Exploration of the impact of electric vehicle policies on vehicle registrations, emissions and cost-benefit-analysis

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Background

- EU Roadmap: 60% less transport induced GHG emissions in 2050 vs. 1990 (EC White Paper 2011)

- Electric vehicles are seen as one key component of GHG reduction strategies, e.g. in Germany: 1 million EV in 2020 as a national goal

- However, market diffusion pathways of EV depend on different factors such as
  - EU-wide and national policy settings,
  - technological and
  - economical developments

- …and are yet open - analysing electromobility scenarios and their socio-economic impacts is needed

Electromobility scenarios: set-up

Research questions

- Business as Usual (BaU): What will the market penetration of electrified vehicles be with current policies and technologies until 2030?
- Politically Driven (PoD): Which impact do alternative policies at national and at EU-level have to enable a faster and more pronounced market penetration of electrified vehicles?

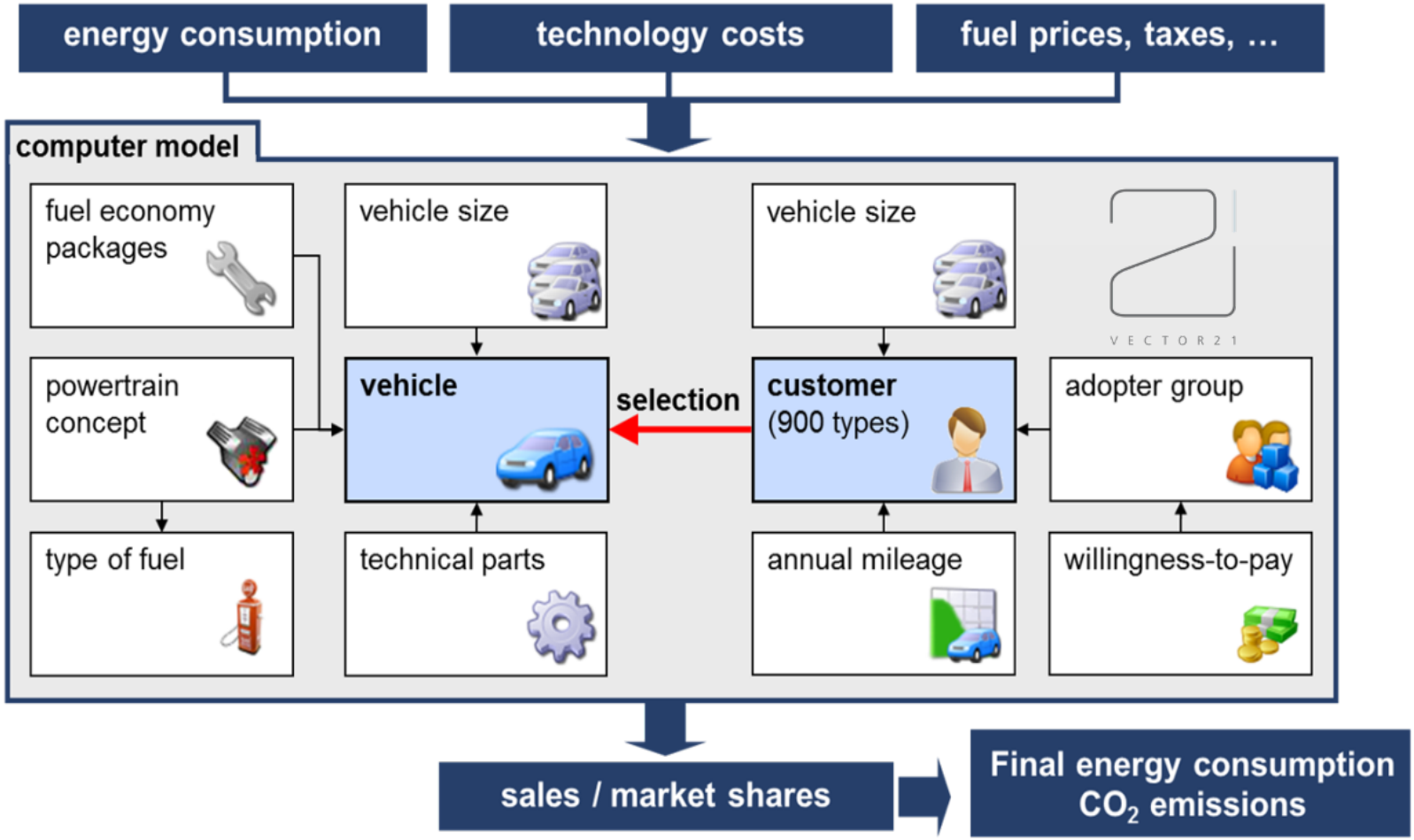
Markets

- Finland, France, Germany, Italy, Poland, the United Kingdom and EU-28

Methods and Tools

- Scenario analysis using a passenger car market model
- Cost-benefit analysis (CBA)
- Wider economic analysis (WEA)

VECTOR21 – a passenger car market model



Scenario – key characteristics

	BaU	PoD-GER	PoD-EU
Vehicle design	6 powertrain concepts, 5 electrified; 3 sizes; 9%-30% increase in vehicle energy efficiency up to 2025[1]	As in BaU	As in BaU
Traction battery costs	2010-2015: 450 €/kWh; floor costs reached in 2029 (230 €/kWh)[2]	As in BaU	As in BaU
Charging infrastructure	Coverage according to EC proposal COM(2013) 18 final, e.g. Germany 2020: 25%; 2030: 50%	Germany: increasing coverage by 10% p.a.[3]	As in BaU
CO_2 targets	2015: 130 g/km; 2021: 95 g/km; 2030: 75 g/km, incl. phase-in & super credits	As in BaU	2015: 130 g/km; 2021: 95 g/km; 2030: 60 g/km
Taxes & subsidies	As current legislation	Germany: 1,500 €/EV (2016-2020)[4]; exemption from renewable energy levy	As in BaU
Willingness-to-Pay	Adapted per country according to PPP[5]	Germany: increasing WTP by 10%[3]	As in BaU

[1] engine-based measures, lightweight construction, improvements in aerodynamic drag
[2] based on sold units using learning curves
[3] in relative terms
[4] e.g. by purchase premiums or tax exemptions
[5] Purchasing Power Parity (Eurostat 2014)

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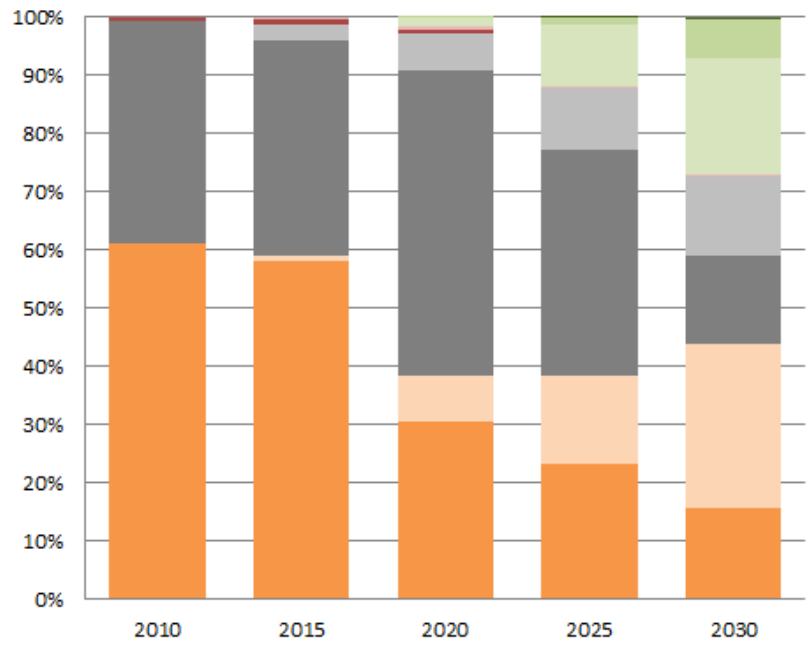
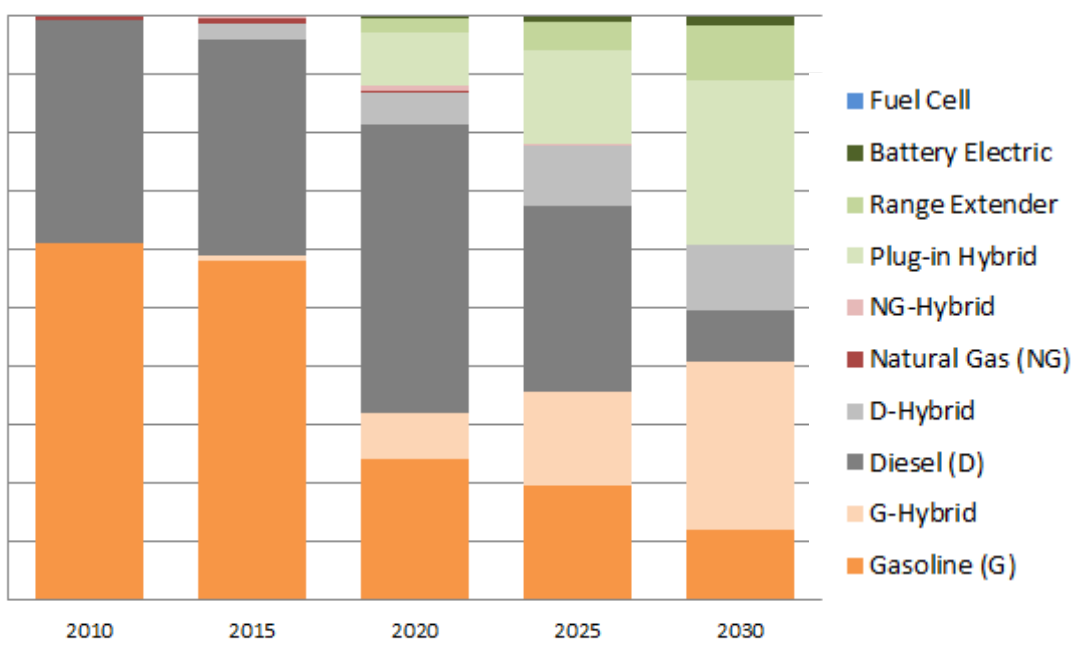
Germany - New passenger car sales

Business as Usual scenario



Politically Driven scenario



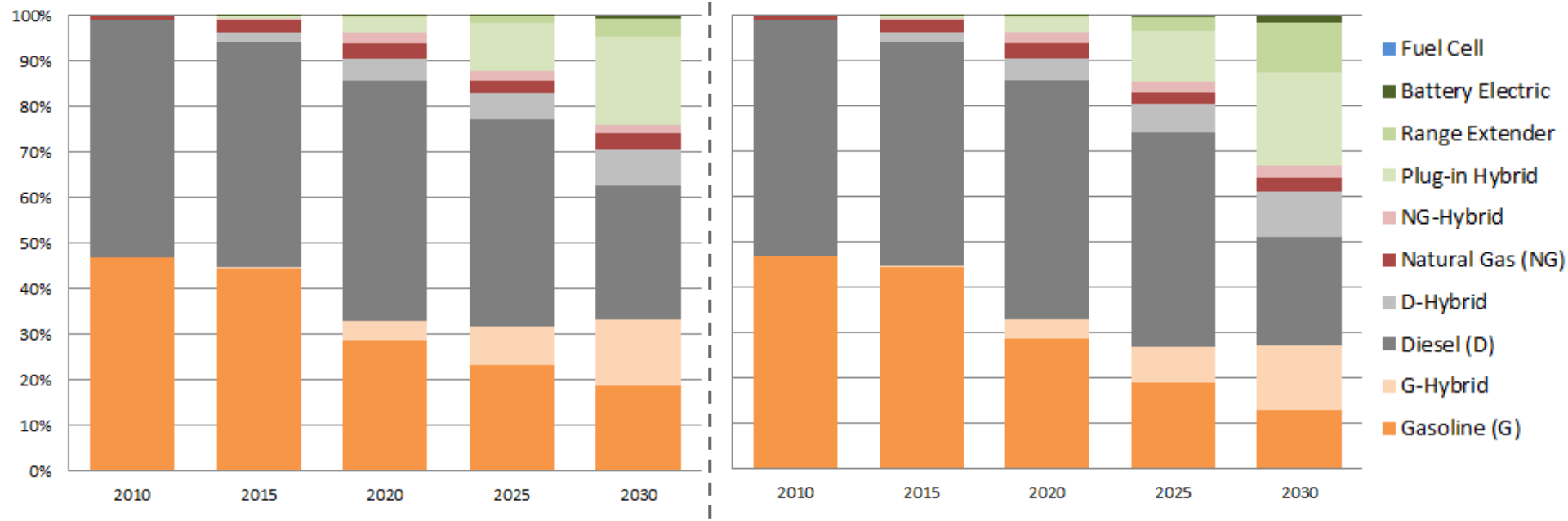
- Share of conventional **diesel vehicles** increases towards 2020 but shrinks afterwards due to more stringent CO_2 emission limits
- **Hybrid EV** gain market shares from 2015 on
- Almost no **BEV** as high purchase costs and high electricity prices prevent a pay-off over vehicle usage
- Increasing sales of **PHEV** after 2020: economically favorable vs. **BEV**

- Through measures to enhance electromobility, the share of **EV** increases
- Already in 2020 almost 10% of new vehicle sales are **PHEV**
- In 2030 40% of vehicles have a **charging device** of which <5% are **BEV**
- Only 20% of vehicles are **conventional**, not-electrified vehicles in 2030

EU28 - New passenger car sales

Business as Usual scenario

Politically Driven scenario



- Market shares over time are comparable to the German market
- **PHEV** are the most favorite EV
- **CNG** shares are mostly due to sales in Italy

- By tightening EU CO_2 limits from 2021 on, market penetration of **EV** is faster and more pronounced
- In 2030 30% of vehicles have a **charging device** of which <5% are **BEV**
- 40% of vehicles are **conventional**, not-electrified vehicles in 2030

Economic analysis – key elements

Cost Benefit Analysis

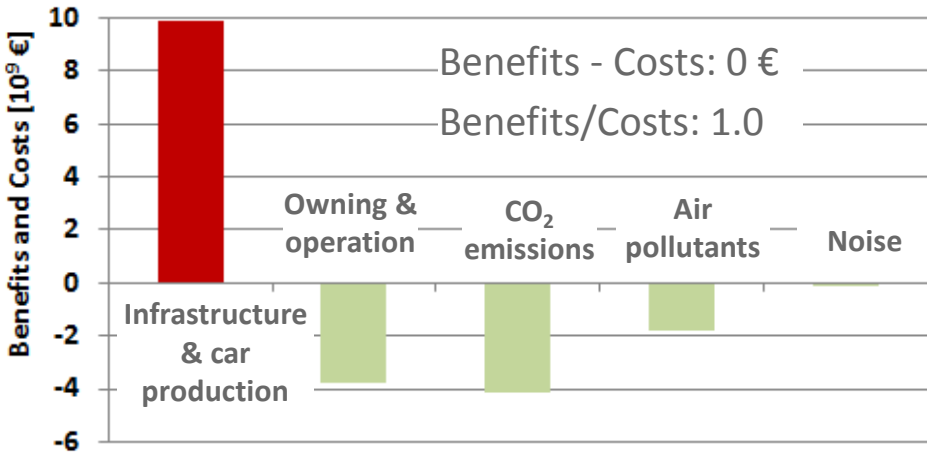
- costs (resource use) and benefits (resource savings) of EV diffusion from a societal point of view
- 2010-2030, 1% annual discount rate, net costs (taxes and subsidies not included)
- Aspects considered:
  - Infrastructure and production
  - Owning and operation
  - CO_2 emissions
  - Air pollutants
  - Noise

Wider Economic Analysis

- Macroeconomic effects such as
  - Employment
  - Gross value added
  - Fiscal revenues

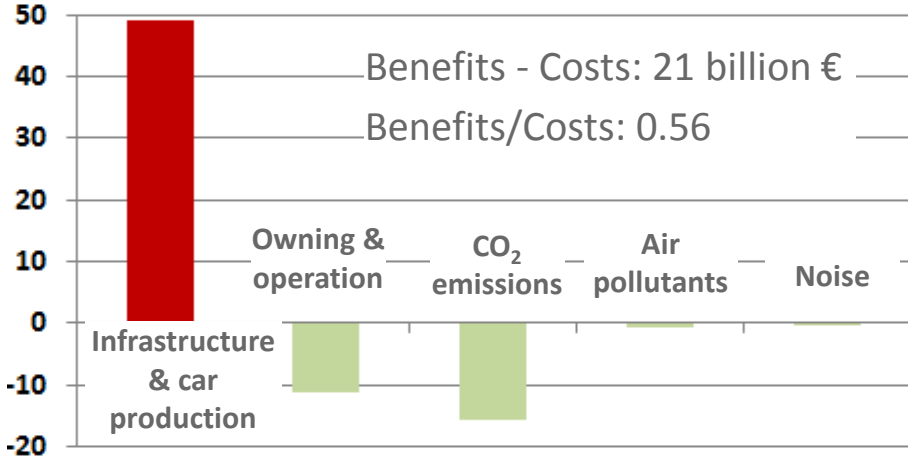
Cost-Benefit-Analysis – PoD vs BaU, 2010-2030

Germany



- Higher market diffusion of EV causes higher costs for infrastructure and car production (EV technology costs)
- At the same time, there are savings due to lower
  - energy costs
  - CO_2 emissions
  - Air pollutants/Noise

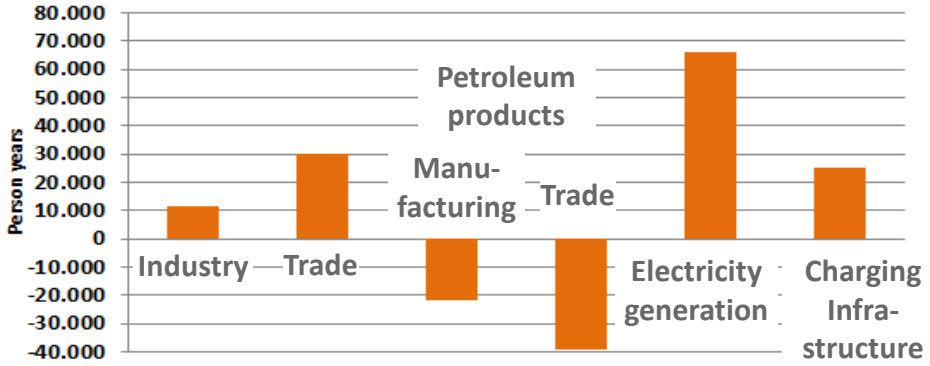
EU28



- One important obstacle for EV market penetration is charging infrastructure that needs building up and is cost-intensive

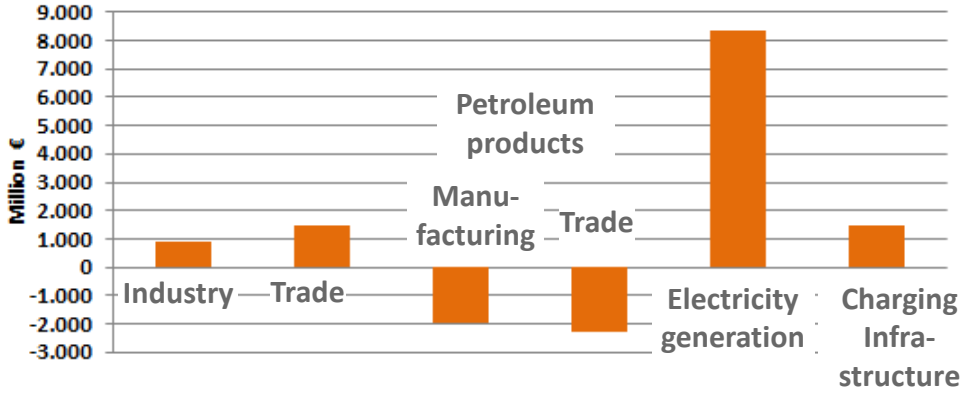
Wider Economic Analysis – Germany PoD vs BaU

Employment



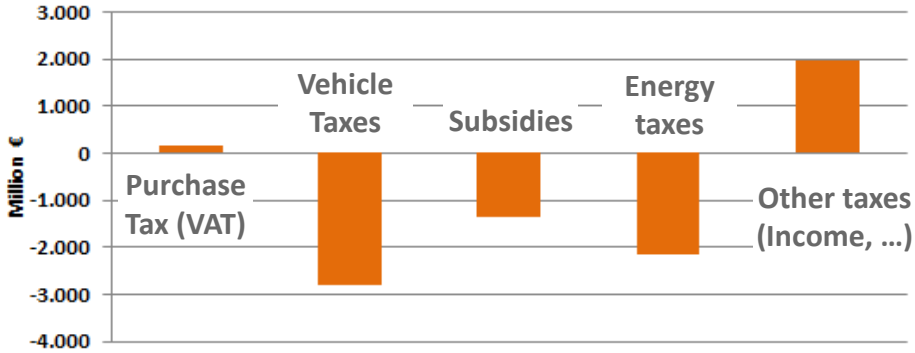
72,000 person years gained

Gross value added (net present value)



8 million € gross value added

Taxes (net present value)



4 million € tax losses

Conclusion

- Market penetration of EV is feasible from 2020 on, but depending on
  - Technological and infrastructure costs
  - Political support (e.g. strengthening of EU CO_2 limits)
- The share of BEV stays low in all scenarios
- EV are one important component to lower transport induced emissions and noise, although those benefits are not automatically higher than EV market penetration costs
- EV Policies can have a positive effect on employment and gross value added but, if financial incentives are given, could lead to tax losses

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Electromobility+ project **eMAP**
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http://www.project-emap.eu/

Electromobility+

SEVENTH FRAMEWORK PROGRAMME

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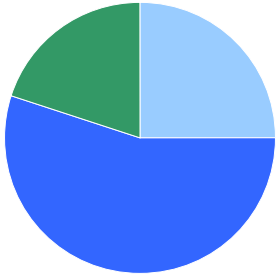
VECTOR21
Customer specification

Vehicle segment

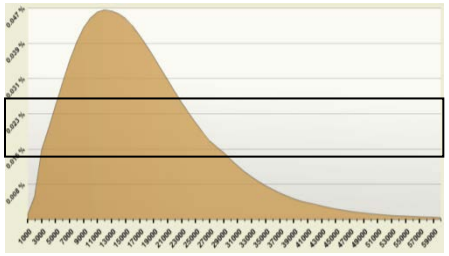


- 3 vehicle segments: small, medium, large
- Based on historical data and forecasts for each country

3

x

Annual mileage

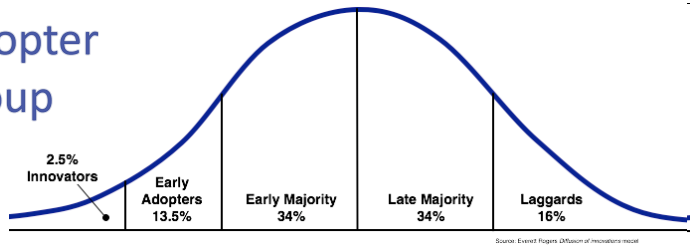


- Different annual mileage for each segment and country
- Based on surveys and publications

60

x

Adopter group

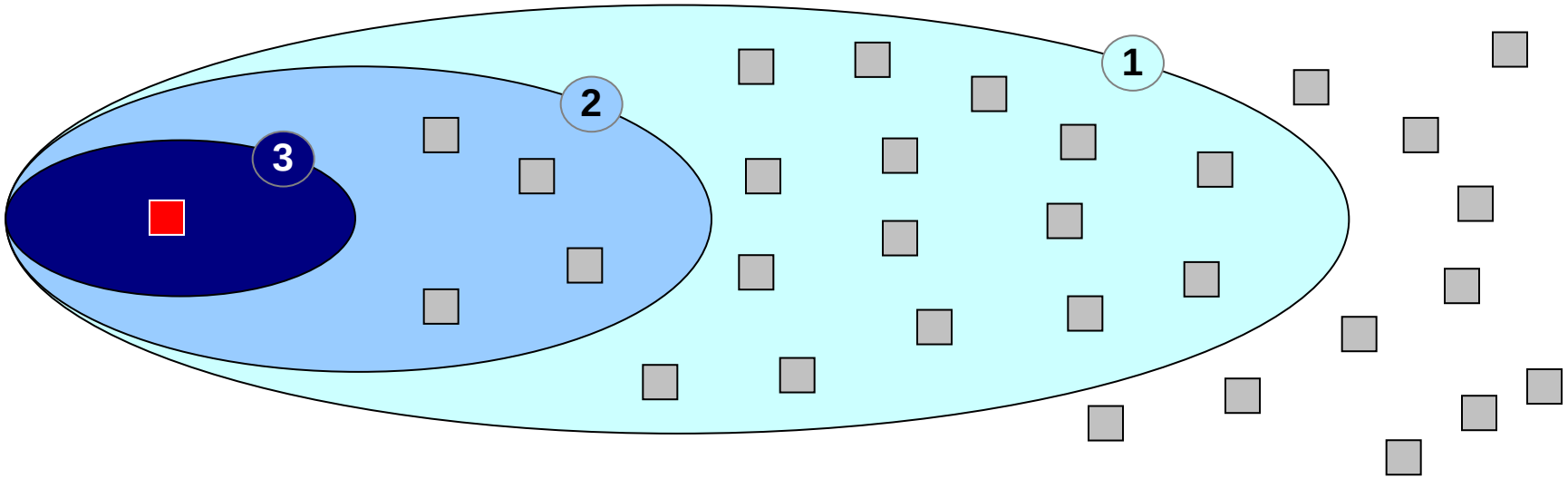


- Five different adopter groups
- Influence on customers‘ willingness to pay

5

900

VECTOR21
Decision process



Vehicle type (technology / fuel combination)

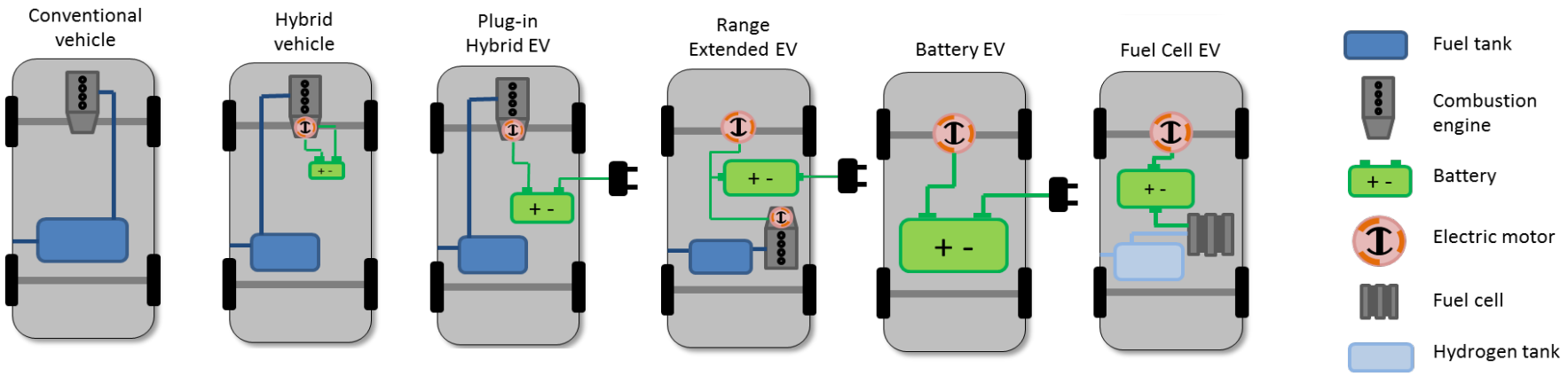
0 Step 0: Availability of vehicle

1 Step 1: Vehicle segment and basic requirements

2 Step 2: least RCO (Relevant cost of ownership) + willingness to pay

3 Step 3: least WTW CO2-Emissions (Assumption: costumer knows about WTW)

Powertrain concepts



- 10 Powertrains per vehicle segment (G, D, CNG, G_HEV, D_HEV, CNG_HEV, PHEV, REEV, BEV and FCEV)

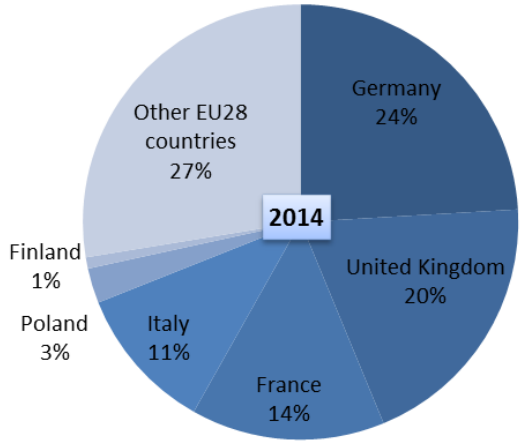
	Small			Medium			Large		
	Electric motor [kW]	Traction battery [kWh]	Power electronics [kW]	Electric motor [kW]	Traction battery [kWh]	Power electronics [kW]	Electric motor [kW]	Traction battery [kWh]	Power electronics [kW]
HEV	15	1	15	25	2	25	40	3	40
REEV	65	10	65	100	15	100	160	20	160
PHEV	40	8	40	60	12	60	90	16	90
FCEV	65	2	65	100	3	100	160	4	160
BEV	65	20	65	100	25	100	160	40	160

Scenario parameters

- Moderate increase of oil price assumed.
- As foreseen in the current regulation, an EU-wide CO2-limit is taken as well as a continued development until 2030.

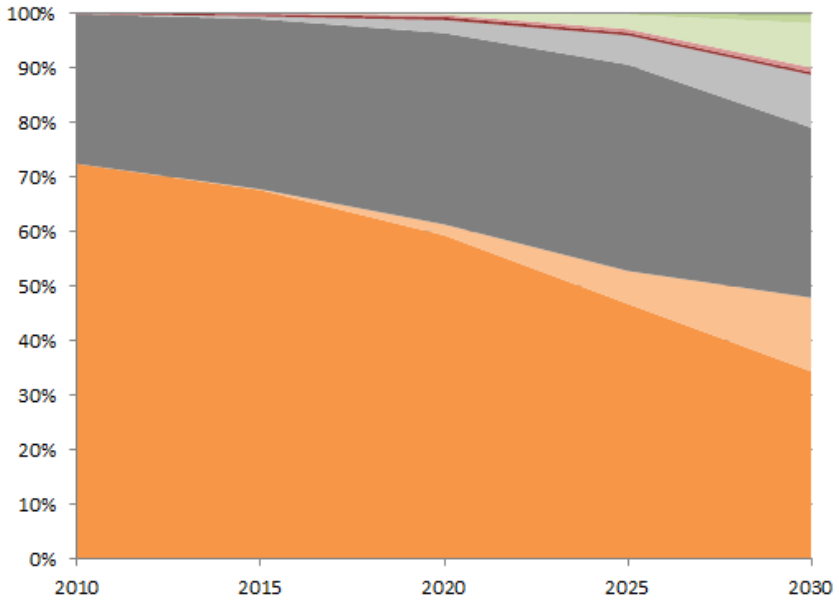
	Parameter	Unit	2010	2020	2030	Source
Energy and resource prices	Oil price	[$_{2011}$/bbl]	108	120	124	IEA (2012)
	H_2 price	[€$_{2010}$/kg]	20	8	6	McKinsey (2011)
Energy supply and emissions	CO_2 intensity H_2	[g CO_2/MJ]	100	73	21	McKinsey (2011)
	CO_2 intensity CNG	[g CO_2/MJ]	9	9	9	JRC (2013)
CO_2 regulation	EU CO_2 limit	[g CO_2/km]	2015: 130	2021: 95	75	EU law

- The eMAP countries cover approx. 28% of the new vehicle sales in the EU.
- To cover more than 70%, the United Kingdom, France and Italy are additionally simulated within the eMAP project.
- The market shares (size of segment and share of drivetrain) of these 6 countries correspond to those of the EU15 (93% of entire EU28 market size).



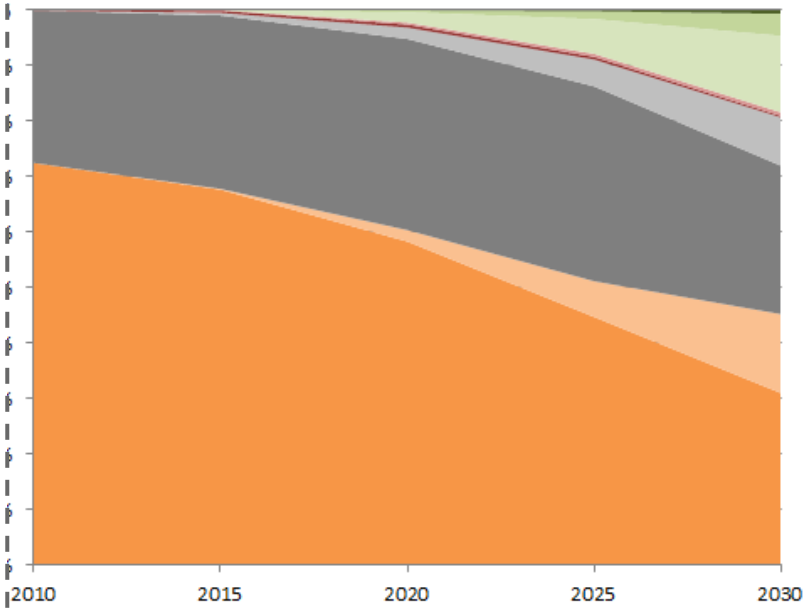
Germany - Stock

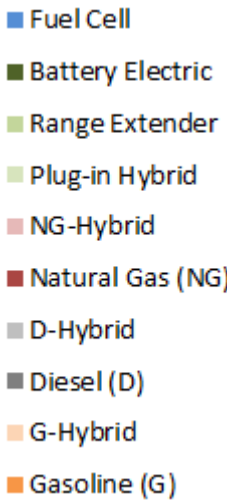
Business as Usual scenario



- Share of **EV** in stock is 35% in 2030
- **WtW CO_2 emissions** and **energy consumption** are decreasing by 30% in 2030 vs. 2010 due to
  - increasing efficiencies of conventional powertrains
  - an increasing number of electrified powertrains
  - An increasing share of renewables in electricity production

Politically Driven scenario

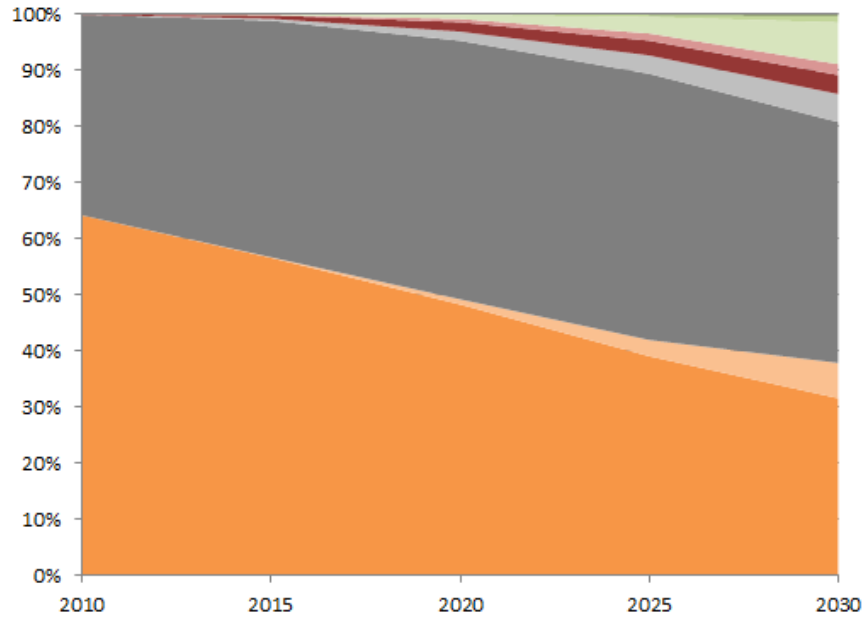




- Share of **EV** in stock is 40% in 2030
- **WTW CO_2 emissions** and **energy consumption** are further reduced (<5% in 2030 vs. BaU)

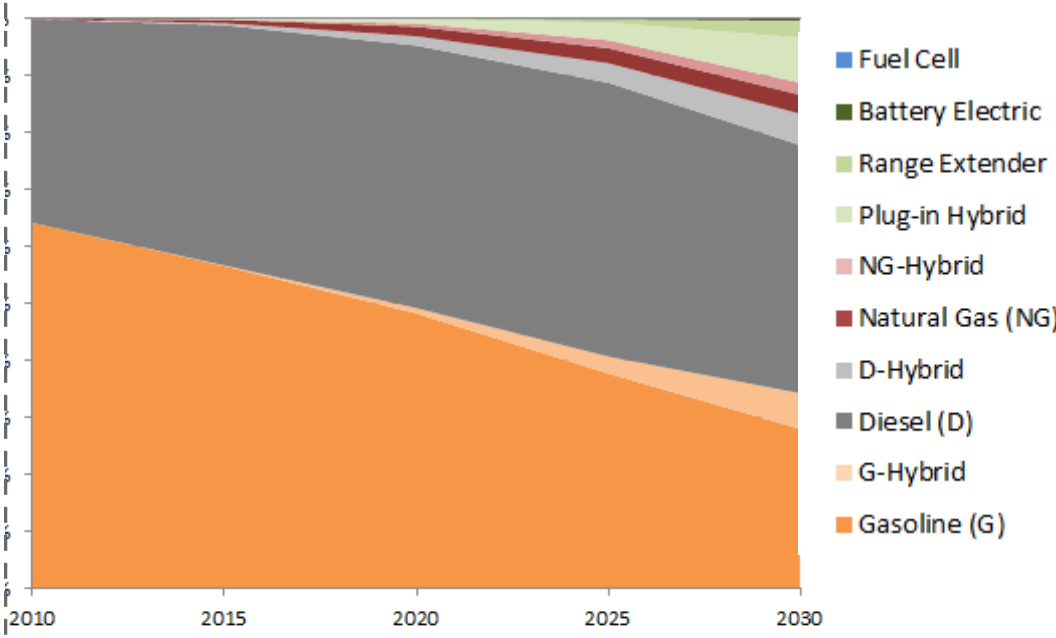
EU28 - Stock

Business as Usual scenario



- Share of **EV** in stock is 20% in 2030
- **WtW CO_2 emissions** and **energy consumption** are decreasing by 30% in 2030 vs. 2010 due to increasing efficiencies of conventional powertrains and an increasing number of electrified powertrains

Politically Driven scenario



- Share of **EV** in stock is ¼ in 2030
- **WTW CO_2 emissions** and **energy consumption** are further reduced (<5% in 2030 vs. BaU)

Stock