BOSTON CONSULTING GROUP

Impact Assessment of the Transition to Zero-Emission Trucks in Europe

BCG study

SEPTEMBER 19, 2023

TRANSPORT & ENVIRONMENT

Executive summary

- The truck industry is a central part of Europe's economy, contributing €75B in GDP and 577K jobs in 2022, causing ~ 4% of Europe's CO_2 emissions. Zero-emission vehicle technology provides new opportunities to achieve climate ambitions while retaining economic contribution. Previous BCG research shows an expected rise to 55% ZEV in 2030 and 77% ZEV in 2035.
- Regulation mandates the baseline for the shift from ICE to ZEV, resulting in demanded adoption rates of at least 49% by 2035 (base case: EU commission), or 97% by 2035 respectively (more ambitious T&E case). In this study, we investigate the economic impact of both regulatory scenarios on GDP and employment development in Europe.
- Shift to ZEV has potential to create up to €32B in GDP and 30K additional jobs in Europe by 2035 (T&E case) versus 2022. Key drivers are battery cell production and the shift from foreign fossil fuels to domestically produced electricity.
- Despite an overall positive effect on Europe's economy, a redistribution of value and jobs is created by the shift from ICE to ZEV, impacting current suppliers and OEMs, moving away from ICE components and periphery manufacturing toward battery cells, electric drive, power electronics, and less labor-intensive module packaging.
- Key levers for strong positioning of the EU in light of new industry dynamics entail a buildup of domestic battery cell production, reskilling of labor force, charging infrastructure readiness, and affordable renewable electricity.
- Technology shift enables market entry for new, foreign ZEV players. While exports represent starting point to compete in major markets, localized production becomes crucial for long-term dominance. Negative impact from non-European ZEV players on GDP and employment depends on the concrete scenario, esp. no. of entrants, localization degree etc., while benefits from transitioning to ZEV along the full value chain are expected to outweigh losses from new competition.

Source: BCG

The European trucking sector's shift to ZEVs could create up to €32 billion GDP and add 30,000 jobs by 2035

OEMs
Could loose up to 35,000 positions related to making ICE, while GDP contribution is positive. Requires a substantial workforce transformation towards new capabilities to produce and market ZEVs.

+€3B GDP

-35,000 Jobs

Suppliers
Expected to add value by switching from making ICE to ZEV components, in particular battery cells, electric drives, which will be needed for 400,000 ZEV trucks by 2035. Requires distinct new capabilities for supplier base.

+€6B GDP

+3,000 Jobs

ZEV infrastructure players
Will contribute towards GDP and job growth. Need to install up to 185,000 charging points by 2035 and overcome implementation hurdles to ensure sufficient charging network coverage.

+€1B GDP

+6,000 Jobs

MHDT-related utilities
Need to ramp up renewable electricity generation from <1 TWh in 2022 to > 160 TWh in 2035 to fuel up to 1.8M BEV trucks on the road. Major driver of positive economic impact due to high European added value for renewable electricity generation, compared to fossil fuel import.

+€22B GDP

+55,000 Jobs

Sources: Statista; BCG analysis.
Notes: GDP and employment increases from 2022 to 2035 under high adopt scenario.

Preface: What this study is—and what it is not

In scope	Out of scope
Medium- and heavy-duty trucks (in following referred to as MHDTs) Heavy-duty (HDT > 15 t GVW), medium-duty (MDT 6–15 t GVW)	Vehicles used for passenger transport, buses and coaches, trailers, and other light commercial vehicles (LCV < 6 t GVW)
EU-27 + UK, Switzerland, Norway and Iceland US and China in extended scope to understand competitive landscape	Other regions of the world
Powertrain-related value chain steps Suppliers, OEMs, ZEV infrastructure, and MHDT-related utilities	Raw materials and impact on value chain steps with no major dependence on powertrain (e.g., after sales), included via steady state assumption
Contribution of defined value chain steps to European GDP Components and production of new MHDTs (supplier, OEM), ZEV charging infrastructure hardware, and energy consumption for MHDT ops. (utilities)	Raw materials, one-time expenses for buildup of H_2 stations and energy grid, filling stations; after sales, fin. services, platform services, transport solutions, resale, reuse, and recycling kept constant in timeframe
Employment in Europe for defined value chain steps Components and production of new MHDTs (supplier, OEM), ZEV charging infrastructure hardware, and energy consumption for MHDT ops. (utilities)	Raw materials, one-time expenses for buildup of H_2 stations and energy grid, filling stations; after sales, fin. services, platform services, transport solutions, resale, reuse, and recycling kept constant in timeframe
Truck-level trade flows from and into Europe Focus on imports and exports from and to US and China	Trade of components and detailed analysis of worldwide trade flows between other regions

Note: Assuming no strategic changes to current OEM business model; GVW = gross vehicle weight

This study covers the shift of the MHDT industry in Europe toward zero emissions

MHDTs across 3 powertrain technologies

MDT (6–15 t)

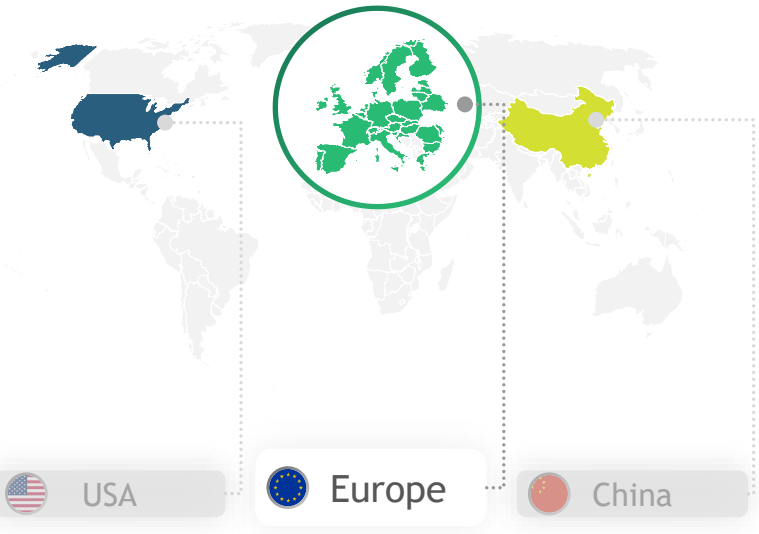
HDT > 15 t

Diesel

BEV

H_2

Focus Europe—US & China in extended scope



Value chain from suppliers to utilities

Supplier
- Raw materials
- Components

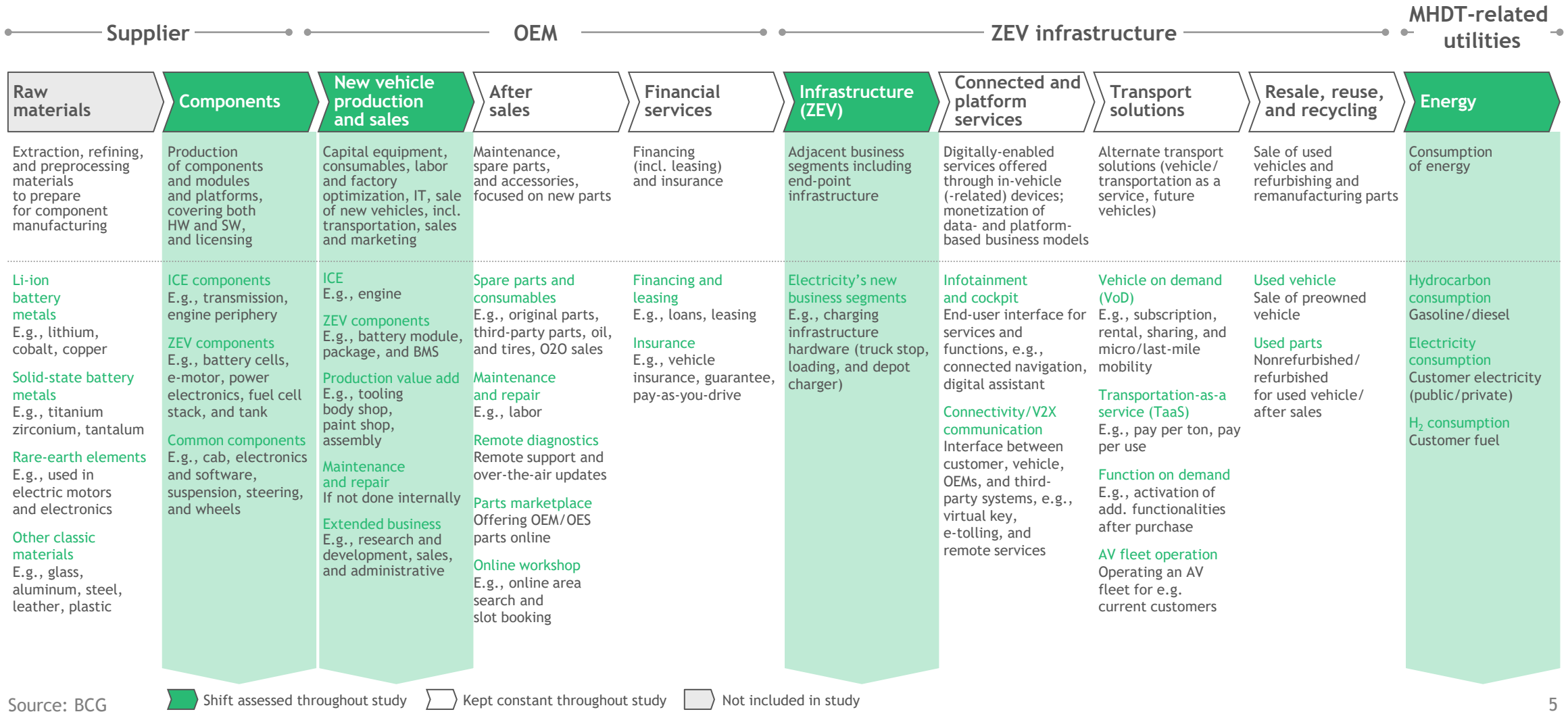
OEM
- New vehicle production and sales
- After sales
- Financial services

ZEV infrastructure
- Infrastructure (ZEV)
- Connected and platform services
- Transport solutions
- Resale, reuse, and recycling

MHDT-related utilities
- Energy

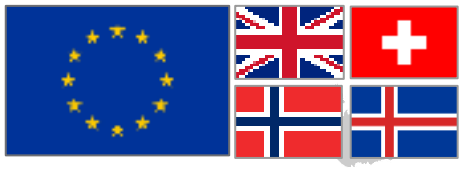
Note: EU-27 + UK, Switzerland, Norway, Iceland
Source: IHS Markit (Feb 2023); T&E; BCG

Along the value chain, the study focuses on shifts in powertrain-related elements



Source: BCG

Impact of ZEV adoption on competitiveness of Europe's truck industry[1] until 2035 …

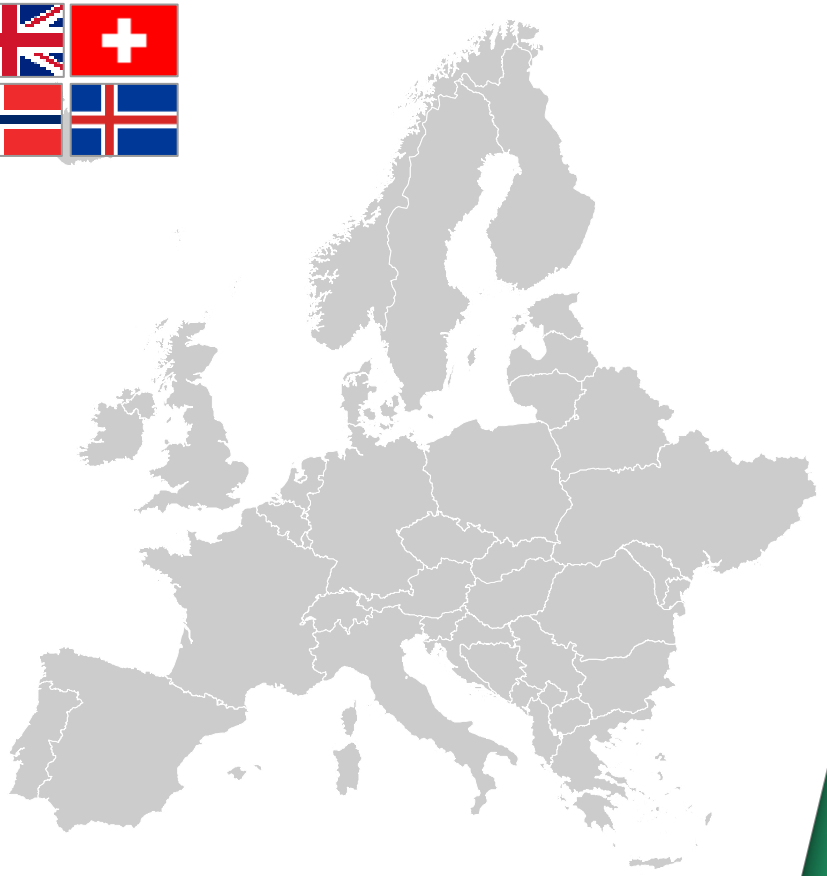


€75B

GDP (2022)

577K

Jobs (2022)



1. Consisting of EU-27 + UK, Norway, Switzerland and Iceland, covering suppliers, OEMs, ZEV infrastructure, and CV-related utilities
Source: Statista; BCG

… presented along five building blocks

1. Current state of the European truck industry
2. Shift to ZEV and underlying key drivers
3. Impact of ZEV shift on European economy on GDP and employment until 2035
4. Supporting the shift to zero emissions
5. Emerging competition from ZEV trend in US and CN

Agenda

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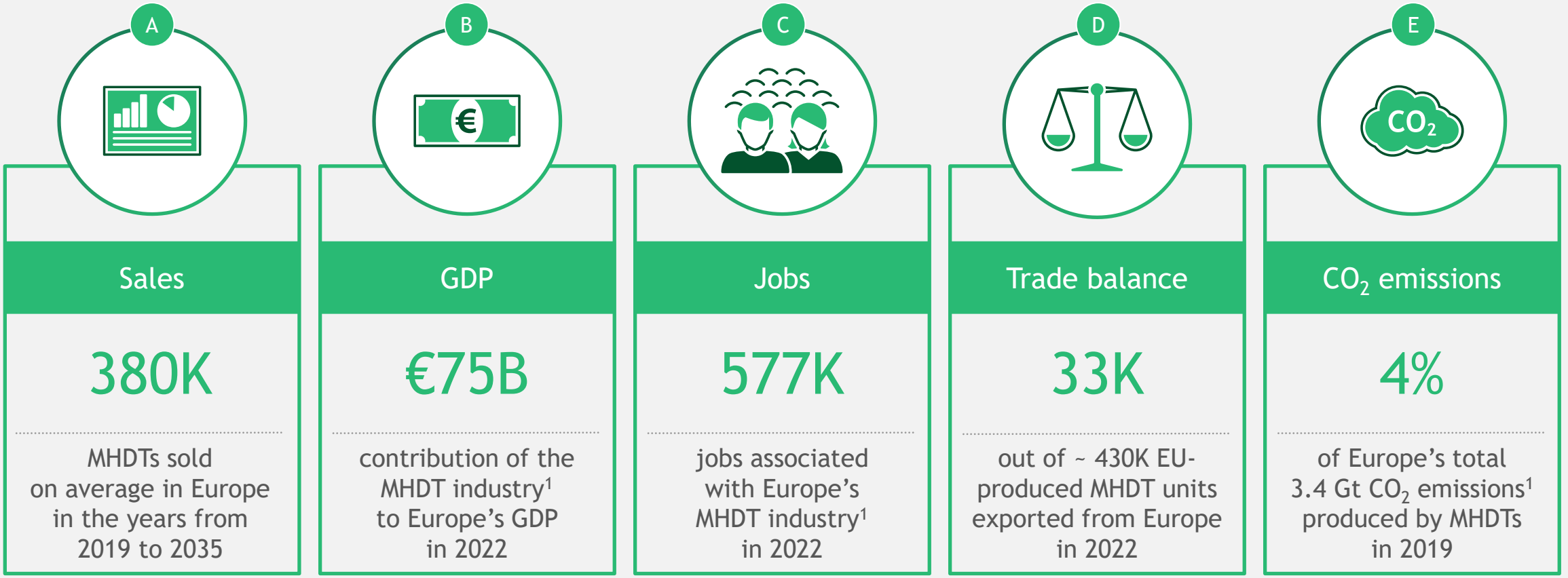
5. Outlook: Emerging competition from new non-European ZEV players

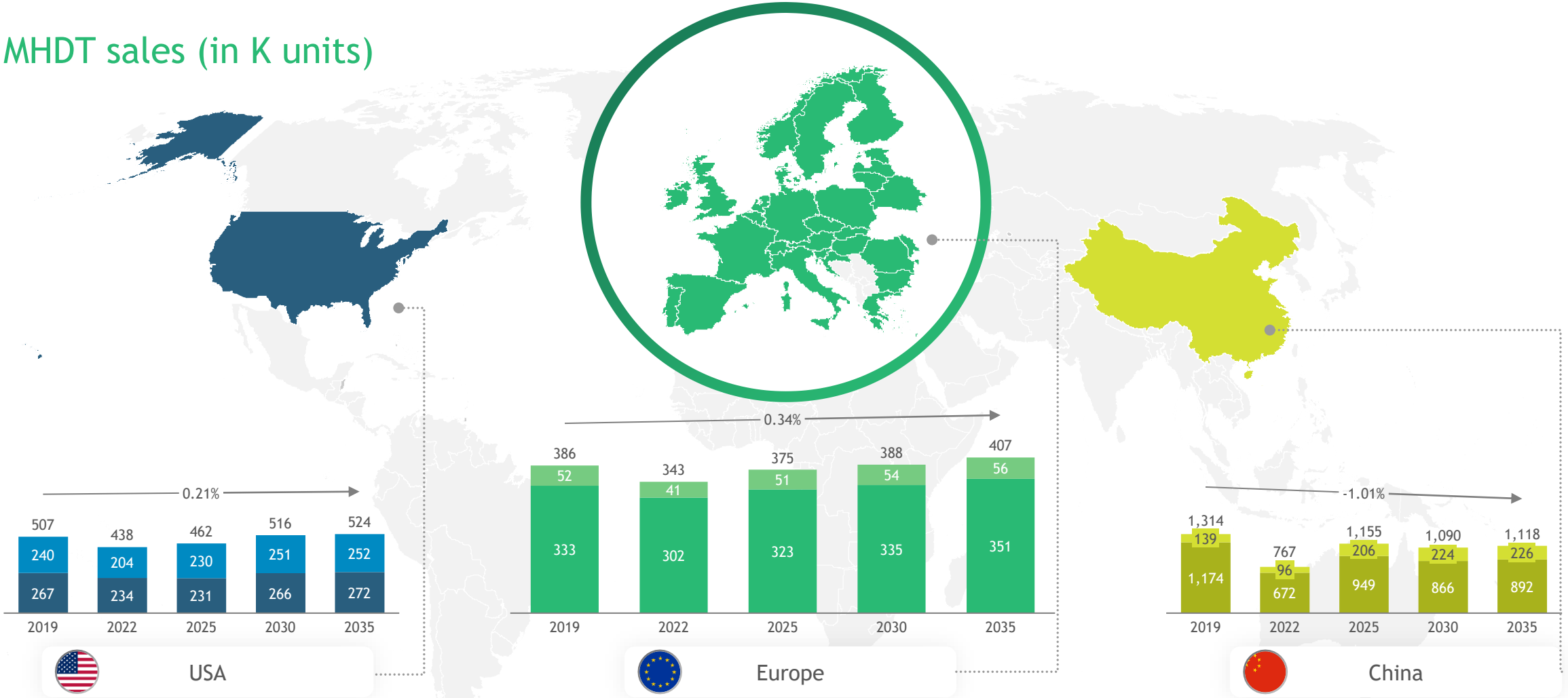
Europe’s truck industry in figures



1. In considered value chain elements 2. For EU-27, excludes the sector “Land use, land-use change, and forestry” (6.9%)
Source: Eurostat; European Environmental Agency (EEA); IHS Markit (Feb 2023); Statista; World Bank; BCG

~ 380K MHDTs sold every year in Europe at a mostly stable rate until 2035

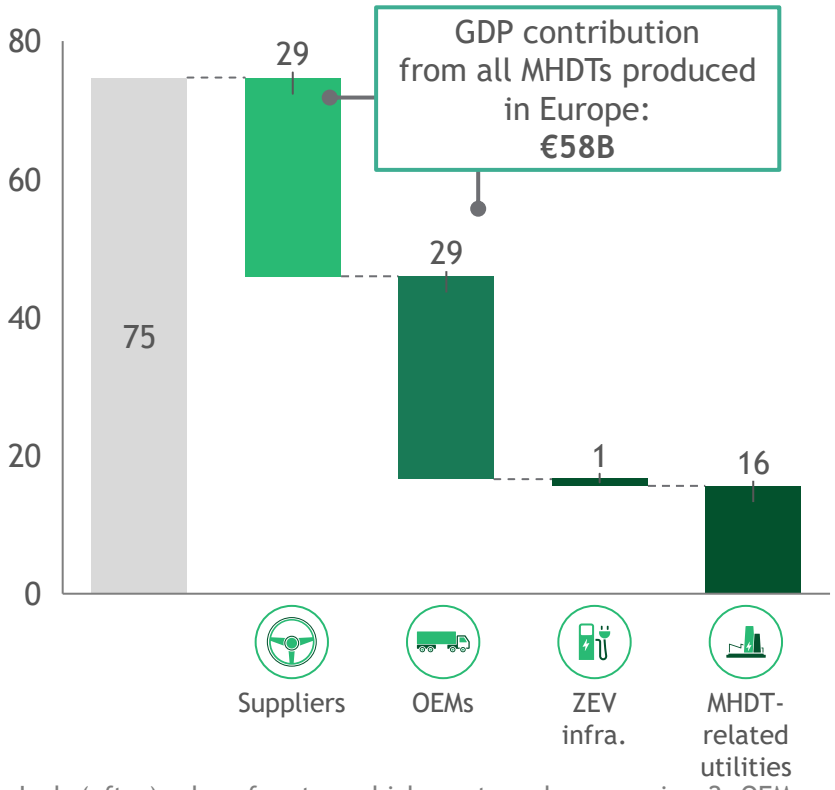
MHDT sales (in K units)



Note: EU-27 + UK, Switzerland, Norway, and Iceland
Source: IHS Markit (Feb 2023); BCG

Along the four core value chain elements, the industry currently contributes ~ €75B to Europe's GDP in 2022

Total GDP contribution in Europe in 2022 (in B€)



€75B GDP in Europe generated by 4 clusters along the value chain …

… of which €29B (39%) GDP is associated with **suppliers**,[1] including firms like ZF, Continental, and Knorr-Bremse

… of which €29B (39%) GDP is associated with **OEMs**,[2] including firms like Daimler Truck, Scania, and MAN

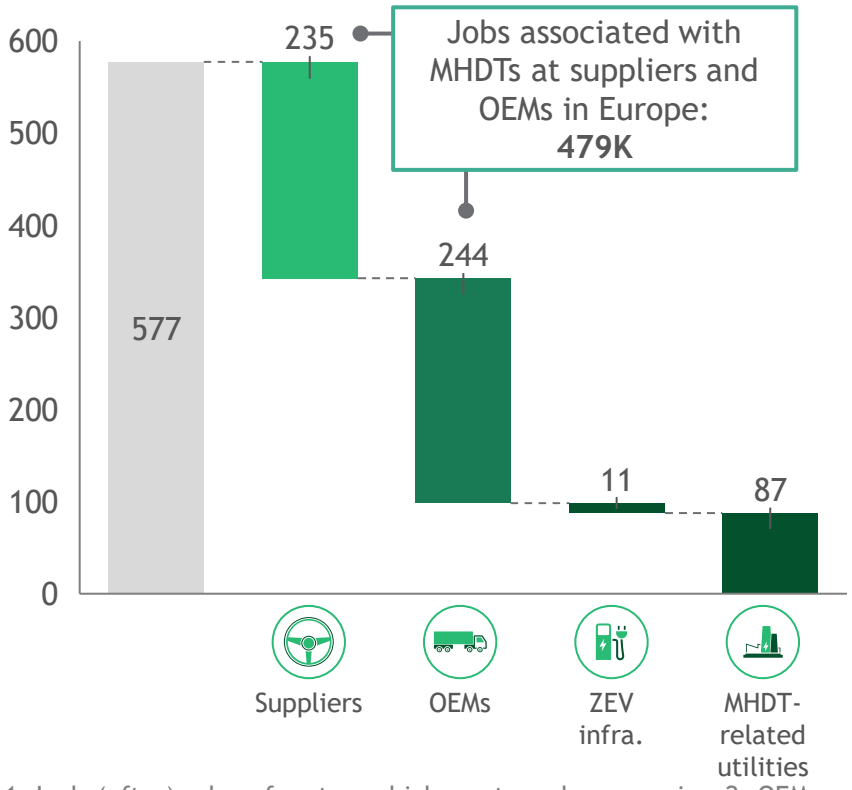
… of which > €1B (< 1%) GDP is associated with **ZEV infrastructure**,[3] including firms like ABB, sennder, and Milence

… of which €16B (21%) GDP is associated with refining of diesel and generation of **electricity**, including firms like Shell and E.ON

1. Incl. (after) sales of motor vehicle parts and accessories 2. OEMs generate value via ICE, production value add (e.g., assembly, tooling), and nonproduction elements (e.g., SG&A and R&D), including (after) sales and maintenance 3. Base including infrastructure, connected and platform services, transport solutions, and resale, reuse, and recycling
Source: Eurostat; BCG

In 2022, ~ 577K jobs are associated with Europe's MHDT industry

Total number of jobs in Europe in 2022 (in K)



577K jobs in Europe associated with 4 clusters along the value chain …

… of which 235K (41%) jobs are associated with **suppliers**,[1] including firms like ZF, Continental, and Knorr-Bremse

… of which 244K (42%) jobs are associated with **OEMs**,[2] including firms like Daimler Truck, Scania, and MAN

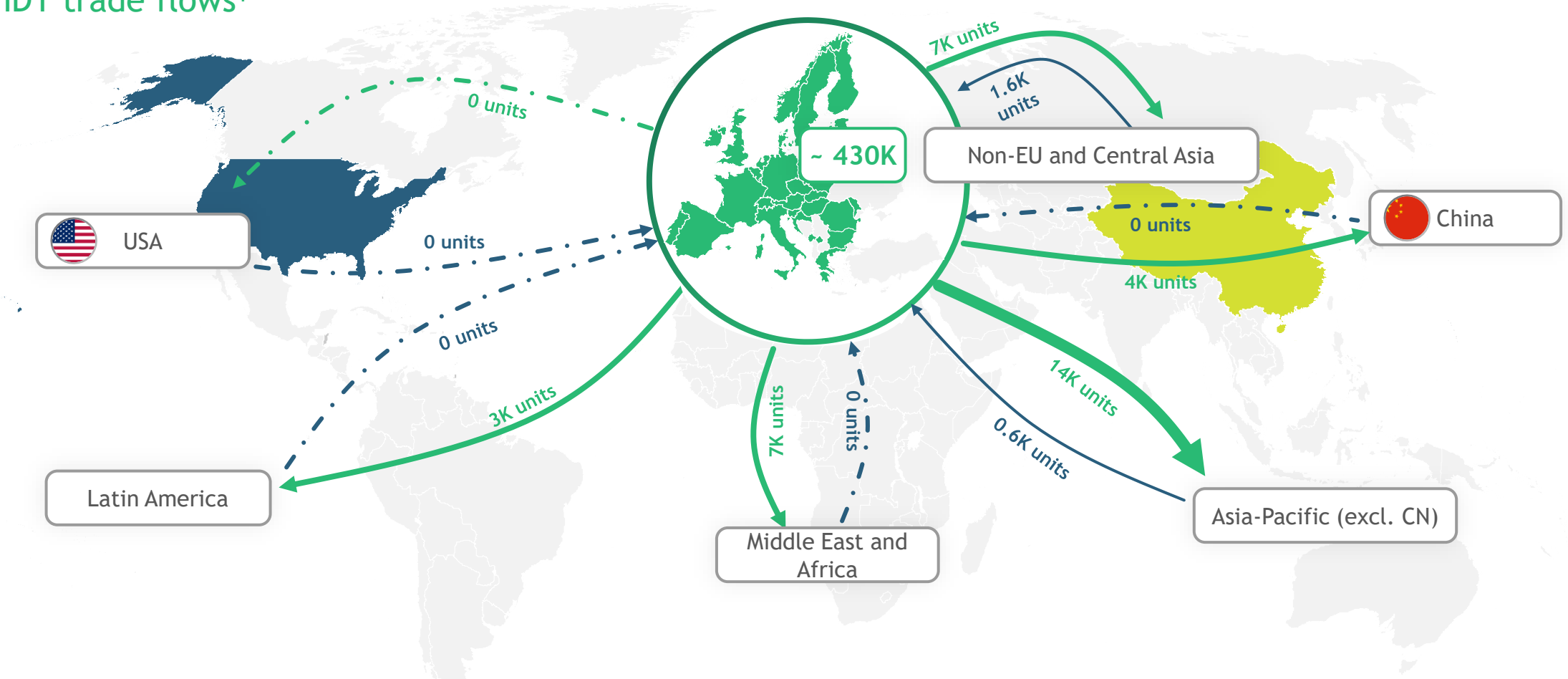
… of which < 11K (2%) jobs are associated with **ZEV infrastructure**,[3] including firms like ABB, sennder, and Milence

… of which 87K (15%) jobs are associated with refining of diesel and generation of **electricity**, including firms like Shell and EON

1. Incl. (after) sales of motor vehicle parts and accessories 2. OEMs generate value via ICE, production value add (e.g., assembly, tooling), and nonproduction elements (e.g., SG&A and R&D), including (after) sales and maintenance 3. Base including infrastructure, connected and platform services, transport solutions, and resale, reuse, and recycling
Source: Eurostat; BCG

EU net exports totaled 33K units to small markets in 2022—CN and US dominated by domestic players

MHDT trade flows[1]



1. Excluding component business (suppliers and OEMs)
Note: EU 27 + UK, Switzerland, Norway and Iceland; new trucks only
Source: IHS Markit (May 2023); World Bank; BCG

European OEMs operate and produce locally in key regions, trade with low relevance for European GDP

Global footprint of selected European MHDT OEMs

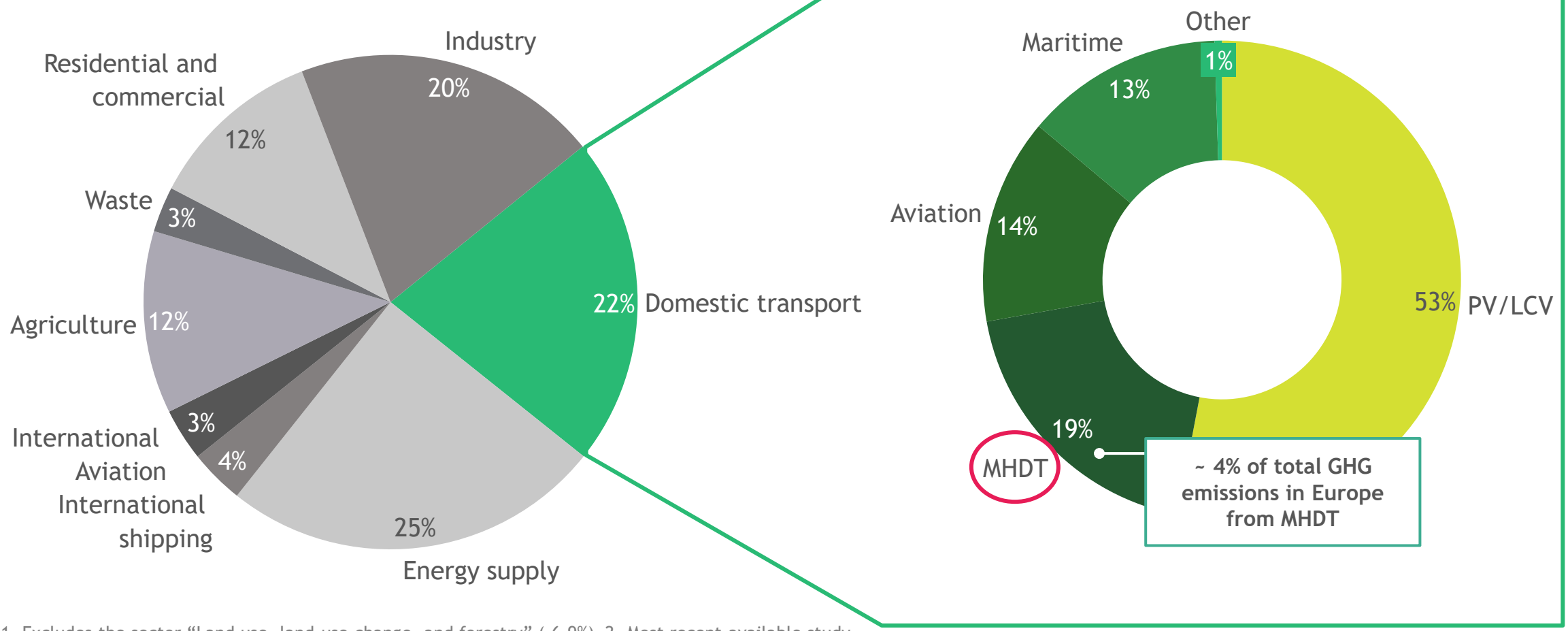
Americas | Europe | Asia

Daimler Truck	FREIGHTLINER, WESTERN STAR		FUSO, FOTON
Volvo Trucks	MACK, VOLVO	VOLVO, RENAULT TRUCKS	DFM, EICHER
TRATON	Caminhões Ônibus, NAVISTAR	MAN, SCANIA	SINOTRUK, HINO
PACCAR	KENWORTH, Peterbilt	DAF	
...			

Note: Logos indicate own brands as well as associates (equity stakes) and alliances for MDT
Source: BCG

MHDTs responsible for ~ 4% of Europe's GHG emissions

EU-27 GHG emissions by sector[1] (2019[2])



1. Excludes the sector "Land use, land-use change, and forestry" (-6.9%) 2. Most recent available study
Note: GHG = greenhouse gas
Source: European Environmental Agency (EEA), April 2021; BCG

Three major trends will drastically shape current market landscape

Focus

Electrification

Gradual replacement of ICE drivetrain with BEV and H_2 drivetrains

ZEV powertrain the next big change in MHDT sector

Digitalization

Increased relevance of digitalized controls and fleet monitoring

Push for telematics and fleet management systems

Autonomous vehicles

Increased activity and value potential in MHDT highly automated driving development

New highly automated driving vehicle concepts

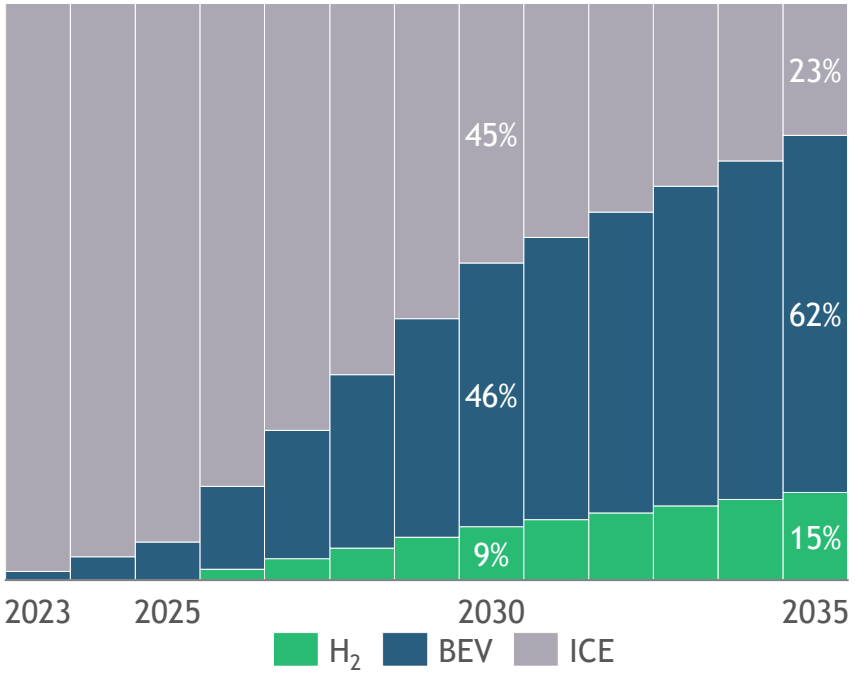
Source: BCG

Market perspective shows an expected rise to 55% ZEV in '30 and 77% ZEV in '35

2030	MDT[1]	HDT regional distribution	HDT long haul	Vocational	Total (2030)[3]
H_2[1]	0%	9%	14%	7%	9%
BEV	57%	49%	35%	52%	46%
ICE[2]	43%	42%	51%	41%	45%

BCG market perspective

Europe powertrain mix for new MDT/HDT sales



1. H_2 includes both H_2 ICE and FCEV 2. ICE contains diesel and xNG 3. Weighted by respective share of each type in overall sales
Note: TCO = total cost of ownership; H_2 = hydrogen; BEV = battery electric vehicle; ICE = internal combustion engine
Source: BCG market model

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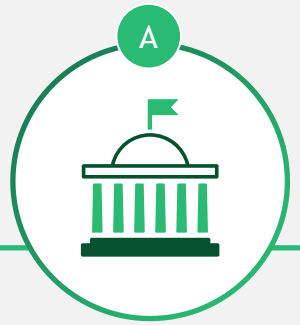
Shift to ZEV for MHDT mainly driven by four factors

A



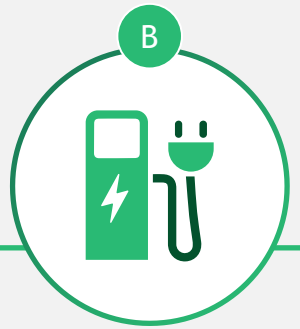
Regulation: MHDT CO_2 standards tightening further

EU set goal to reach **climate neutrality by '50**, addressing high-polluting sectors in particular

CO_2 reduction targets for MHDT in '30 to increase from **30% to ~ 45%** based on EU Commission proposal[1]

Call for additional intensification of **CO_2-reduction targets** to reach **100% by '35[1] (T&E case)**

B



Infrastructure ramp-up

AFIR[2] sets **legally binding nat'l and EU-wide targets** for deployment of alternative fuels infrastructure

Complete charging infra. coverage of TEN-T[3] core network to be completed by '30

Major players to invest in buildup of truck charging infrastructure (e.g., €500M by Milence, comprising Volvo, Daimler, and Traton)

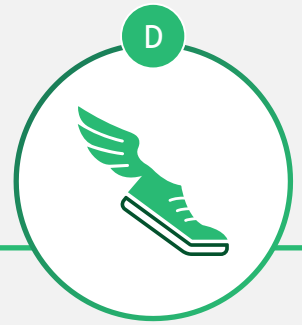
C

TCO shift toward ZEV

TCO for electric trucks to outperform diesel around **'25/'26** in Europe

BEV cost to decrease by over 40% until '35 (vs. '22), while range and charging capabilities improve

D



OEMs prepare for ZEV

ZEVs offered/announced by major OEMs—**33 BEV models** to be offered by European OEMs by '25

EU OEMs, incl. Daimler Truck, Scania, and MAN set **objectives to achieve 100% ZEV sales by '40**

Partnerships among OEMs formed to manage high R&D costs (e.g., e-mobility JV between Traton and Hino)

1. Compared to 2019 levels 2. Alternative Fuel Infrastructure Regulation 3. Trans-European Transport Network outlines strategic connections linking the most important nodes in Europe
Source: Company websites; EU Commission; T&E; BCG

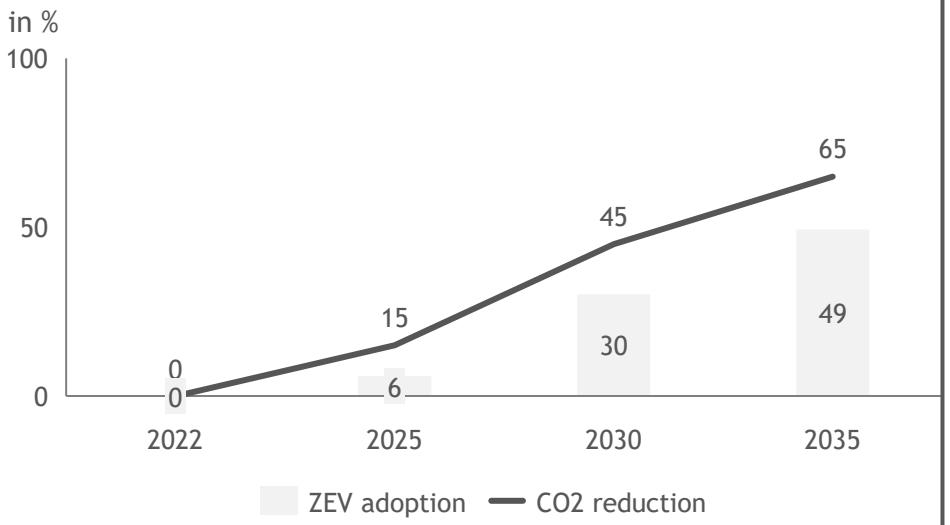
Regulation: With higher CO_2 standards, ZEV adoption could reach 97% by 2035

Regulations

These cases are the base for the GDP and emplyoment impact analysis in the next chapter

Base case:
Proposed EU Commission CO_2 standards[1]

EU targets mandate base level of average new fleet emissions

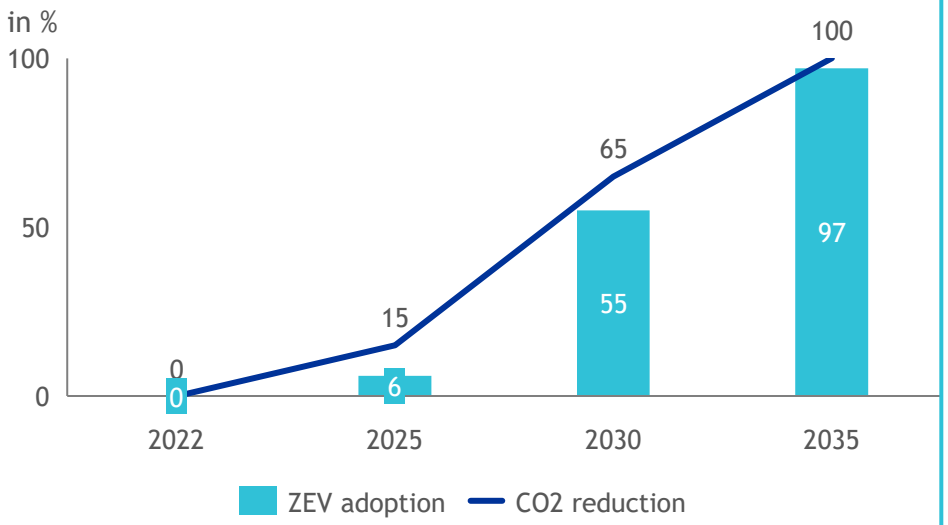


Tightened CO_2 emissions standards as proposed by the EU Commission in Feb. 2023 (approval pending—expected in 2024)

Case below current market perspective, used as minimum scenario for future adoption

T&E case:
Elevated CO_2 standards (beyond EU Commission)[2]

Stricter regulations to become CO_2 champion



Elevated CO_2 emissions standards leading to 97% ZEV adoption by 2035 across truck segments

Case assumes higher adoption than current market per-spective beyond 2030, making ZEV more attractive

1. Not covering unregulated MHDT segments (e.g., vocational, noncertified) 2. Incl. unregulated MHDT (under EU Commission)
Note: CO_2 reduction consists of both ZEV adoption, efficiency improvements of ICE MDHT, supercredits (until 2024), and benchmarked-based crediting systems (from 2025)
Source: T&E; BCG

Infrastructure: Mandatory deployment targets established via Alternative Fuel Infrastructure (AFIR) Regulation for road transport

EU Green Deal regulation to deploy alternative fuel infrastructure

European Green Deal: ambitious new law agreed to deploy sufficient alternative fuel infrastructure (AFIR)

Regulations

- **Every 60 km** along the TEN-T core network, MHDT charging pools of **at least 3,600 kW** must be installed **by 2030**
- **Four recharging points** in each safe and secure parking lot **by 2030**
- **H_2 refueling** infrastructure must be deployed by **2030** in all **urban nodes** and every **200 km** along the TEN-T core network

TEN-T[1] core network corridors

Network corridors	km
Baltic-Adriatic	2,410
North Sea-Baltic	3,800
Mediterranean	5,390
Orient-East Mediterranean	4,360
Scandinavia-Mediterranean	5,610
Rhine-Alpine	1,690
Atlantic	4,240
North Sea-Mediterranean	2,260
Rhine-Danube	4,540

Illustrative

- TEN-T[1] core network outlines strategic connections linking the most important nodes; expected to be completed by 2030
- Nine core network corridors (CNCs) identified to streamline development

1. TEN-T = Trans-European Transport Network
Note: Map only covers 9 strategic corridors of TEN-T—not exhaustive
Source: EU commission; T&E; BCG

TCO parity for ICE and BEV expected in 2025/26

Example HDT: Key assumptions on critical cost drivers

General (for all technologies):

• Annual mileage:	120,000 km
• Driver cost:	€50,000 p.a.

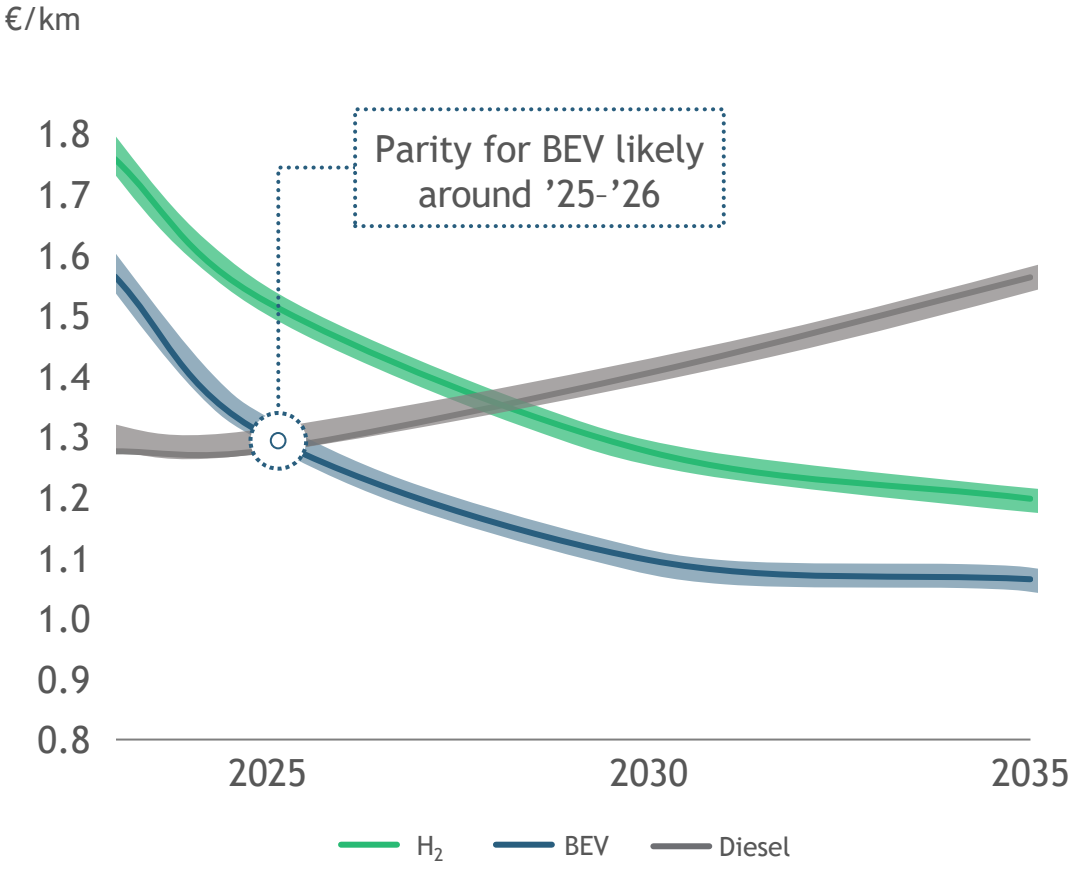
Powertrain costs:

	2023	2030	2035
• Batteries (€/kWh):	226	112	112
• FC (€/kW):	130	70	60

Fuel sources (excl. VAT)[1]:

	2023	2030	2035
• Diesel (€/l):	1.31	1.74	2.25
• Electricity (€/kWh)[2]:	0.28	0.23	0.20
• Hydrogen (€/kg):	11.50	7.00	7.00

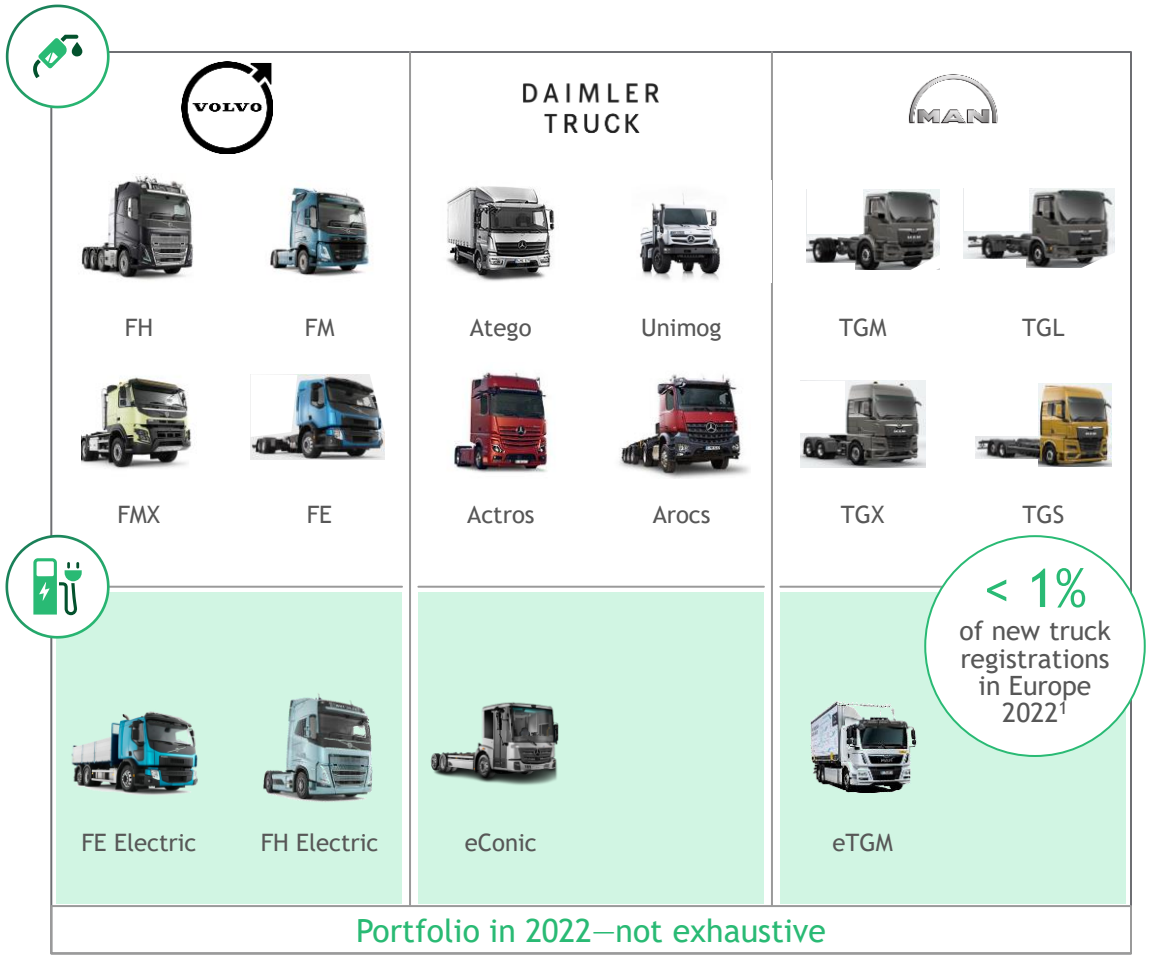
Total cost of ownership on HDT



1. Avg. price between Western and Eastern Europe 2. Price without surcharge, assuming up to 100% surcharge for public fast-charging services, leading to an end-customer price of up to 0.56€/kWh
Note: Energy costs assumptions: 2023 actuals; from 2025–28, return to pre-crisis levels by extrapolating historical growth rates with 2019 as the starting point
Source: BCG analysis

OEMs introduce first ZEV trucks in portfolio and announce further commitments

European OEMs offer first ZEV trucks …



1. 2022 new truck registrations for EU-27, UK, Norway, Iceland, and Switzerland
2. Announcements of Daimler, Scania, and MAN
Source: IHS; ACEA; company websites; BCG

… and communicate objectives for 2030 and beyond

Selected statements of OEMs

VOLVO	DAIMLER TRUCK	Scania	MAN
70% of new EU ZEV sales by 2030	60% of new sales ZEV by 2030	> 50% of new sales ZEV by 2030	50% of EU new sales ZEV by 2030

Objectives to achieve 100% ZEV sales by 2040[2]

OEMs are adapting their business models with partnerships emerging to manage high investments and R&D costs

Update: *Iveco fully acquires JV with Nikola on BEV and H_2 trucks to effectively buy out Nikola from European markets—yet ties remain (May 9, 2023)*

Jan 2022

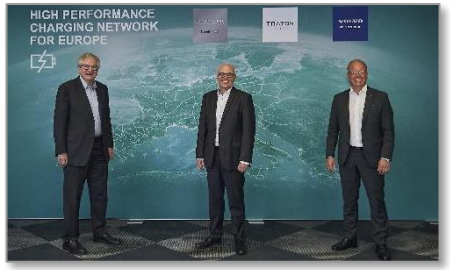
ISUZU and Cummins
FCEV collaboration

- Agreement to create a **prototype MD battery electric truck**
- Battery electric truck to be **introduced in North America**
- **First zero-emission solution** of partnership formed in May 2019

Jul 2021

Daimler, Volvo, TRATON:
Milence charging network

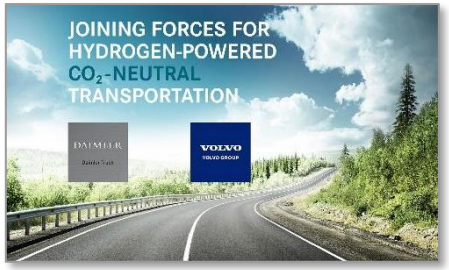
- 3 largest players agreed on developing & operating a **charging network**
- Agreement is basis for a **JV starting operations in 2022**
- Plan is to install **1,700**[1] charging points **within 5 years**



Nov 2020

Daimler and Volvo:
FCEV JV cellcentric

- **Volvo Group** acquired **50% of existing Daimler Truck Fuel Cell**
- Ambition is to become a **leading global manufacturer** of **fuel cells**
- Focus is on **development of fuel-cell systems** for use **in HDT**



Oct 2020

TRATON and Hino:
E-mobility JV

- **Hino** and **TRATON** drive sustainable transport with e-mobility JV
- Focus is on **BEV, FCEV,** and **EV platform** development
- Activities will be launched in **Sweden** first and then **Japan**

Sep 2019

IVECO, FPT, Nikola:
FCEV and BEV JV

- **IVECO, FPT,** and **Nikola** JV to achieve zero-emission transport
- Nikola provides **fuel-cell** and **advanced-technology** expertise
- IVECO contributes **eng.** and **manuf. knowledge** to industrialize ZEVs

1. High-performance charging points

Source: Company webpages; Reuters; BCG

Agenda

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2 Shift to ZEV and underlying key drivers

3 Impact of ZEV shift on European economy until 2035

4 Supporting the shift to zero emissions

5 Outlook: Emerging competition from new non-European ZEV players

Overall positive GDP and employment development along MHDT value chain in Europe 2035 versus 2022

Supplier

GDP

+3B — +6B

Jobs

+1K — +3K

Additional GDP and employment, driven by increase in battery cell production from new player base

OEM

GDP

+2B — +3B

Jobs

-18K — -35K

Increase in GDP, yet reduction in jobs due to phaseout of ICE engine production

ZEV infrastructure

GDP

+0.3B — +0.6B

Jobs

+3K — +6K

Additional GDP and employment to build charging infrastructure hardware

MHDT-related utilities[1]

GDP

+11B — +22B

Jobs

+25K — +55K

GDP and employment increase driven by shift from foreign-sourced fossil fuels to domestically produced electricity

Base case — T&E case

1. Assuming share of renewables from total electricity production ~ 88% in Europe in 2035
Note: Assuming no strategic changes to current OEM business model
Source: BCG

Depending on ZEV adoption rates, changes along MHDT value chain impact EU economy to different extents

Change in vehicle components, …

Supplier

- ICE transmission
- ICE engine periphery
- Battery cells
- E-motor (incl. inverter, trans.)
- Power electronics
- Fuel cell stack and tank
- Cab exterior and interior
- Electronics (control units, etc.)
- Axles incl. breaks
- Suspension
- Steering (gear, linkage)
- Wheels and tires

OEM

- ICE
- Battery module and pack (incl. BMS)
- Production value add

New/omitted components lead to redistribution of value creation and labor requirements in the industry

… infrastructure, and utilities due to ZEV

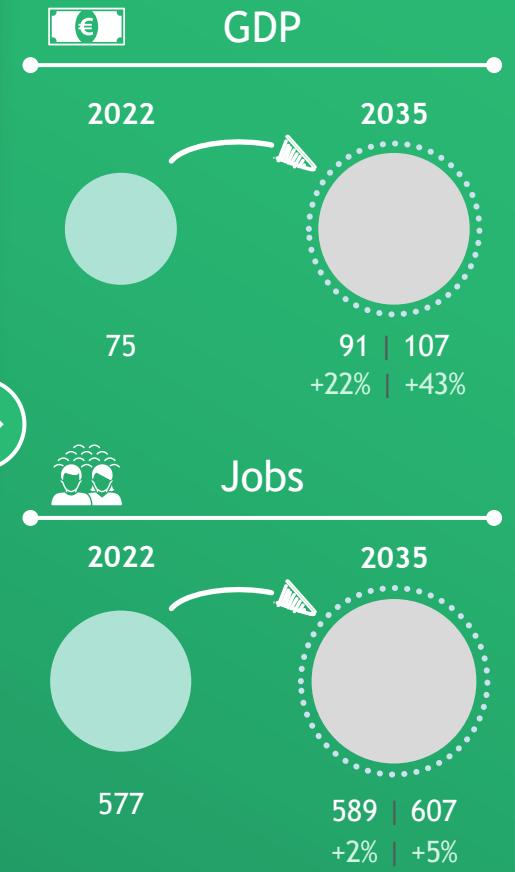
ZEV infrastructure

- Filling stations[1]
- Truck stop chargers
- Loading area chargers
- Depot chargers

MHDT utilities

- Fossil fuels
- Electricity, esp. renewables
- H_2

New infrastructure and MHDT-related utility need to support ZEV shift, adding to European GDP with high value add

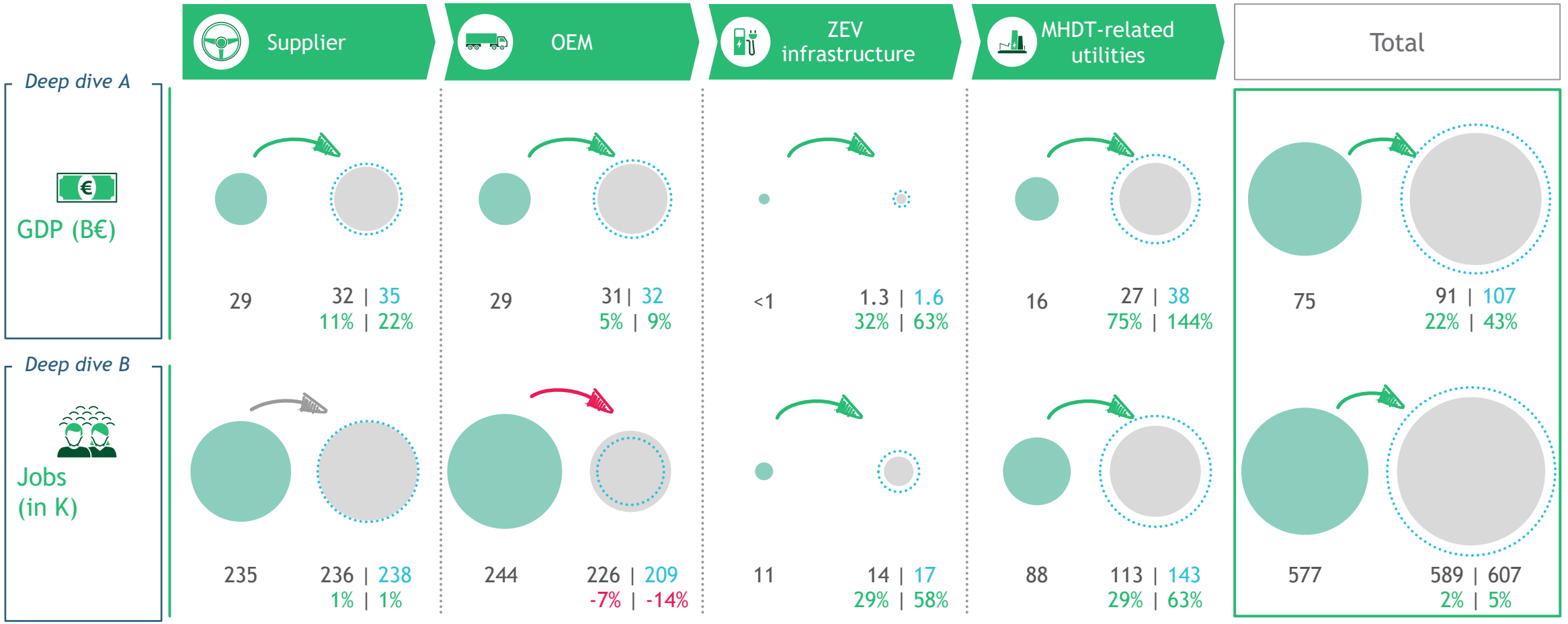


1. As a majority of the fleet remains ICE until 2035, no substantial change for filling stations associated with MHDT transition in considered time frame

Source: BCG

ZEV component · ICE component · Common ICE & ZEV

Shift to ZEV has potential to create up to €32B in GDP and 30K additional jobs in Europe by 2035 versus 2022



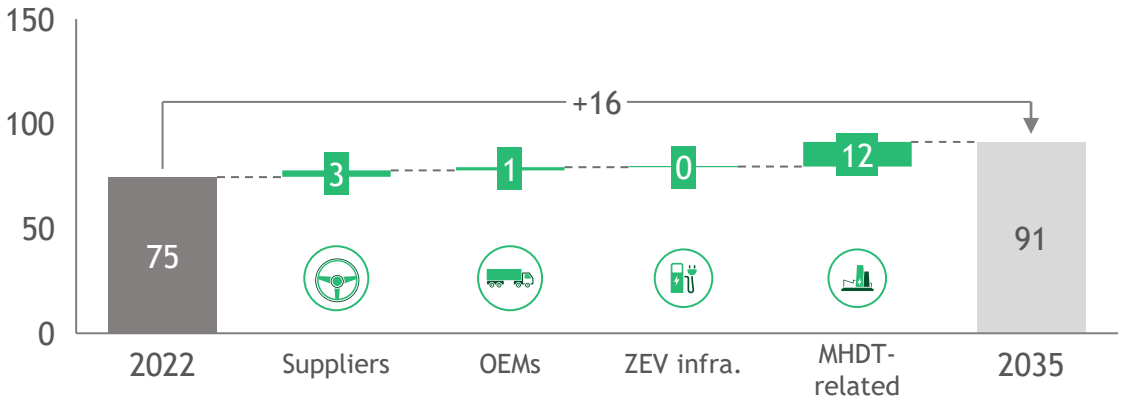
Note: Size of circles indicative; assuming no strategic changes to current OEM business model
Source: BCG

2022 Base case T&E case

Deep dive A (1/3): GDP increase of up to ~ €32B in Europe by 2035 possible, driven by significant uptake in energy sector

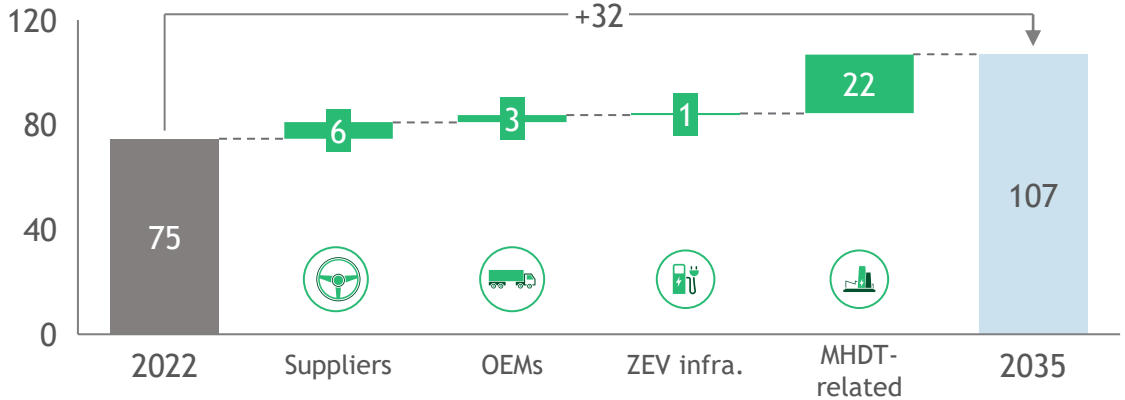
Base case:
Current EU commission proposal

GDP (B€)



T&E case:
Increased CO_2 regulations

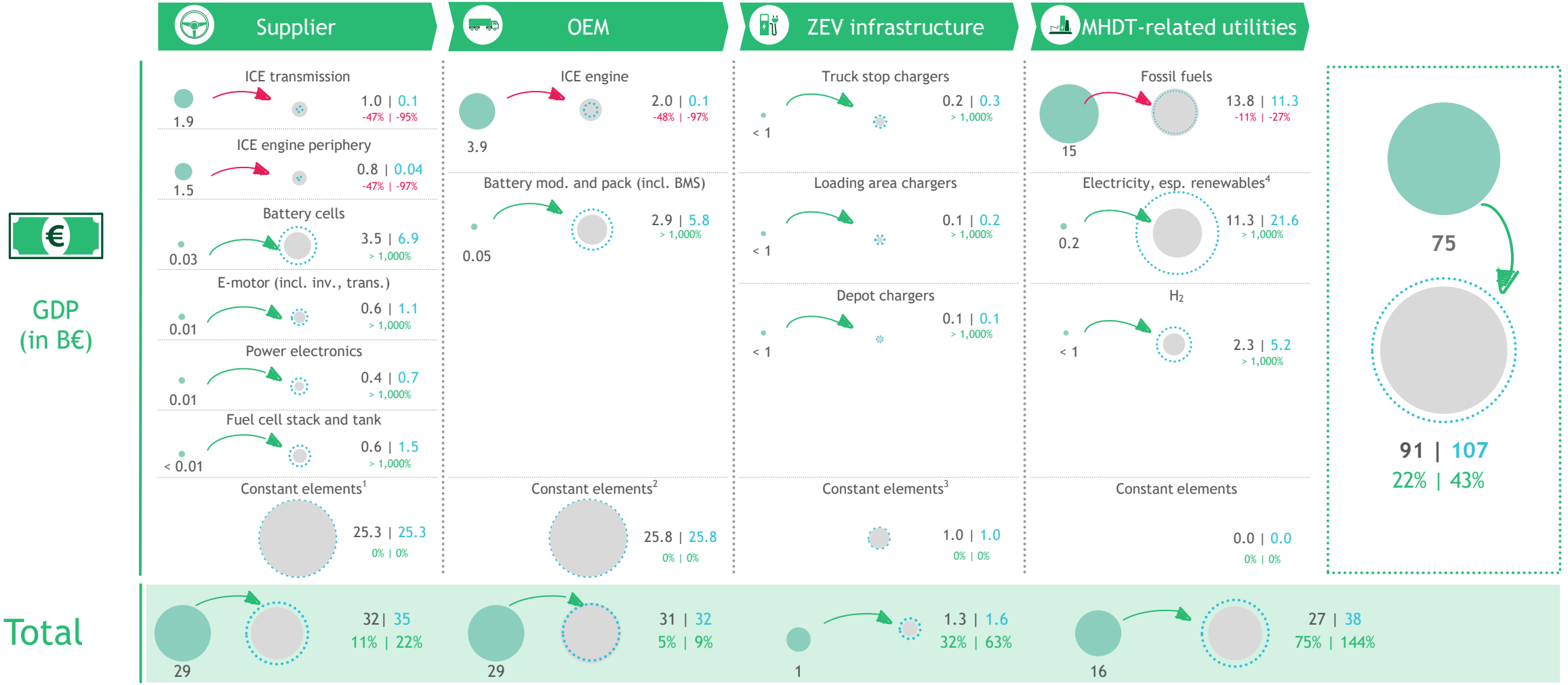
GDP (€ bn)



+3.1B	Higher GDP contribution from suppliers in Europe from 2022 to 2035, due to increased value generated via battery production	+6.3B
+1.4B	Marginally increased GDP at OEM associated with shift to ZEVs, driven primarily by production of battery module and pack	+2.8B
+0.3B	GDP increase based on new charging infrastructure hardware	+0.6B
+11.7B	Additional GDP created based on energy mix driven by shift from fossil fuels to (renewable) electricity produced primarily in Europe[1]	+22.5B

1. Assuming share of renewables from total electricity production ~ 88% in Europe in 2035
Note: Production volumes adjusted for cyclicality; assuming no strategic changes to current OEM business model
Source: BCG

Deep dive A (2/3): New GDP driven by increase in shift to (renewable) electricity and battery cell production; phaseout of ICE with dampening effect



1. Incl. core vehicle components and (after) sales of motor vehicle parts and accessories 2. Production value add (e.g., assembly, tooling) and nonproduction elements (e.g., SG&A, R&D), incl. (after) sales and maintenance 3. Incl. connected and platform services, transport solutions, resale, reuse, and recycling 4. Assuming share of renewables of ~ 88% in Europe in 2035
Note: Size of circles indicative Source: BCG

2022 Base case T&E case

Deep dive A (3/3): GDP contribution highly dependent on shift to domestically produced electricity and battery cells

OEMs

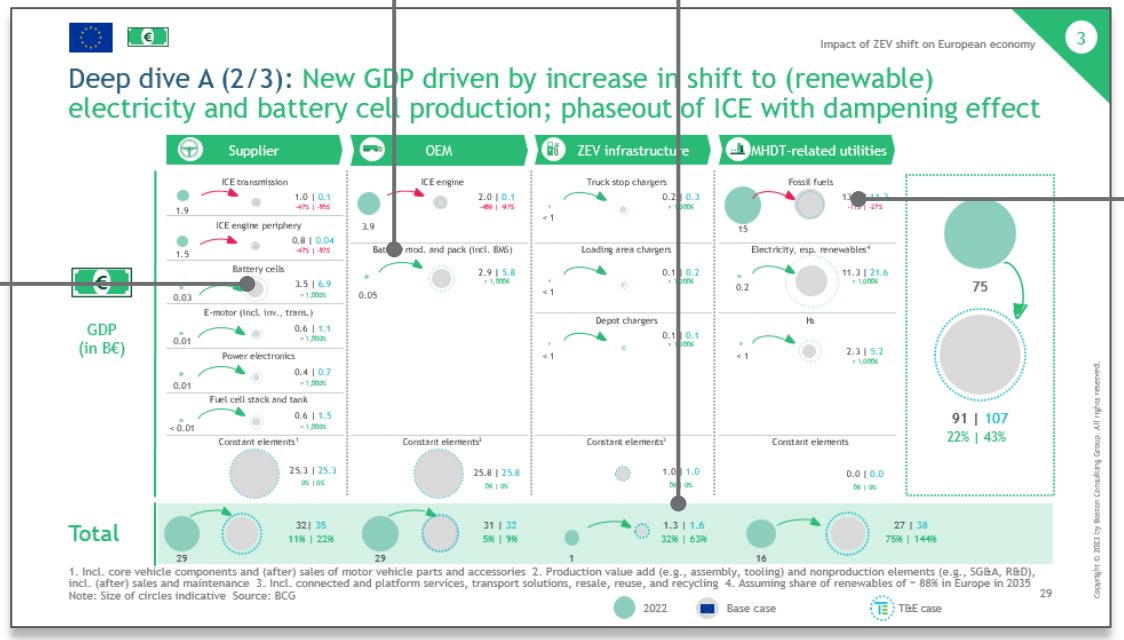
- **High-value battery module and pack production** enough to balance loss of €3.8B in GDP from ICE production

ZEV infrastructure

- **Truck charging infrastructure** required to run increasing ZEV fleet in 2035 creates **€0.6B** in additional GDP from ZEV infrastructure

Suppliers

- Up to **€6.3B add. GDP**, as increase in battery cell production overcompensates ICE losses
- Supplier GDP highly **dependent on domestic value add of ZEV components** (esp. battery cell prod.) in Europe



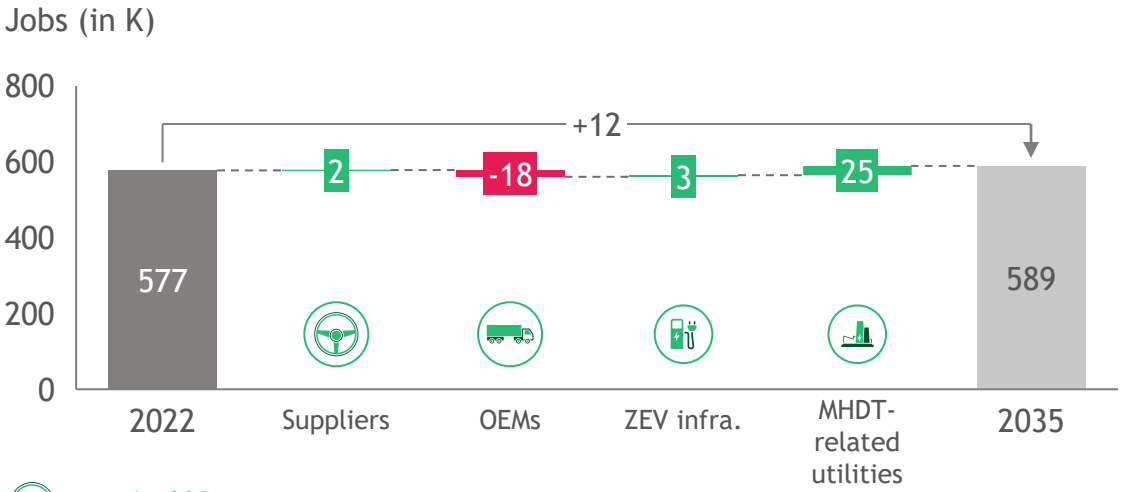
MHDT-related utilities

- Majority of up to **€22B net GDP contribution** from MHDT-related utilities driven by shift from foreign-sourced diesel to **domestically produced electricity**

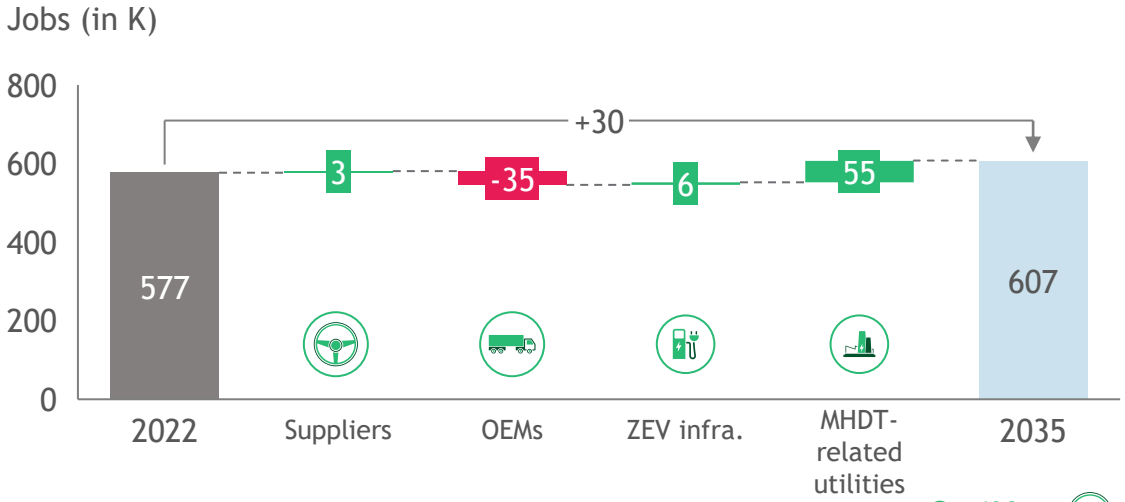
Source: BCG

Deep dive B (1/3): Shift to new energy sources drives job creation until 2035 in both scenarios, overcompensating job losses at OEMs

Base case:
Current EU commission proposal



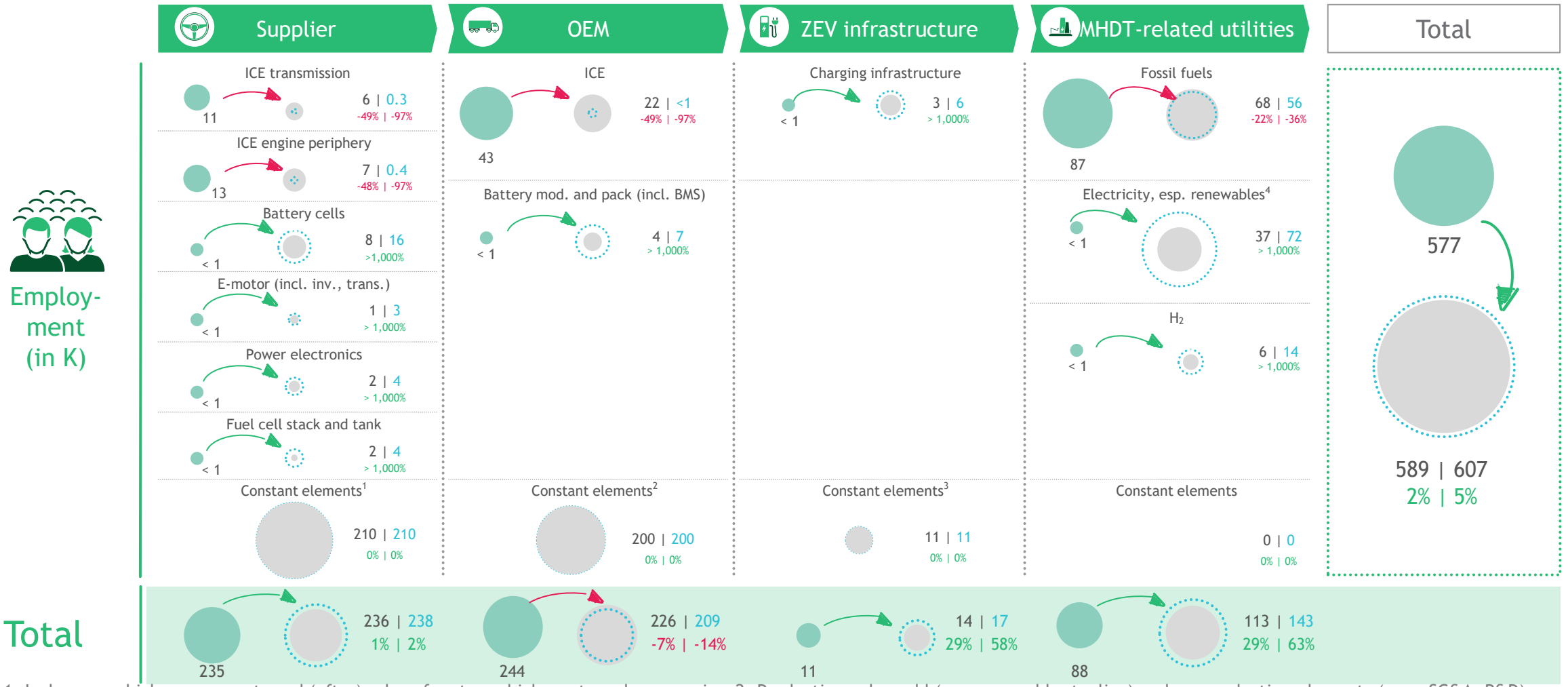
T&E case:
Increased CO_2 regulations



+1.6K	Additional jobs at suppliers based on increased battery production needs in Europe	+3.4K	
-17.7K	Jobs lost at OEM; increase in production of battery modules and packs cannot offset losses from ICE[1]	-35.1K	
+3.2K	Job increase driven by new charging infrastructure hardware	+6.2K	
+25.1K	Job increase based on energy mix driven by shift from fossil fuels to (renewable) electricity produced primarily in Europe[2]	+55.2K	

1. Assuming no further changes in business model 2. Assuming share of renewables from total electricity production ~ 88% in Europe in 2035
Note: Production volumes adjusted for cyclicality; assuming no strategic changes to current OEM business model
Source: BCG

Deep dive B (2/3): Job reduction due to shift from ICE overcompensated by new demands in MHDT-related utilities; major shift across value chain steps



1. Incl. core vehicle components and (after) sales of motor vehicle parts and accessories 2. Production value add (e.g., assembly, tooling) and nonproduction elements (e.g., SG&A, R&D), incl. (after) sales and maintenance 3. Incl. connected and platform services, transport solutions, resale, reuse, and recycling 4. Assuming share of renewables of ~ 88% in Europe in 2035
Note: Size of circles indicative Source: BCG

2022 Base case T&E case

Deep dive B (3/3): High value add of electricity production main driver for net employment gain, overcompensating losses from phaseout of ICE

OEMs

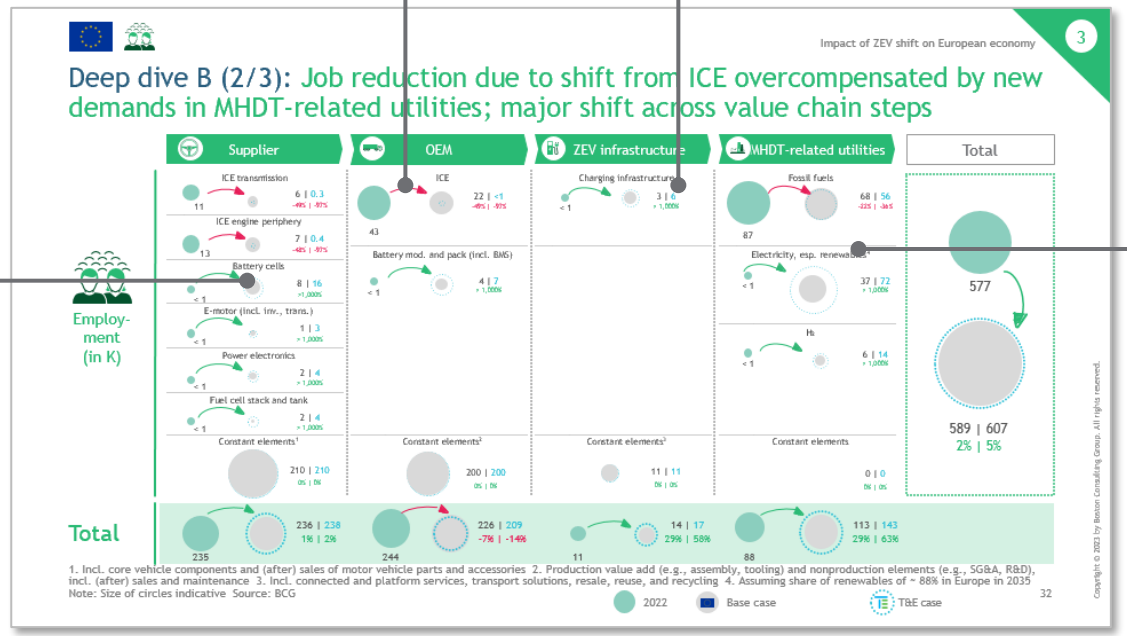
- Phaseout of ICEs leads to ~ **42K lost jobs** until 2035
- Due to **reduced number of parts** and **lower production complexity, battery and module** can only **replace ~ 16% of lost jobs at OEM**

ZEV infrastructure

- **No employment reductions from diesel infrastructure** (i.e., filling stations)—will continue operations to cater to ICE vehicles, comprising major share of truck fleet by 2035
- **~ 6K additional employees for** charging infrastructure hardware required to enable widespread ZEV usage

Suppliers

- **Net employment gain** based on production of BEV and H_2 components
- **Battery cell** represents key driver of employment gains, **compensating over 60% of lost ICE-related jobs**



MHDT-related utilities

- **Job increase** due to **electricity production** overcompensates losses from reduced diesel need required to run smaller ICE fleet in ’35
- **Higher domestic value add of (renewable) energy production** versus fossil fuels main driver for net job increase

Source: BCG

Agenda

1 Current state of the European truck industry

2 Shift to ZEV and underlying key drivers

3 Impact of ZEV shift on European economy until 2035

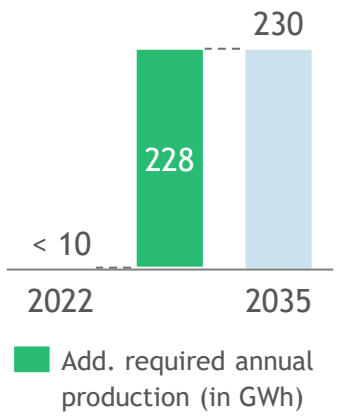
4 Supporting the shift to zero emissions

5 Outlook: Emerging competition from new non-European ZEV players

Various challenges across value chain to support shift to zero emissions

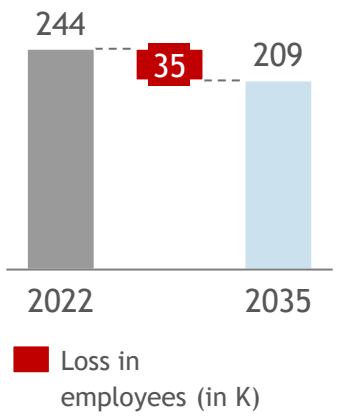
A Supplier

Battery cell ramp-up



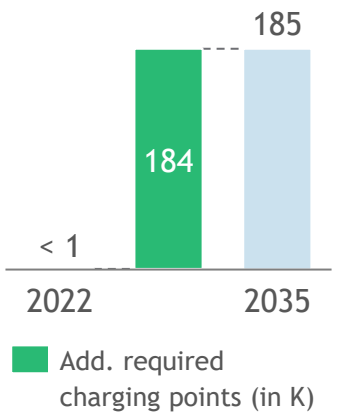
B OEM

Net loss of ~ 14% jobs, additional reskilling required



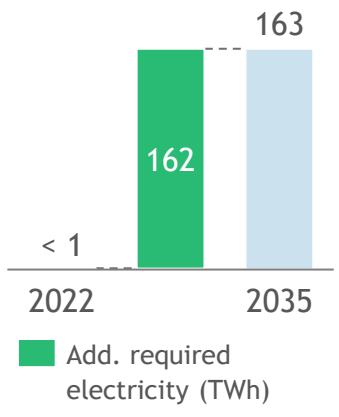
C Service provider

Setup of 200K charging points



D Utilities

Rising electricity consumption



1. Average gigafactory 45 GWh

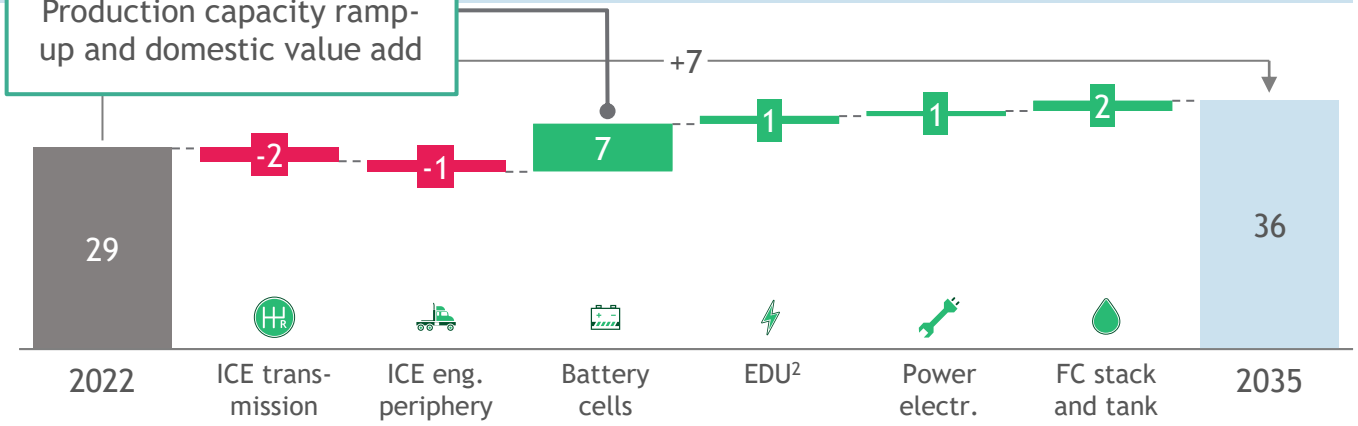
Source: RWTH Aachen Battery Atlas 2022; annual reports; International Trade Association; BCG

Supplier (1/2): ZEV shift brings new economic opportunities to suppliers; battery cell production being the main driver

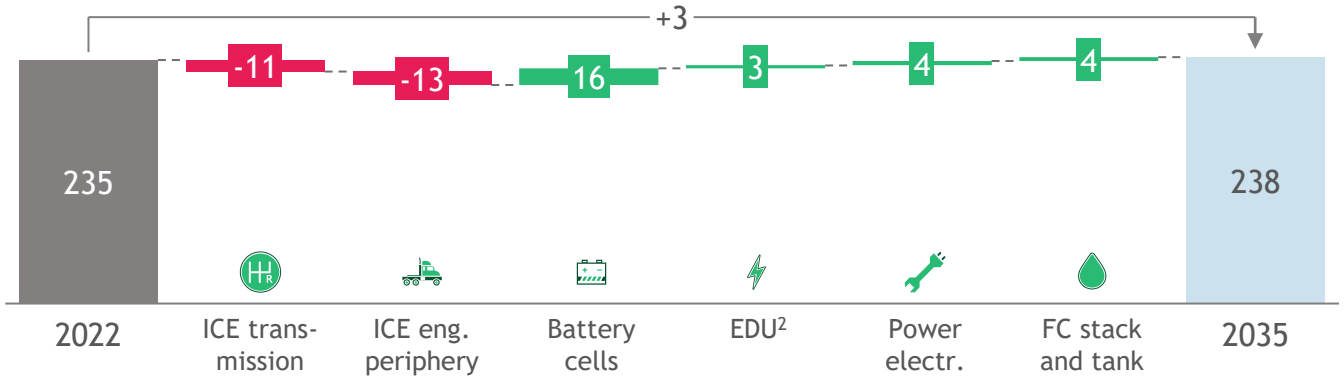
T&E case

Deep dive:
Production capacity ramp-up and domestic value add

GDP (B€)



Jobs (in K)



1. Excludes buses, coaches, and LDVs 2. EDU = electrical drive unit
Note: 2035 figures based on ZEV adoption in T&E case
Source: BCG

230 GWh
Battery cell production capacity need for ZEV[1] in 2035

70 jobs/GWh
For battery cell production in Europe in 2035

Supplier (2/2): Besides securing 230 GWh battery capacity in 2035, strengthening cell production key for resilient battery supply & contrib. to EU economy

2035: Battery key value-add lever to support MHDT industry

Share of battery production costs		Base scenario: Europe securing major share of cell production	Trailblazer scenario: Europe becoming battery champion
Total domestic value add		~ 47%	~ 72%
Battery module and pack[1] (1) (3)	24%	~ 85%	↗ ~ 95%
Cell production (1) (3)	46%	~ 60%	↑ ~ 95%
Raw materials (2) (4) (5)	30%	4%	↗ ~ 18%
Add. supplier GDP 2022 vs. 2035		+€7B	↑ +€13B
Add. supplier jobs 2022 vs. 2035		+16K	↑ +30K

Scenario used in study—figures for T&E case

Policies

Regulations

- ✓ **Net-Zero Industry Act:** Content requirements for batteries to enforce local production
- ✓ **Critical Raw Mat. Act** proposed in March 2023 addresses shortages and supplier concentration
- ✓ **Framework to secure sustainable supply of critical raw mat.**, supported by battery regulation's recycling and recovery requirements
- 1 **Taxes on import** of battery to increase attractiveness of local battery production
- 2 **Local sourcing requirements** for obtaining government contracts or licenses

Incentives

- ✓ **New tech support:** Country-specific schemes in comb. with Temporary Crisis and Transition Framework and Green Deal Industrial Plan[2]
- 3 Addl. tax incentives, subsidies, and grants to attract investment in battery infrastructure
- 4 **Grants to R&D activities** for innovative **raw material exploration and processing**
- 5 Support for accelerated build of **battery recycling infrastructure**

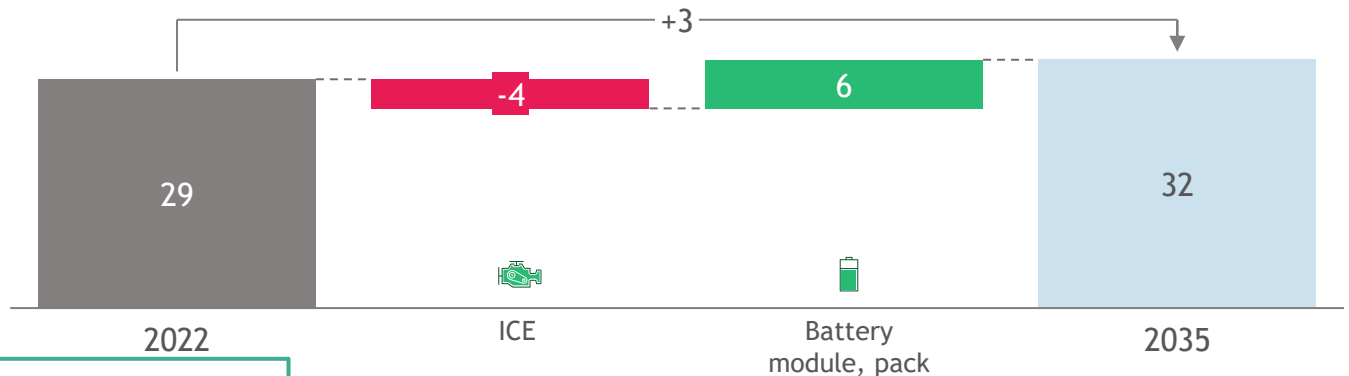
1. Battery mod. & pack covered by OEM, effects shown only for cell prod. & raw mat. at supplier 2. State aid valued at €837M granted to Spain for supporting battery prod. with loans & grants; Northvolt with support of ~ €500M in Germany 3. Assumptions for sensitivity demo
Source: Expert interviews; BCG

↑ Change from base case ✓ Existing policies x Addl. policy levers to support trailblazer scenario Value add in Europe[3]

OEMs (1/2): While GDP grows, job losses from ICE phaseout cannot be replaced fully by new ZEV parts

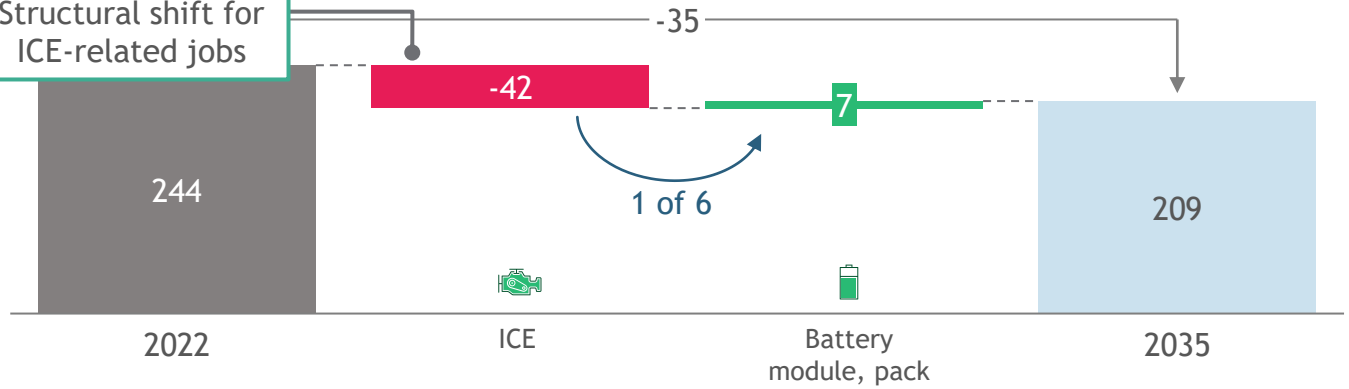
T&E case

GDP (B€)



Deep dive: Structural shift for ICE-related jobs

Jobs (in K)



Note: 2035 figures based on ZEV adoption in T&E case; assuming no strategic changes to current OEM business model
Source: BCG

35K jobs

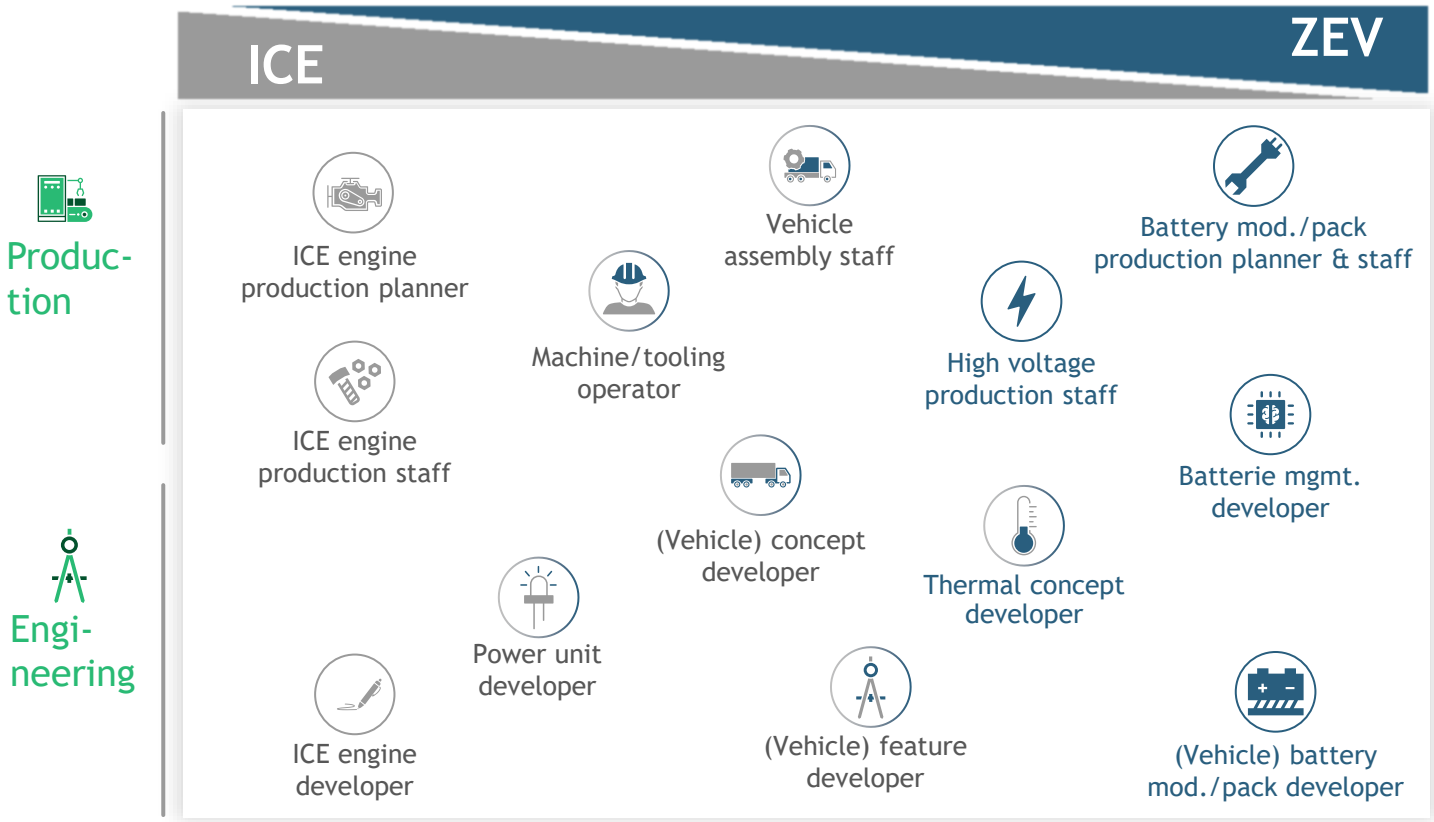
Net job loss driven by phaseout of ICE and reduced labor need for battery module and pack

1 in 6 jobs

ICE employees require reskilling to secure shift to battery module and pack production in 2035

OEMs (2/2): Structural changes create need for reskilling labor force

2035: 35K employees in major job families affected



Policies

Incentives

- **Green reskilling as part of Green Deal Industrial Plan**—e.g., via Erasmus+ initiative (€1.1B), European Skills Agenda
- **Social investment and skills window (SISW)**—support of supply and demand of skills (e.g., students, learners, and SMEs)
- **Recovery and resilience facility (RRF)** support with grants and loans for development of skills to support green and digital transition
- **(National) location-based reskilling program** supporting OEMs shift to ZEV and green production based on new job profiles

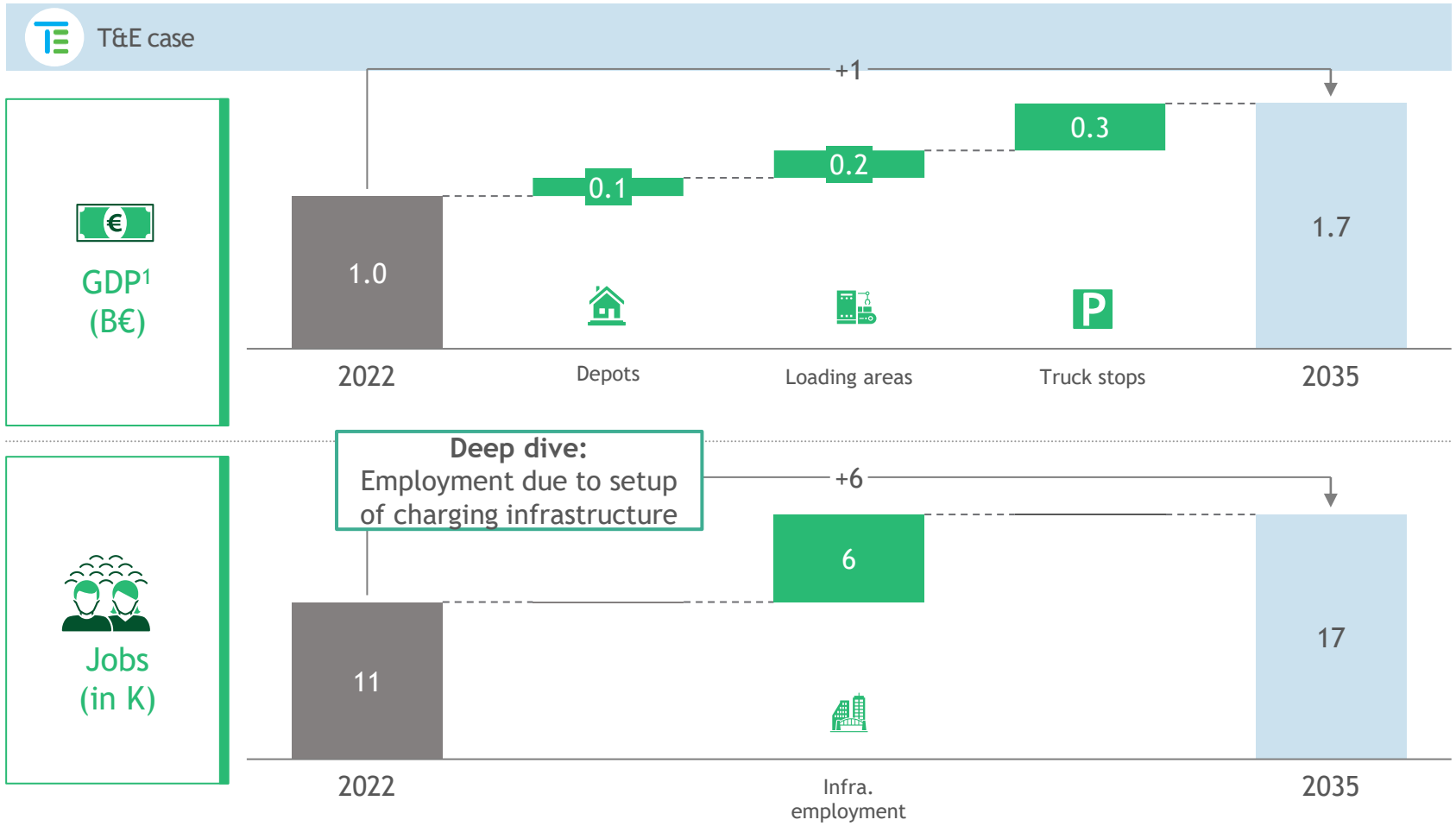
General trends affecting ICE jobs

- (Early) retirement schemes
- Remote and flexible work
- Demographic shifts

Note: Same applies to suppliers and utilities with significant changes in job demands and profiles taking place
Source: BCG

✓ Existing policies ! Addl. policy levers to enable smooth job transition

Infrastructure (1/2): Economic growth driven by buildup in charging infrastructure



1. Incl. connected and platform services, transport solutions, and resale, reuse, and recycling
Note: 2035 figures based on ZEV adoption in T&E scenario Source: BCG

€600 M GDP

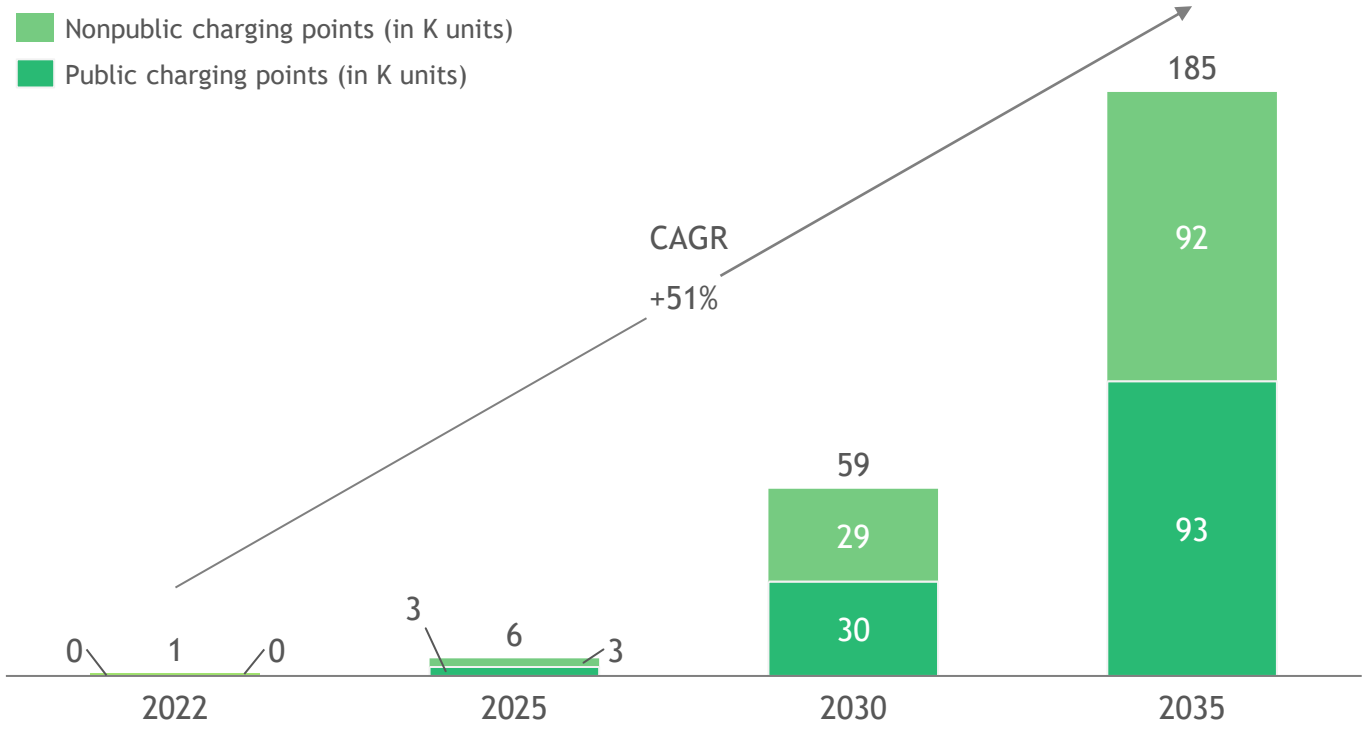
Additional GDP contribution from setup of charging infrastructure

6K jobs

Employment contribution from infrastructure reliant on BEV adoption rates

Infrastructure (2/2): Net ramp-up of charging infrastructure critical for capacity-driven road transport industry

2035: Fast growing number of charging points forecasted



1. Alternative fuel infrastructure regulation
Note: Assuming high-speed charger share of 70% for public charging points; CAGR = compound annual growth rate
Source: BCG

Policies

Regulations

- ✓ **AFIR**[1] requiring at least 3,600 kW MHDT charging pools to be installed every 60 km along TEN-T core network by 2030, supporting major buildup of charging infrastructure in Europe

Incentives

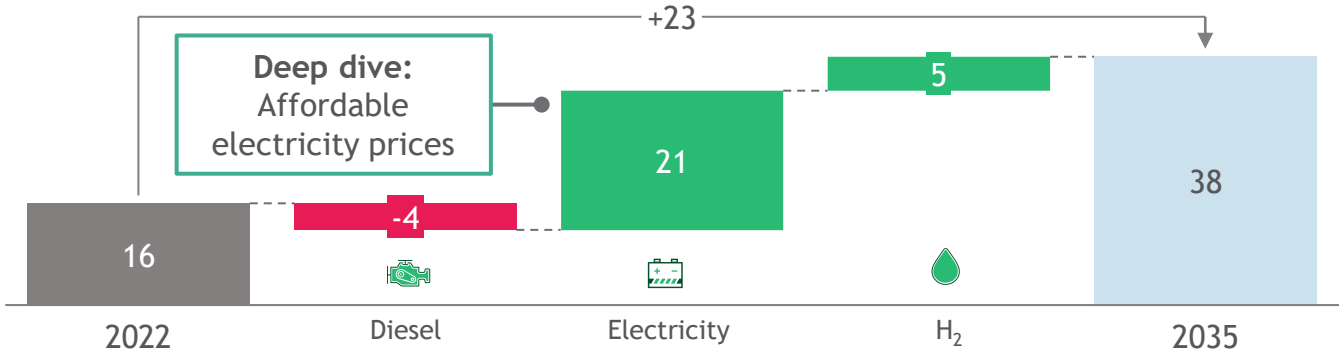
- ! Subsidies and grants to support charging infrastructure providers and SMEs regarding setup of fleet charging options
- ! Support setup of electricity grid as fundamental basis of infrastructure rollout (including light vehicles)

✓ Existing policies ! Addl. policy levers to enable deployment of charging infra.

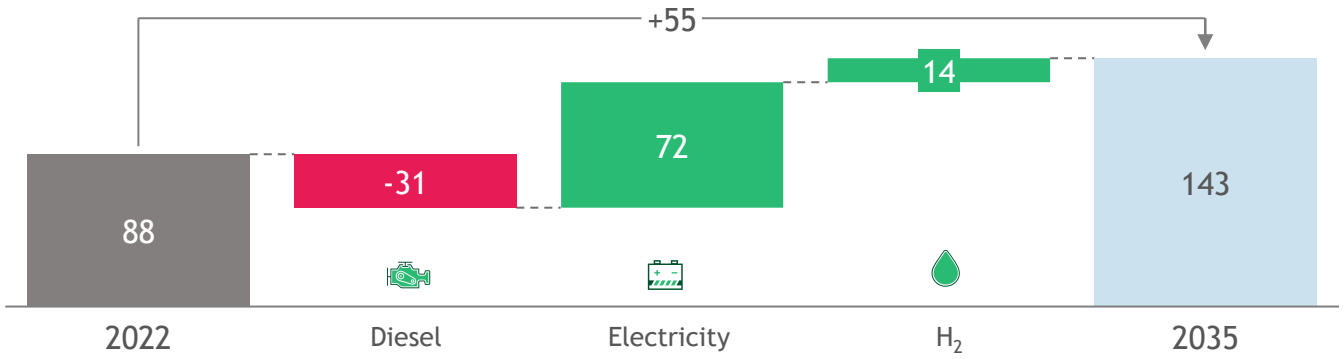
Utilities (1/2): GDP and jobs created by new energy needs; main driver electricity due to high value share in Europe

T&E case

GDP (B€)



Jobs (in K)



€4 B GDP

Diesel GDP loss due to shrinking diesel fleet and lower consumption

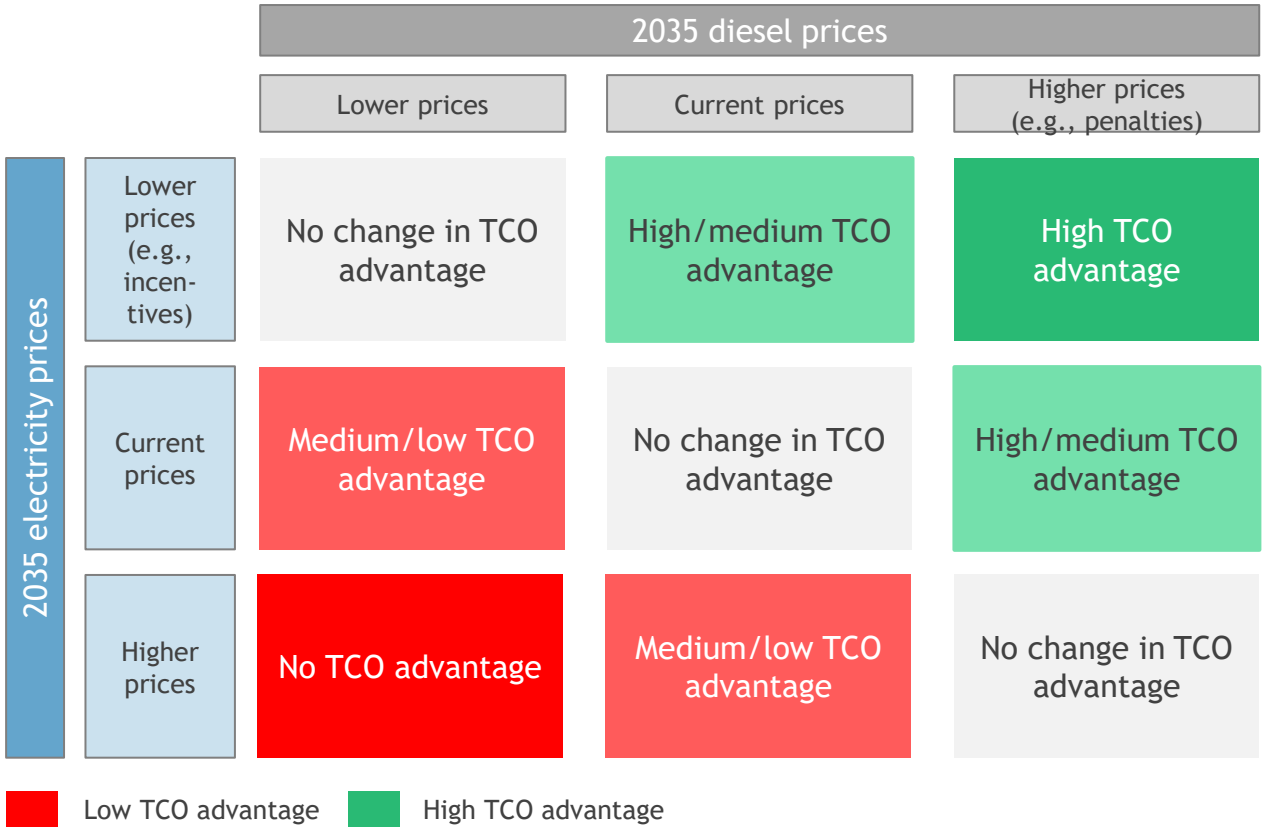
€21 B GDP

GDP contribution by electricity, driven by high value add in Europe

Note: 2035 figures based on ZEV adoption in T&E case
Source: BCG

Utilities (2/2): Contribution from electricity consumption reliant on affordable energy prices and value add versus diesel

2035: Sensitivity of TCO to energy prices



Source: BCG

Policies

Regulations

- **Net Zero Industry Act:** Strengthen manu-facturing capacity of net-zero technologies, overcoming barriers to scaling up
- **REPowerEU Plan:** Decarbonizing the industry by accelerating the switch to electrification and providing affordable energy

Incentives

- **Partial toll reductions:** Subsidies for BEVs, e.g., no road tolls in scale-up phase
- **Green subsidies:** No/lower cost for access to grid of renewable electricity
- **Wholesale prices:** Access to large scale electricity prices for smaller fleets

Existing policies
Addl. policy levers to enable smooth job transition

EU already with substantial mechanisms in place to support shift to ZEV

Not exhaustive

Regulations R	CO_2 reduction targets	**CO_2 emissions reduction targets** of **15% by 2025** and **30%** by **2030**[1]; case for stricter targets awaiting final approval		✓		
	Manufacturing ecosystem	**Net Zero Industry Act** to strengthening net-zero technology products, setting enabling conditions for batteries and energy with 40% domestic production benchmark by 2030	✓	✓		✓
	Battery supply	**Critical Raw Materials Act** addresses shortages for critical and strategic raw materials sets a 40% target for the local processing of these materials by 2030	✓	✓		
	Infrastructure	**Alternative Fuels Infrastructure Regulation** with complete TEN-T network coverage to be achieved by '30 with MHDT charging pools **at least 3,600 kW** to be installed every 60 km			✓	
	Energy	**REPowerEU Plan** diversifies EU energy supply by investing in renewables and securing affordable energy supplies				✓
Incentives I	Purchase subsidies	**National level subsidies** (e.g., Germany and Austria up to 80% of price delta to ICE truck; NL 45%)		✓		
	Road tolls	**Partial toll reductions** on natl. level (e.g., Germany €0/km until 2023, afterward reduced until 2040)				✓
	CO_2 pricing	**CO_2 price on transport fuels** increasing diesel prices and thus relative TCO adv. of ZEVs		✓		
	Tech funding	**New tech support** via e.g., NextGen EU (€800B), Horizon Europe R&D program (€40B)	✓	✓	✓	✓
	Skills funding	**Green reskilling as part of Green Deal Industrial Plan**—e.g., via Erasmus+ initiative (€1.1B), European Skills Agenda; **social investment and skills window (SISW)**	✓	✓	✓	✓

Common incentive along the value chain

1. Relative to 2019 level; stricter CO_2 standards revised for MHDTs based on EU commission case (Feb. 2023) of 45% by '30 & 65% by '35, applicable to trucks (> 5 t), city buses, long-distance buses (> 7.5 t), trailers; final approval still pending; additional targets set on national level

Source: BCG

✓ Regulations & policies supporting ZEV shift

Agenda

1. Current state of the European truck industry
2. Shift to ZEV and underlying key drivers
3. Impact of ZEV shift on European economy until 2035
4. Supporting the shift to zero emissions
5. Outlook: Emerging competition from new non-European ZEV players

Global trend toward ZEV challenges traditional market structures, offering new players opportunities to enter into the European truck industry

A

Technology shift is enabler for market disruption

Shifts in technology and business model open up opportunities for new players in the market, incl. non-European truck manufacturers

B

Exports are starting point for new players, moving toward localization

Depending on home-market cost structure, localization becomes crucial for long-term dominance for non-European players, but requires minimum volume of ~ 5-10K vehicles p.a.

C

Three scenarios for the rise of non-European players foreseen

Overall impact of non-European ZEV players on GDP and employment depends upon the concrete scenario, esp. number of entrants, localization degree, etc.

Source: BCG

ZEV shift is accelerating fast, impacting traditional MHDT OEMs

Market trends

Core MHDT market is tougher, growth shifts to Asia, rules of the game being redefined

MHDT market maturing, limited growth in Europe

Temporary volume shocks due to COVID and semiconductors

New valuations emphasize the transition

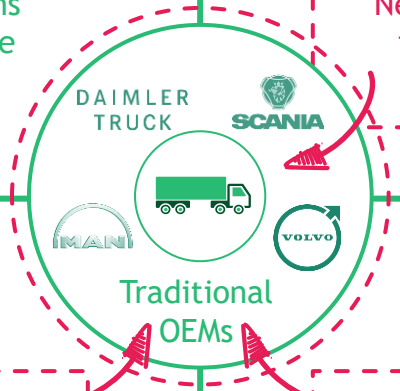
Technological development

Rapid tech development forces large investments and redefinition of industrial operations

New powertrain technologies accelerating

Digital solutions gaining speed

Autonomous vehicles maturing



External forces

Sustainability and environment top of the agenda, through both push and pull forces, accelerating the shift

Push from regulations and standards

Geopolitical implications

Sustainability and climate pull from customers

Value drivers and business models

Profit pools shift toward new business models, where the right to win is not as given for traditional OEMs

New ZEV competition—often driven by new entrants from US & CN

Value pools are shifting toward new technologies

Customer landscape is changing

Source: BCG

New ZEV competition expected mainly from new market entrants

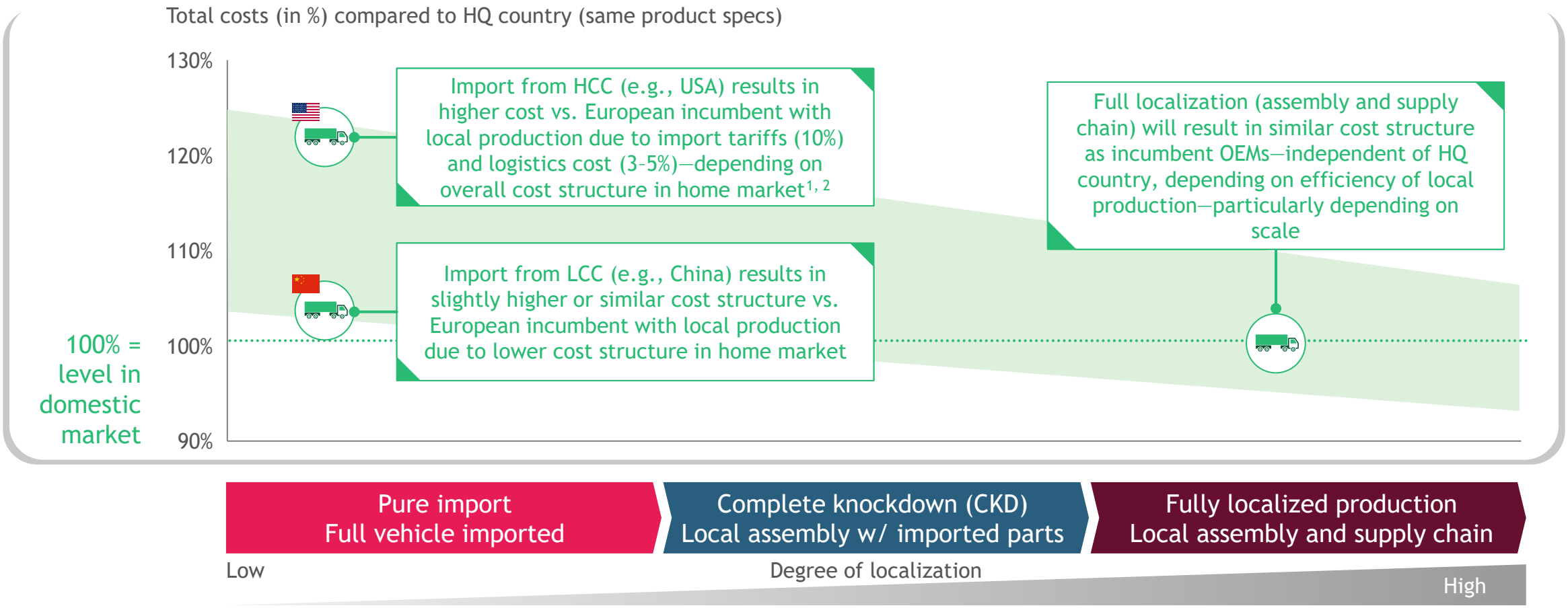
Not exhaustive

Potential candidates for entry into European MHDT market

Company	HQ	xEV portfolio	Highlights of what is known	Year established
TESLA	US		• Preorders from UK, Netherlands, and Norway, no delivery date disclosed	2003
NIKOLA	US		• Developed electric and hydrogen truck eligible for European market, recently sold European stake to IVECO	2015
BOLLINGER MOTORS	US		• Main BEV presence currently in the US	2015
XOS	US		• Main BEV presence currently in the US	2020
LION ELECTRIC	CA		• Currently in production but only available to North American market as of yet	2008
BYD	CN		• Presented MHDT designed to enter European market at IAA in 2022	2003[1]
WINDROSE	CN		• Developed native NEV-truck aiming for US and Chinese markets	2002
HYUNDAI	KR		• Hyundai expands its hydrogen fueled truck fleet in Europe	1967[2]
...	...	...	...	...
New European Players				
TEVVA	UK		• Tevva started in UK, recently expanding into mainland Europe	2012
VOLTA	SE, EU		• Production partnership with Steyr, supplying Schenker with ~ 1,500 trucks	2017
einride	SE, EU		• Partnered with Scania to deliver 110 trucks primarily for Swedish market	2016
QUANTRON	DE, EU		• Partnerships with NEUMAN & ESSER in Germany, and Ballard Power Systems in Canada	2019
...	...	...	...	...

1. BYD founded in 1995 as battery manufacturer, entered automobile business in 2003 2. Announced H2 MHDT offering for Europe in 2020
Source: Press releases

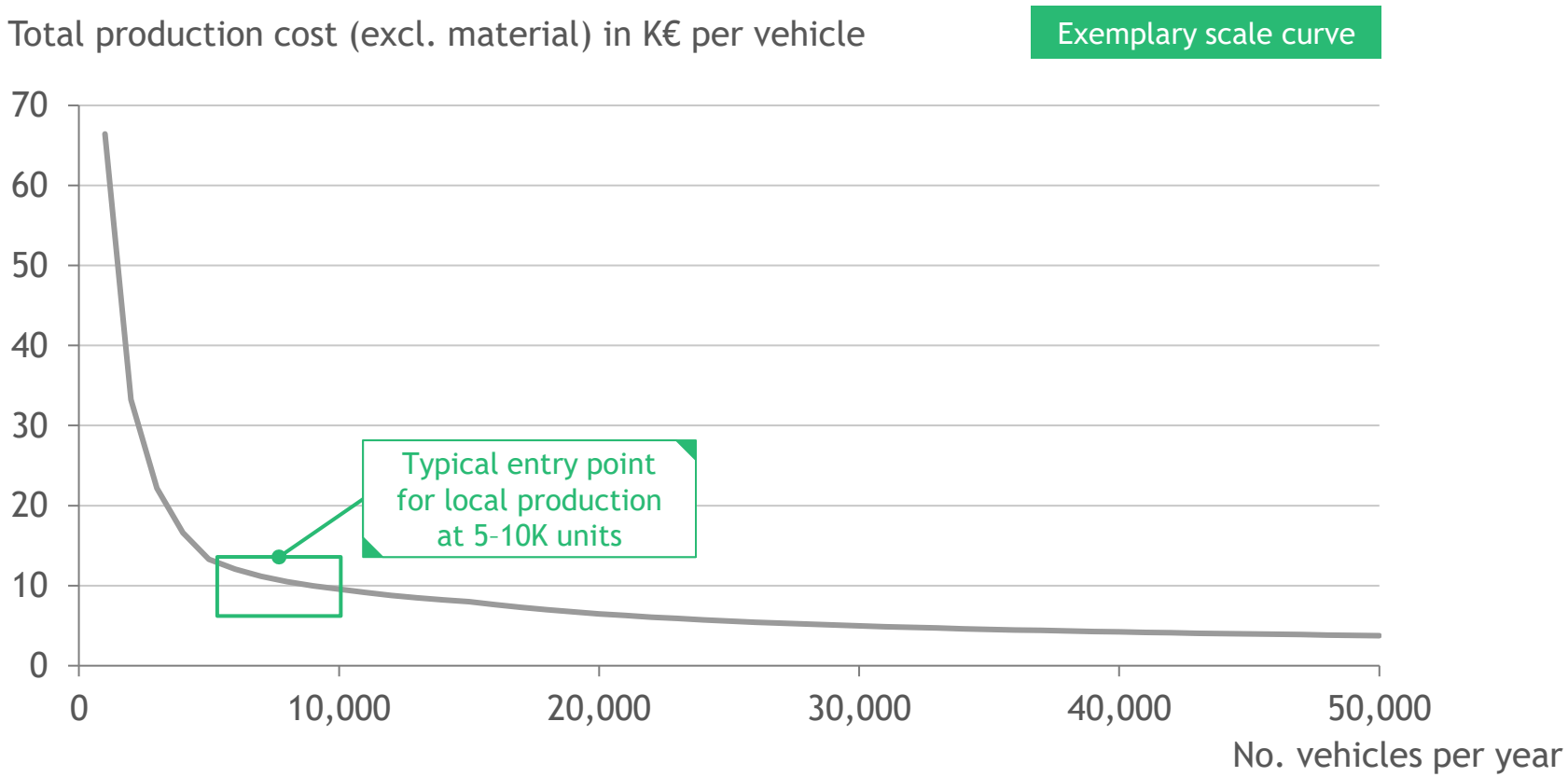
Exports are typically starting point for new players, moving toward localization



1. Under IRA subsidies, US likely to be in lower range of scenario 2. Tesla Semi likely to fall under 16% tariff being categorized as road tractor
Note: HCC = high-cost country, LCC = low-cost country
Source: BCG

Localization requires minimum volume of 5-10K units p.a. to reach efficient production levels

Typical scale curve for MHDT production



Source: BCG

Production cost significantly declines per vehicle until 5-10K units per year

If respective volume is in sight, players typically shift to local assembly (CKD) and start to localize supply chain

Reasons and barriers for entering the European market

Key reasons to **enter** European market

Supply shortage: European incumbents do not fulfill high ZEV demand, attracting new players to fill the gap

Technological advantage: New players entering with advanced offering (e.g., range, performance) outperforming incumbents

Supply chain advantage: New players may have access to potential scarce resources than incumbent OEMs

Cost advantage: Potentially lower cost structure besides tariffs and logistics cost of new players

Potential lead market: Current regulation could make Europe front-runner for BEV truck market (versus USA)

Key **barriers** to European market entry

Development effort: Homologation and product adaptations needed to fulfill European needs

Low-margin market: Overall low margins realized in recent years in Europe

Trade barriers: Tariffs (also if lowered) may make imports (temporarily required to establish brand) less attractive

Service/aftermarket network: Need to offer dense network of workshops and spare part supply

Sales network and customer relations: Long-standing customer relations[1] limit market potential for new players

Investments at risk: High investments needed to establish market presence but limited guarantee to succeed

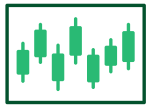
1. Brand stickiness in MHDT market lower than in light vehicle market due to focus on TCO
Source: BCG

Three scenarios considered for non-European player market entry

	0 Defend	I Fully localized production	II Local assembly with partial local sourcing	III Import-based competition
Assumption	Baseline scenario, assuming no new compe-tition	Two players establish in market and transition to fully localized production from import-only model. Peak import to be expected around 2030. Long-term only limited vehicle import to Europe	Two players established in market and transition toward local production with CKD model. Long-term only little whole vehicle import to Europe	No entrant can achieve sufficient market share to establish local production: Also in medium- to long-term only imports at relatively low levels
Mkt shr. '35[1]		-11% (thereof 1% vehicle import)	~ 8% (thereof 1% vehicle import)	~ 3% (all vehicle import)
Localization approach		After achieving sufficient market share (2-3%), start to localize assembly and supply chain to achieve similar cost structure as incumbents, targeting full localization	After achieving sufficient market share (2-3%), start to localize assembly and partially also supply chain (50% of incumbent OEM levels). Limited further growth prevents from full localization	No localization, full import
		Peak (2028) / 2035	Peak (2029) / 2035	Peak (2035) / 2035
GDP (B€)		-1.6 / -0.4	-1.8 / -1.4	-1.2 / -1.2
Jobs (K)		-11.3 / -1.6	-12.3 / -7.4	-7.6 / -7.6

1. Assuming upper range in following analyses for more prominent results 2. In high adoption case versus 2022
Source: BCG

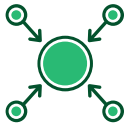
Underlying foundations and assumptions for market entry scenarios



GDP and employment effect of scenarios calculated against base scenario, i.e., no competition from abroad

Underlying base is the current BCG market perspective (see chapter 1), which showcases a median trajectory between the two regulatory scenarios (Base case and T&E case)

Start of local assembly derived from truck production scale curve (see section 5B) and transition period toward full local assembly assumed to take 5–7 years



Number of entrants estimated based on today's potential entrants and competitive dynamics in European truck market (saturated, low-margin, BEV technology already available, etc.)

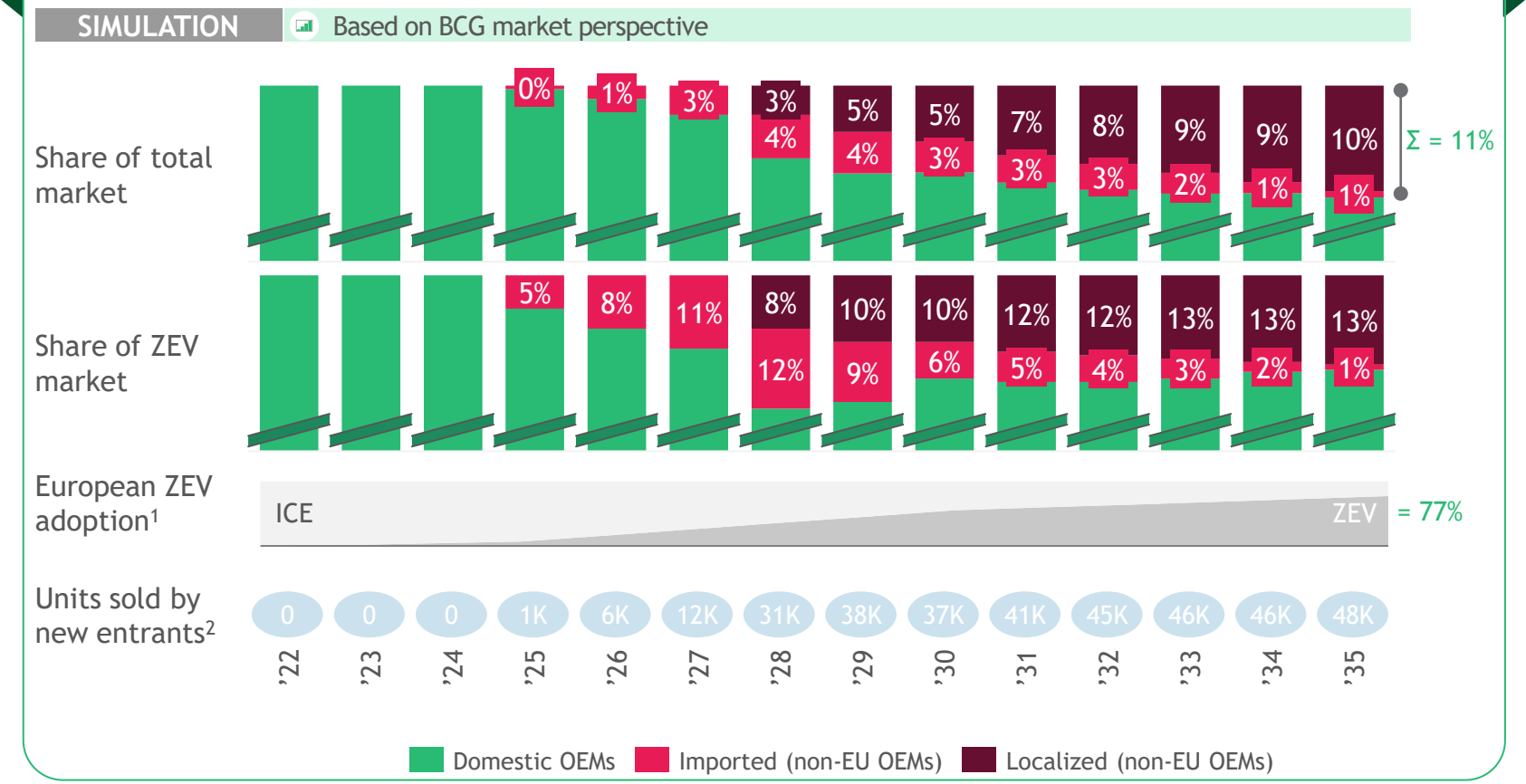
Focus of GDP and employment calculations is on OEMs and suppliers. ZEV infrastructure and MHDT-related utilities assumed stable with/without new entrants

Source: BCG

Fully localized production (1/2): New player market share of 11% in 2035, assuming two fully localized new entrants

I Fully localized production

SIMULATION | Based on BCG market perspective



1. Underlying ZEV adoption in new-vehicle sales 2. Units sold for upper market-share range in each scenario
Source: IHS Automotive; BCG

Few new players enter market with import model first

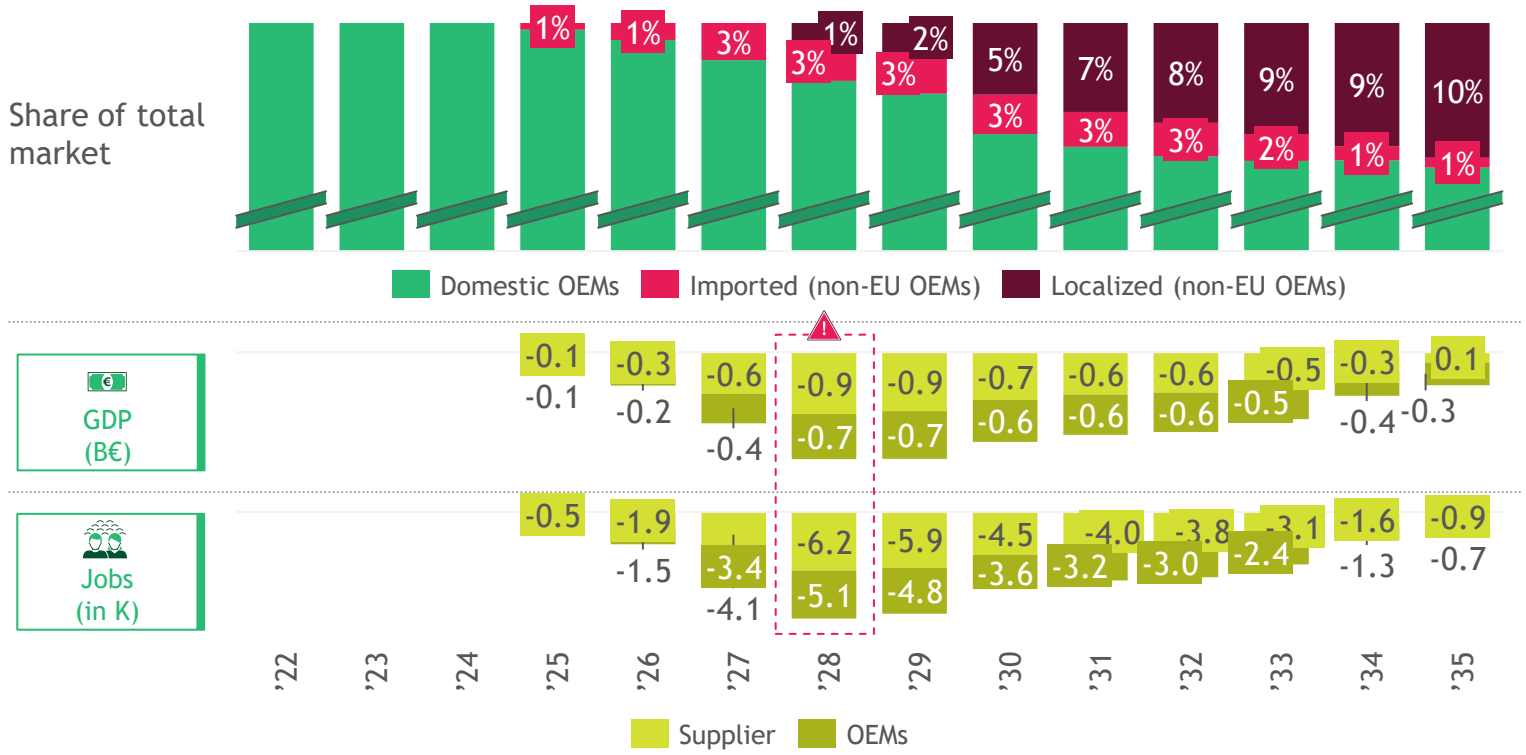
Two players can establish in market and transition to fully localized production when volume of ~ 5K units p.a. is in reach

Leaving limited window of opportunity for additional competition through import (only 1% market share long-term)

Fully localized production (2/2): Intermediate dip in GDP and employment during “import peak” with recovery after

I Fully localized production

SIMULATION | Based on BCG market perspective



2028
-1.6B

2035
-0.4B

GDP decrease during import peak temporary up to 1.6B

2028
-11.3K

2035
-1.6K

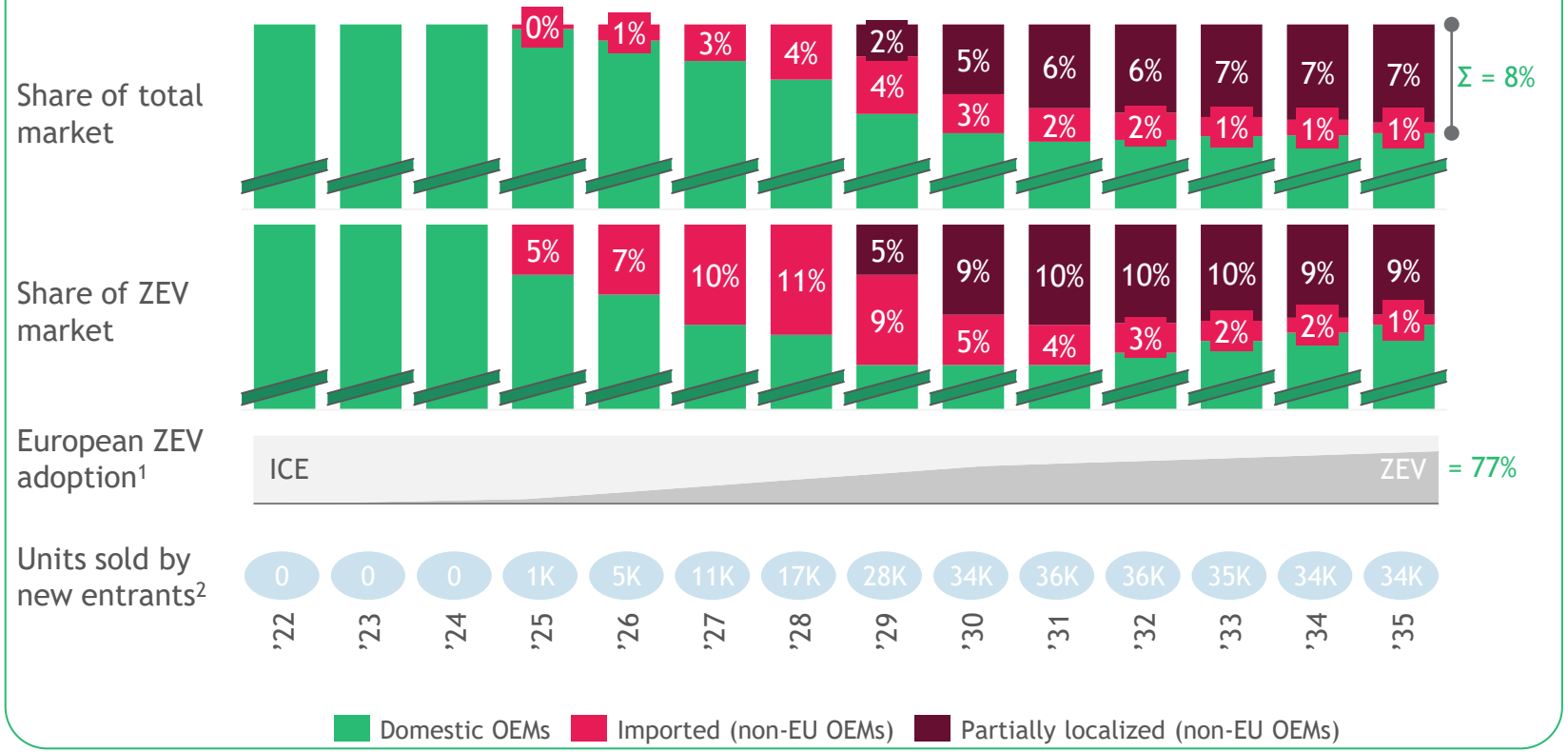
Employment losses throughout import phase up to 11.3K

Source: IHS Automotive; BCG

Local assembly w. partial local sourcing (1/2): New player market share of 7% expected in 2035, w. partial localization

II Local assembly with partial local sourcing

SIMULATION | Based on BCG market perspective



1. Underlying ZEV-adoption in new-vehicle sales 2. Units sold for upper market-share range in each scenario
Source: IHS Automotive; BCG

Few new players enter market with import model first

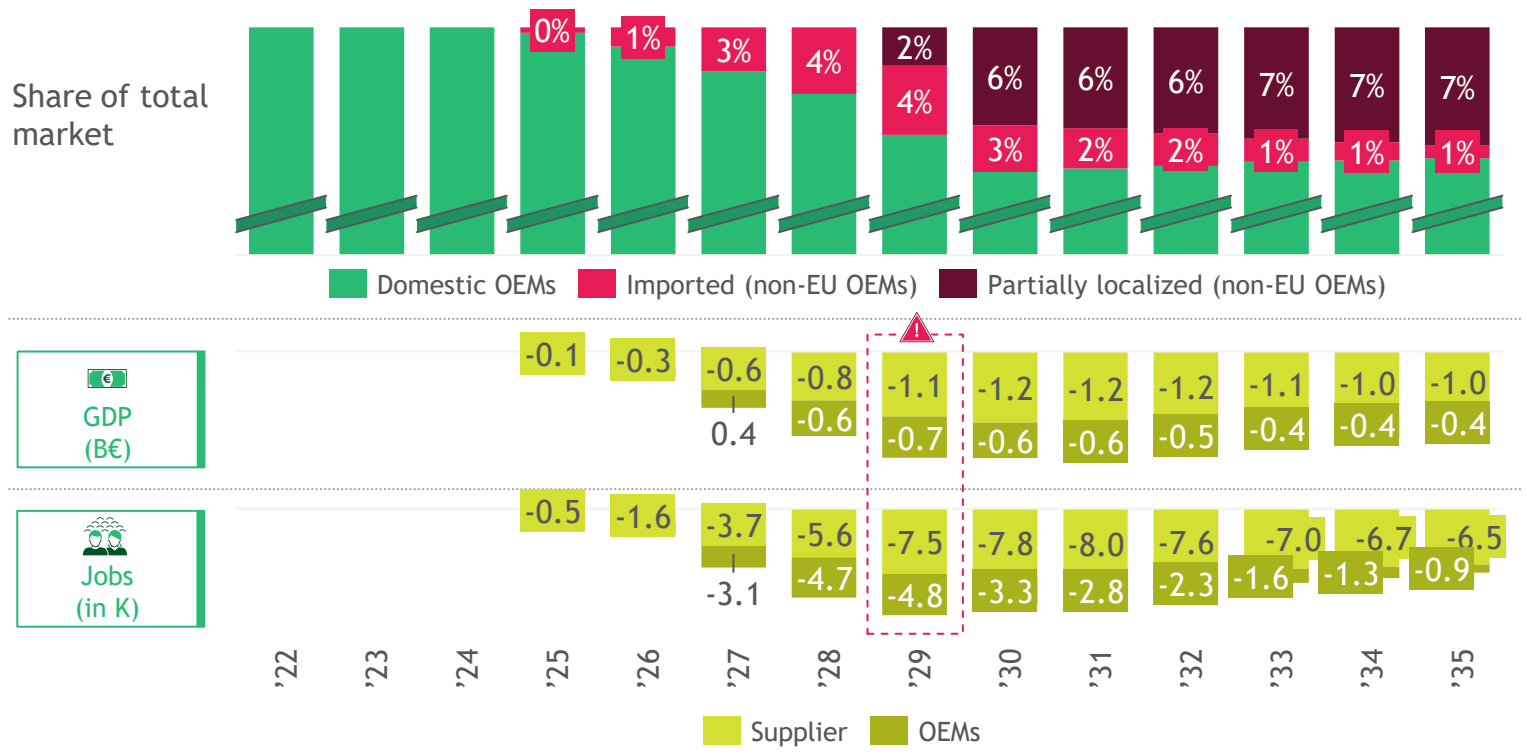
Two players can get established in market and partially transition toward local production, however they don't fully localize. Localization of supply chain reaches 50% of incumbent's level

Vehicle import very low in long term, as new players and incumbents leave little room

Local assembly w. partial local sourcing (2/2): Substantial decline in GDP and jobs if supply chain is not localized

II Local assembly with partial local sourcing

SIMULATION | Based on BCG market perspective



2029 **-1.8B**

2035 **-1.4B**

GDP decrease during import peak in 2030 temporary up to 1.8B

2029 **-12.3K**

2035 **-7.4K**

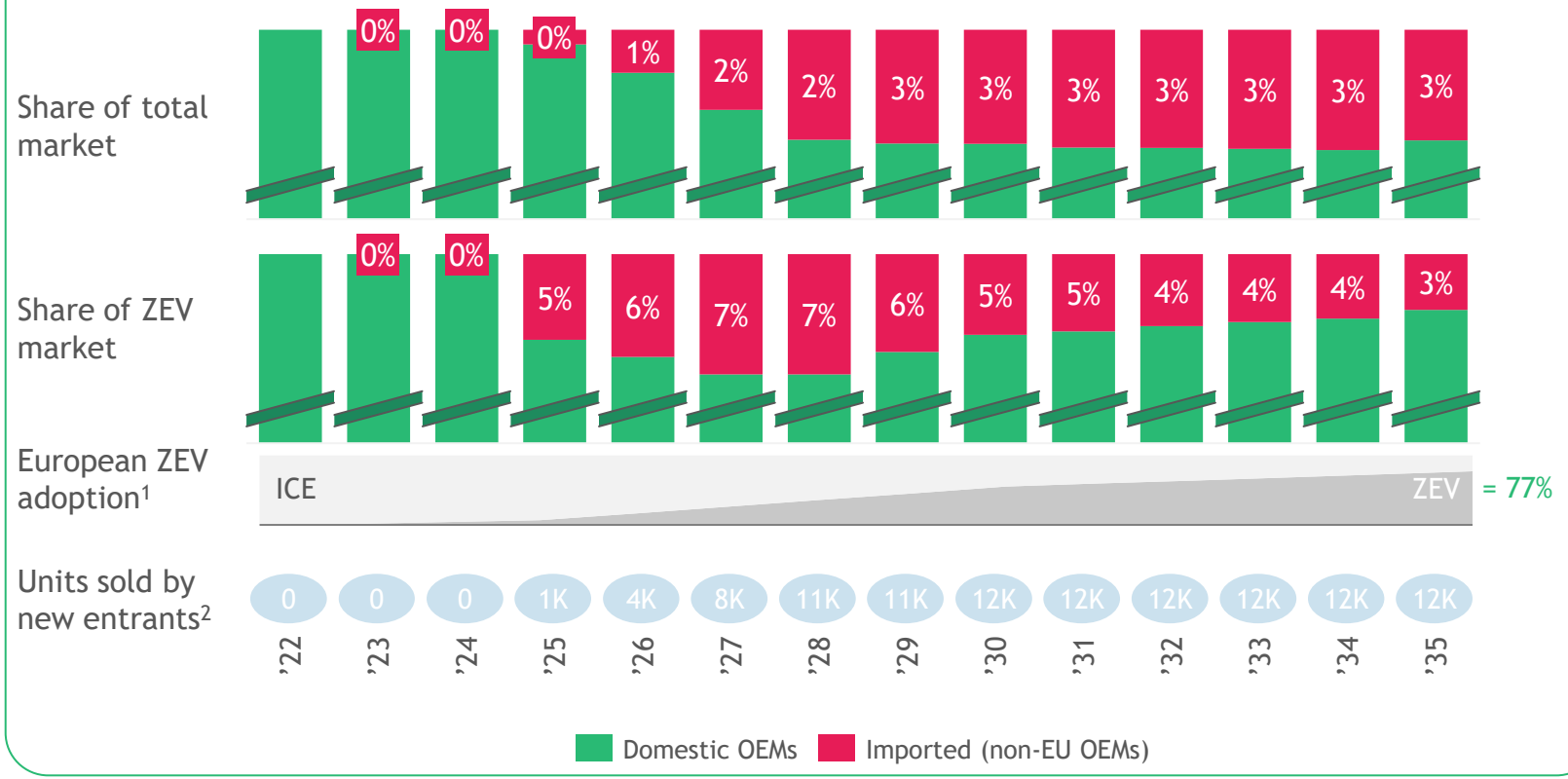
Employment losses throughout import phase up to 12.3K

Source: IHS Automotive; BCG

Import-based competition (1/2): New player market share of 3% expected in 2035, with pure import business model

III Import-based competition

SIMULATION | Based on BCG market perspective



1. Underlying ZEV adoption in new-vehicle sales 2. Units sold for upper market-share range in each scenario
Source: IHS Automotive; BCG

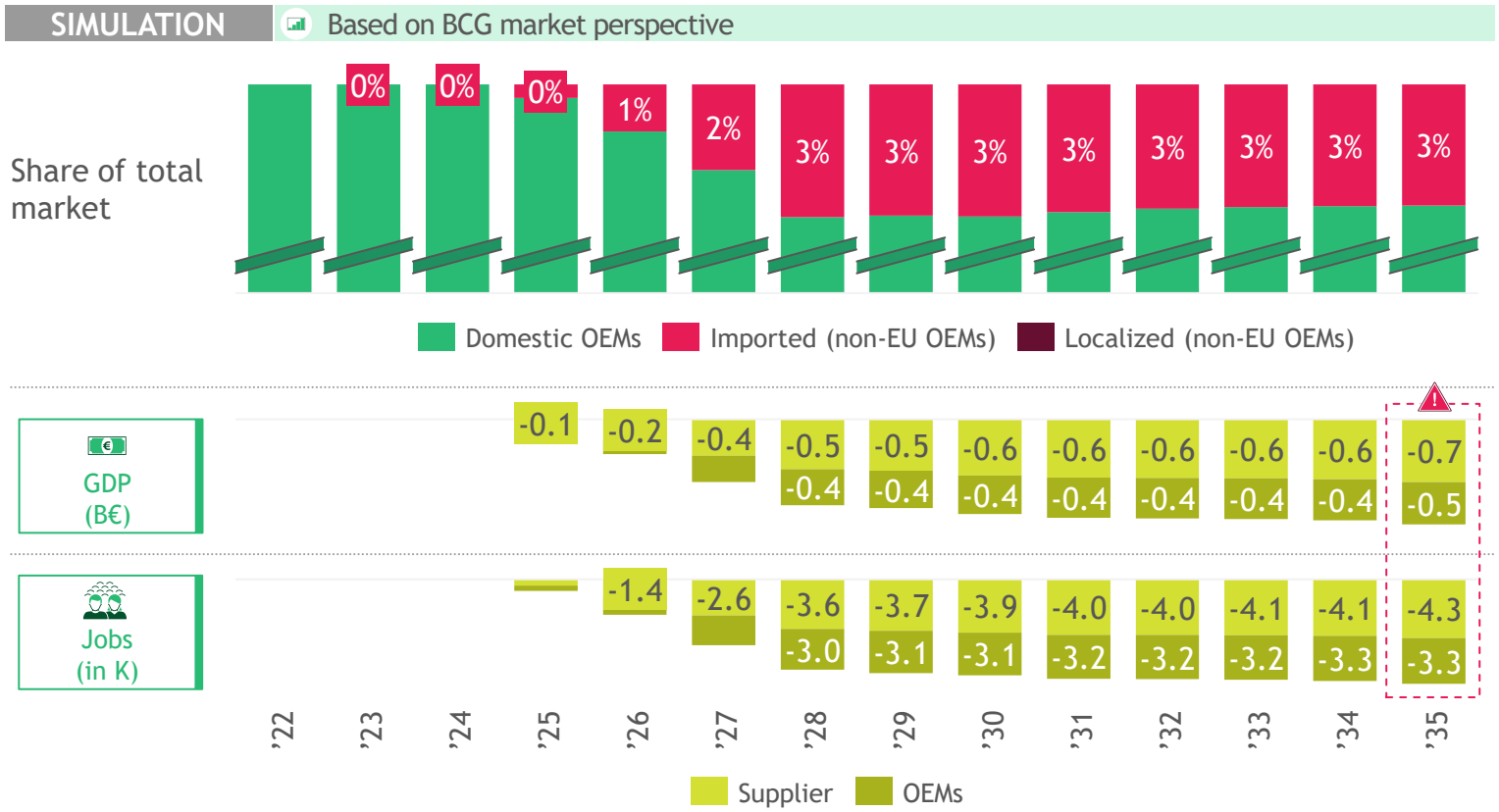
Few players try to enter market but no player achieves sufficient volume for local production

Limited import of ~ 3% of the European truck market expected

Import-based competition (2/2): GDP and employment loss grows with ZEV adoption

III Import-based competition

SIMULATION | Based on BCG market perspective



2035 -1.2B

2035 -7.6K

Impact increases over time with higher ZEV adoption

1. Total value for OEMs and suppliers; loss incurred from share of imported vehicles only
Source: IHS Automotive; BCG

Summary: Highest risk for GDP and employment loss in steady state from new entrants with local assembly and partial local sourcing (scenario II)

–	I	II	III
Defense	Fully localized production	Local assembly with partial local sourcing	Import-based competition
Baseline scenario, assuming no new compe-tition	**Most attractive scenario**[1] in terms of 2035 GDP and employment impact (almost no change), as new entrants will create similar value as incumbent OEMs and **limit opportunity for pure-import players** However, in first years, new players will import entire vehicles before local assembly and sourcing is established. Import expected to peak around 2030, leading to an **interim GDP (-€1.6B) and job loss (-11.3K)**	**Least attractive scenario** in terms of 2035[1] GDP loss of €1.4B and just a slightly lower job loss of 7.4K over fully import-based competition **Loss happens mainly at suppliers** (GDP: -€1.0B, jobs: -7.4K in 2035), as new players import large share of their components As players start with import model first, GDP and job loss is slightly higher during interim period and **peaks around 2029 with GDP loss of €1.8B and job loss of 12.3K**	In 2035[2] expected GDP loss is €1.2B and job loss slightly more pronounced (7.6k) than Scenario II In this scenario, competition (3% market share) is only from import without localization, **substantial GDP and job loss is expected** **Loss happens on almost equal levels at OEMs and suppliers** and grows with ZEV adoption

1. Under the assumption that new competition cannot be avoided (baseline scenario) 2. Peak effect at end of investigated horizon—to slightly grow afterward with increasing ZEV adoption
Source: BCG

Potential levers to influence rise of non-European MHDT competition (extract)

Lever		Potential impact on new non-European market entrants
Standards	Emission targets	Imposing minimum emission standards for MHDT players. Depending on the exact design the lever can incentivize or deter new entrants
	Increased technical requirements	With requirements to invest largely to meet local demands, import (III) and semi-localization (II) scenarios can become less likely
	…	…
Tariffs / Local content	Higher tariffs on vehicles	Local production is incentivized by making imports less attractive. Import-only becomes less likely, and new entrants may shorten import phase and ramp-up local production more quickly
	Higher tariffs on components	Entire-vehicle import not affected by lever, but CKD production (II) becomes less likely, and players may shorten time for localization of supply chain
	Local content requirements	Depending on specifics of regulation, import (III) can be fully suppressed and full localization (I) can be made more attractive
	…	…
Subsidies	Subsidies for development	May speed up ZEV shift in Europe, thus limiting a supply gap, which can make a market entry for new players less attractive
	Subsidies, e.g., for local production	Supports semi/full localization in Europe
	Customer incentives to push demand	Supports demand for ZEV, which increases adoption and might drive a supply gap, thus attracting new players
	…	…

Source: BCG

Conclusion: All scenarios for non-European market entry have a negative impact on OEMs and suppliers, though ZEV transition outweighs losses along full value chain

In all scenarios with new entrants, GDP and jobs are lower than in base scenario without new competitors. In worst scenario (II) GDP is -€1.4B and jobs -7.4K lower in a steady state for full ZEV adoption in 2035 versus baseline scenario assuming no competition

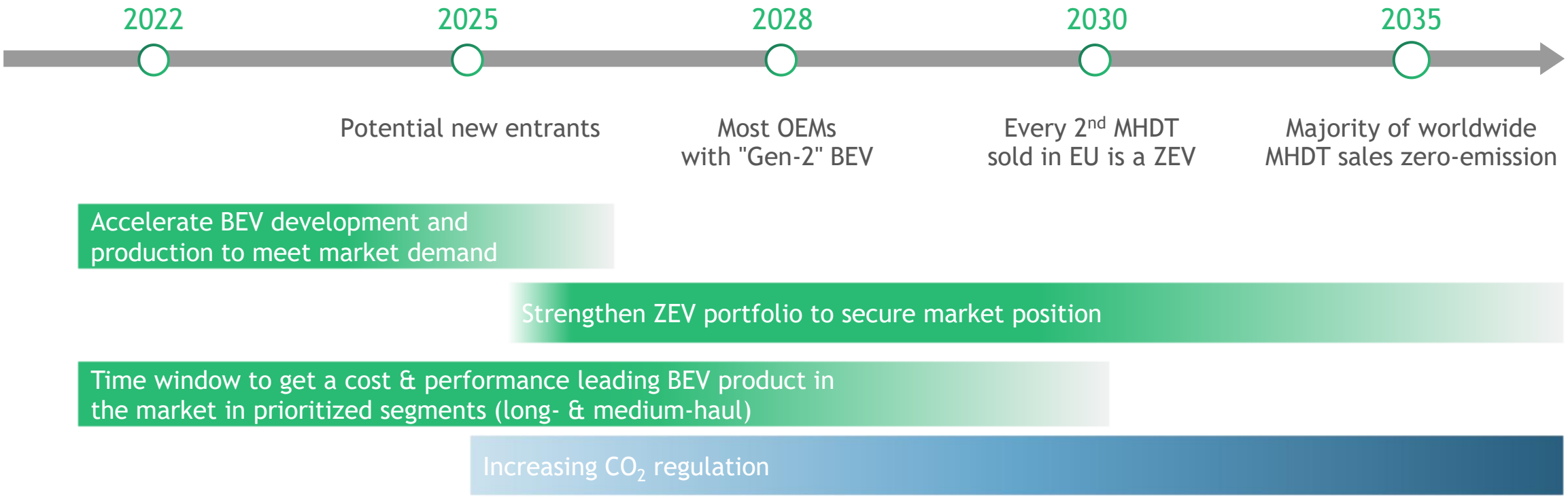
If new players cannot be avoided, long-term a scenario with full localization (I) could be most advantageous in terms of GDP and jobs. However, new entrants will start with import model first that leads to an interim peak loss in employment and GDP around 2030 relative to baseline scenario

Policymakers can influence likelihood of scenarios with protective measures (e.g., MHDT CO_2 standards, import tariffs, local content requirements) or subsidies for local players

Considering the full value chain, overall positive GDP (+€16B in the lower base and +€32B in the higher T&E case) and job (+16K/+30K) development can be achieved. This positive effect from the transition to ZEV is reduced in all scenarios, but not at risk, with non-European players entering the market

Source: BCG

Outlook: Roadmap for European MHDT OEMs to secure ZEV leadership as ZEV volumes significantly increase and new players enter the market



Source: BCG 2023 report on the future of CV/heavy road transport; BCG

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Appendix

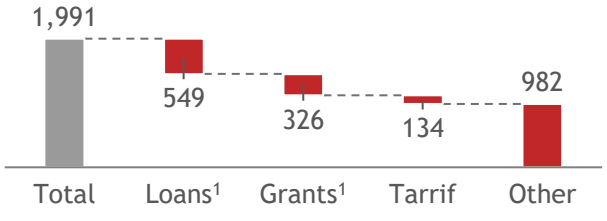
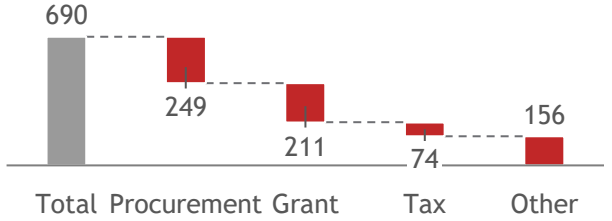
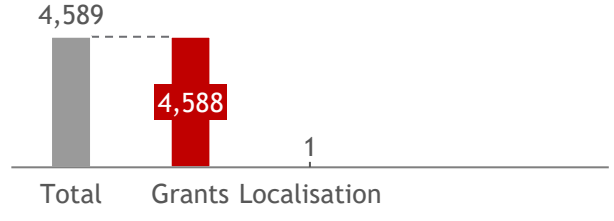
EU with broadest set of policies amongst peers promoting shift to ZEV

		EU	US	China
Regulations	CO_2 red. targets	✓ **CO_2 emissions reduction targets** of **15% by '25** and **30%** by **'30**[1]; Case for stricter targets waiting for final approval	✓ **CO2 reduction targets for various HD CVs**, reducing CO2 emissions by in '27 (depending on vehicle category/weight)	? No specific ZEV policies beyond '23 but announced commitments
	ZEV sales targets	✓ **11 European countries signed the MOU:** 30% MHDTs ZEV sales by '30 and 100% by 40[2]	✓ **Also signed MOU:** 30% MHDTs ZEV sales by '30 and 100% by 40[2]**;** addl. natl.-level funds (e.g., **CA Air Resources Board** bans sale of diesel trucks by '36)	✓ **ZEV credit targets for manufacturers** as % of their annual sales, Program extended to '23 (18% in '23, 16% in '22, 14% in '21)
R&D support and grants	Tech funding	✓ **New tech support** via, e.g., NextGen EU (€250B), Horizon Europe R&D program (€40B)	✓ **IRA invests $1B to replace MHDTs with ZEVs;** new tech support via, e.g., battery supply chain fund ($7B); addl. natl. funds (e.g., NY $500K for ZEV infrastructure)	✓ **Four-year pilot program** announced—select cities receive support for R&D and demonstration of fuel cell EVs
	Skills funding	✓ **Green reskilling as part of Green Deal Industrial Plan**—e.g., via Erasmus+ initiative (€1.1B), European Skills Agenda	✓ **Green reskilling as part of IRA** funding for infrastructure, workforce training/planning & maintenance/charging; funds available through FY '31	✗ Potential reskilling incentives are being discussed
Economic incentives	Purchase subsidies	✓ **National level subsidies**; (e.g., Germany and Austria up to 80% of price delta to ICE truck; NL 45%)	✓ **Tax credits** via $430B policy bill for new BEVs (i.e., up to $7.5K for L-& MDVs & up to $40K for MHDTs); addl. state-level subsidies	? **Subsidies for NEVs** (phased out in '22); **purchase tax exemption** until '23 (10% of purchase tax); now subsidies shifted **from national to regional level**
	Road tolls	✓ **Partial toll reductions** on natl. level (e.g., Germany €0/km until '23, afterward reduced until '40)	✗ **No current subsidies for road tolls for HD CVs**	✗ **No current subsidies for road tolls for HD CVs**
	CO_2 pricing	✓ **CO_2 price on transport fuels** increasing diesel prices and thus relative TCO adv. of ZEVs	✗ **Current tax doesn't include the CO_2 charge** and potential charge of $35 per mt of CO_2 will cause a decline of 2% of emissions associated with HD CVs	✗ **Current tax doesn't include CO_2 charge**
Usage incentives	Infra-structure	✓ Process of infrastructure deployment to start in 2025 and **cover all TEN-T roads by 2030**	✓ State support to fund the **ZEV corridors with EV charging and H_2 refuelling** across 23 states	✗ Not announced, needs $14T-17T in additional green infrastructure investments

✓ Existing policies ? Under discussion ✗ Nonexisting

1. Relative to 2019 level; stricter CO_2 standards revised for MHDTs based on EU Commission case (Feb. 2023) of 45% by '30 & 65% by '35, applicable to trucks (> 5 t), city buses, long-distance buses (> 7.5 t), trailers; final approval still pending; additional targets set on national level 2. Nonbinding memorandum of understanding (MOU); Source: BCG

Import tariffs and broad range localization incentives support localized market structure but low tariffs in Europe for ZEV open up market to imports

Import tariffs[1]	Truck >5t (GVW)	16% - 22% ICE ad valorem 10% ZEV av for BEV and other propulsion[2]	4% - 25% ad valorem No special tariffs for other propulsion	9% - 15% ad valorem No special tariffs for other propulsion
	Light vehicles	*10% ad valorem*	*2.5% ad valorem*	*15% ad valorem*
Non-tariff	Number of harmful measures put in force since '21 (#)			
	Local content /Procurement	International Procurement Instrument threatens to exclude bidders from countries disadvantaging EU-companies in public tenders	NAFTA requires 75% North American content to apply for tariff waiver; Buy America requires 40% local-content in public tenders	Public procurement strong lever due to high share of state-owned companies
	Sourcing restrictions	Requirement to source battery raw materials from eco-certified suppliers	40% of battery raw materials from 'US or FTA-partners and not from 'foreign entities of concern'	Currently no sourcing restrictions in place in China
	Subsidies for local production	EU pledged to mobilise € 1tr, to support transition to net-zero over the next decade	IRA is a $ 400bn, fund to support clean energy industries	China 2025 provides $ 500bn, to support domestic manufacturing in strategic sectors affecting automotive

1 Maximum ad valorem (AV) duty (MFN) for 8701xx and 8704xx; 2 Tesla Semi despite likely to be applicable to 16% duty since categorized as road tractor

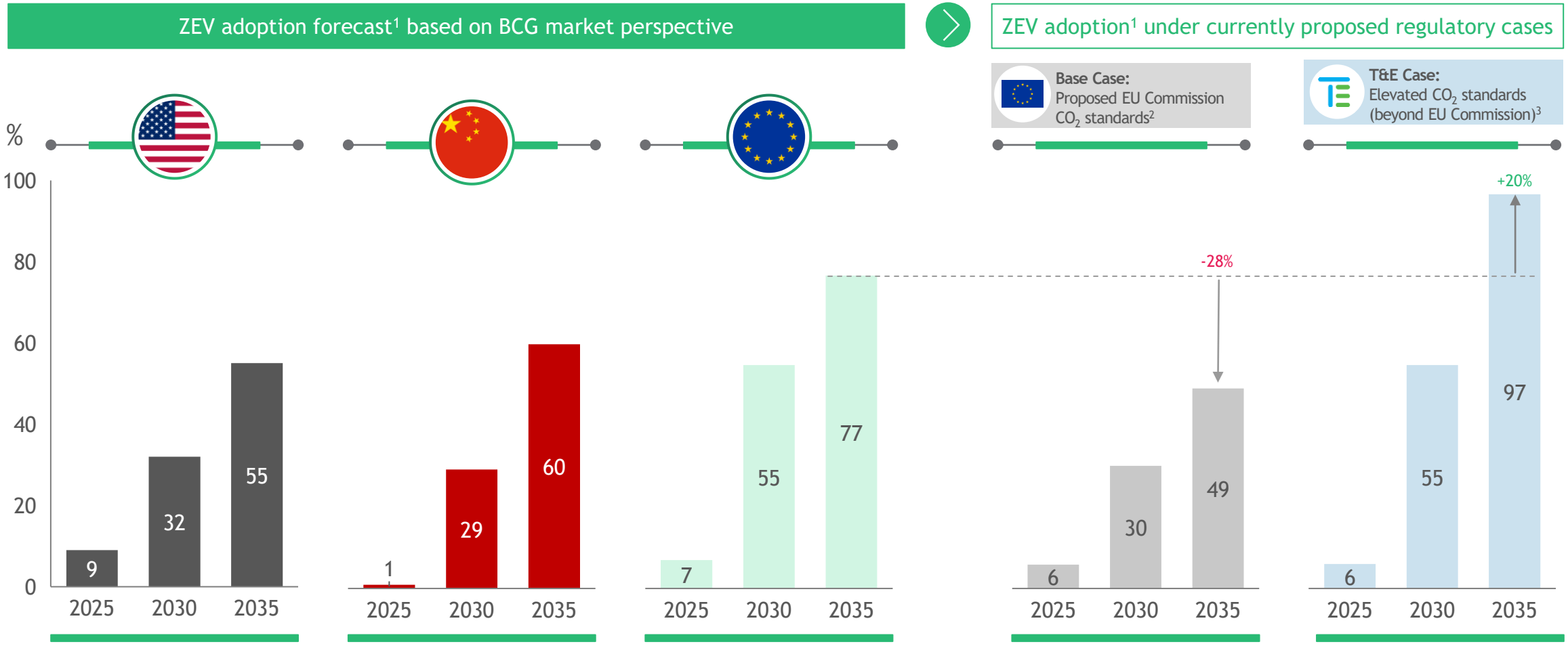
Note: Loans and grants considered harmful since only benefitting local producers; ad valorem = payment, rate, or tax calculated according to the price of a product or service, rather than at a fixed rate

Source: World Bank; Global Trade Alert; BCG

Proposed EU commission standards are below projected ZEV adoption 2035 across geographies, whereas progressive T&E case is above

ZEV adoption forecast[1] based on BCG market perspective

ZEV adoption[1] under currently proposed regulatory cases



1. Entails both BEV and H2 HDVs 2. Not covering unregulated MHDT segments (e.g., vocational, non-certified) 3. Incl. unregulated MHDT (under EU Commission)
Note: EU Commission proposed new CO2 standards for new ZEV sales in Feb