotive

Adjacent industries



26 affected industries defined for detailed analysis along 8 industry clusters

Core automotive

OEMs



Manufacture of motor vehicles

ICE-focused suppliers



Manuf. bearings, gears & driving elements

Manuf. cooling & ventilation equipm.

Manuf. pumps & compressors

Non-ICE suppliers



Manufacture of bodies

Manuf. of electrical & electronic equip.

Manuf. rubber tires and tubes

Manuf. computers & equipment

Manuf. e-motors & generators ☆

Manuf. electric lighting equipm. ☆

Manuf. of batteries & accumulators

Shaping & processing flat glass

Manuf. of other parts & accessories

Maintenance & Repair



Maintenance & Repair of vehicles

Adjacent industries

Equipment & Services



Equipment & Machinery

Industrial Service provider

Energy production



Manuf. of refined petroleum products

Production of electricity

Transmission of electricity

Distribution of electricity

Trade of electricity

Energy infrastructure



Fuel infr. (Manuf. & Service)

Fuel infr. (Instal. & Ops.)

Charging infr. (Manuf. & Service) ☆

Charging infr. (Instal. & Ops.) ☆

Material recycling



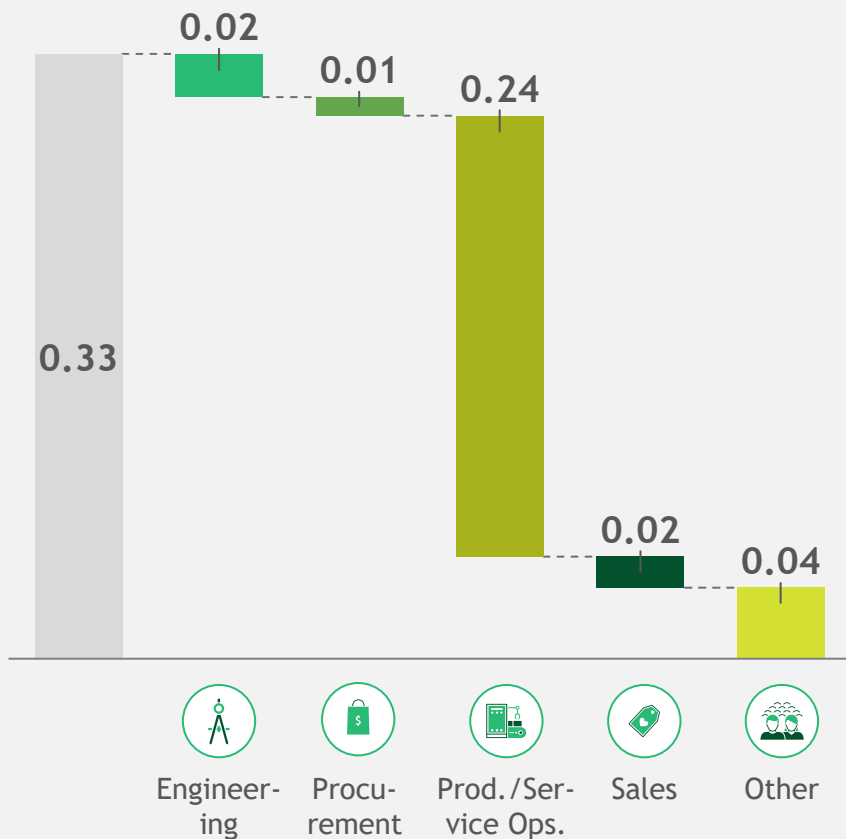
Recovery of sorted materials

Extensive change in industry expected ☆



Most employees working in production & service ops

Total number of jobs with functional split
[Numbers in M]



31 affected job families clustered in 5 categories along the value chain ...



... whereof, **0.02M (7%)** jobs are associated with **engineering**, which includes 9 company functions like Power units/electronics researcher



... whereof, **0.01M (3%)** jobs are associated with **procurement**, which includes 5 company functions like Production material procurer



... whereof, **0.24M (73%)** jobs are associated with **production & service operations**, which includes 5 company functions like Production material procurer



... whereof, **0.02M (5%)** jobs are associated with **sales**, which includes 5 company functions like sales analyst



... whereof, **0.04M (12%)** jobs are associated with **other functions**, e.g., Human Resources



31 job families defined within the affected company functions

Engineering

Power units/electronics researcher

Power units/transmission developer

↳ **Electrical power unit developer** ☆

(Vehicle) concept developer

↳ **Thermal concept developer** ☆

(Vehicle) feature developer

(Vehicle) Battery/Cell developer ☆

Software/system developer

System/function developer

↳ **Batterie mgmt. developer** ☆

Electrical/mechatronic designer

Development project manager

Business partner manager

Procurement

Production material procurer

Production facilities procurer

Services & transport procurer

Vendor parts procurer

Controlling/accounting staff

Production/Service

Production planner

↳ **E-motor production planer** ☆

↳ **Battery/Cell production planer** ☆

Operational production staff

↳ **High voltage production staff** ☆

Machine operator

Logistics planner

Operational logistics staff

(Production) maintenance staff

↳ **Charger maintenance staff** ☆

(Vehicle) mechanic

(Vehicle) electrician

↳ **Charger installation staff** ☆

Sales/Marketing

Sales manager/planner

Sales/after sales staff

Sales analyst

Marketing strategy staff

Product marketing staff

Digital Marketing staff

Market analyst

Service technology staff

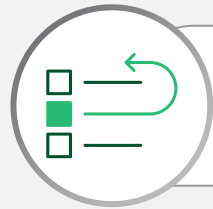
Upcoming/Growing (Sub)-Job families ☆

Agenda



Industry sectors and **job families** primarily affected

1



Major trends influencing job development in Auto industry

2



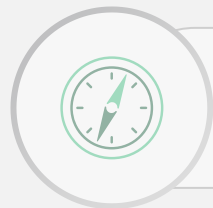
Net impact of job development until 2030

3



Transition over time, across industries, job families, regions

4



Recommendations for companies and governments

5



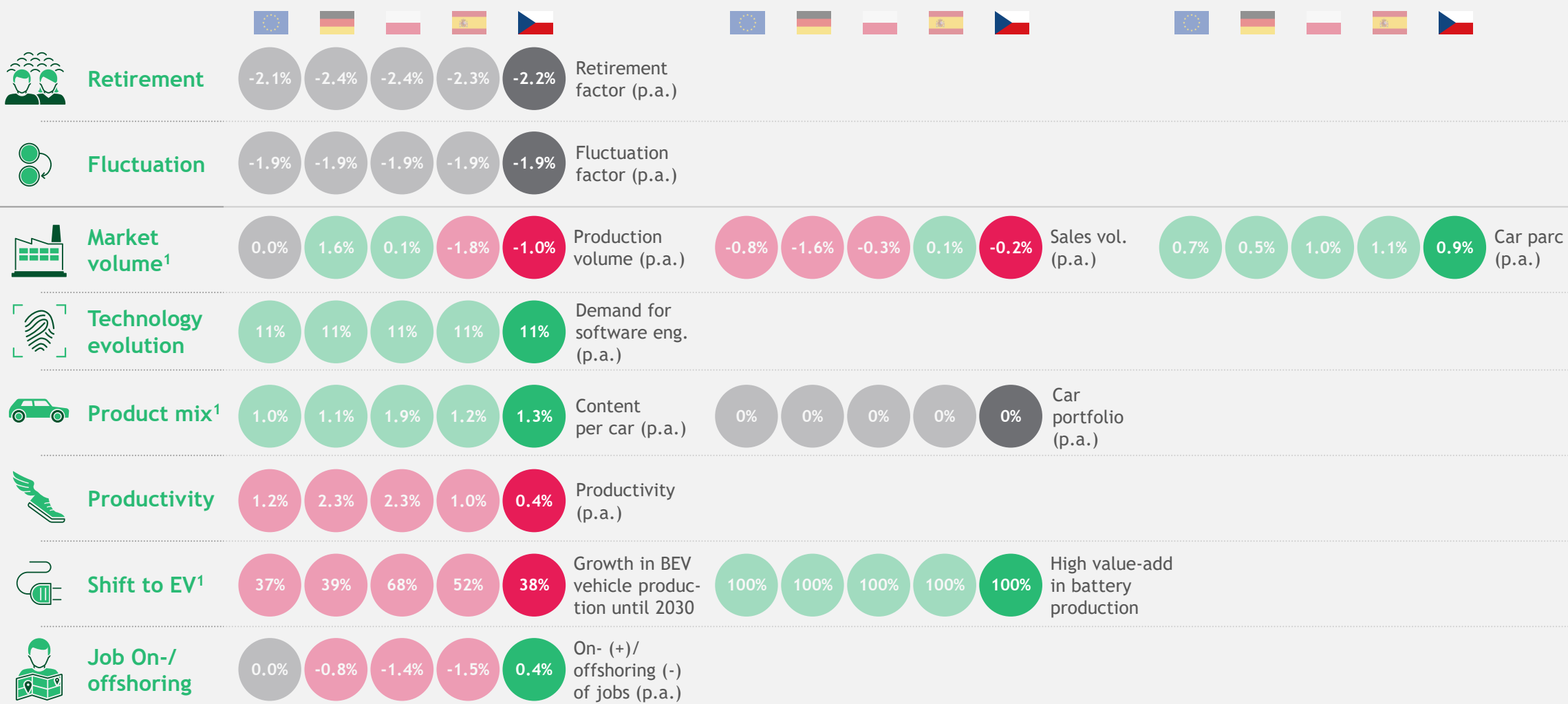
Overview of 8 trends driving the Automotive industry

Major trends

Quantification

Overarching

Industry specific



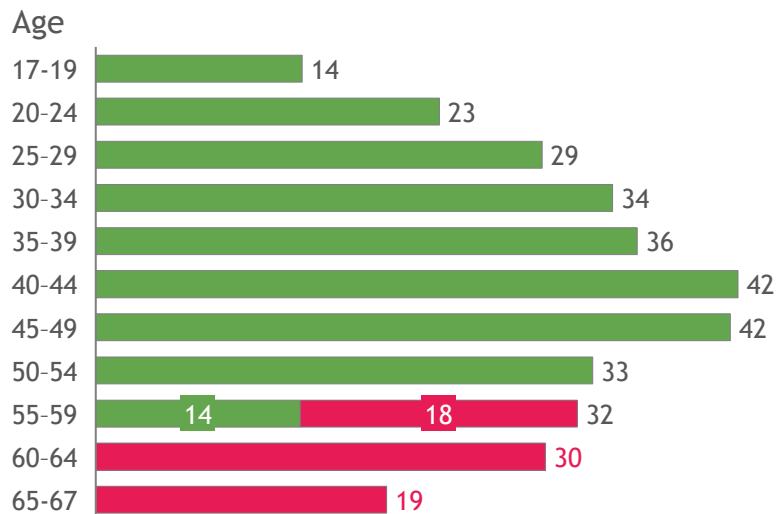
1. Numbers for Czech Republic refer to 2022, all others refer to 2021
Source: IHS Markit; BCG

● Positive impact on job demand
 ● Negative impact on job demand
 ● No impact on job demand



Retirement and fluctuation causing employee movement

Retirement factor [Employees in k]



67K retired employees until 2030 (~20% of total car employees)

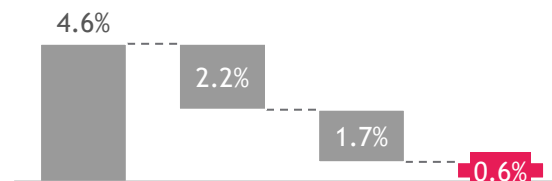


Affected number of employees leads to a retirement factor of **2.2%** (y-o-y) until 2030

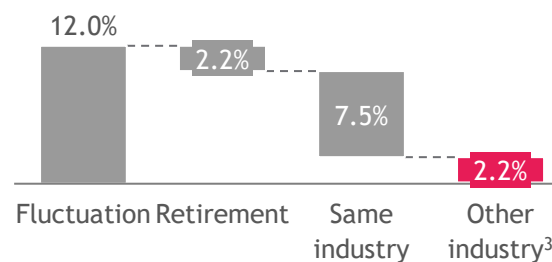
Fluctuation factor [Employees in k]



OEM¹
(~20% of employees)



Rest of industry²
(~80% of employees)



Fluctuation due to industry change lower for OEMs (~0.6%) than rest of industry (~2.2%)



Weighted average fluctuation factor (industry change) is **1.9%** y-o-y

2.2%
y-o-y

Share of workforce retiring y-o-y

1.9%
y-o-y

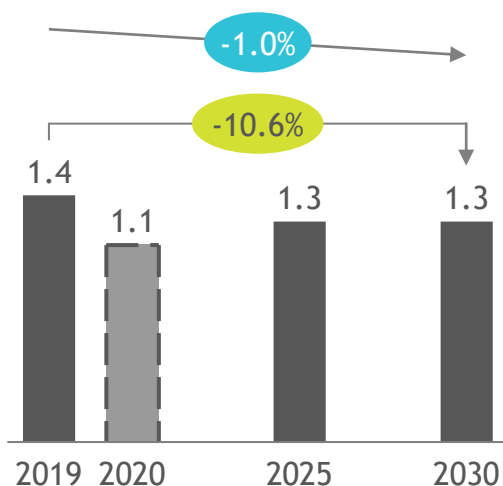
Fluctuation in other industries y-o-y

1. Daimler used as proxy for European OEMs 2. German auto industry used proxy for auto industry
3. 23% of ended employments lead to industry change
Source: Company data; Stepstone; BCG



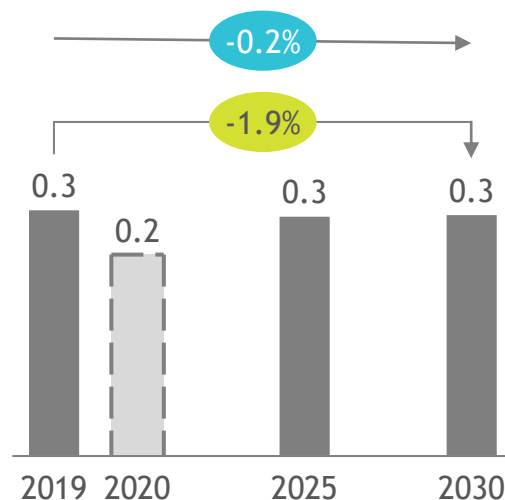
Long-term decrease in production and sales, car parc increase

Forecast vehicle production [in M cars]



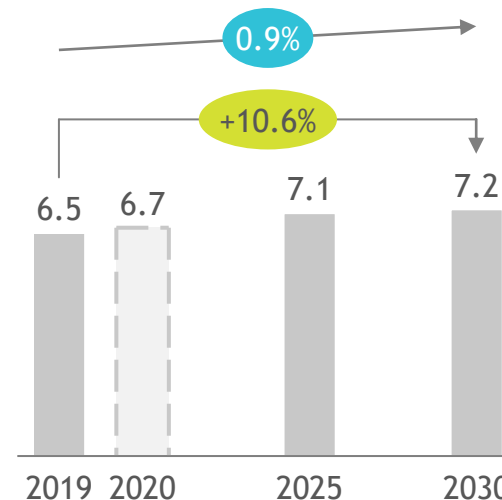
After a decline of -20% from '19 to '20, vehicle production will remain stable until 2030

Forecast vehicle sales [in M cars]



After a steep drop in 2020, vehicle sales will recover until 2025 and then remain stable

Car parc [in M cars]



~11% increase in car parc until 2030 with minor growth rates over decade

Note: Forecast for light vehicle (<3,5t)
Source: IHS Market database; BCG

Legend: XX% Year-over-year growth X.X% Growth from '19 to '30

-1.0%
y-o-y

Production volume decrease

-0,2%
y-o-y

Sales volume decrease

+0.9%
y-o-y

Car parc increase



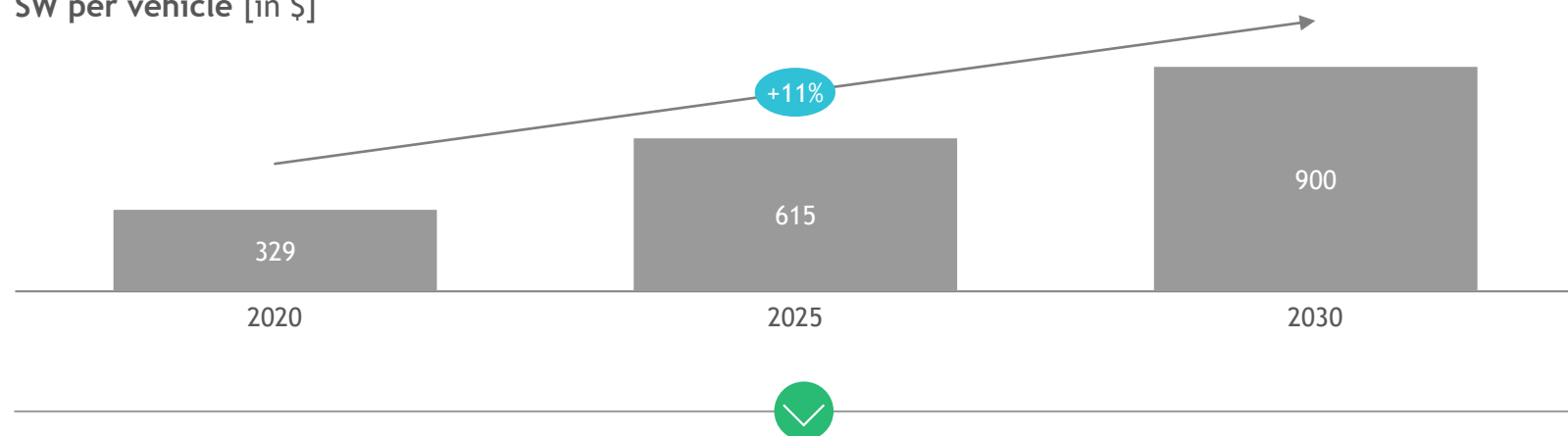
Technology trends influence employee movement

Technology trends driving SW demand

Key technology trends

- Assistant/Autonomous driving
- Connectivity increase
- Analog to digital migration

SW per vehicle [in \$]



+11%
y-o-y

SW cost per vehicle
CAGR - demand for SW
engineers

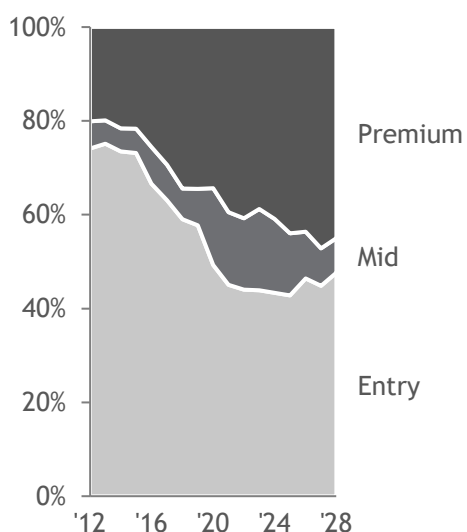
New rising technologies (mainly SW based) are becoming crucial to manage for auto industry



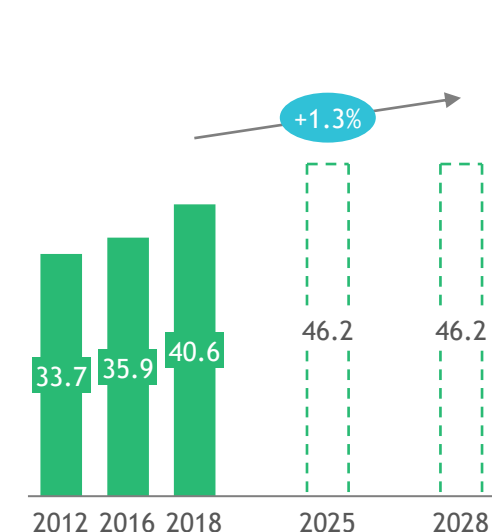
Product mix leads to increased average content per car

Production: Trend of increasing content per car continues

Production mix



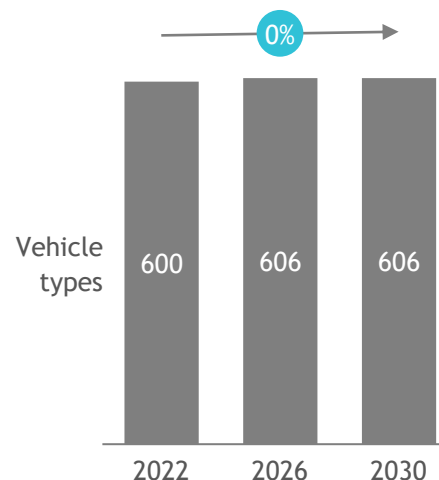
Average content per car [K€]



Growing premium segment leads to increased average content per car - average growth of **~1.3% y-o-y** until 2030

Engineering: Constant number of vehicle types

Product portfolio forecast



Stable number of vehicle types in 2030 - **Stable** demand of **development engineers**

1.3%
y-o-y

Content increase per car through growing share of premium vehicles

0.0%
y-o-y

Constant engineering demand due to stable number of vehicle types

Note: Entry segment below €30K content per car, premium segment above €50K.
Source: IHS Market database; Eurostat, BCG

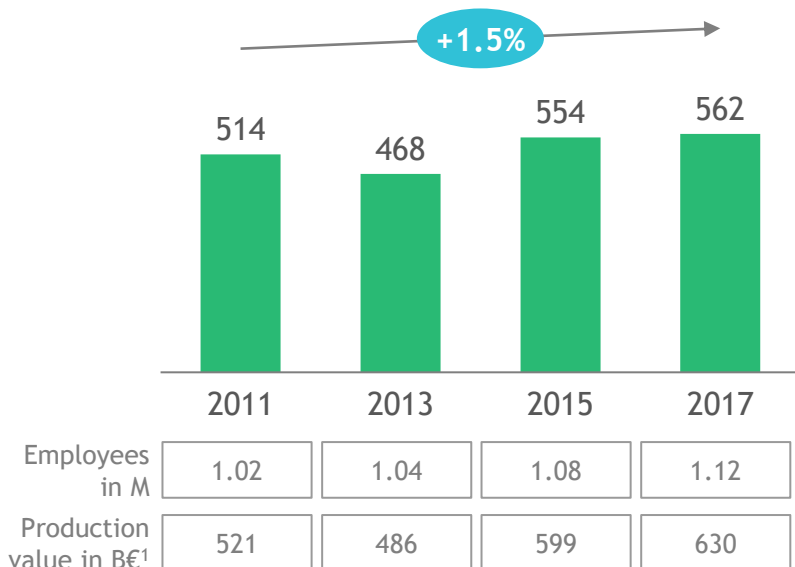
Legend: X.X% Year-over-year growth



Yearly productivity increase of ~0.4% for the Czech Republic

Previous approach for Europe:
Same productivity across industries

Production value per employee¹
[K€ per employee]



Based on production value productivity increases ~1.5% per year

Updated approach for the Czech Republic
Industry specific productivity

Gross value added per employee¹
[Yearly average increase between 2014-2018]

Industry	Yearly average increase
Manufacture of motor vehicles	0.0%
Manufacture of bodies (coachwork) for motor vehicles	2.1%
Manufacture of electrical and electronic equipment for motor vehicles	3.0%
Manufacture of other parts and accessories for motor vehicles	0.3%
Manufacture of rubber tires and tubes	0.0%
Manufacture of computers and peripheral equipment	4.3%
Manufacture of electric motors, generators and transformers	1.0%
Manufacture of bearings, gears, gearing and driving elements	1.4%
Manufacture of cooling and ventilation equipment	2.9%
Manufacture of electric lighting equipment	0.0%
Manufacture of batteries and accumulators	0.0%
Manufacture of other pumps and compressors	1.3%
Shaping and processing of flat glass	0.1%
Recovery of sorted materials	3.1%
Equipment & machinery	0.3%
Industrial service provider	0.0%
Maintenance and repair of motor vehicles	0.3%
Charging infrastructure (Manf.&Service)	0.0%
Charging infrastructure (Operation&Maint.)	0.0%
Fueling infrastructure (Manf.&Service)	0.3%
Fueling infrastructure (Operation&Maint.)	0.3%

Based on industry weighted average productivity increases ~0.4% per year



Productivity increase (adjusted for inflation)

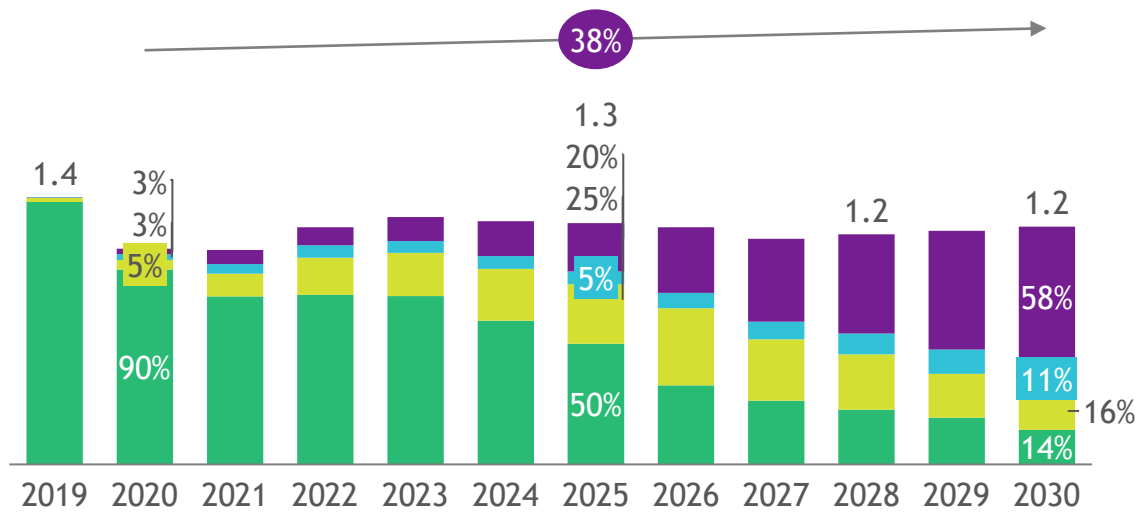
1. Adjusted for inflation
Source: Eurostat; BCG

Legend: X.X% Year-over-year growth



Only 14% ICE production remain in the Czech Republic by 2030

Vehicle production [in M cars]



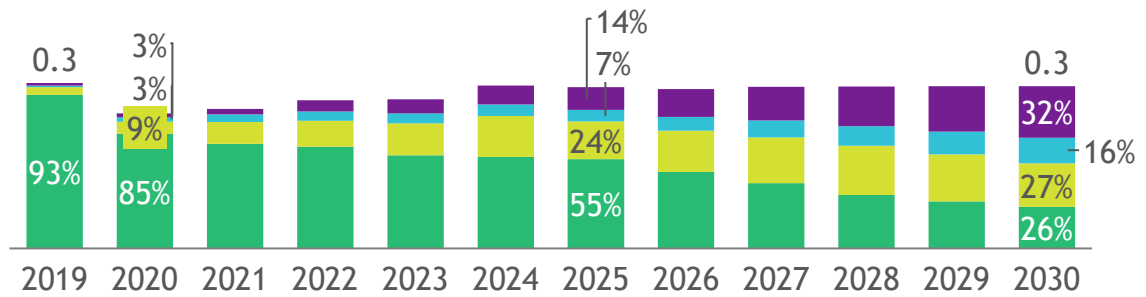
BEV with a strong growth until 2030 (58% share)

PHEV slowly gains share up to 11% in 2030

HEV increase until 2025 to 25%, afterwards decrease to 16%

Strong decline in ICE vehicle production, only 14% ICEs in 2030

Vehicle sales [in M cars]



58%

BEV share in vehicle production in 2030

38% y-o-y

Growth in BEV vehicle production

Note: ICE = Internal combustion Engine; BEV = Battery electric; PHEV = plug-in hybrid electric; HEV = (mild) hybrid electric
 Source: IHS Markit database; BCG



High value add in battery manufacturing forecasted

Trend towards production in Europe



"VW announced a plan for six battery gigafactories in Europe"

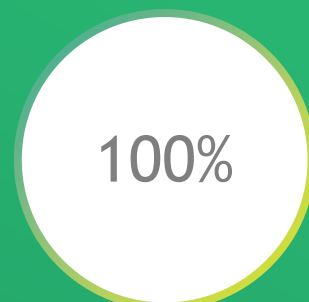


"Towards 2030, we intend to produce 150GWh battery cells across several gigafactories in Europe"

Possible scenarios until 2030

	Share of prod. costs	Low value add	Medium value add	High value add
Battery production	~10%	✓	✓	✓
Module production	~12%		✓	✓
Cell production	~78%			✓
Share of jobs based in Europe		~10%	~22%	~100%

Forecasted scenario for 2030



High value-add in battery production



Huge battery cell demand fuels plans for local production

Local battery demand grows up to 47 GWh in 2030...

BEV & PHEV production in 2030



Average battery capacity¹

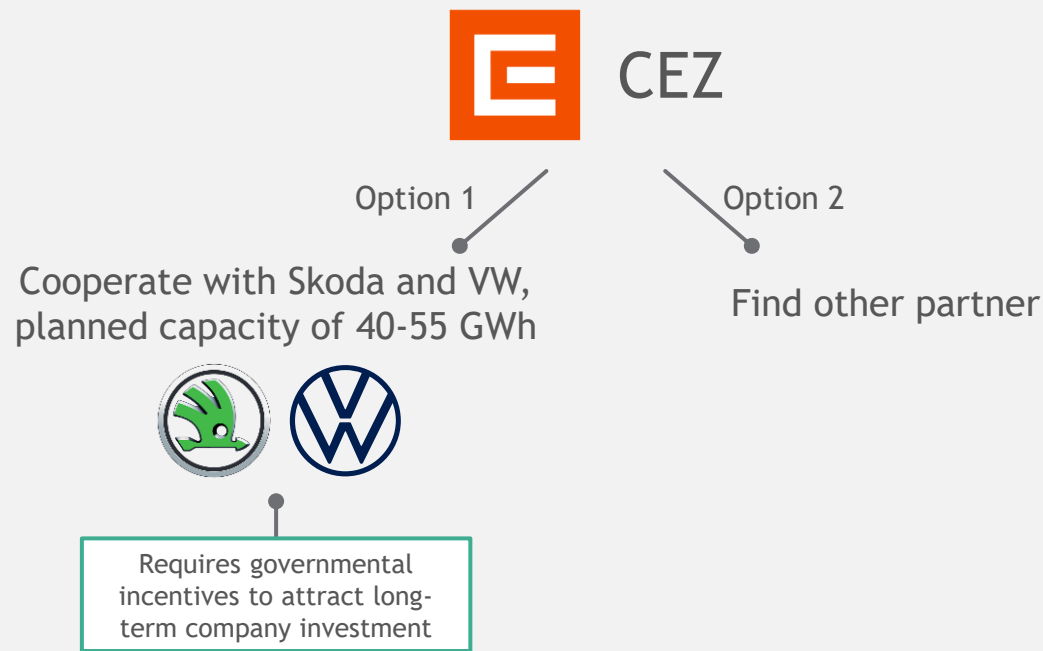


47 GWh battery cell demand²



... underlining the need of Czech battery production plans for domestic industry

Publicly discussed options shown only

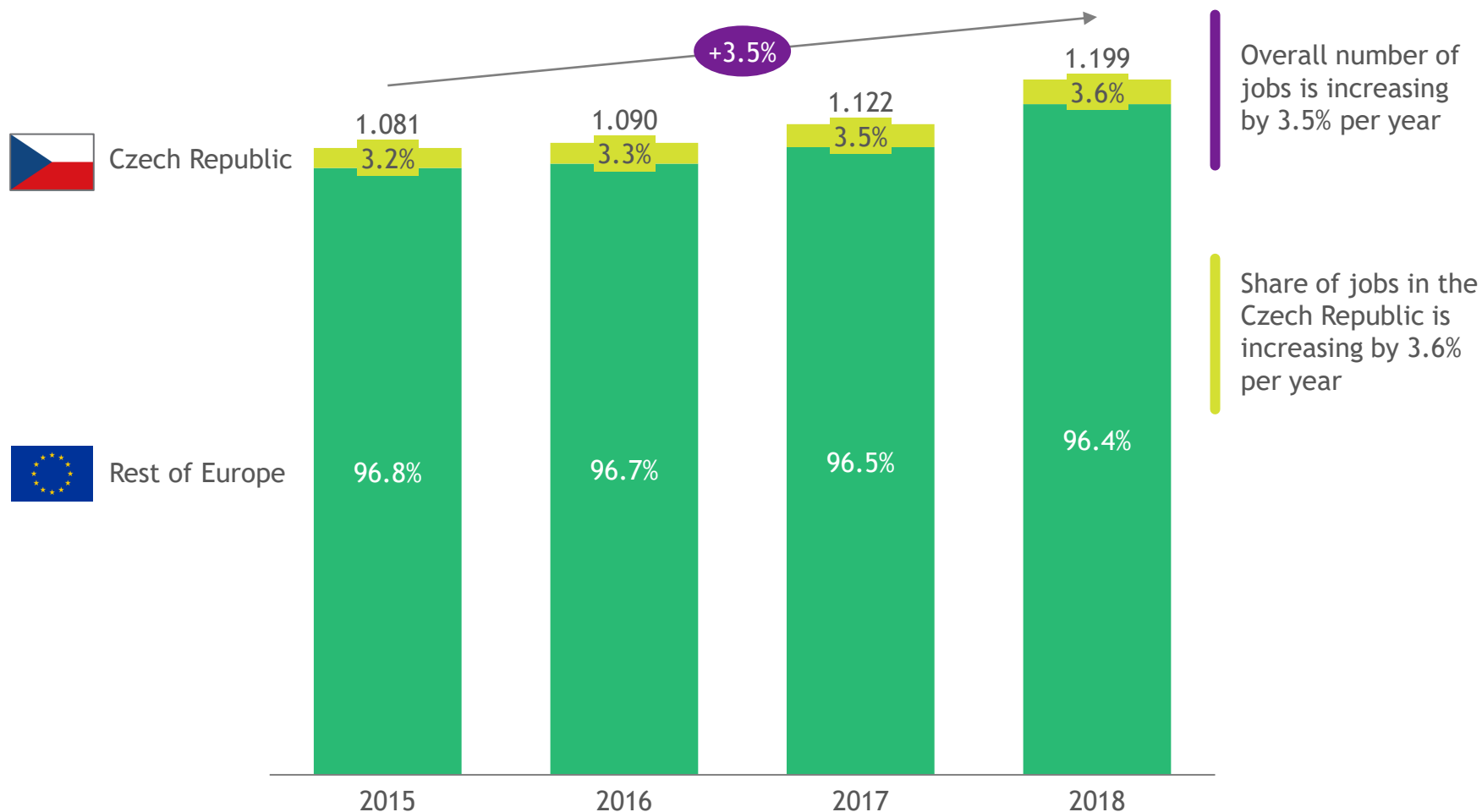


1. Assuming 62 kWh average battery size for BEV and 13 kWh for PHEV 2. Annual average until 2030 equals 32 GWh/year with battery factory SOP in 2025 Source: BCG Analysis



Share of Czech OEM jobs in EU increases by 3.6% p.a.

Automotive OEM employees
[in M]



Overall number of jobs is increasing by 3.5% per year

Share of jobs in the Czech Republic is increasing by 3.6% per year

3.6%
y-o-y

Historic onshoring of Czech Automotive jobs during growing automotive sector

0.4%
y-o-y

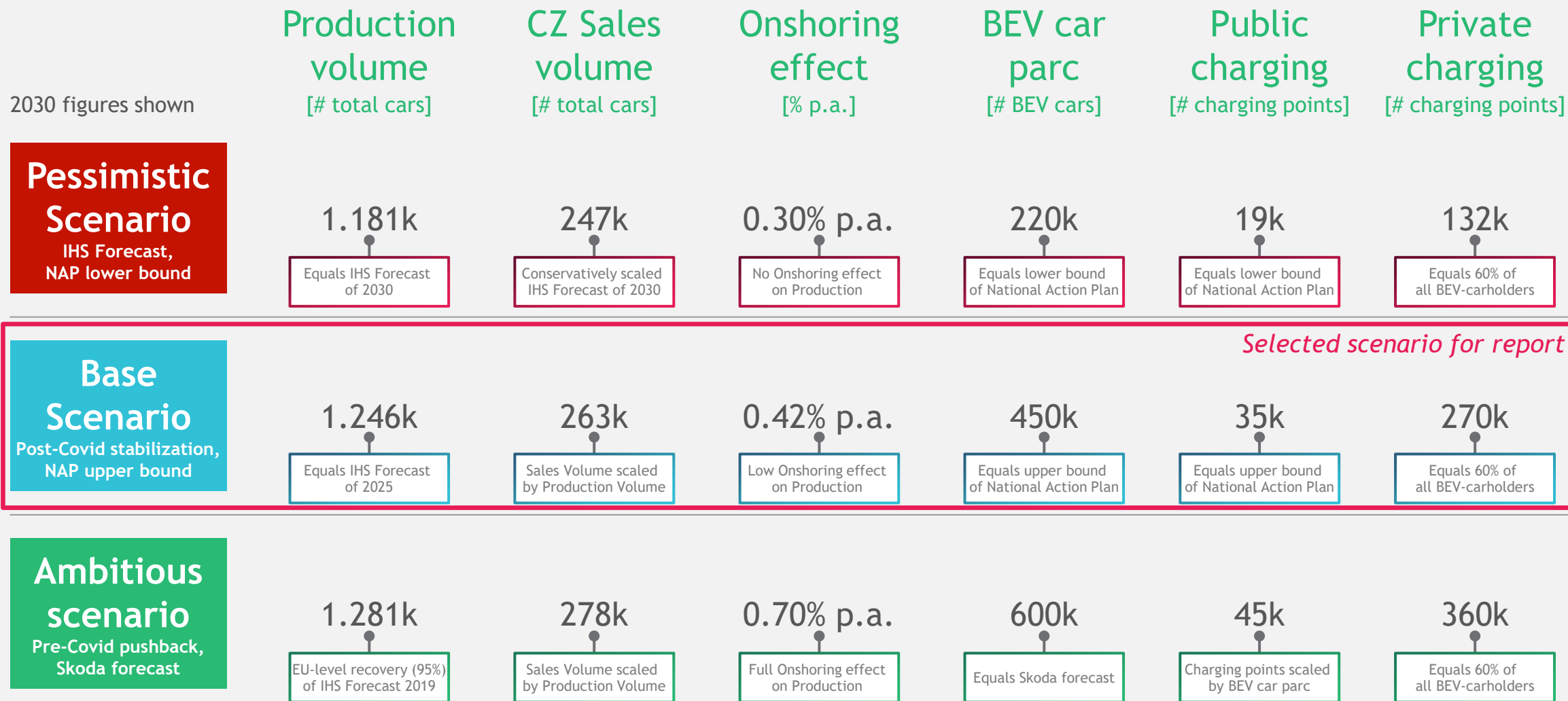
Future onshoring of Czech Automotive jobs during stable automotive sector

Source: Eurostat; BCG

X.X% Year-over-year growth



Three scenarios developed, Base selected



Agenda



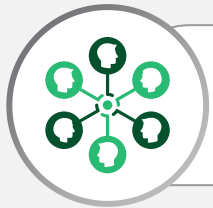
Industry sectors and **job families** primarily affected

1



Major trends influencing job development in Auto industry

2



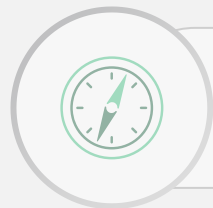
Net impact of job development until 2030

3



Transition over time, across industries, job families, regions

4



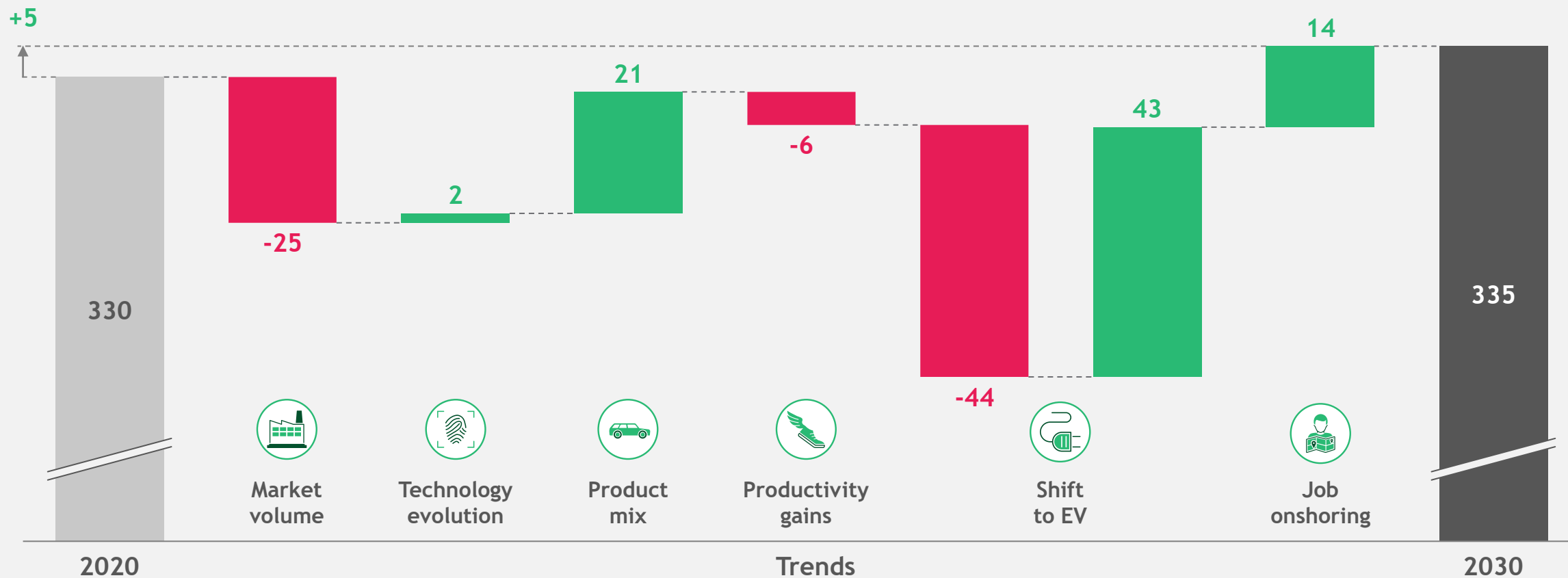
Recommendations for companies and governments

5



Overall positive impact, shift to EV with big transitions

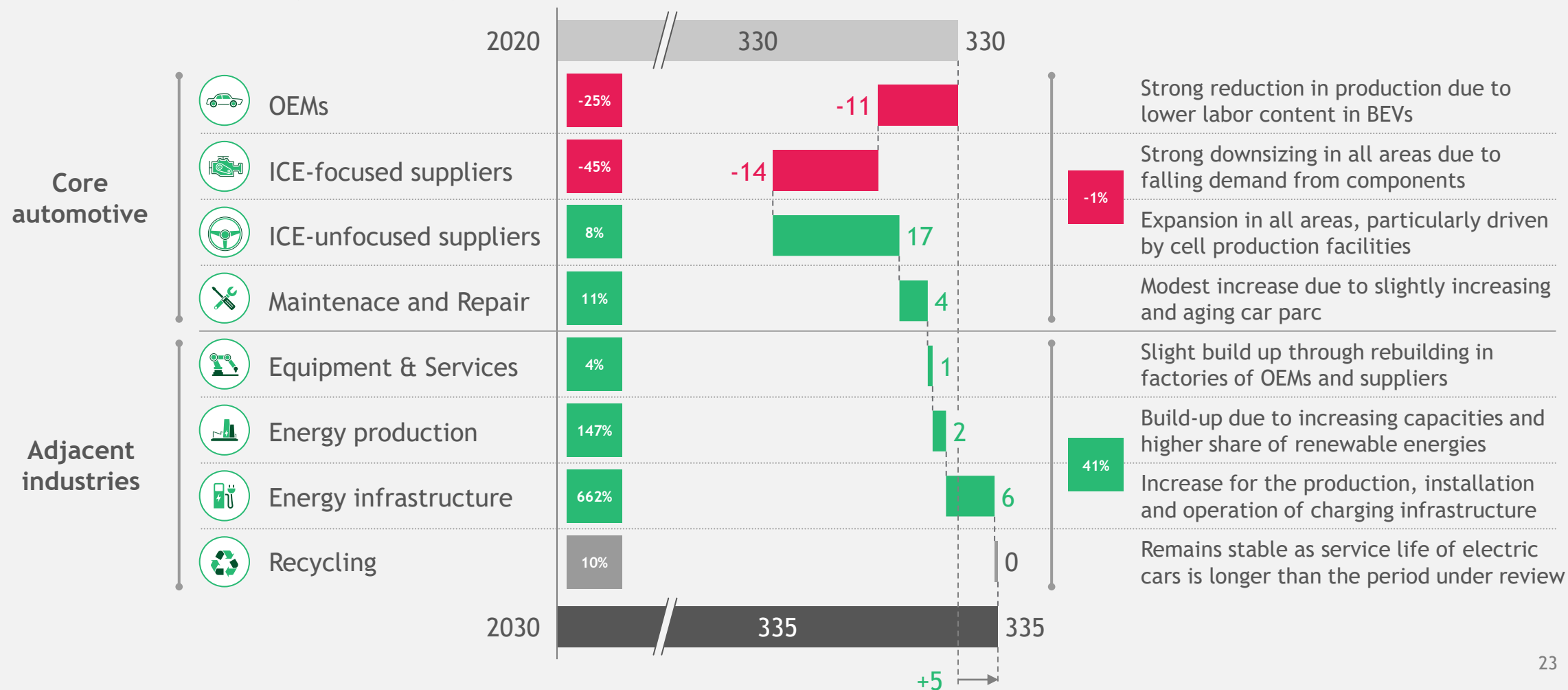
Job losses and job gains (in thousands) due to various trends





Declining development in core, upside in adjacent industry

Job losses and job gains (in thousands) across different industries





Decrease for core and increase for adjacent industries

Absolute number of jobs in 2030 [in k] and relative change to 2019 [in %]

Job category²

Industry cluster¹

	Engineering	Procurement	Production/ Service Ops.	Sales	Other	Total 2030	
Core automotive	OEMs	3 38%	1	20 -34%	2 -30%	6	32 -25%
	ICE-focused suppliers	2 -42%	1	10 -47%	1 -30%	3 -47%	17 -45%
	Non-ICE suppliers	19 27%	6 29%	166 12%	5 -29%	19 -20%	215 8%
	Maintenance & Repair	0	3	32 8%	3	2	40 11%
Adjacent industries	Equipment & Services	2	1 69%	10 6%	1 -30%	1	16 4%
	Energy production	1 181%	0	2 147%	0	0	3 147%
	Energy infrastructure	0	1 1299%	5 633%	0	1	7 662%
	Material recycling	1	1	3	0	0	5
	28 20%	13 30%	248 3%	14 -17%	32 -17%	335 2%	

304 -1%

32 41%

1. Based on 26 industries
 2. Based on 31 jobs families
 Note: Numbers may not sum up due to roundings
 Source: EuroStat; BCG

Total job demand in 2030 [k] — ● — Relative change in job demand ■ Higher demand ■ Lower demand ■ Constant demand 24



Decrease for core and increase for adjacent industries

Absolute number of jobs in 2030 [in k] and relative change to 2019 [in %]

Job category²

Industry cluster ¹		Job category ²					Total 2030	
		Engineering	Procurement	Production/Service Ops.	Sales	Other	Absolute	Relative
Core automotive	OEMs	1 38%	0	-10 -34%	-1 -30%	0	-11	-25%
	ICE-focused suppliers	-1 -42%	0	-9 -47%	-1 -30%	-2 -47%	-14	-45%
	Non-ICE suppliers	4 27%	1 29%	18 12%	-2 -29%	-5 -20%	17	8%
	Maintenance & Repair	0	1	2 8%	1	0	4	11%
Adjacent industries	Equipment & Services	0	0 69%	1 6%	-1 -30%	0	1	4%
	Energy production	0 181%	0	1 147%	0	0	2	147%
	Energy infrastructure	1	1 1299%	4 633%	0	1	6	662%
	Material recycling	0	0	0	0	0	0	
		5 20%	3 30%	7 3%	-3 -17%	-7 -17%	5	2%
							-4	-1%
							9	41%

1. Based on 26 industries
 2. Based on 31 jobs families
 Note: Numbers may not sum up due to roundings
 Source: EuroStat; BCG

Relative job demand in 2030 [k] — — — Higher demand Lower demand Constant demand 25



Decrease for core and increase for adjacent industries

Absolute number of jobs in 2030 [in k] and relative change to 2019 [in %]

Job category²

Industry cluster ¹	Job category ²					Total 2030
	Engineering	Procurement	Production/Service Ops.	Sales	Other	
Core automotive						
OEMs	3 (+1) 38%	1	20 (-10) -34%	2 (-1) -30%	6	32 (-11) -25%
ICE-focused suppliers	2 (-1) -42%	1	10 (-9) -47%	1 (-1) -30%	3 (-2) -47%	17 (-14) -45%
Non-ICE suppliers	19 (+4) 27%	6 (+1) 29%	166 (+18) 12%	5 (-2) -29%	19 (-5) -20%	215 (+17) 8%
Maintenance & Repair	0	3	32 (+2) 8%	3	2	40 (+4) 11%
Adjacent industries						
Equipment & Services	2	1 (+0) 69%	10 (+1) 6%	1 (-1) -30%	1	16 (+1) 4%
Energy production	1 (+0) 181%	0	2 (+1) 147%	0	0	3 (+2) 147%
Energy infrastructure	0	1 (+1) 1299%	5 (+4) 633%	0	1	7 (+6) 662%
Material recycling	1	1	3	0	0	5
Total	28 (+5) 20%	13 (+3) 30%	248 (+7) 3%	14 (-3) -17%	32 (-7) -17%	335 (+5) 2%

304 (-4) -1%

32 (+9) 41%

1. Based on 26 industries

2. Based on 31 jobs families

Total (relative) job demand in 2030 [k] — Relative change in job demand

Higher demand Lower demand Constant demand

Note: Numbers may not sum up due to roundings

Source: EuroStat; BCG



Deep dives across the 8 industry clusters



OEMs



ICE-focused Suppliers



Non-ICE Suppliers



Maintenance & Repair



Equipment & Services



Energy production

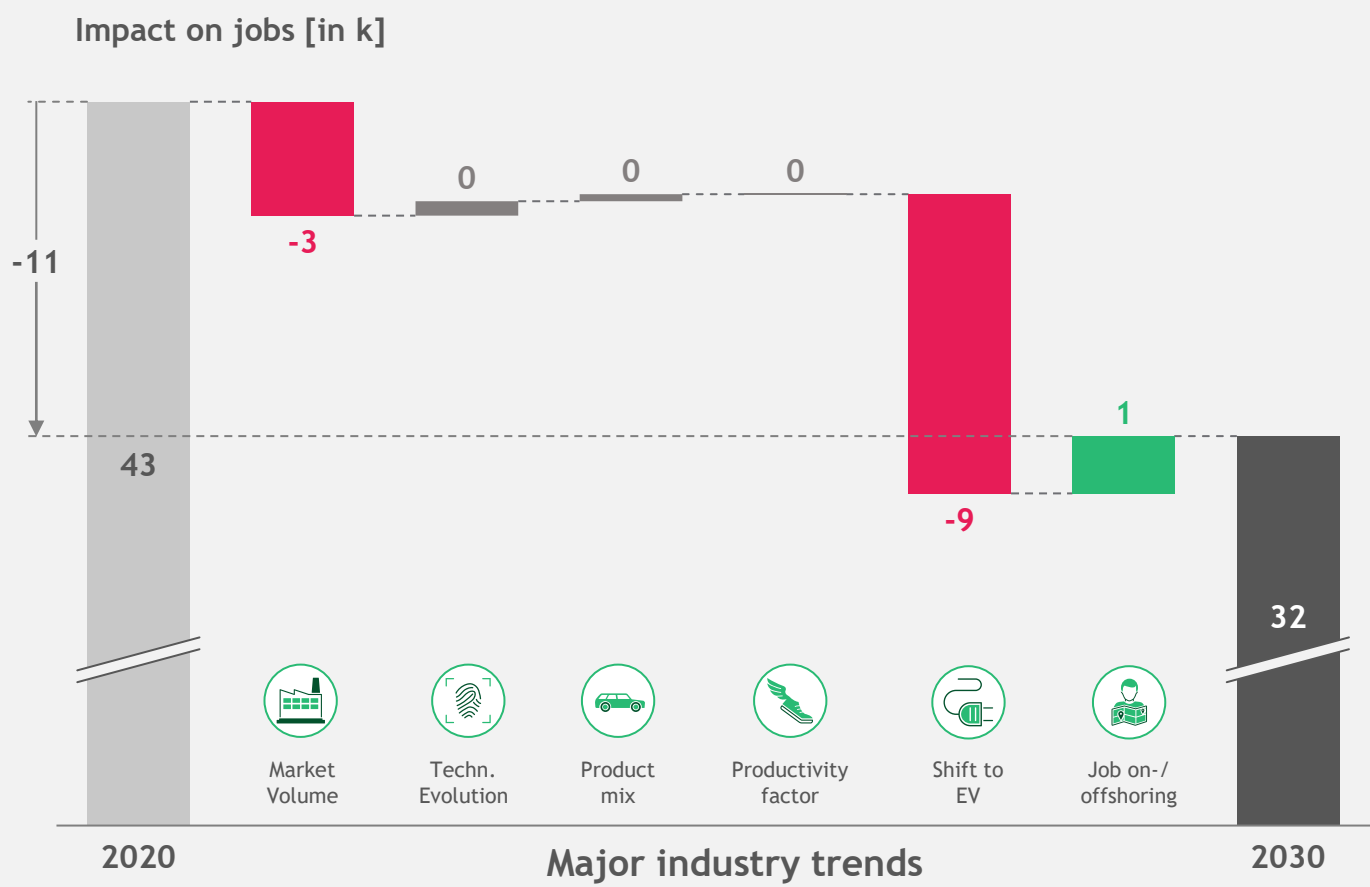








Energy infrastructure



Material recycling

OEMs with negative impact by volume and EV-Shift

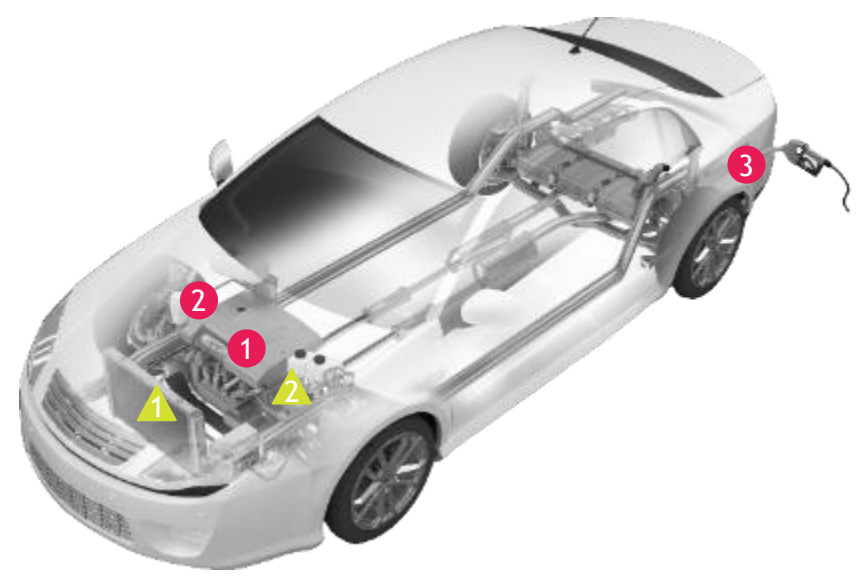



-  **-3k** jobs lost based on a decreased production volume from '20 to '30'
-  Insignificant impact on jobs driven by the increased software technology in the car
-  Stable job demand through constant vehicle portfolio
-  Insignificant impact through productivity
-  **-9k** jobs lost through shift to EV driven by reduced labor hours in engine production
-  **1k** jobs gained by job onshoring from other European countries


Note: Numbers may not sum up due to roundings
Source: BCG

Powertrain & power electronics main differentiators between BEV and ICE

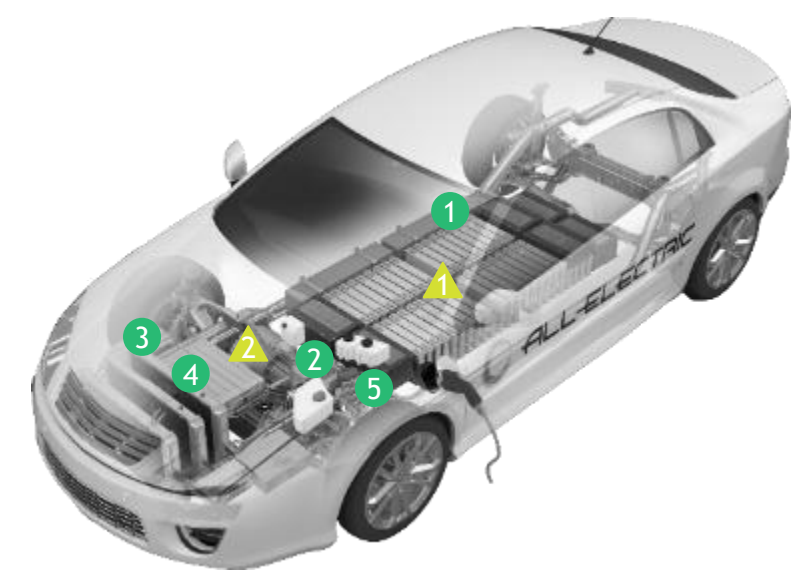
Internal combustion engine vehicle (ICE)



-  **Powertrain**
- ❶ Internal combustion engine
 - ❷ Alternator & starter
 - ❸ Fuel & exhaust system
 - Ⓛ Traction battery pack
 - Ⓜ Electric traction motor
 - ⚠ Cooling system
 - ⚠ Gearbox

-  **(Power) electronics**
- Ⓝ DC/DC & DC/AC converters
 - Ⓓ Power electronics controller
 - Ⓟ High voltage wiring

Battery electric vehicle (BEV)

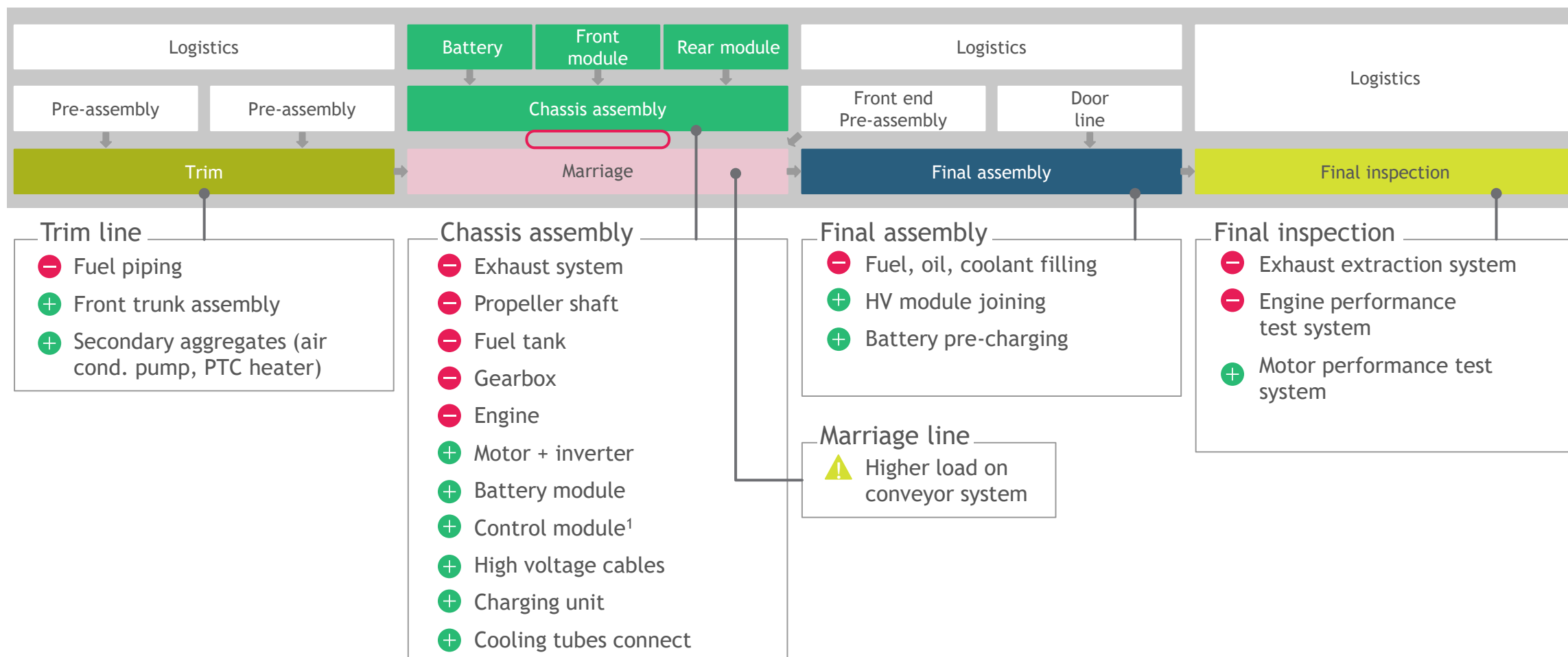


Legend: Ⓛ New component/system in BEV vs ICE ❸ Omitted component/system in BEV vs ICE ⚠ Changed component/system

1. Changes in case of native BEV or xEV platform; not applicable in case of mixed ICE/BEV platform
 Source: BCG

Many changes in vehicle assembly - effort for BEV & ICE similar

Vehicle assembly & final inspection of automotive OEM (BEV only)



1. Control module mostly integrated in battery

Source: BCG

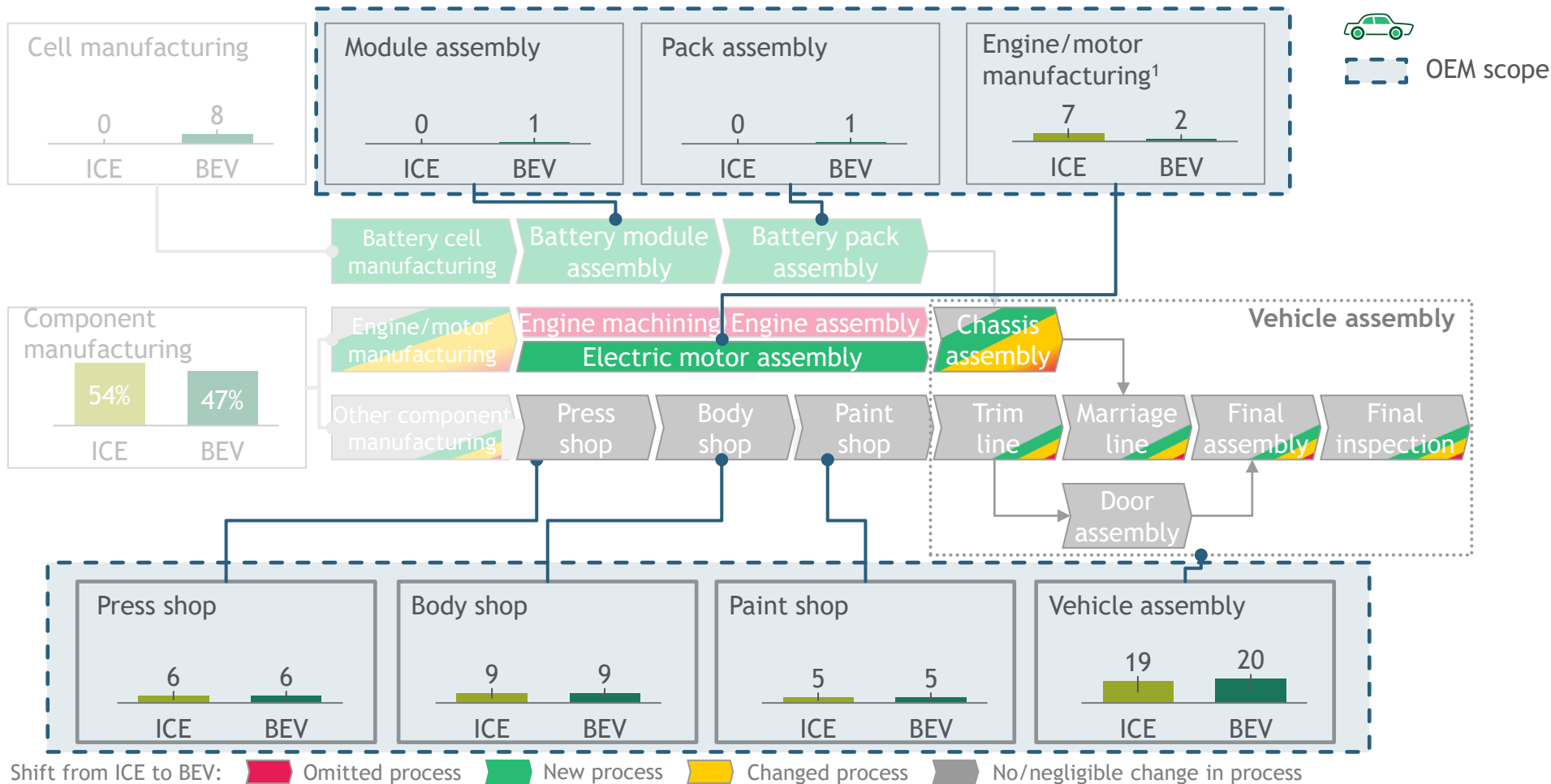
Legend: + New component/system in BEV vs ICE

- Omitted component/system in BEV vs ICE

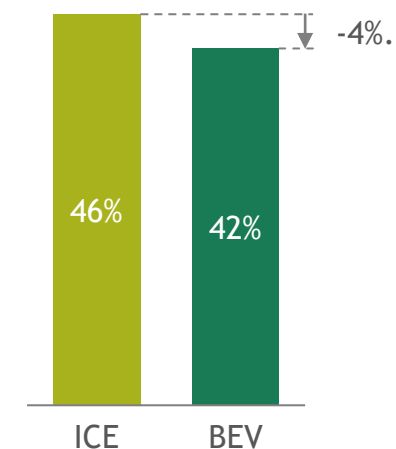
⚠ Changed component/system

Shift to EV: OEM labor requirements for BEVs and ICEs decrease by 4pp

Labor hours per vehicle as a share of ICE (%)



Total labor hours per vehicle as a share of ICE (%)



Number not to be directly linked to study results as multiple effects have been considered.

1. Engine/motor manufacturing including transmission assembly

Note: The reference vehicle for this analysis is a D-segment premium passenger car with one electric motor and an advanced driver-assistance system.

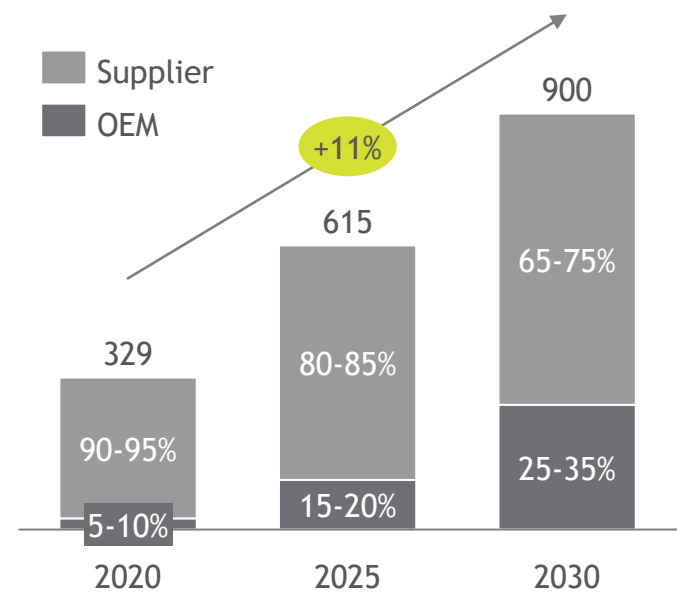
Marriage is the joining of body sections, chassis, and powertrain

Source: BCG

Technology Evolution: Emerging job categories like software engineers

Software content in car increases...

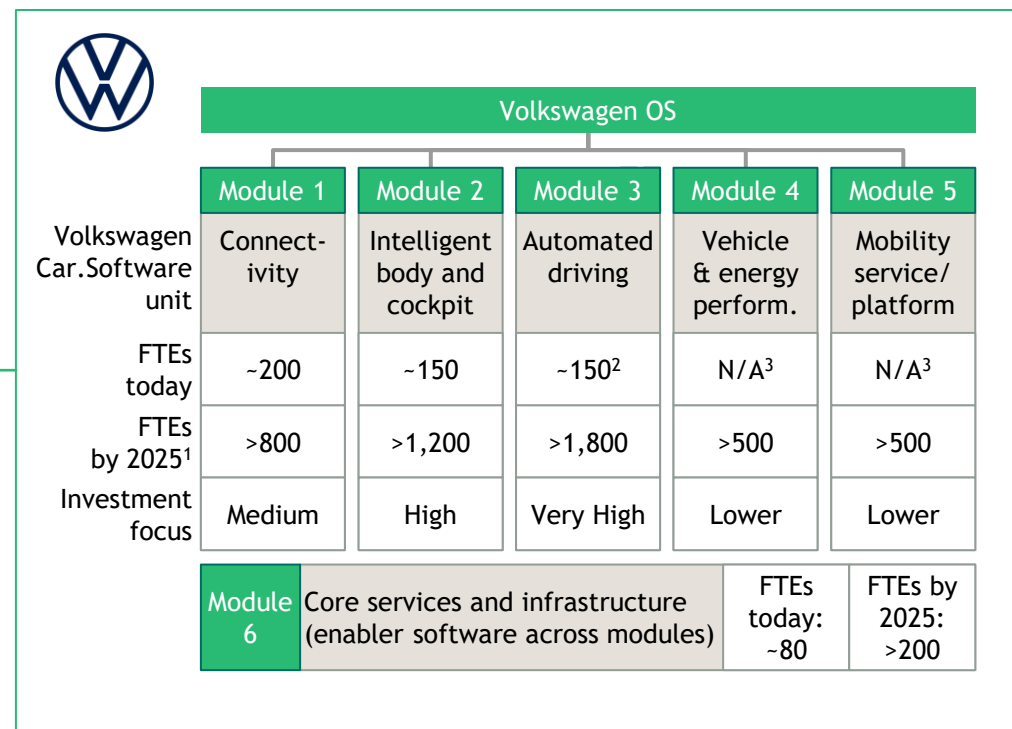
Estimated SW cost per vehicle [in \$]



... and OEMs react with SW engineer recruiting - example VW

5-10K FTE

Software engineers in Volkswagen's Car.Software unit by 2025



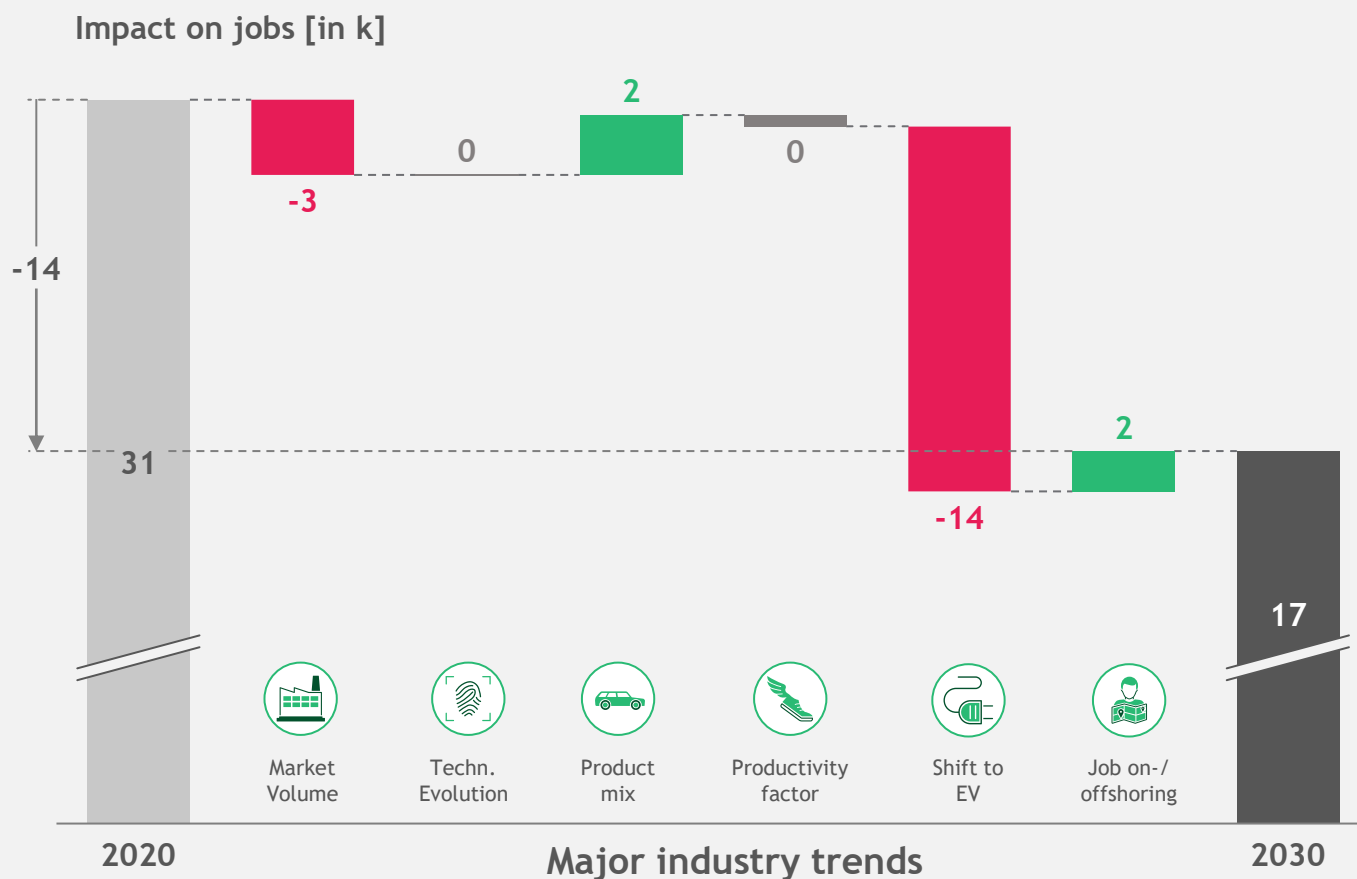
1. Including human resources from close software partnerships 2. Driver assistant teams (e.g., lane assist, cruise control) not yet integrated

3. Not part of the car

Source: Industry reports; Company announcements; Expert interviews; BCG



ICE-focused suppliers with significant negative impact



-3k jobs lost based on a decreased production volume from '20 to '30'



Insignificant impact of new technologies developments for ICE-focused components



2k job increase explained by rising vehicle complexity



Insignificant impact through productivity



-14k major jobs lost through shift to EV driven by reduced demand for ICE-related components



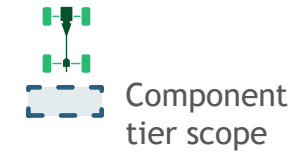
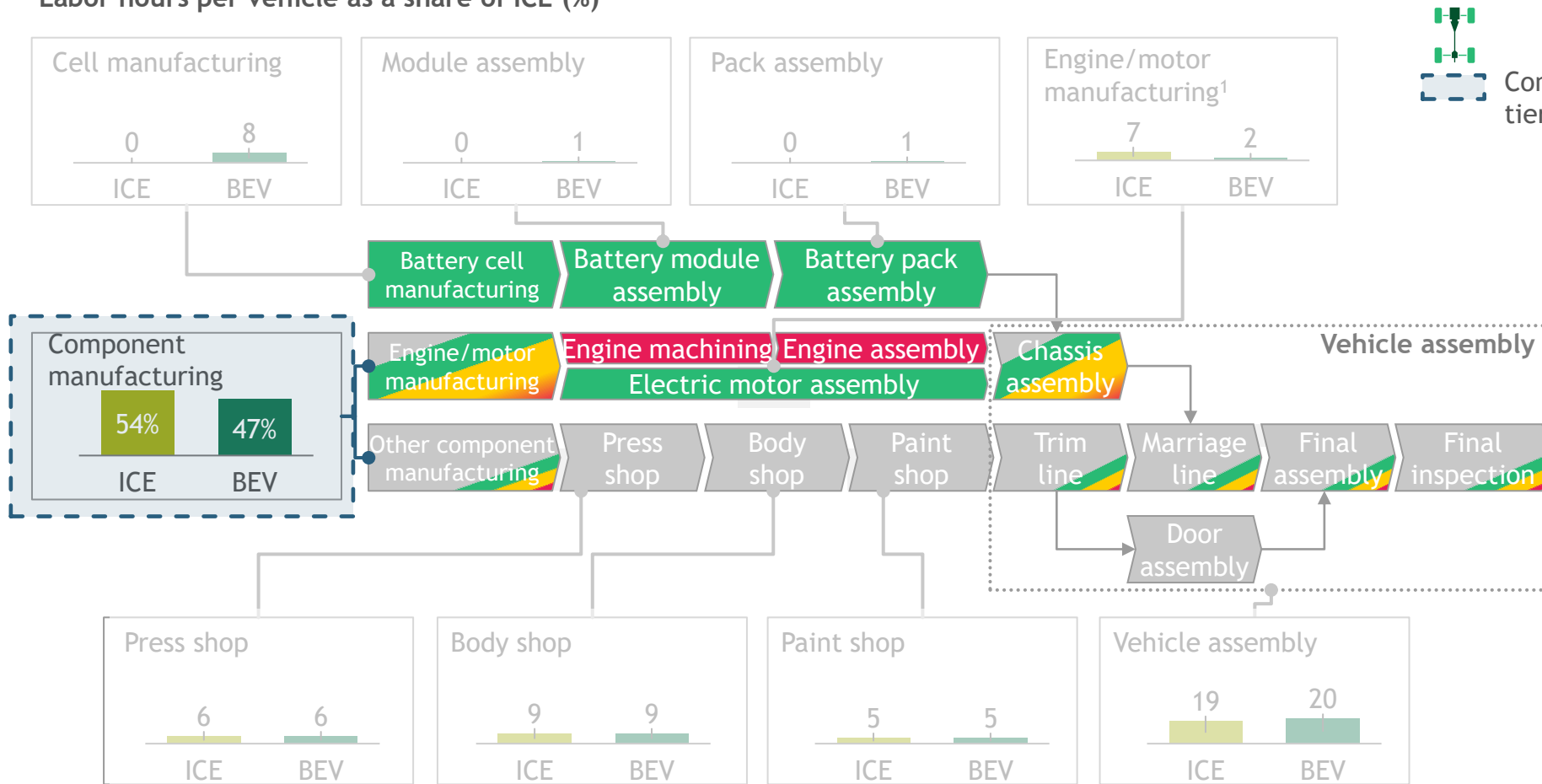
2k jobs gained by job onshoring from other European countries

Note: Numbers may not sum up due to roundings
Source: BCG

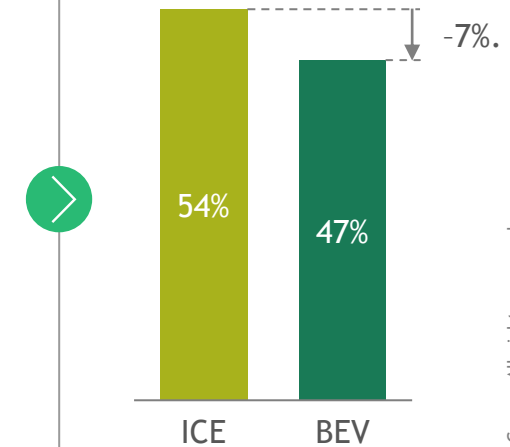


Shift to EV: Component labor requirements for BEVs and ICEs decrease by 7pp

Labor hours per vehicle as a share of ICE (%)



Total labor hours per vehicle as a share of ICE (%)



Number not to be directly linked to study results as multiple effects have been considered.

1. Engine/motor manufacturing including transmission assembly

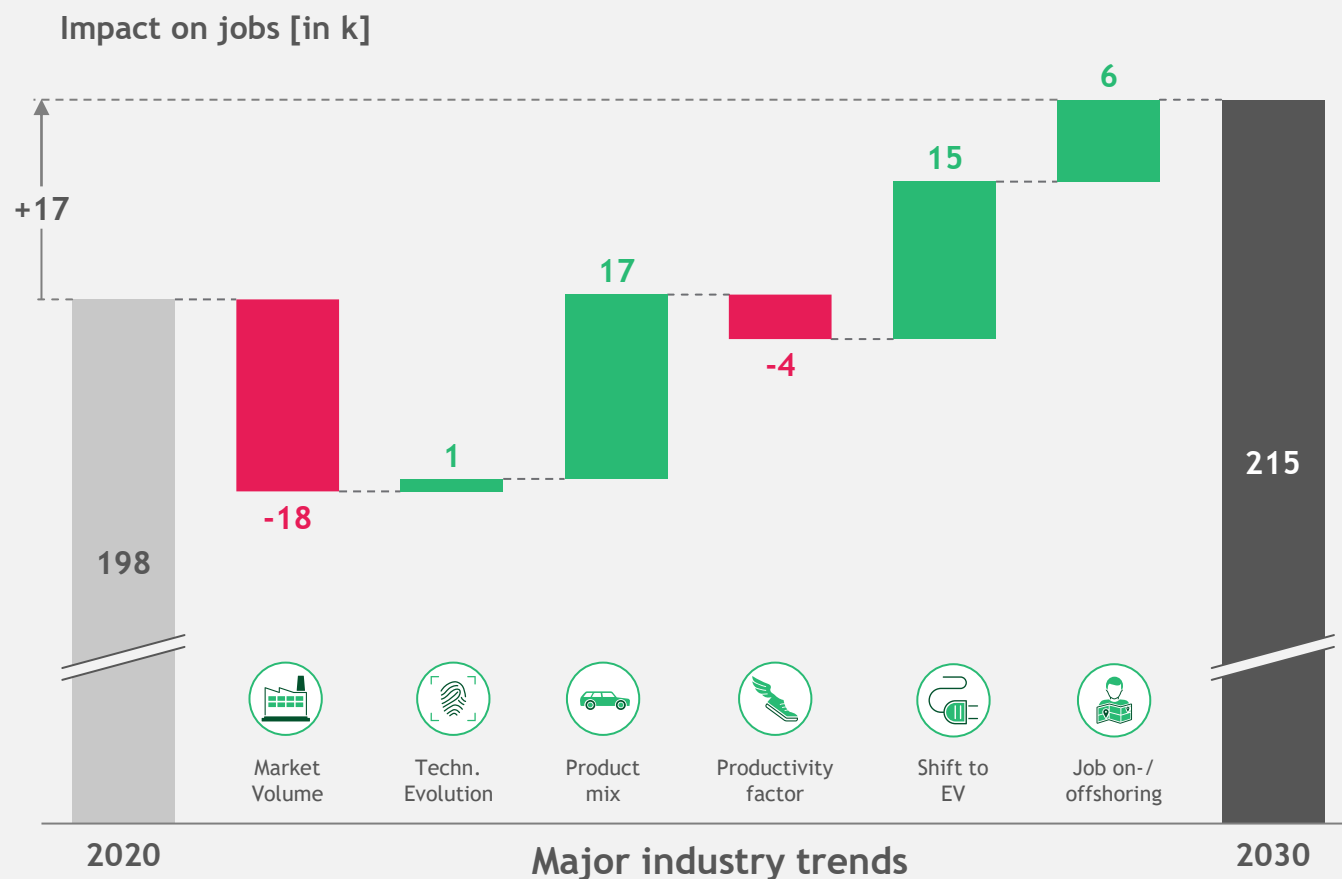
Note: The reference vehicle for this analysis is a D-segment premium passenger car with one electric motor and an advanced driver-assistance system.

Marriage is the joining of body sections, chassis, and powertrain.

Source: BCG



Non-ICE suppliers with slightly net-negative impact



-18k jobs lost based on a decreased production volume from '20 to '30'



1k additional jobs mainly driven by electrical & electronics software extents



17k job increase explained by the rising vehicle portfolio and the linked vehicle complexity



-4k job reduction based on overall increase in productivity and efficiency



15k job increase driven by battery manufacturing and electric motors

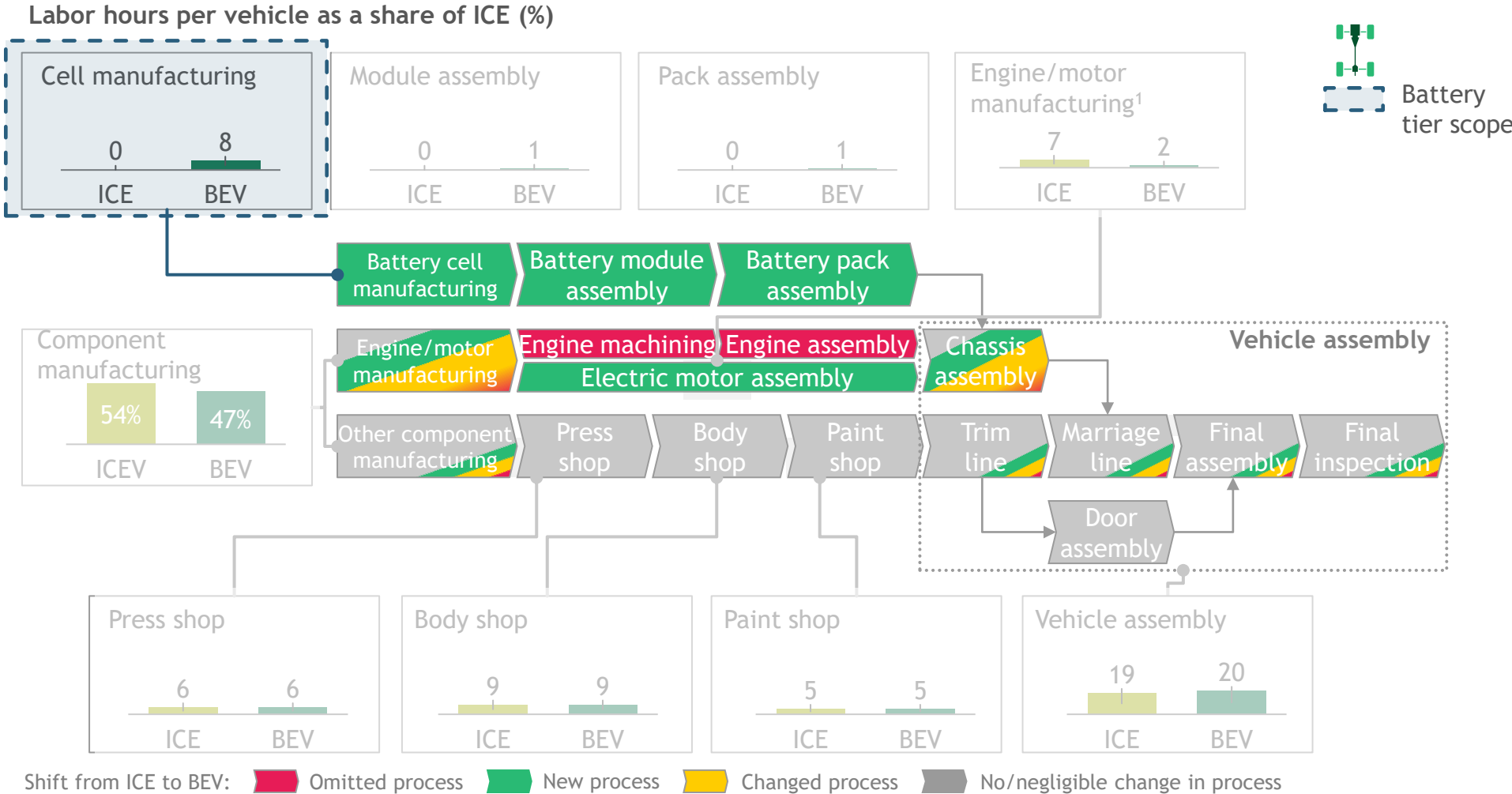


6k jobs gained by job onshoring from other European countries

Note: Numbers may not sum up due to roundings
Source: BCG

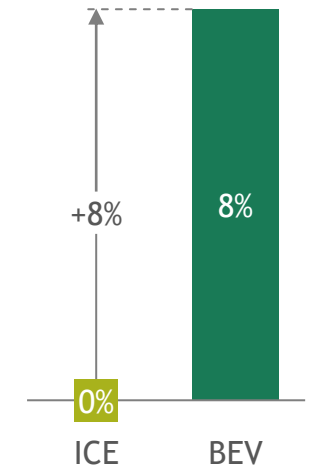


Shift to EV: Battery tier labor requirements for BEVs and ICEs increase by 8%



Total labor hours per vehicle as a share of ICE (%)

Share expected to decrease over next years due to economies of scale.



Number not to be directly linked to study results as multiple effects have been considered.

1. Engine/motor manufacturing including transmission assembly

Note: The reference vehicle for this analysis is a D-segment premium passenger car with one electric motor and an advanced driver-assistance system.

Marriage is the joining of body sections, chassis, and powertrain.

Source: BCG



Maintenance & Repair with stable employment



- 4k** new jobs created based on an increased car parc until 2030
- Insignificant impact of new technologies developments for maintenance & repair
- Insignificant impact by the product mix explained by the small change in the overall car parc
- Minor job reduction based on productivity
- 1k** jobs lost through shift to EV driven by reduced labor hours in battery vehicle maintenance and repair
- 1k** jobs gained by job onshoring from other European countries

Note: Numbers may not sum up due to roundings
Source: BCG



Shift to EV: Decline in repair shop employees by increased e-mobility



Area of focus for Maintenance & Repair		ICE	PHEV	HEV	BEV
Maintenance	Oil change	✓	✓	✓	✗
	Cooling liquids	✓	✓	✓	✗
	Sparking plugs	✓	✓	✓	✗
	Air filter change	✓	✓	✓	✗
	Toothed belt	✓	✓	✓	✗
	Fuel filters	✓	✓	✓	✗
	Break fluid	✓	✓	✓	✓
	Power electronics	✗	✓	✓	✓
	Battery cooling	✗	✓	✓	✓
	Brake pad	✓	✓	✓	✓
Repair	Exhaust system	✓	✓	✓	✗
	Clutch	✓	✗	✗	✗
	Average effort per vehicle compared to ICE	100%	-6% (~94%)	-10% (~90%)	-15% (~85%)

Key Takeaways:

Propulsion type determines the average effort per vehicle

Reduce break wear down crucial for diff. between ICE & HEV/PHEV

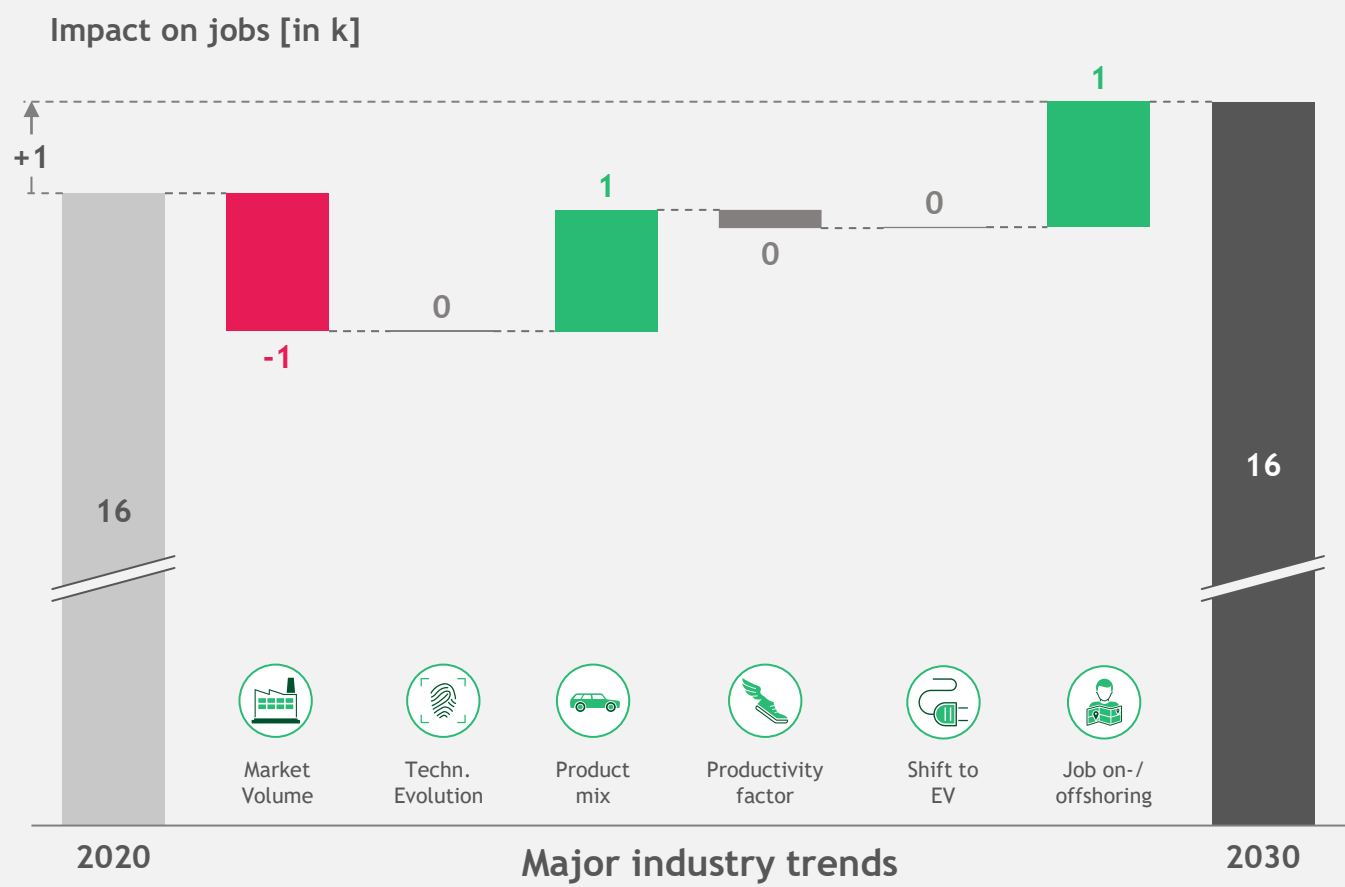
BEV with reduced and changed scope compared to ICE


Numbers not to be directly linked to study results as multiple effects have been considered.


✓ Existent
 ✓ Less complex/wear down
 ✗ Non-Existent





Equipment & Services slightly negative until 2030





-  **-1k** jobs lost based on a decreased production volume from '20 to '30'

-  Insignificant impact of new technologies developments for equipment and services

-  **1k** job increase explained by the rising vehicle complexity

-  Insignificant impact based on overall increase in productivity

-  No job loss or gain through shift to EV

-  **1k** jobs gained by job onshoring from other European countries

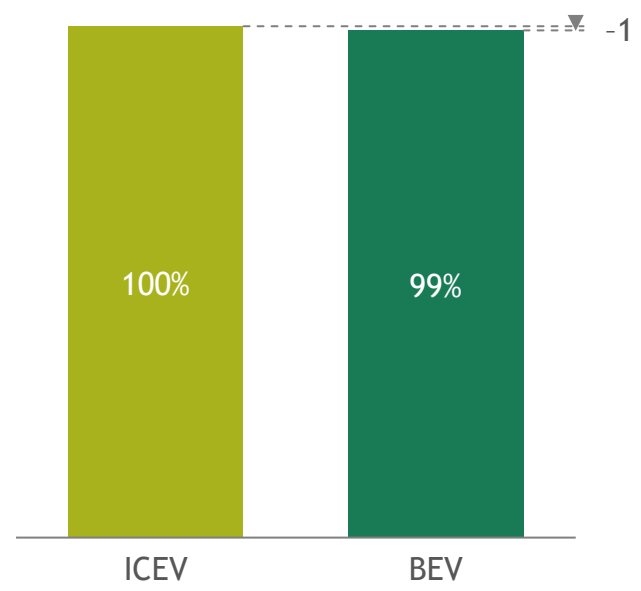
Note: Numbers may not sum up due to roundings
Source: BCG



Shift to EV: Limited impact on demand for equipment and services sector

Total labor requirements for BEVs and ICEs are comparable

Total labor hours per vehicle as a share of ICE (%)



Automotive automation level already high, remaining barriers similar for BEVs and ICEs

Average automation level in automotive production (%)



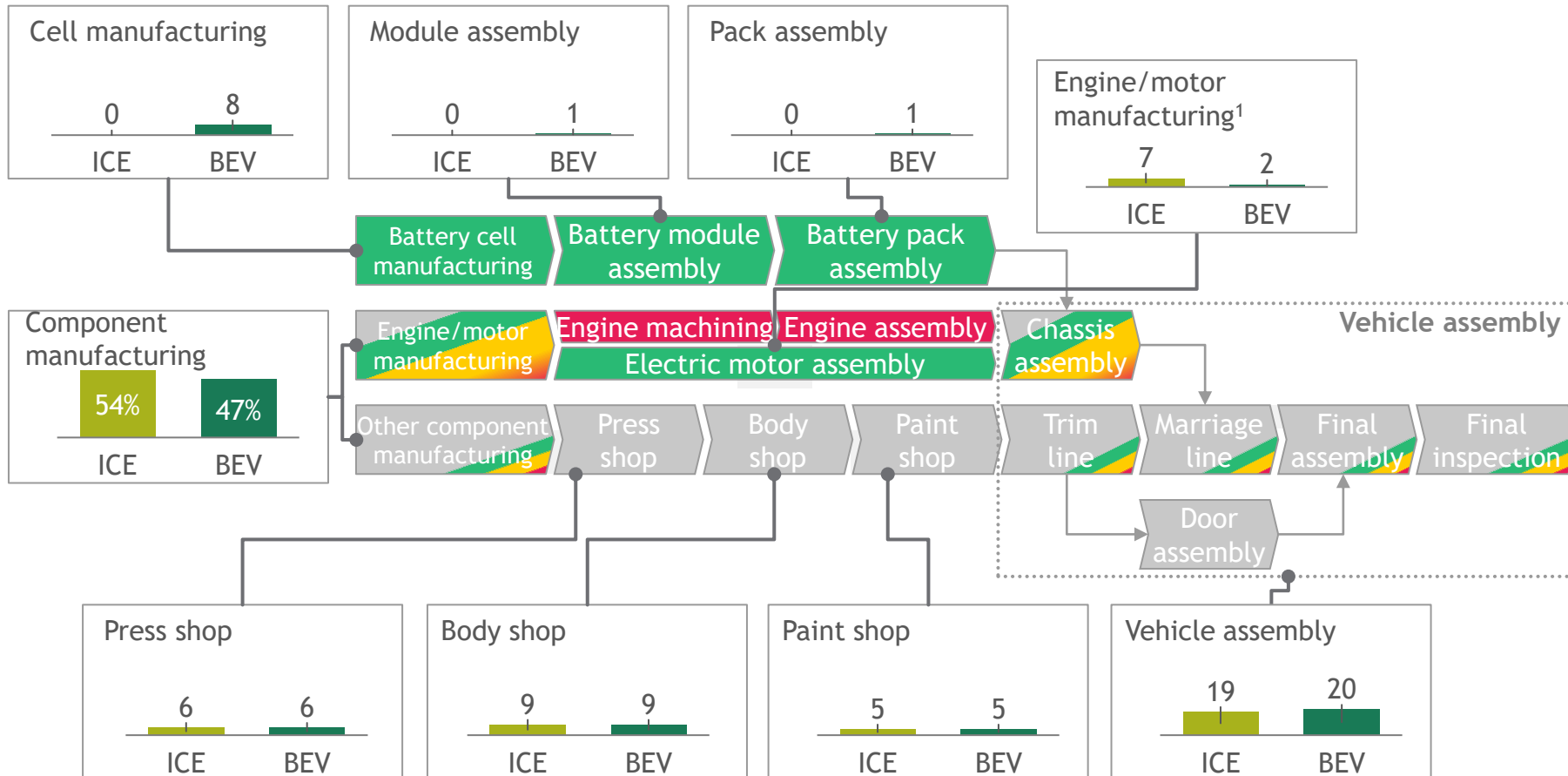
- Press shop, body shop and paint shop already with very high automation levels and limited potential for further advancements
- Assembly process still mainly manual
- Recent trials to further push assembly automation (e.g., Tesla) have all failed due to very low reliability of automated processes
- Progress in upcoming years expected, but automation barriers in assembly (e.g., flexible components) similar between BEVs and ICEs

Note: The reference vehicle for this analysis is a D-segment premium passenger car with one electric motor and an advanced driver-assistance system. Marriage is the joining of body sections, chassis, and powertrain.
Source: BCG



Shift to EV: Total labor requirements for BEVs and ICEs are similar

Labor hours per vehicle as a share of ICE (%)



Shift from ICE to BEV: ■ Omitted process ■ New process ■ Changed process ■ No/negligible change in process

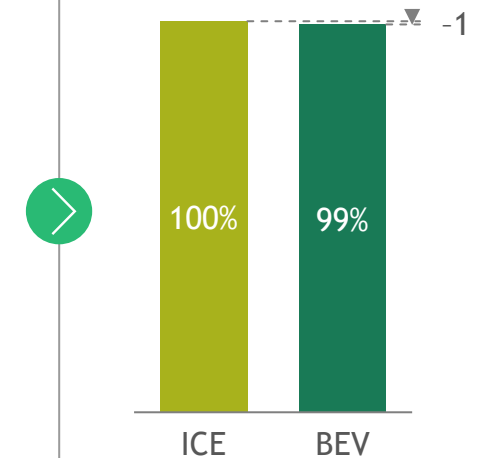
1. Engine/motor manufacturing including transmission assembly

Note: The reference vehicle for this analysis is a D-segment premium passenger car with one electric motor and an advanced driver-assistance system.

Marriage is the joining of body sections, chassis, and powertrain.

Source: BCG

Total labor hours per vehicle as a share of ICE (%)



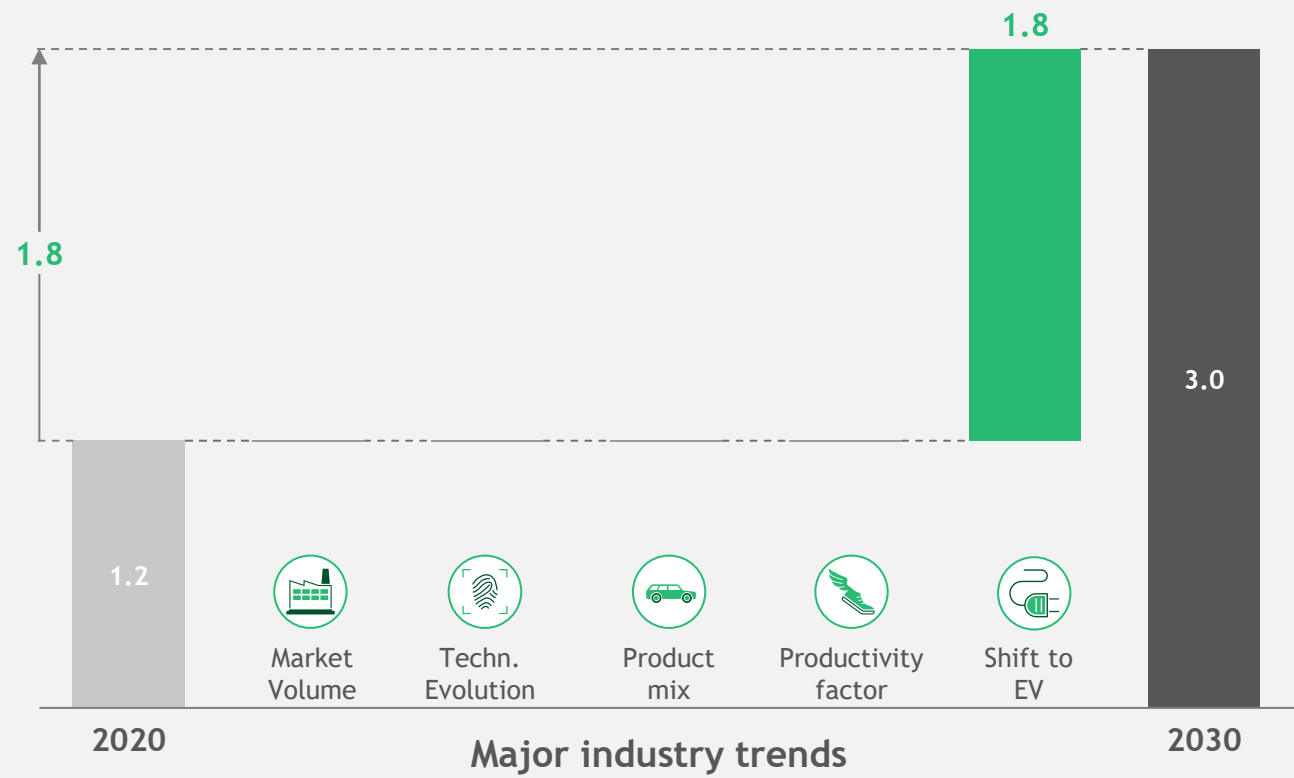
Number not to be directly linked to study results as multiple effects have been considered.



Significant relative increase for energy production



Impact on jobs [in k]



Minimal impact by overall market volume development - shift between propulsion systems is the main driver



Technology evolution in the car with no impact on energy production



Product mix (content per car) has no impact on energy production



Insignificant job reduction based on productivity



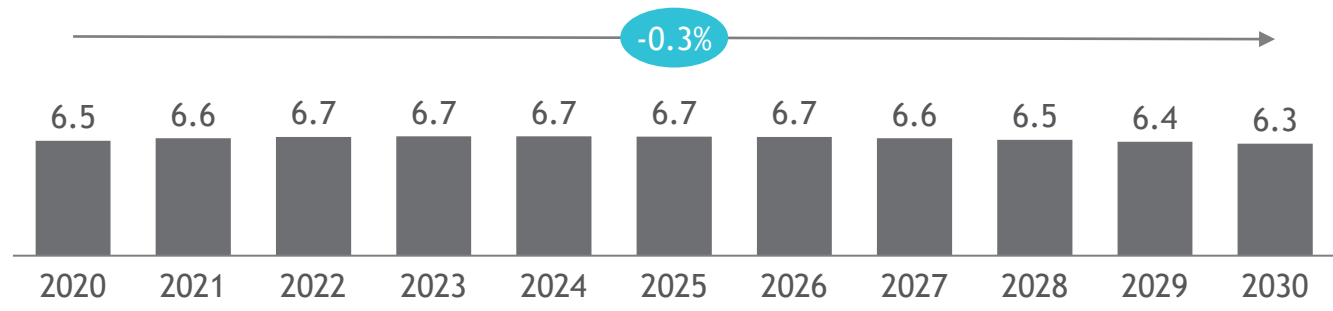
2k jobs gained by job onshoring from other European countries

Note: Numbers may not sum up due to roundings
Source: BCG

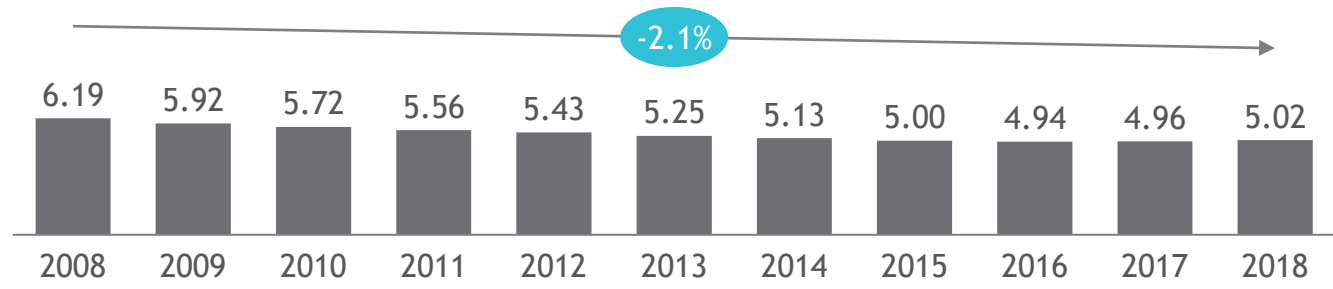


Decrease in fuel consumption driven by three effects

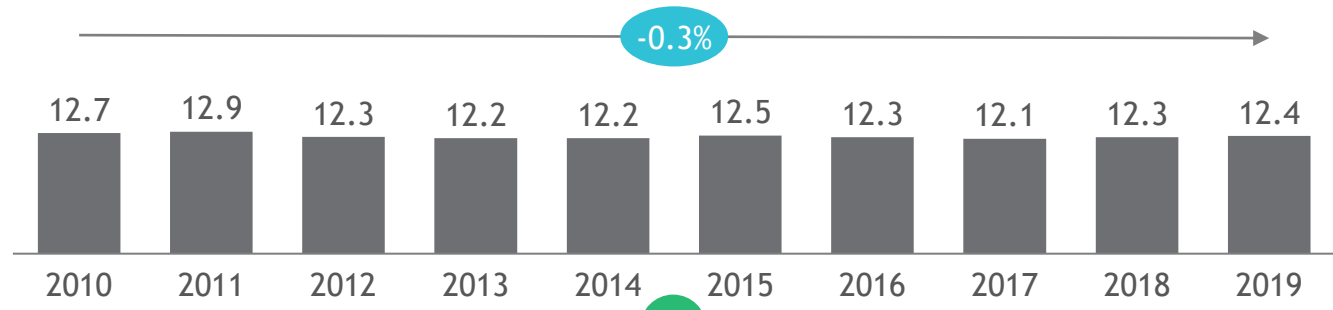
ICE car parc
[M cars]



Average fuel consumption¹
[l/100km]



Average travelling distance per year / car
[1000 km]



~43% of capacity can be shifted towards other products, remainder leads to a job decrease of 1.5% per year (CAGR)

Legend: X.X% Year-over-year growth

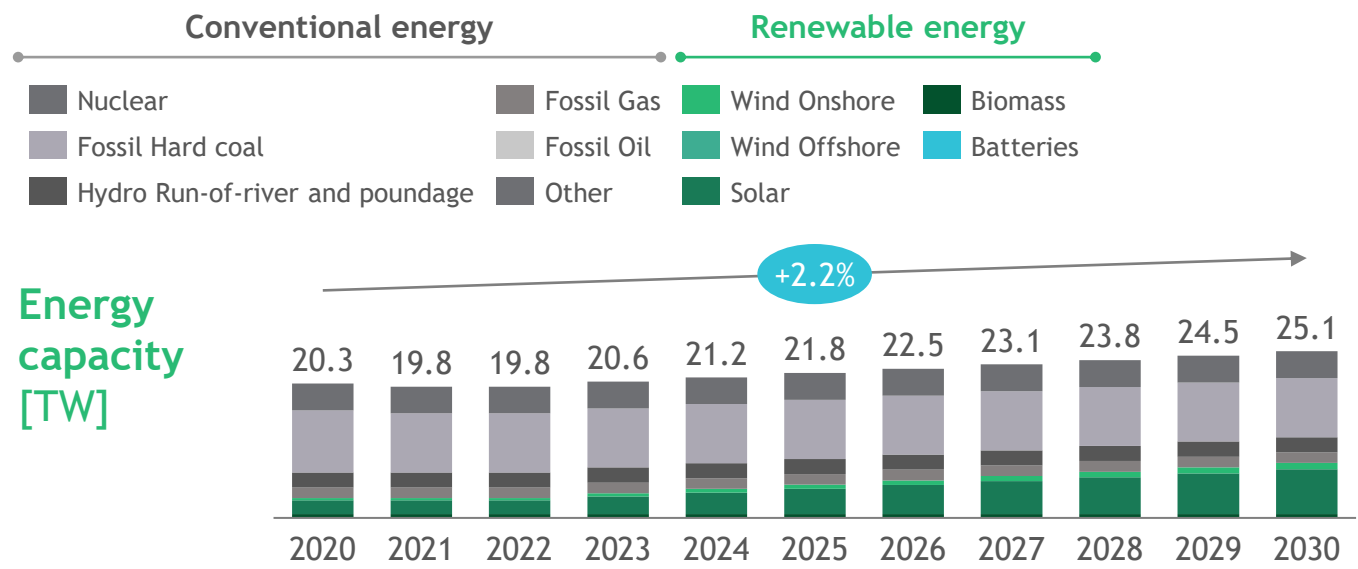
1. Based on EU data
Source: BCG

1.5%
y-o-y

Decrease in ICE related employment in Energy production

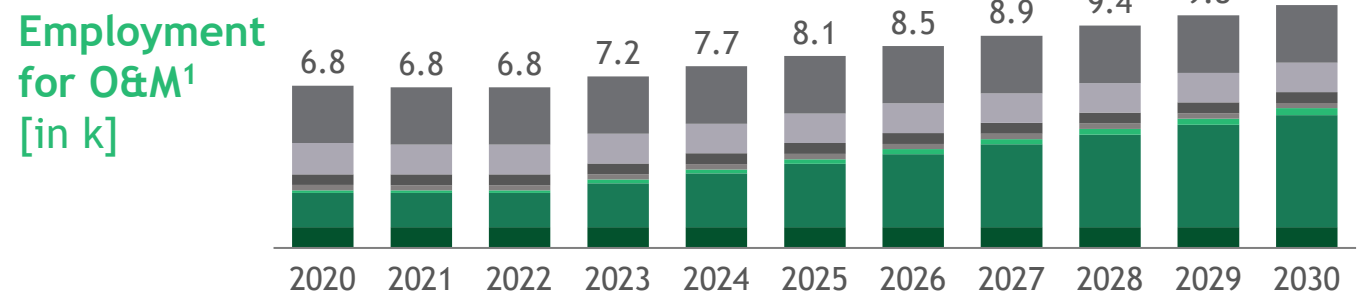


Renewable energy switch strongly increases O&M¹ jobs



Energy capacity [TW]

Steady increase in share of renewable capacity



Employment for O&M¹ [in k]

Huge increase in O&M employment for on-/offshore wind, solar and biomass

2.2%
y-o-y

Increase in total energy capacity

4.1%
y-o-y

Increase in O&M employment for energy production

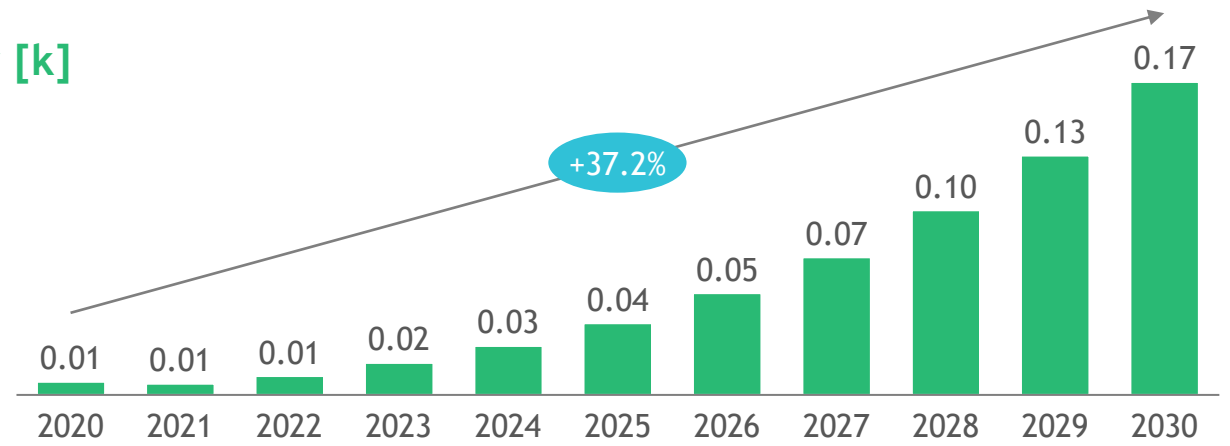
1. Operations & Maintenance
Source: BCG

Legend: X.X% Year-over-year growth



EV energy production jobs will continuously increase

O&M¹
employment
for EV
energy [k]



Massive growth of EV related energy production jobs

38%
y-o-y

Increase in EV related employment in Energy production

EV energy share	0,10%	0,08%	0,15%	0,23%	0,34%	0,47%	0,63%	0,82%	1,04%	1,29%	1,62%
BEV car park [k]	13	22	39	60	89	124	165	216	274	341	416



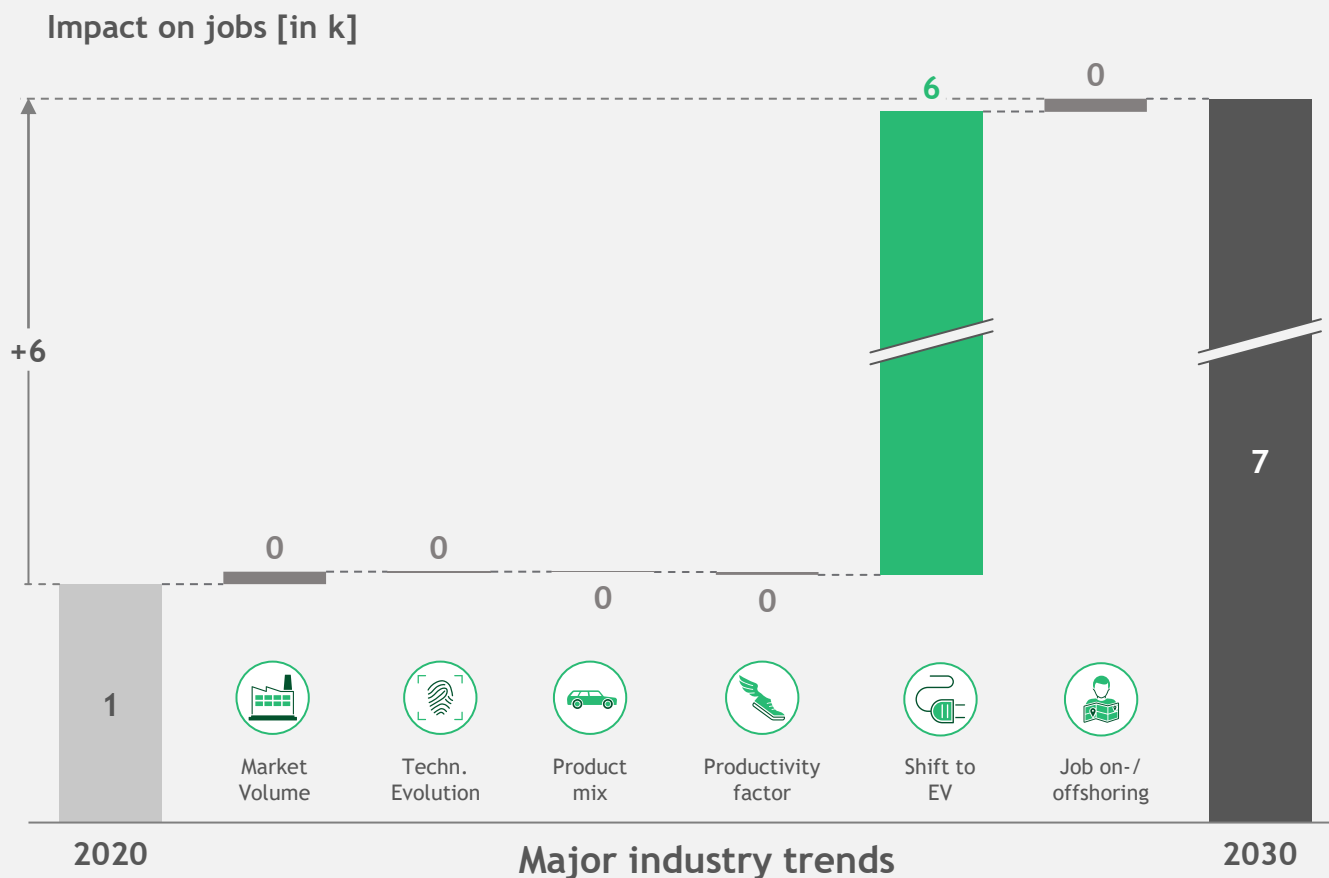
Based on share of energy consumption for EVs, employment increases **49% per year (CAGR)**

1. Operations & Maintenance
Source: BCG

Legend: X.X% Year-over-year growth



Charging infrastructure causes strong job growth



Minimal impact by overall market volume development - shift between propulsion systems is the main driver



Technology evolution in the car with no impact on charging infrastructure



Product mix (content per car) has no impact on charging infrastructure



Small job reduction based on productivity in fuel infrastructure



6k job increase by shift to EV due to rising charging infrastructure need for BEV



Insignificant jobs gained by job onshoring from other European countries

Note: Numbers may not sum up due to roundings
Source: BCG



Up to 17.5k public charging stations by 2030

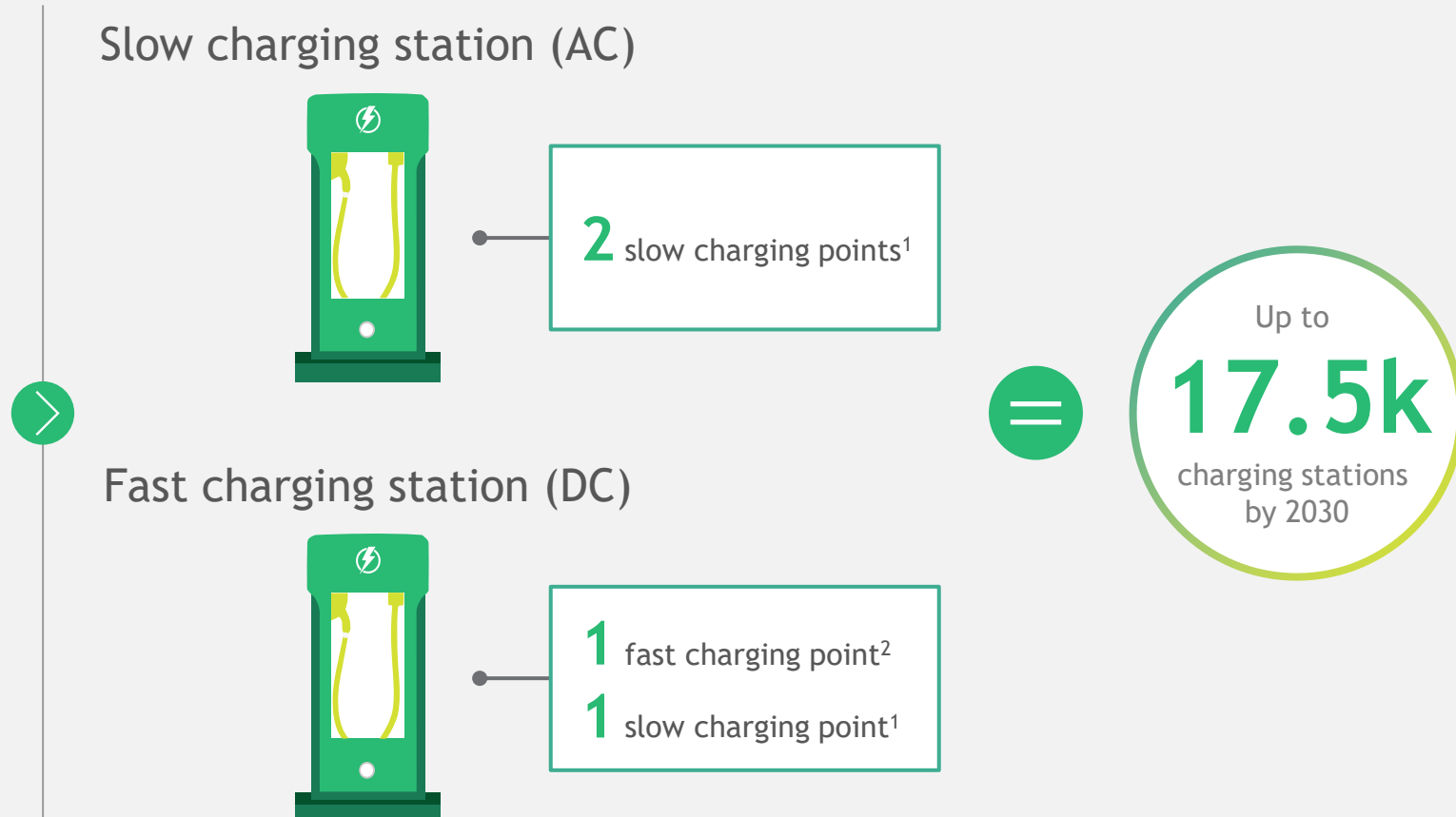
Political ambitious on charging stations ...

... are defining total number of public slow and fast charging stations

National Action Plan outlines development for BEV and charging station development

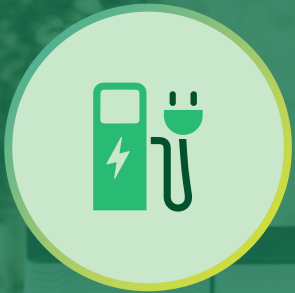
Projects 19-35k public charging points by 2030

Two cars can be charged individually per AC- or DC-charging station, respectively



1. Power of <22kWh 2. Power of >22kWh

Source: Czech National Action Plan for Clean Mobility (NAP CM), Czech Ministry of Transport, Expert Interviews



Cross-check shows that upper limit of NAP CM is rather a base case scenario

	Reference	EVs/charging point ratio	Comment
0	Base Scenario in this study	17.7 ¹	Selected
1	Current global conversion factor	20.0	Conservative
2	International Energy Agency push scenario	10.0	Aggressive
3	European Union target	12.0	Ambitious
4	Current assessment of the Czech Republic	29.7	Non-competitive
5	Netherlands as a reference	4.5	Way too ambitious
6	Norway as a reference	25.1	Different strategy
7	Upper limit of Czech National Action Plan	20.0	Conservative
8	Company Assessment of Skoda	10.0	Aggressive
9	Germany as a reference	13.0	Realistic-ambitious

Lower ratio means higher number of charging points

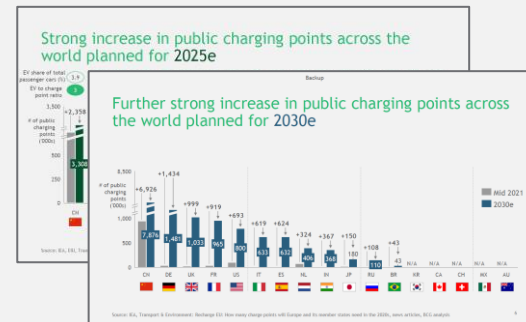
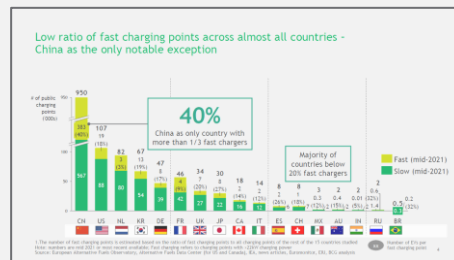
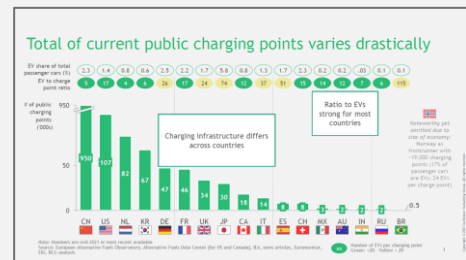
1. Base scenario implicates ~620k EVs by 2030 (BEV and PHEV combined)
Source: BCG Analysis



Case-overarching knowledge assessed, global input

EV to Charging Point conversion factor = 20:1. A ratio of 20 EVs per at least one public charging point is assumed when estimating the required number of charging points based on the number of EVs. The International Energy Agency recommended 10:1, which is aggressive and only partly practical. The EU proposed to increase the ratio to 12:1 in July 2021.

Station to Charging Point conversion factor = 1:1.8. For 2 countries (Brazil and Russia) only data on Station level was available. In such cases, a Station to Charging Point conversion factor of 1.8 is conservatively assumed based on BCG experience, i.e., a Station has 1.8 Charging Points on average.



EV/Charger-ratios

1
20:1
Current global average¹

2
10:1
International Energy Agency

3
12:1
European Union

1. Considering countries with EVs in focus
Source: Market Assessment

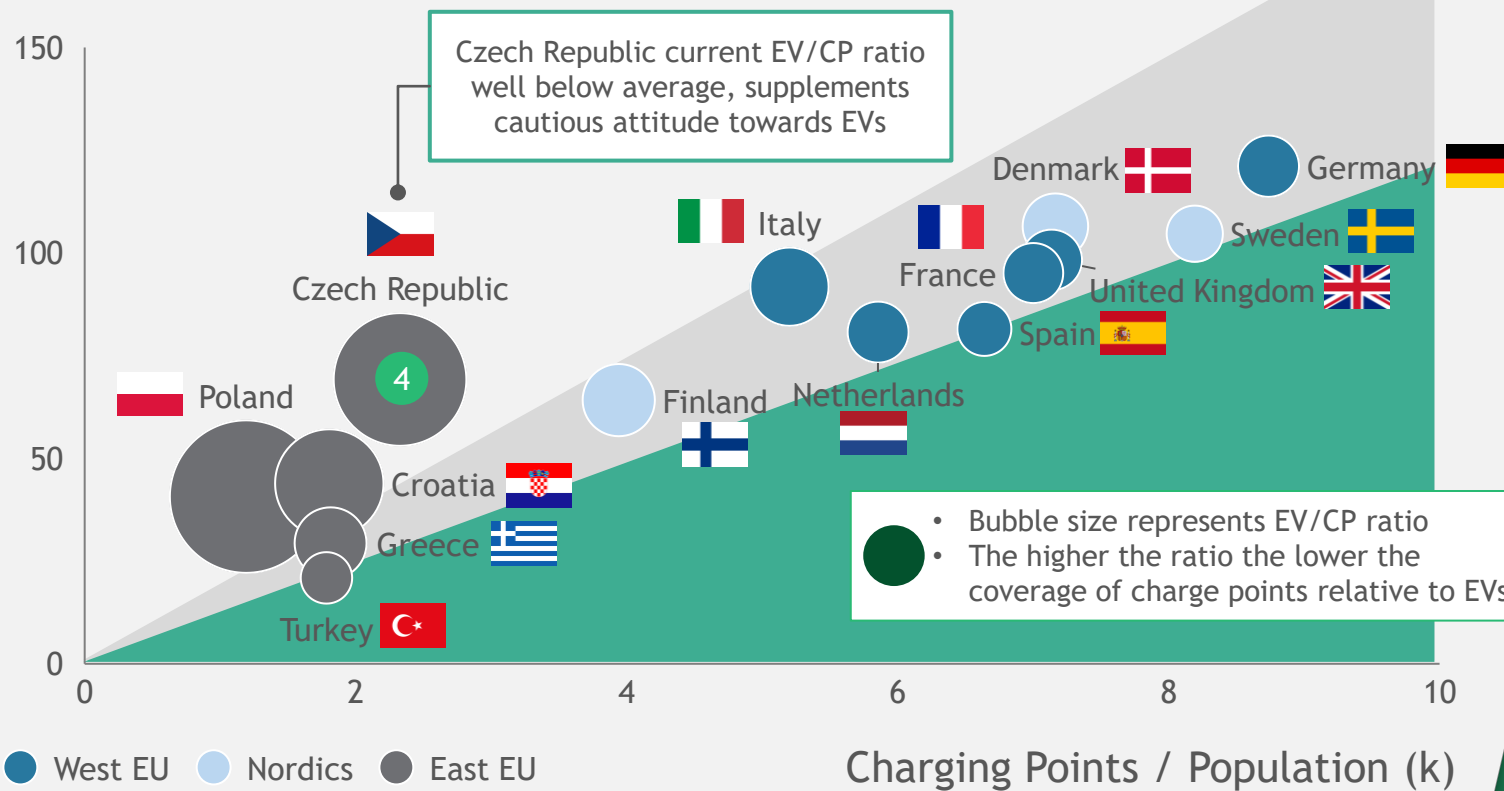


Countries on different paths in EV & charging network



EV/Charger-ratios

Electric Vehicles / Population (k)



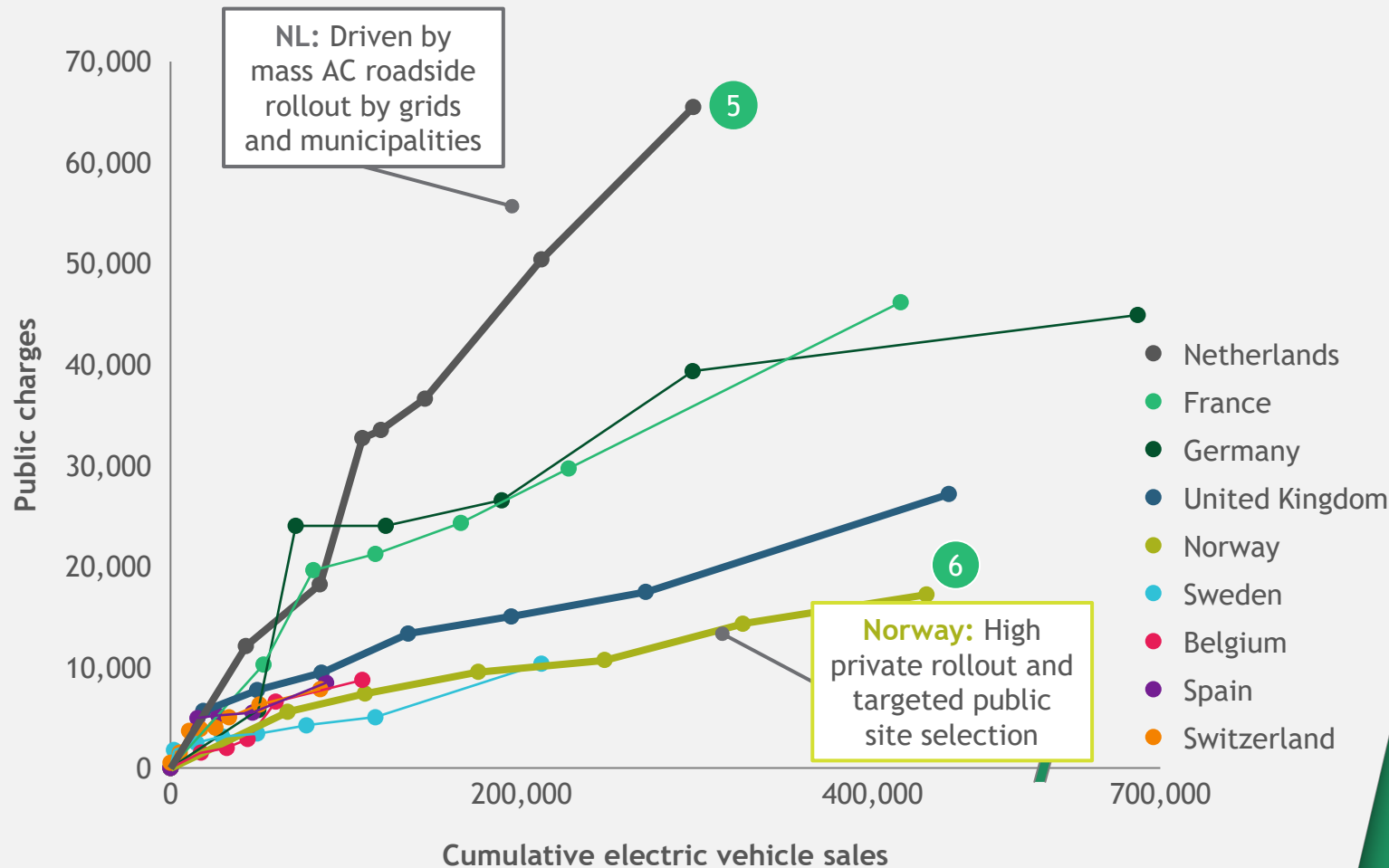
4

30:1

Current assessment in Czech Rep.



All European countries show rapid public charging growth



EV/Charger-ratios

5

5:1

Current assessment in the Netherlands

6

25:1

Current assessment in Norway



Expert interviews, discussions for Czech-specific insights



EV/Charger-ratios

CEZ - Tomáš Chmelík, Václav Kropáček (30/03/22) - As the biggest energy company (conglomerate) in the Czech Republic, CEZ follows the data from the Czech National Action Plan for Clean Mobility (NAP CM) for 2030 (lower limit: 220k BEV, 19k charging points; upper limit: 500k BEV, 35k charging points). It is to be noted that one fast charging station (DC) consists of one fast charging point (>22kWh) as well as one slow charging point (<22kWh) and one slow charging station consist of two slow charging points. Therefore, the upper limit charging stations according to the NAP CM sums up to 17.5k. These numbers are seen as realistic (upper limit: of 35k charging points by 2030). 7

Skoda - Michal Kadera (19/04/22) - Even though Skoda is aware of the NAP CM, a more aggressive, internal target of 600k BEVs on car parc by 2030 are projected by Skoda. Estimations say that one charging point per 10 vehicles is realistic. Regarding fast chargers, Skoda estimates 800 high performance charging points (150 kWh) by 2025 to be installed in the Czech Republic. 8

Internal discussion with Leef - Martin Cmíral, Markéta Adamcová (27/04/22) - From what Martin has heard when talking to CEZ directly, the current utilization plan (upper target of 35k charging points by 2030) is already seen to be challenging, thus, publishing higher numbers might meet incomprehension by the Czech energy providers.

7

20:1Upper limit
National Action
Plan¹

8

10:1Current
assessment of
Skoda²

1. NAP CM upper boundaries are 500k BEVs and 35k charging points by 2030. Considering the projected share of PHEVs in a Base scenario, the total number of EVs grow to approximately ~700k 2. No PHEVs considered, i. e., conservative ratio Source: Expert Interviews



Germany Comparison via Climate Paths 2.0 findings on charging points



EV/Charger-ratios

Tabelle 17: Verhältnis Pkw zu Ladeinfrastruktur

Art des Ladepunktes	Einheit	2021	2030	
Privater Ladepunkt	BEV- und PHEV-Pkw pro Ladestation	1,4	1,7	1
Ladepunkt am Arbeitsplatz	BEV- und PHEV-Pkw pro Ladepunkt	1,5	3,3	2
Öffentlich zugänglicher Ladepunkt, langsam	BEV- und PHEV-Pkw pro Ladepunkt	11	15	3
Öffentlich zugänglicher Ladepunkt, schnell	BEV-Pkw pro Ladepunkt	46	100	4

Quelle: BCG-Analyse

9

9

13:1

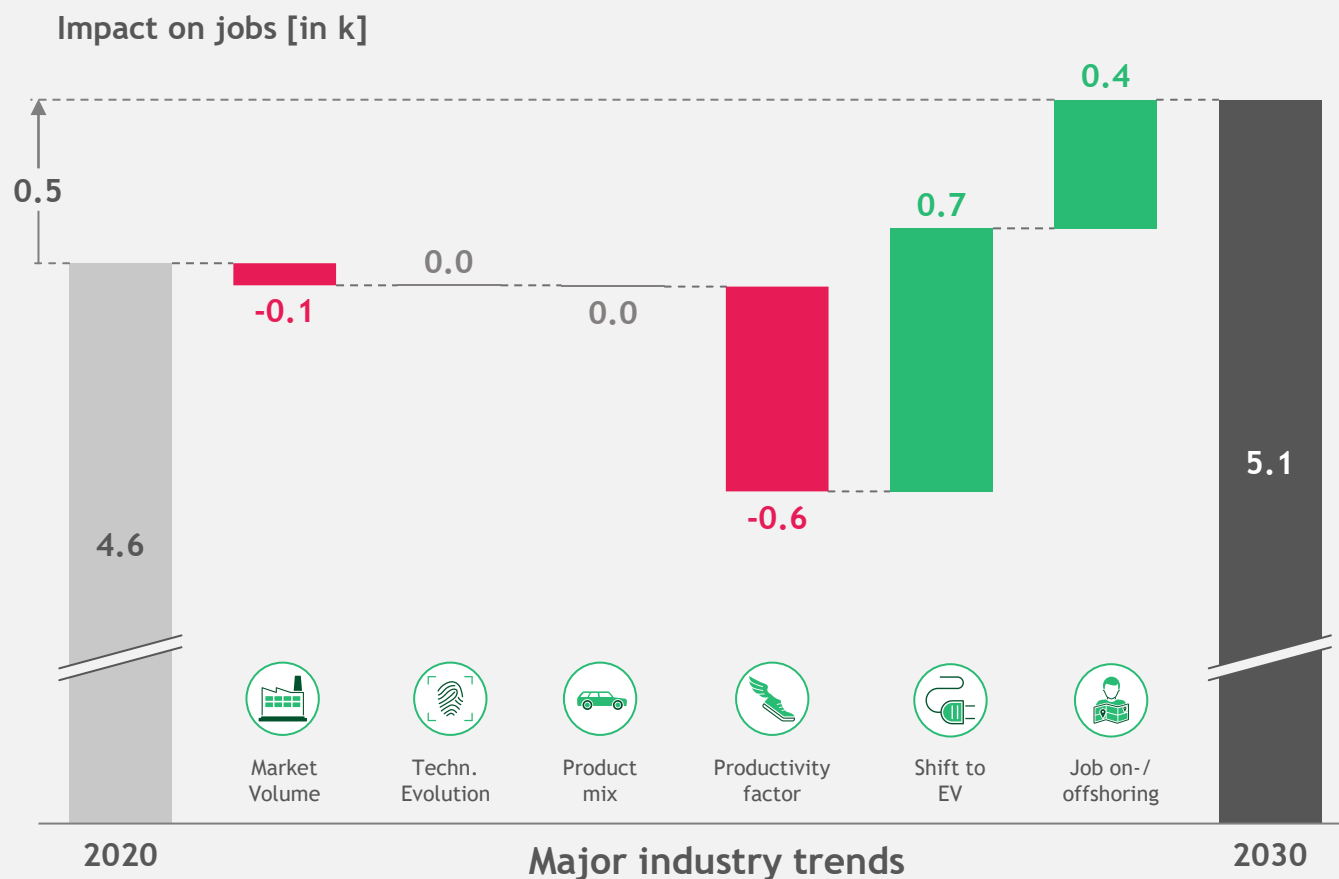
Current
Assessment in
Czech Rep.

Key findings for 2030

- 1 Roughly 60% of all EV owners will have a private charging station
- 2 Charging points at workplaces will double within this decade
- 3 The number of charging points per EV in car parc sums up to almost 7%
- 4 The share of fast chargers is about 13% in Germany by 2030



Material recycling significant relative growth



-0.1k decrease in jobs based on reduced number of sold cars until 2030



Insignificant impact of new technologies developments for material recycling



Product mix (content per car) has no impact on charging infrastructure



-0.6k job reduction based on overall increase in productivity and efficiency



0.7k job increase by shift to EV due to rising recycling need for BEV components



0.4k jobs gained by job onshoring from other European countries

Note: Numbers may not sum up due to roundings
Source: BCG



Shift to EV: Battery recycling becoming mandatory for producers in EU & China



Europe

Ambitious plans to become global leader in sustainable battery production

EU introduced 'The Battery Directive', making producer of batteries responsible for financing costs of collection and recycling at end-of-life of battery

No regulation dealing explicitly with Lithium-ion batteries yet



China

Passed significant reforms in 2017 making EV manufacturer responsible for battery recycling

Manufacturers responsible for recovery of EV-batteries and set up of recycling channels

Battery makers are encouraged to adopt standardized and easily dismantled product designs, to help automate recycling process



USA

Subsidized Lithium-ion battery recycling

No EV battery recycling regulation on federal level - few states passed regulations

USA is attempting to pass regulation on battery recycling; currently conducting research

Agenda



Industry sectors and **job families** primarily affected

1



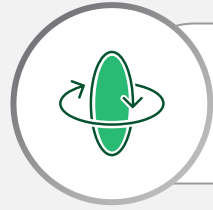
Major trends influencing job development in Auto industry

2



Net impact of job development until 2030

3



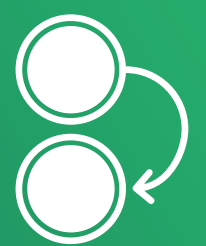
Transition over time, across industries, job families, regions

4



Recommendations for companies and governments

5



Transition of job positions in 3 perspectives



Transition over time



Pre-COVID level of ~330k jobs reached by 2030



Transition between industries & job families



68k jobs to be shifted to & from industry clusters in Auto & adjacent industries



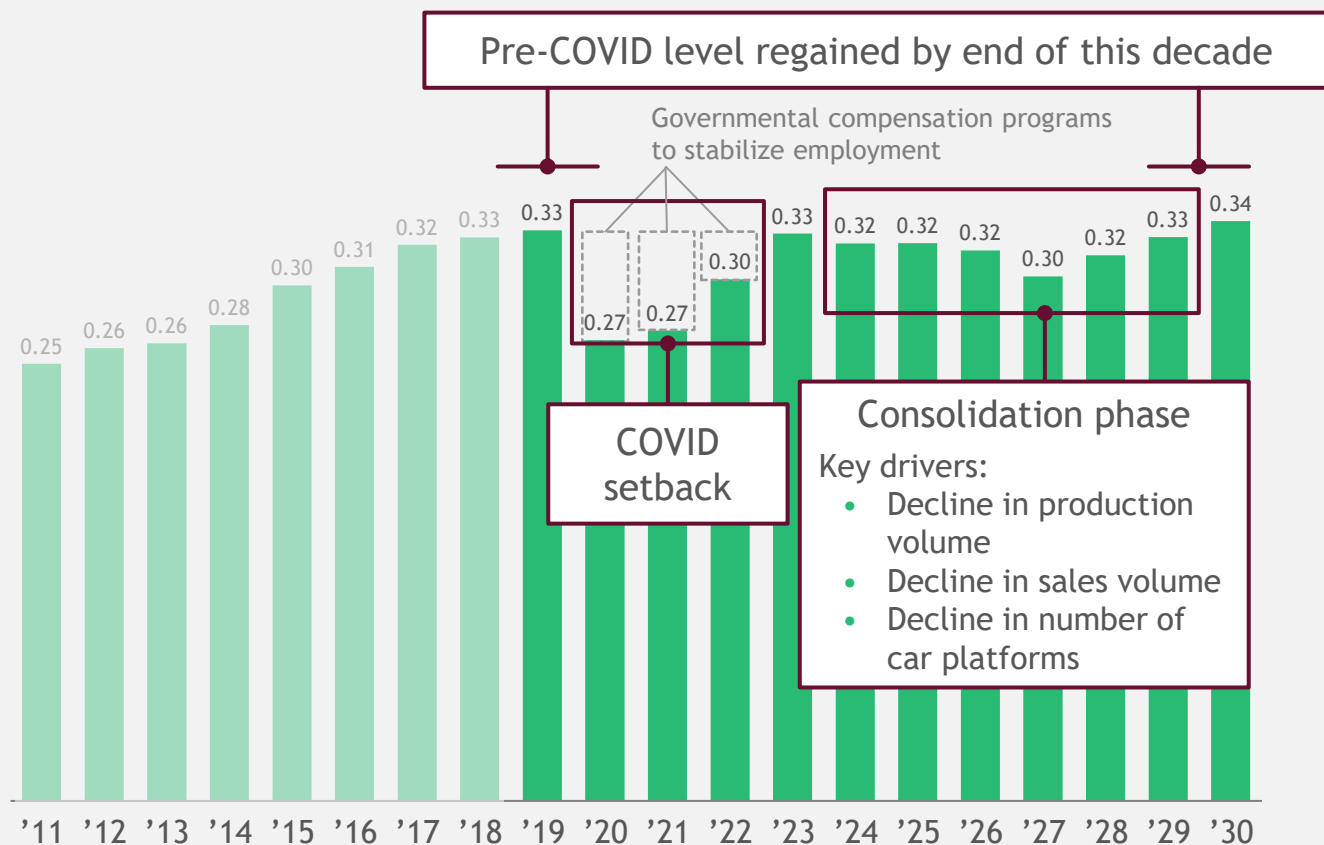
Transition across regions



Job growth in Czech Rep. expected, slight decline in most of Europe

Employee demand with fluctuations until 2030

Total of job development 2010 - 2030 in the Czech Republic [in million]



Key characteristics 2020-30



Return to previous growth trajectory by end of decade



Recovery from COVID setback expected until ~2023



Consolidation phase 2025-27 due to total volume decline

87k trainings, plus 68k transitions with varying effort

Staying

Small transition

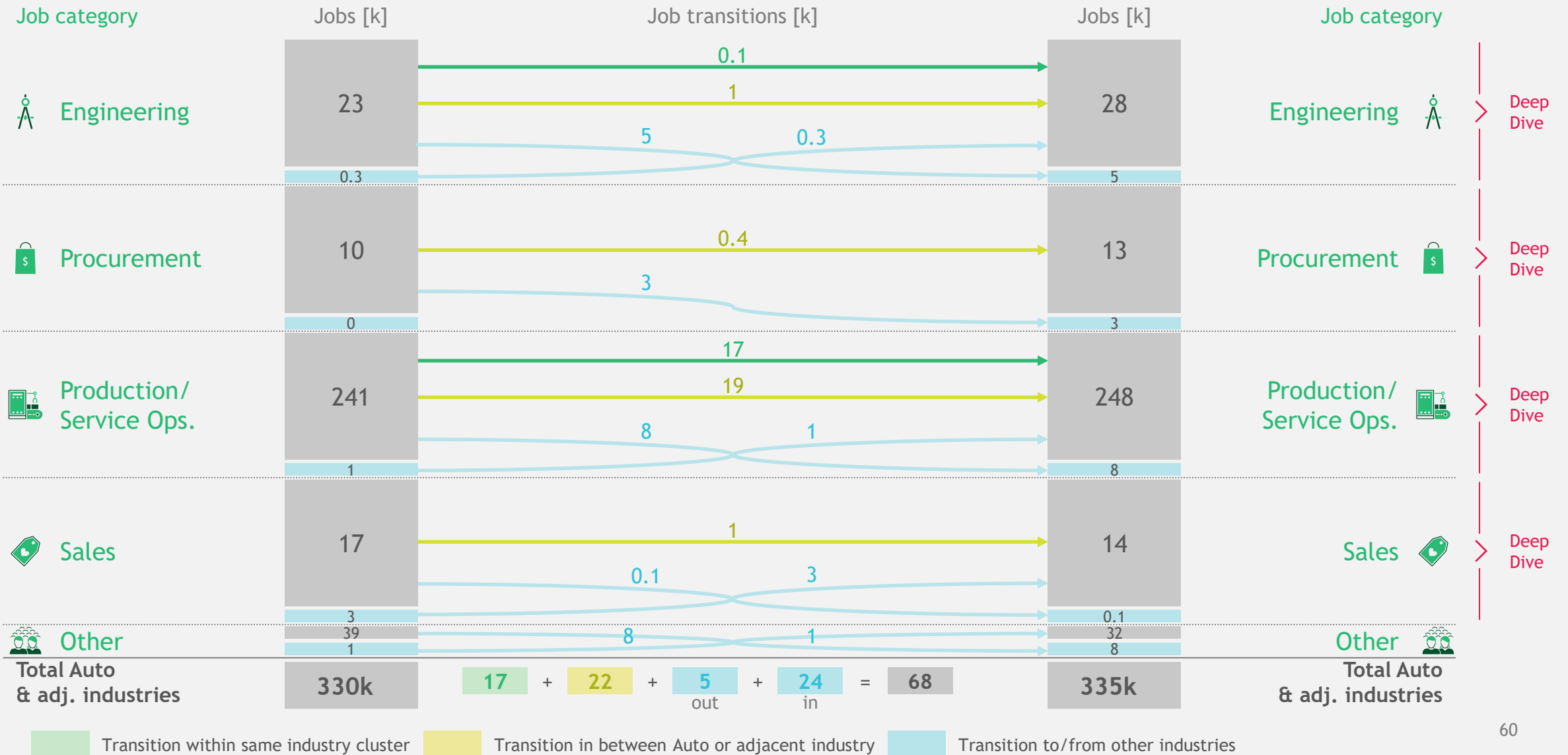
Large transition

Industry exit

Industry	No transition		same industry cluster	similar industry cluster	other industries
Job family			same job family	same / similar job family	same / similar job family
Transition effort	●●● No effort		●●● Low effort, minor re-qualification needed	●●● Medium effort, re-qualification & incentives needed	●●● High effort, intense re-qualification & support needed
Priority	0 Prepare employees for future job demands through training		1 1 st choice transition - as many jobs shifted within industry as possible	2 2 nd choice transition - only if shift within industry not possible	3 3 rd choice transition - only if shift in Auto/adj. Industry not possible
Affected Positions	~262k -87k with major retraining -175k with no/minor retraining		~17k	~22k	~29k

Focus of this chapter

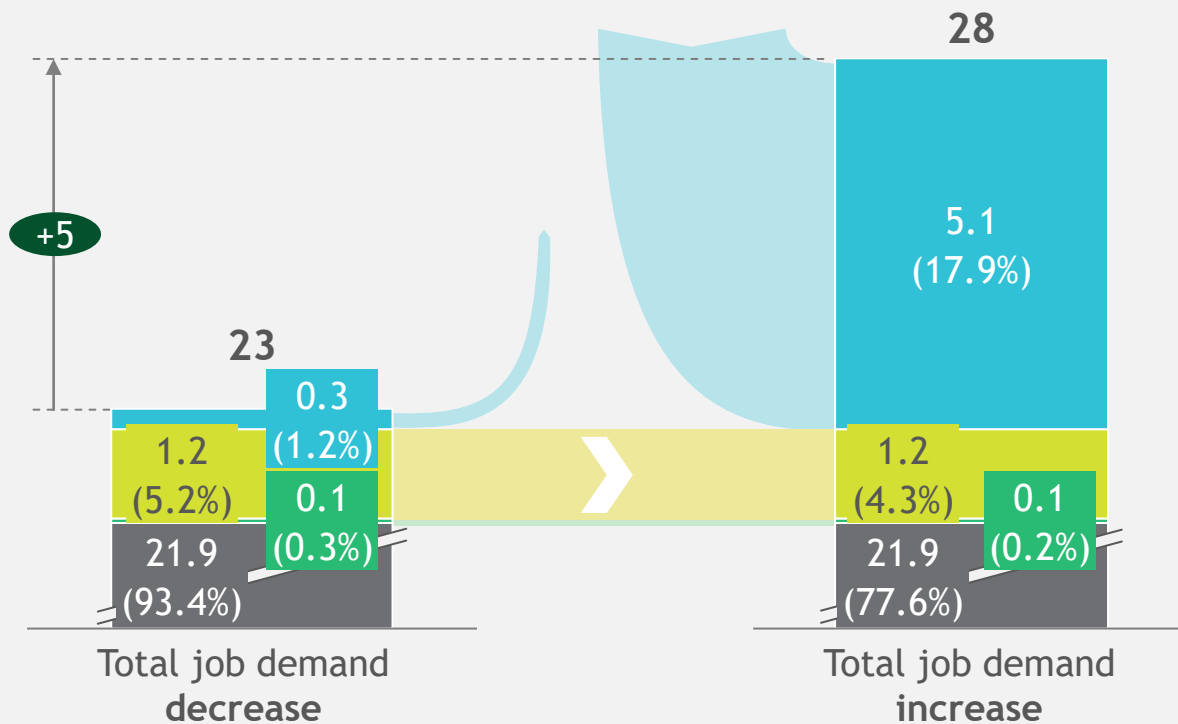
~68k total job shifts between industry clusters



Engineering: ~5k jobs to be compensated outside

Engineering

Transition of jobs in Engineering [in k]



5k net job increase in Engineering



0.1k lost jobs can be compensated by new jobs in the same industry cluster



1.2k lost jobs can be compensated by new jobs in other Auto and adjacent industries



0.3k lost jobs cannot be compensated within Auto or adjacent industries due to missing demand match

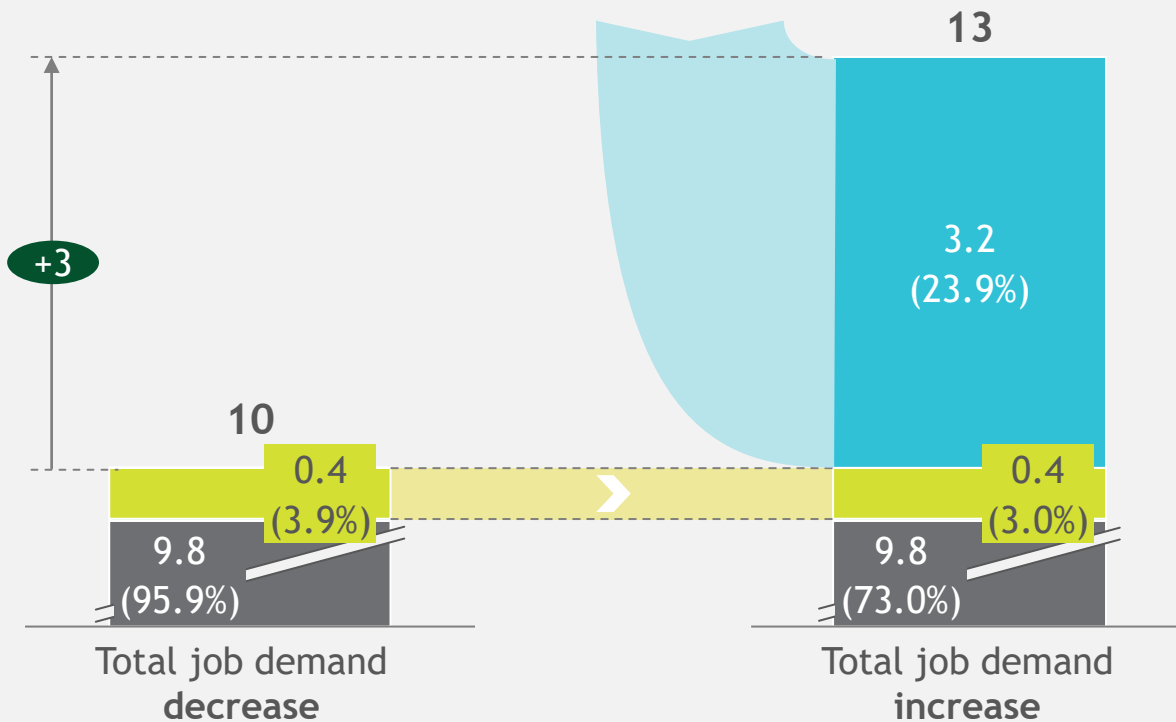


5k new jobs cannot be filled by transition from Auto or adjacent industries - compensation from outside needed

Procurement: ~0.4k job shifts within industries only

Procurement

Transition of jobs in Procurement [in k]



3k net job increase in Procurement



No compensation of jobs in the same industry cluster



0.4k lost jobs can be compensated by new jobs in other Auto and adjacent industries



No need to compensate lost jobs outside of Auto or adjacent industries due to missing demand match

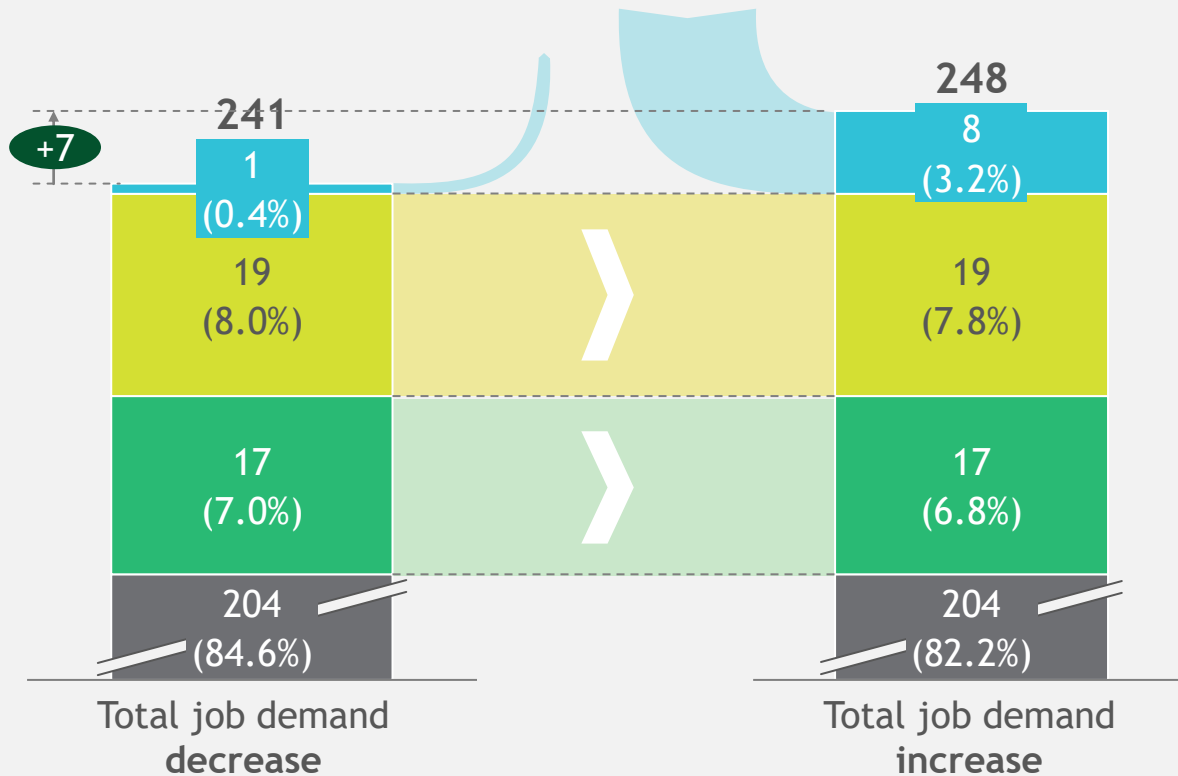


3.2k new jobs cannot be filled by transition from Auto or adjacent industries - compensation from outside needed

Production: ~19k lost jobs shifted across industries

Production/Service Ops.

Transition of jobs in Production & Service Ops. [in k]



7k net job increase in Production/Service Ops.



17k lost jobs can be compensated by new jobs in the same industry cluster



19k lost jobs can be compensated by new jobs in other Auto and adjacent industries



1k lost jobs cannot be compensated within Auto or adjacent industries due to missing demand match

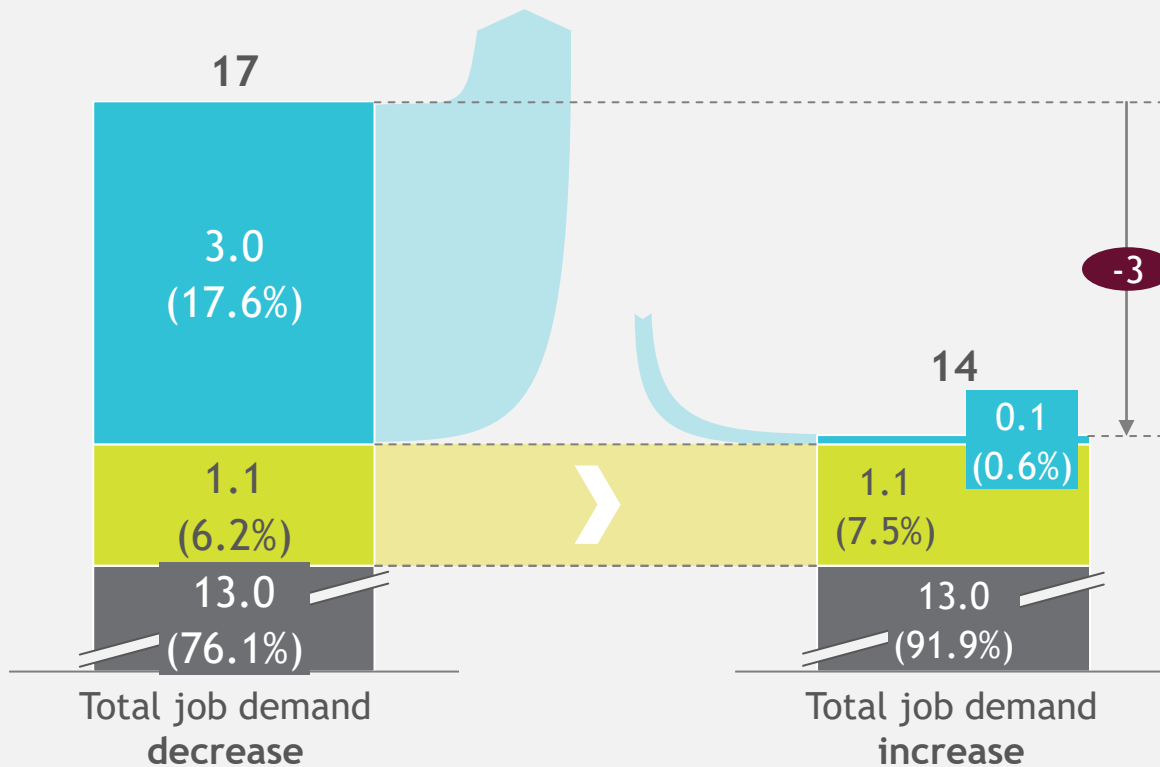


8k new jobs cannot be filled by transition from Auto or adjacent industries - compensation from outside needed

Sales: ~3k of lost jobs not to be compensated

Sales

Transition of jobs in Sales [in k]



3k net job loss in Production/Service Ops.



No compensation of jobs in the same industry cluster



1.1k lost jobs can be compensated by new jobs in other Auto and adjacent industries



3k lost jobs cannot be compensated within Auto or adjacent industries due to **missing demand match**



0.1k new jobs cannot be filled by transition from Auto or adjacent industries - compensation from outside needed

Highest demand increase in non-ICE production staff



Top 10 job families highest demand increase

Industry cluster	Industry	Job family	Change
Non-ice	Manufacture of electric motors, generators and transformers	Operational (production) staff	12.783
Non-ice	Manufacture of electric motors, generators and transformers	Operational (logistics) staff	4.425
Non-ice	Manufacture of electrical and electronic equipment for motor vehicles	Operational (production) staff	3.144
Non-ice	Manufacture of batteries and accumulators	Operational (production) staff	1.998
Energy infrastructure	Charging infrastructure (Operation&Maint.)	Operational (production) staff	1.783
Non-ice	Manufacture of electric motors, generators and transformers	Machine operator	1.475
Non-ice	Manufacture of computers and peripheral equipment	Operational (production) staff	1.252
Non-ice	Manufacture of electrical and electronic equipment for motor vehicles	Operational (logistics) staff	1.088
Non-ice	Manufacture of electric motors, generators and transformers	Maintenance (production) staff	983
Maint. & Repair	Maintenance and repair of motor vehicles	Operational (production) staff	927

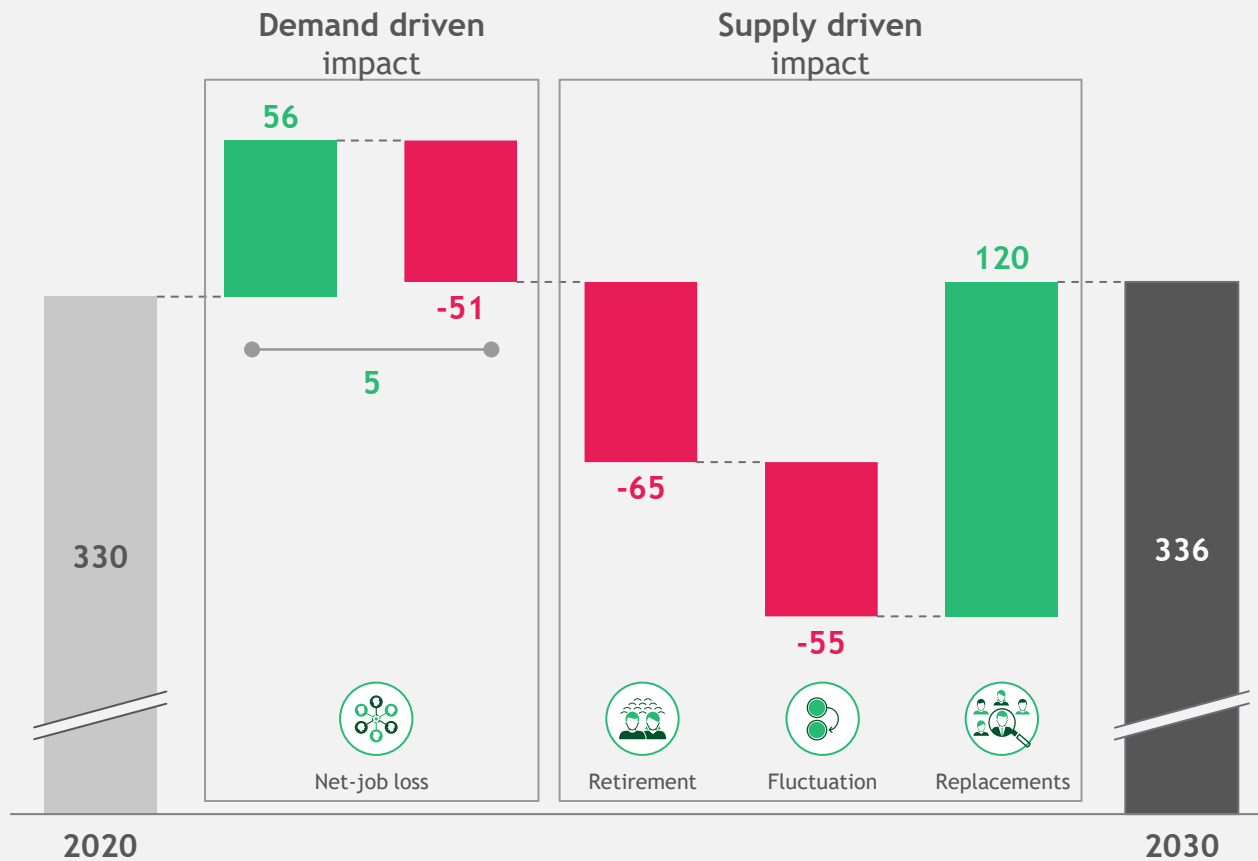


Bottom 10 job families highest demand decrease

Industry cluster	Industry	Job family	Change
Non-ice	Manufacture of other parts and accessories for motor vehicles	Operational (production) staff	-10.066
OEM	Manufacture of motor vehicles	Operational (production) staff	-6.156
Non-ice	Manufacture of other parts and accessories for motor vehicles	Other	-4.554
Non-ice	Manufacture of other parts and accessories for motor vehicles	Operational (logistics) staff	-3.484
ICE-focused	Manufacture of cooling and ventilation equipment	Operational (production) staff	-3.108
OEM	Manufacture of motor vehicles	Operational (logistics) staff	-2.427
ICE-focused	Manufacture of cooling and ventilation equipment	Other	-1.440
ICE-focused	Manufacture of other pumps and compressors	Operational (production) staff	-1.329
ICE-focused	Manufacture of bearings, gears, gearing and driving elements	Operational (production) staff	-1.164
Non-ice	Manufacture of other parts and accessories for motor vehicles	Machine operator	-1.161

~176k employees need to be hired overall

Impact on jobs in Europe [in k]



Demand driven impact

5k jobs gained in with
~56k new & ~51k lost jobs

Transitions as shown on previous slides

Supply driven impact

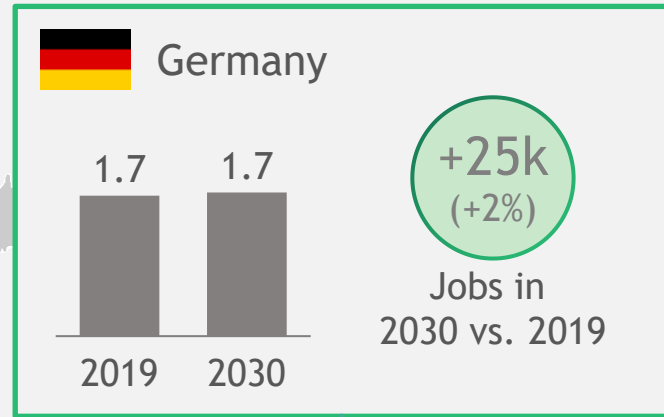
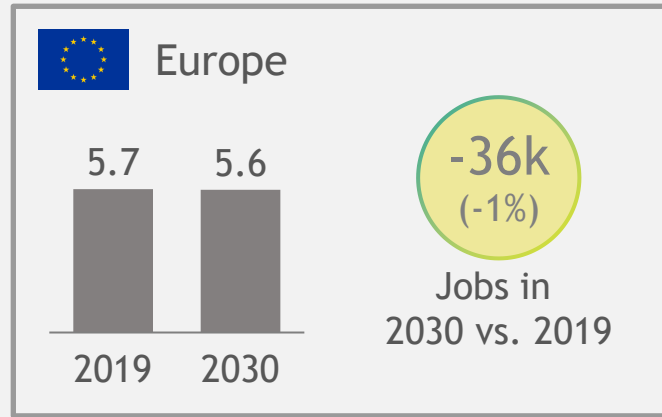
~120k replacements needed to compensate retirement/fluctuation

Additional shifts to be managed

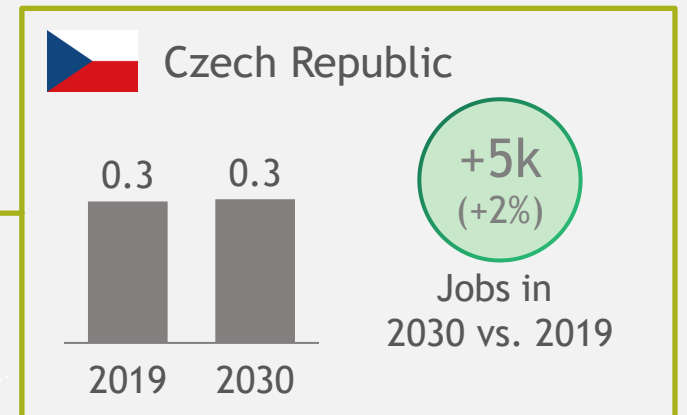
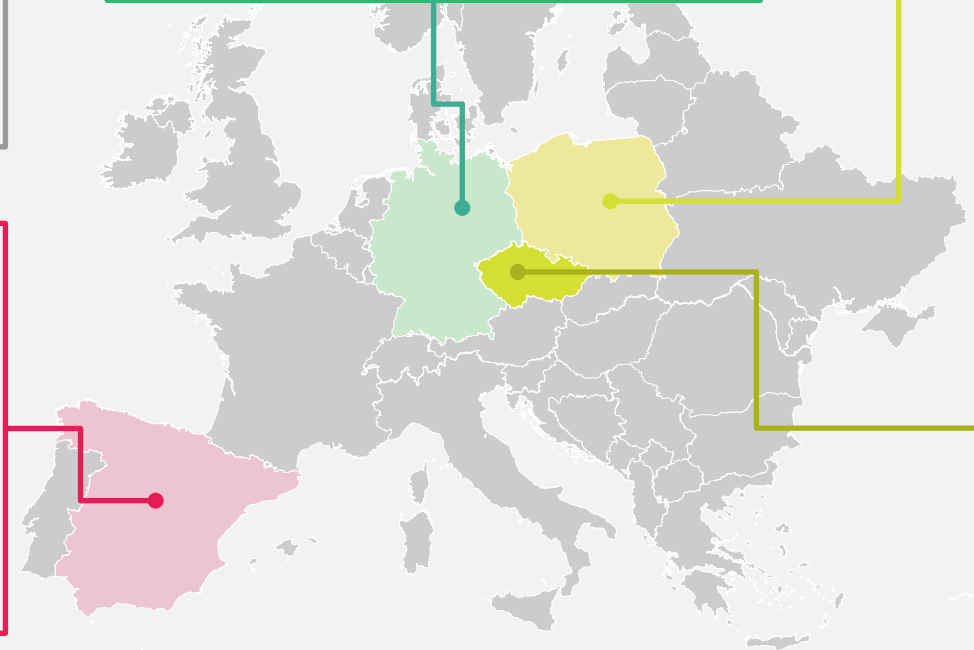
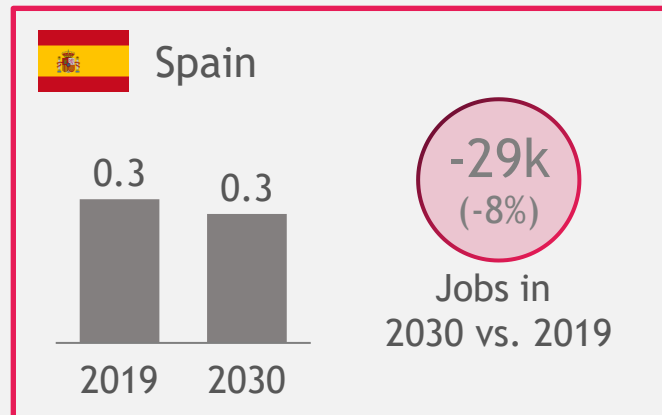
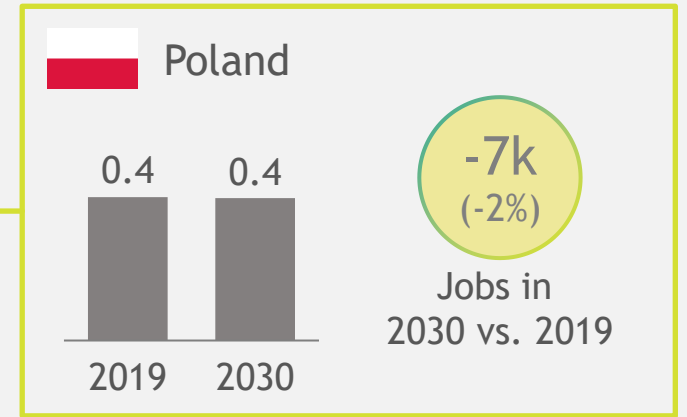
~176k employees need to be hired in affected industries until 2030

Czech Rep. with slight increase, withstands overall trend

Regional distribution of jobs across Europe [in M]



Limited transitions across European countries due to personal & cultural barriers



Agenda



Industry sectors and **job families** primarily affected

1



Major trends influencing job development in Auto industry

2



Net impact of job development until 2030

3



Transition over time, across industries, job families, regions

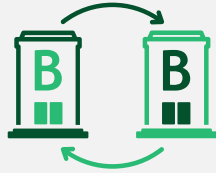
4



Recommendations for companies and governments

5

Companies, governments & NGOs need to **act now** to **master the transition!**



Companies

Analyze status-quo with regards to future product evolutions and demands, operations, job profiles

Design a company-specific 2030 target picture based on a clean-sheet, "zero-based" approach

Revisit make-or-buy decisions (e.g., battery cell mfg.)

Determine additional adjustments on job demands and profiles as well as operations

Design re-qualification/upskilling programs and hiring as well as restructuring programs



Governments & NGOs

Create awareness within sectors and companies about the upcoming changes and necessary transition

Provide incentives to affected sectors and companies in order to master the transition

Tailor educational curricula towards new technologies and specifically train job seekers accordingly

Ensure globally leading position of European automotive industry to maintain status as EU job motor

Push vehicle electrification towards ambitious scenario ...



The Base-Case is not a "per default"-scenario, measures need to be undertaken to achieve it

➤ Czech Republic in competition with other countries, especially in Eastern Europe

➤ The government is the responsible driver for the domestic market conditions

➤ Follow National Action Plan of Clean Mobility and even tighten targets

➤ Stimulate domestic e-mobility market by governmental incentives

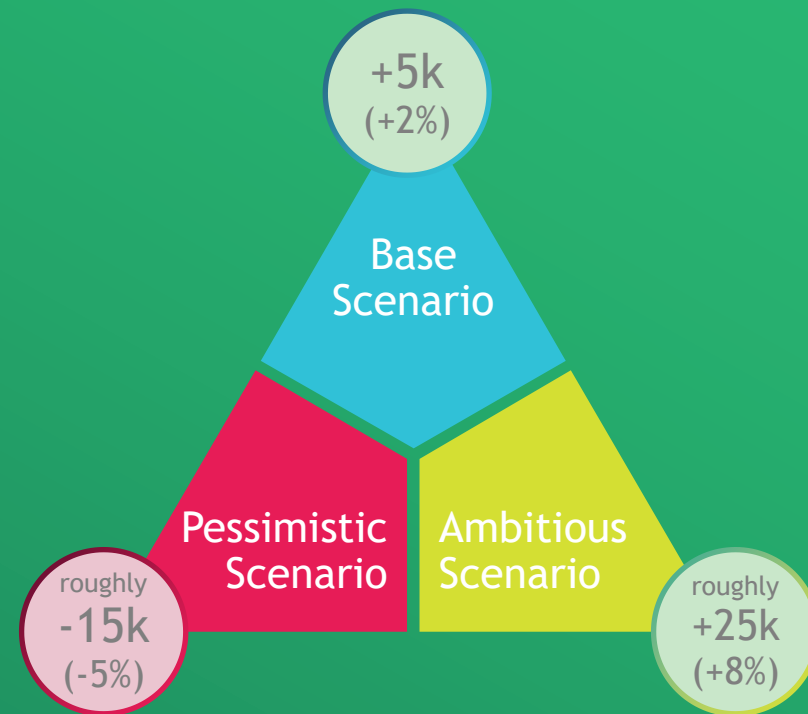
➤ Tools by the government can comprise monetary to structural measures

Deep Dive

Source: BCG Analysis

... as impact on jobs is highly dependent

Job impact per scenario
[# (%) by 2030 vs. 2019]





Deep Dive: Take measures to impact scenario development

Exemplary, non-exhaustive



Production volume

- Implement programs for job preservation (e.g., short-time allowances)
- Support car manufacturers in regaining pre-COVID production level, e.g., car scrappage premium



CZ Sales volume

- Prevent customers from postponing purchase decision by incentive models
- Support promotion programs of car dealers



Onshoring effect

- Outline competitive advantages in international market competition
- Keep or extend existing incentive and promotion programs



BEV car parc

- Increase attractiveness of e-mobility, e.g., reduced or free parking
- Reduce barrier to purchase EVs, e.g., by reducing purchase price



Public charging

- Accelerate charging infrastructure roll out driven by big energy distributors
- Follow National Action Plan of Clean Mobility



Private charging

- Media effective promotion of e-mobility use-cases with private infrastructure
- Subsidize electricity for wall boxes

Possible action levers



Short-time allowances



Incentive models



Promotion programs



Monetary and tax benefits



Subsidization programs



Advertisement placements

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