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ELECTRIC VEHICLES:

impact on the world economy and energy sector

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Foreword

Electric cars crate a lot of issues both for energy sector and for economy

Energy issues examples:

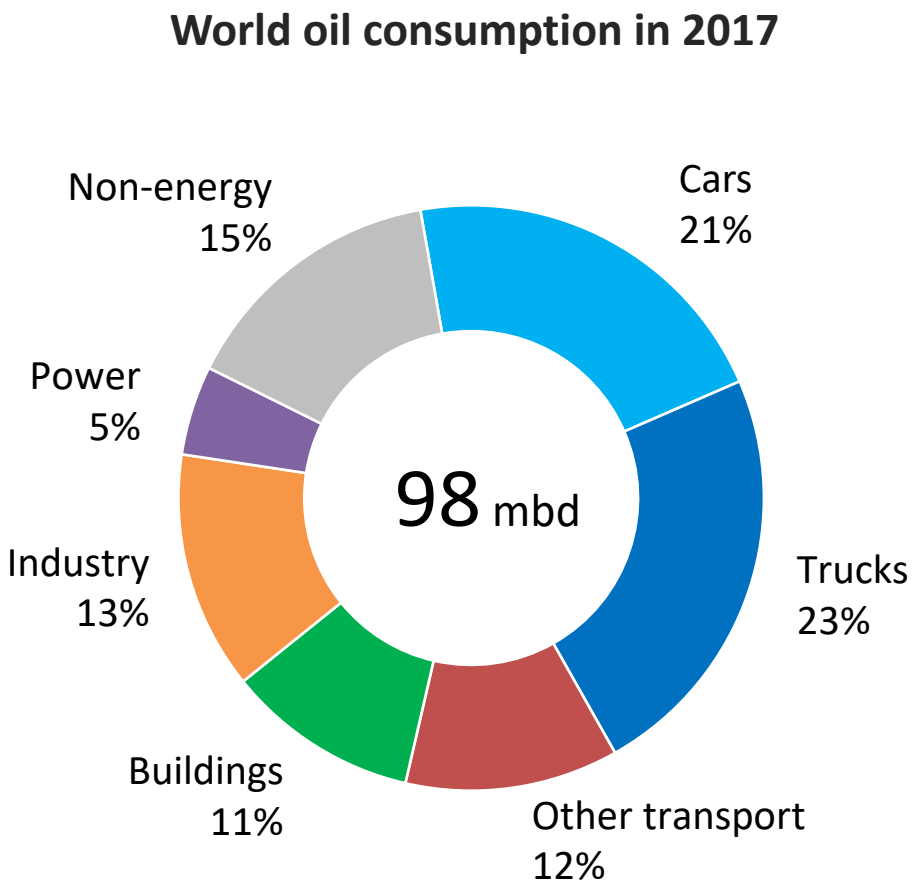
- structure of energy demand *(oil or electricity? and primary energy will we use for electricity generating?)*
- CO2 emissions
- energy prices
- new capacities needs

Economic issues examples:

- economy structure shifts for EVs production and use *(mining, automotive industry, charging, cities planning)*
- world trade
- EVs subsidies and consumer prices changes
- employment

Some of these issues were discussed at Inforum 2016 by Philip Ulrich and Dr. Ulrike Lehr *(Economic effects of an increasing market penetration by electric drives – structural changes in a scenario analysis)*.
Here we try to discuss few another points

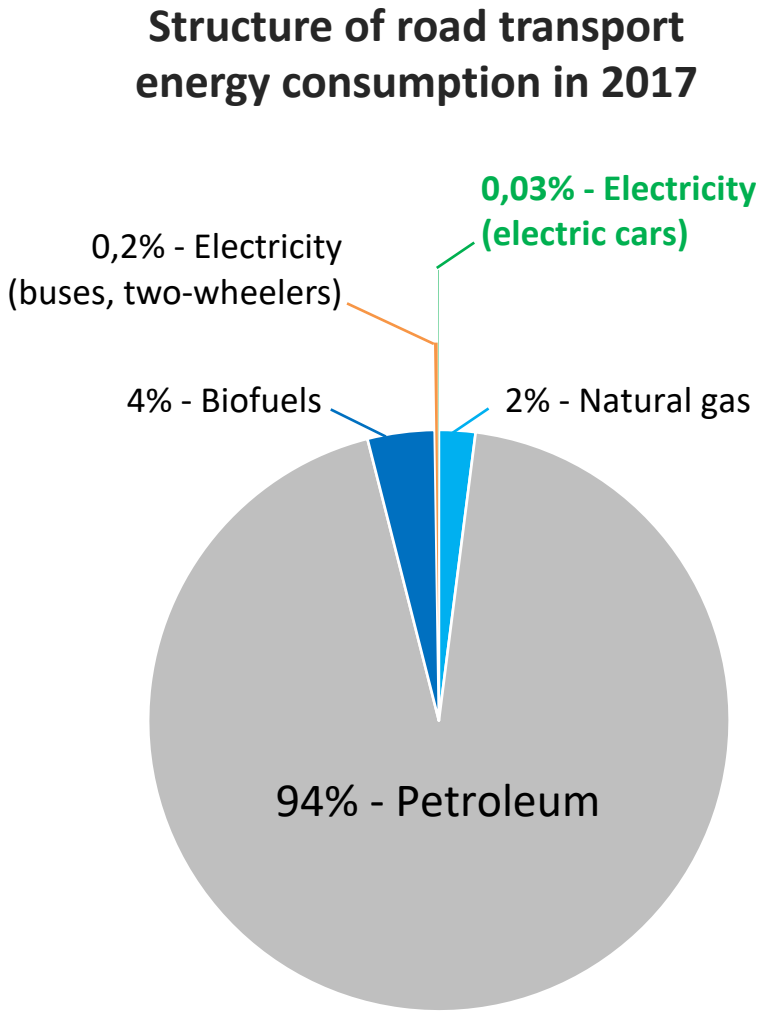
Let’s check the scale



- EVs can not destroy the whole oil demand
- Electric cars compete with 21% of world oil consumption
- Electric trucks will compete with another 23%

Source: BP

Let’s check the scale



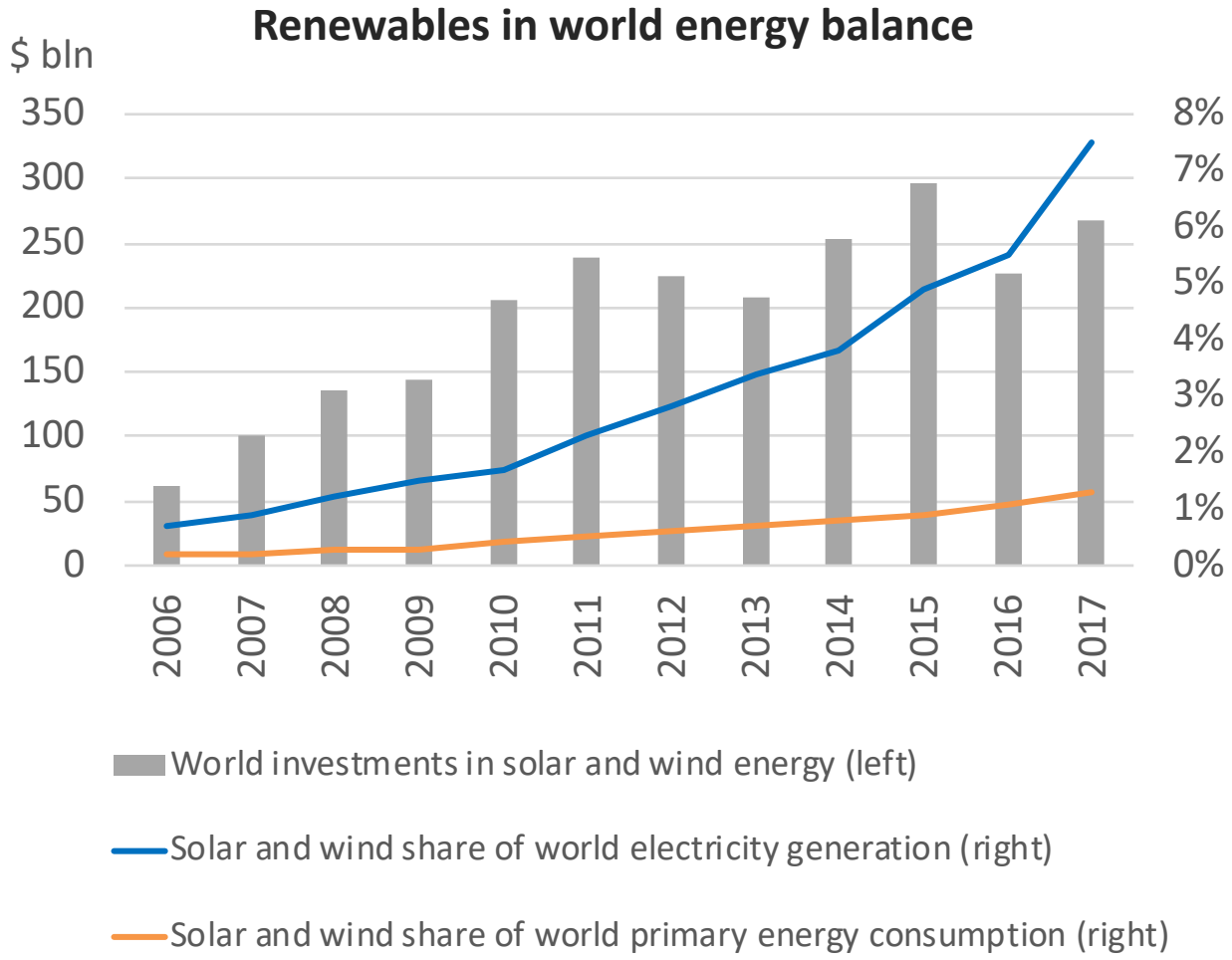
By the end of 2017 electric cars provided:

- 0.3% of world cars fleet
- 0.03% of road transport energy consumption
- 0.04% of world electricity consumption
- 0.005% of world primary energy consumption

Currently for world energy sector EVs are comparable to zero

Source: IEA

Let’s check the scale



In 2006-2017:

- total investments in solar and wind energy amounted to $2.4 trillion
- solar and wind share of world electricity generation increased from 0.7% to 7.5%
- solar and wind share of world primary energy consumption increased from 0.2% to 1.3%

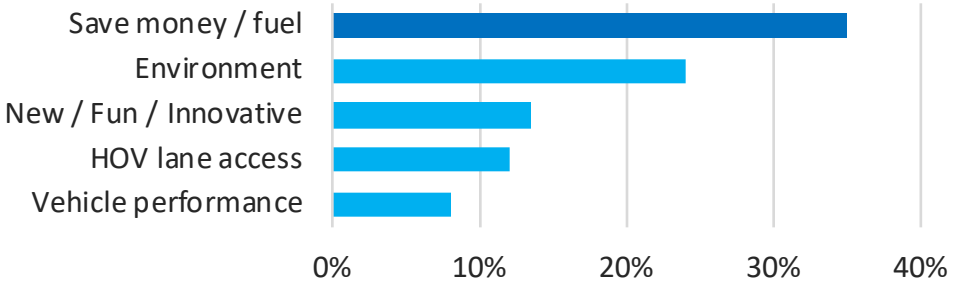
Energy consumption is inert. Structure change of 1% is great result

Source: IEA

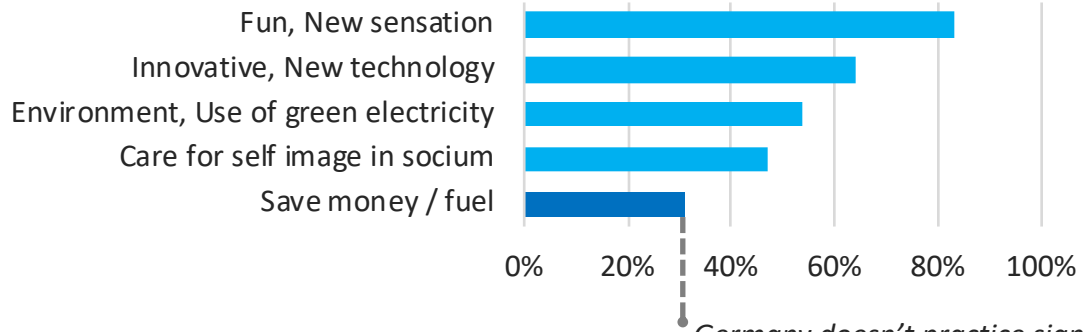
Why do people buy EVs?

Sociological studies show that economic factors have a decisive influence on the consumer's choice to buy EV or to refuse of such purchase

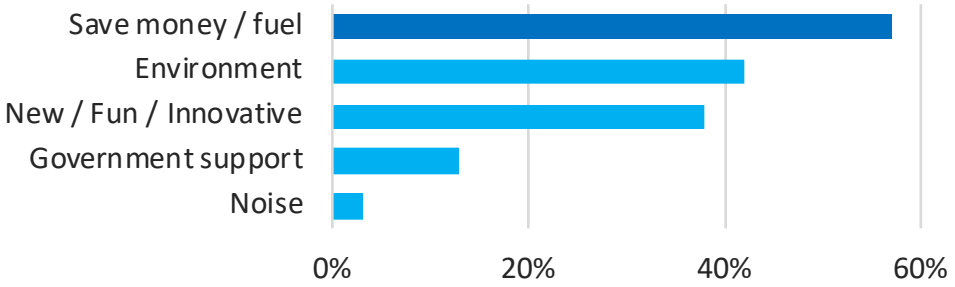
Main reason for buying EV – US, California



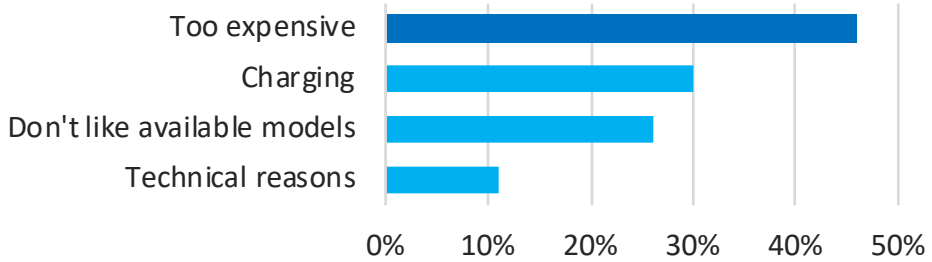
Reason for buying EV – Germany



Reason for buying EV – UK

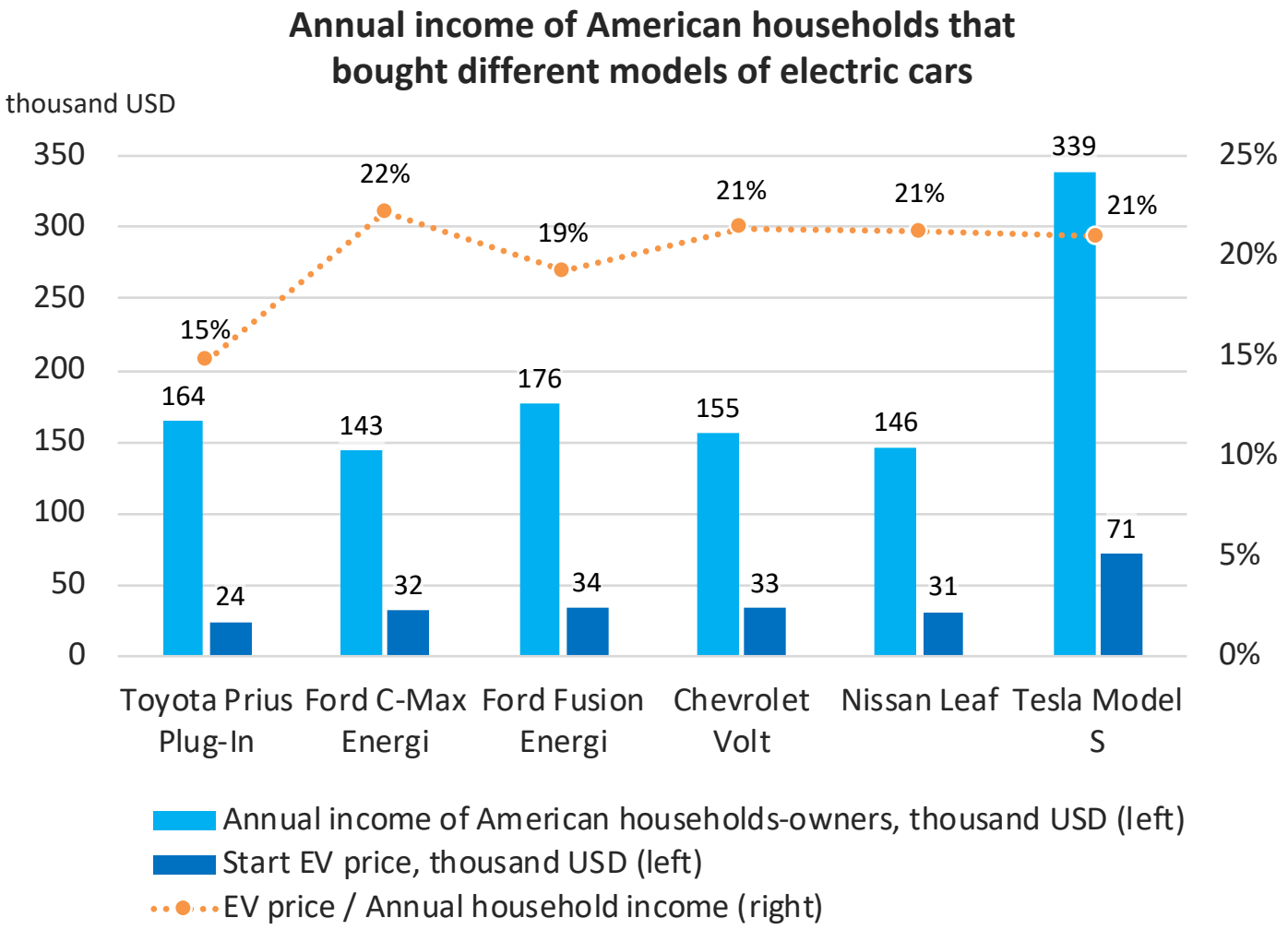


Reason for not buying EV – Germany



Source: EVObsession 2015, M. Vogt. German Emobility User survey 2015

Who buys EVs?



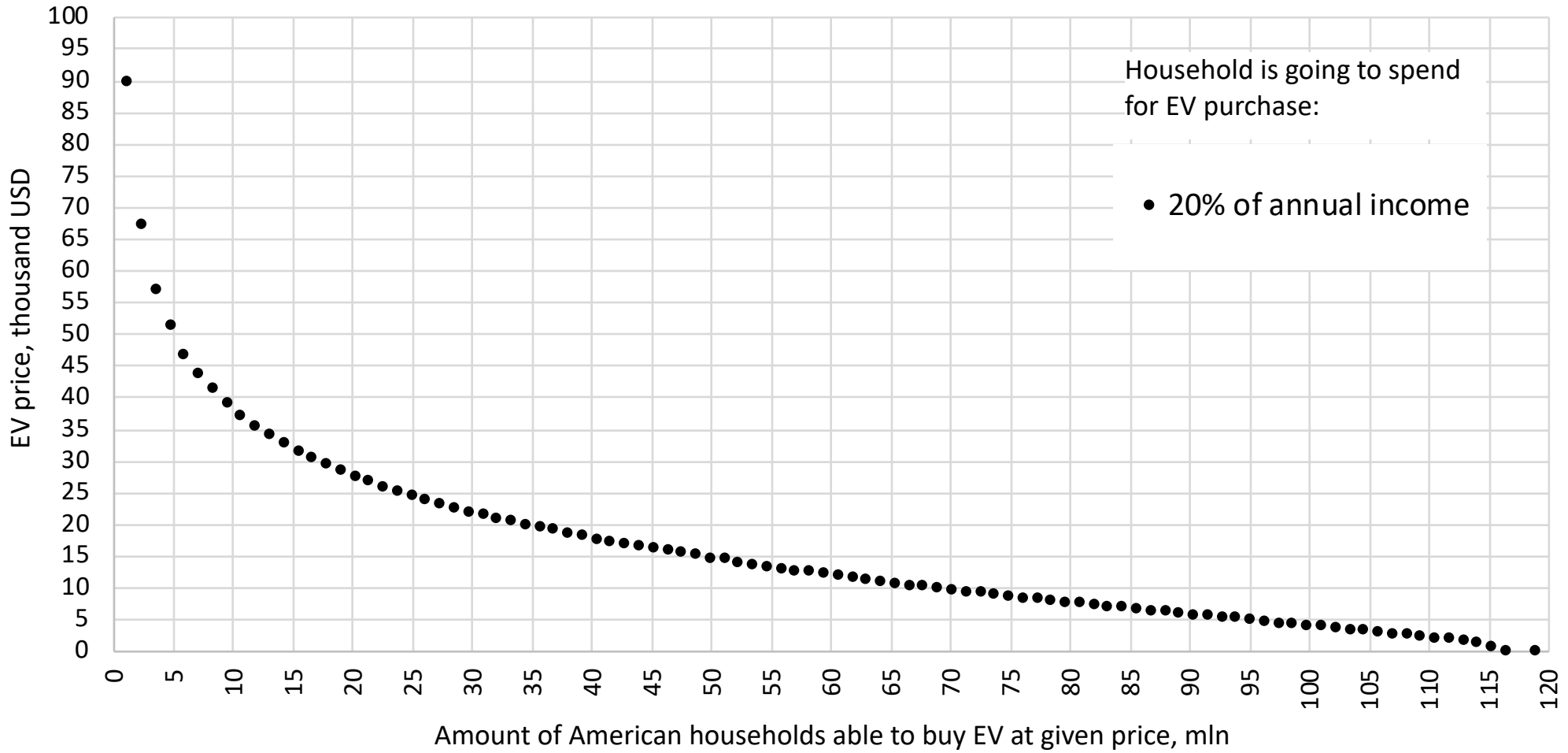
1. Today electric car is a choice for households with annual income of at least $140,000

2. Price of electric car purchased was about 20% of annual income of households-buyers. And this is valid as for relatively cheap models (by the standarts of EVs) with price of 30-35 thousand USD, and for more expensive Tesla Model S.

3. Tesla model 3 is not the cheapest model of electric car. Average American household that will buy Tesla model 3 is likely to have annual income 170-180 thousand USD

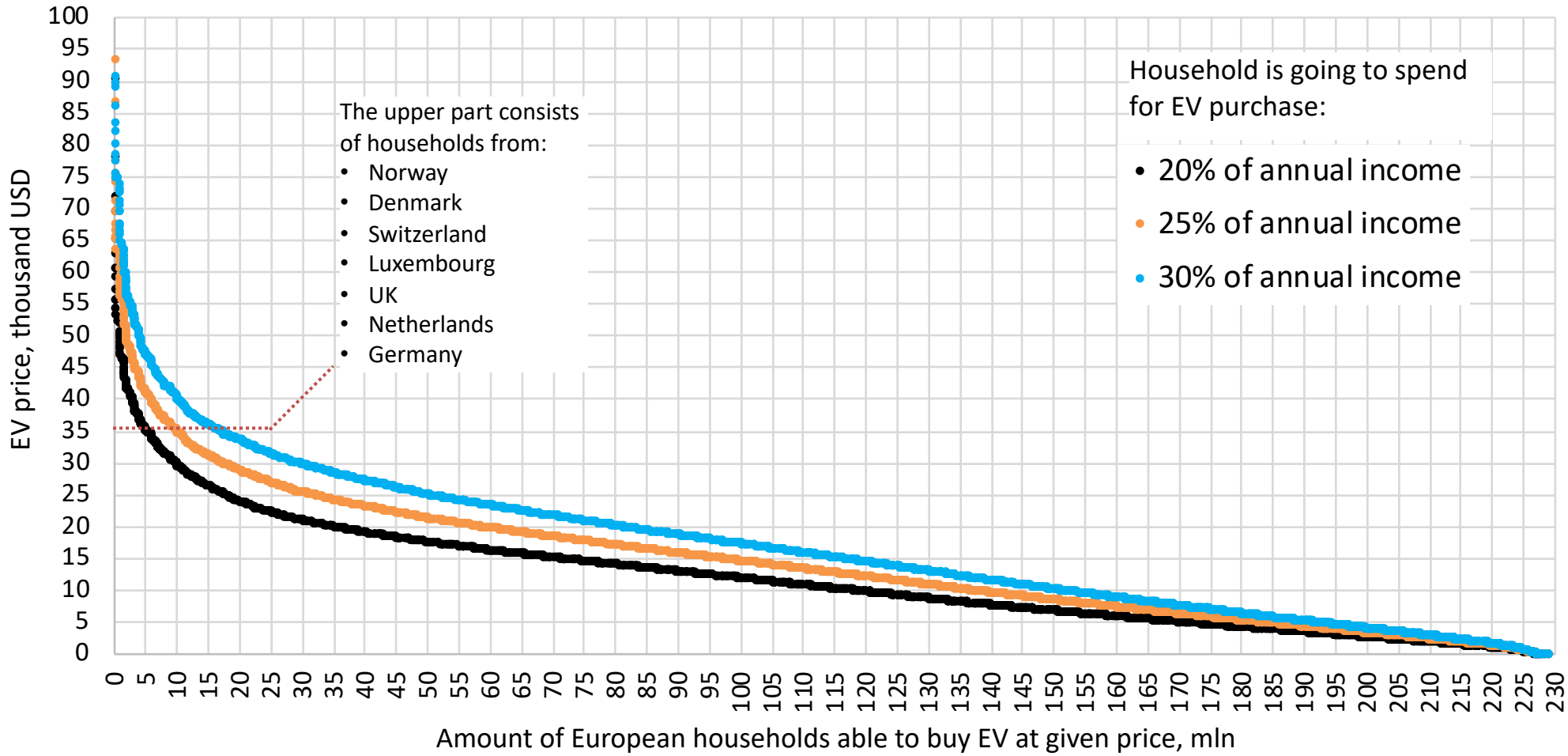
Source: Electric Power Research Institute.
Plug-In Electric Vehicle Multi-State Market and Charging Survey 2016

Amount of American households able to buy electric car depending on its price



Source: IEF RAS estimations based on DQYDJ United States Household Income Brackets and Percentiles in 2017

Amount of European households able to buy electric car depending on its price



Source: IEF RAS estimations based on Eurostat Distribution of income statistics

Potential demand for electric cars

Currently, the IEA scenario, corresponding to the fulfillment of the goals declared in the Paris Agreement, suggests the increase of EV fleet to 120 million by 2030 (about 10% of the total world cars fleet)

If we assume that approximately half of the fleet will locate in the US and Europe (as it is now), then EV fleet here should reach 60 million

If each household purchases only one electric car, then in order to implement such a scenario, average price of electric vehicles purchased must be reduced to $24,000 (25-30% below today's typical levels, which vary in the range of 31-35 thousand USD)

If each household buys 2 electric cars, then the price of $30,000 will be acceptable (10-15% below current typical levels)

But these estimates are valid only if all households choose the electric car, not ICE one

Scenarios of EVs spread

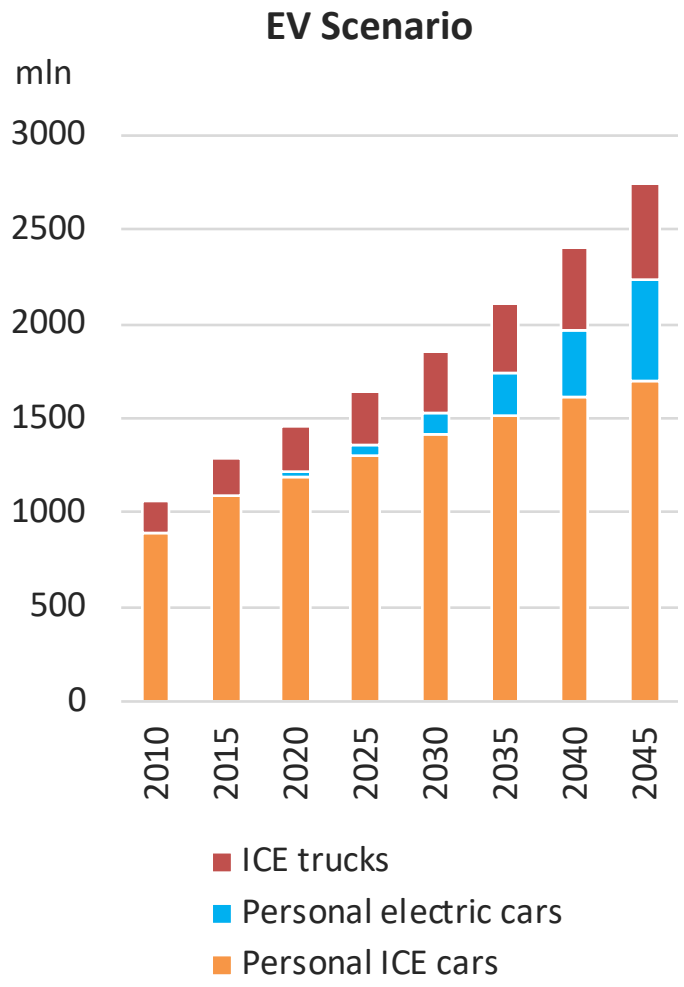
	2010	2015	2020	2025	2030	2035	2040	2045
Common parameters								
World population, mln	6958	7383	7795	8186	8551	8893	9210	9504
World GDP growth rate (average for 5 years)	3.7%	3.4%	3.4%	3.3%	3.1%	2.9%	2.9%	2.8%
Energy intensity of World GDP (2010 = 100)	100	91	84	76	69	63	57	52
EV Scenario								
World cars fleet, mln	888	1087	1215	1362	1534	1735	1969	2238
Personal ICE cars fleet, mln	888	1086	1194	1306	1413	1515	1615	1701
Personal electric cars fleet, mln		1	21	56	121	220	354	537
World ICE trucks fleet, mln	173	208	242	281	325	376	435	502
EV Trucks Scenario								
World cars fleet, mln	888	1087	1215	1362	1534	1735	1969	2238
Personal ICE cars fleet, mln	888	1086	1194	1306	1413	1515	1615	1701
Personal electric cars fleet, mln	0	1	21	56	121	220	354	537
World ICE trucks fleet, mln	173	208	242	275	306	335	361	377
World electric trucks fleet, mln				6	19	41	74	125
EV Trucks + TaaS Scenario								
World cars fleet, mln	888	1087	1215	1356	1472	1561	1618	1680
Personal ICE cars fleet, mln	888	1086	1194	1298	1330	1283	1147	957
Personal electric cars fleet, mln		1	21	56	121	220	354	537
TaaS electric cars fleet, mln				2	21	58	117	185
World ICE trucks fleet, mln	173	208	242	275	306	335	361	377
World electric trucks fleet, mln				6	19	41	74	125

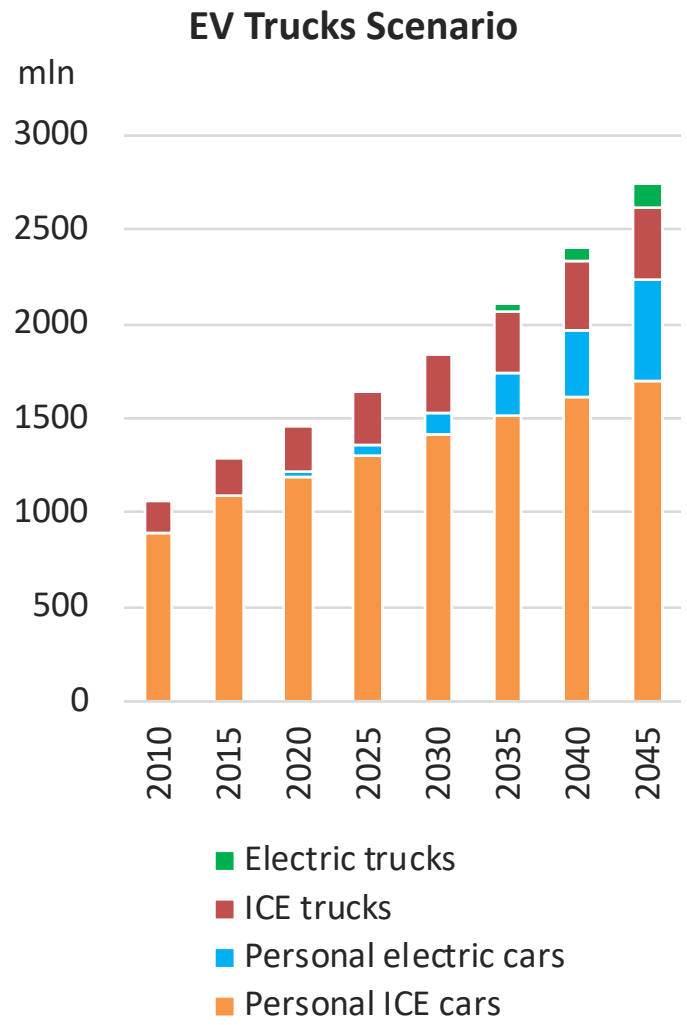
The effect of personal electric cars spread is not very impressive. A multiplier is needed

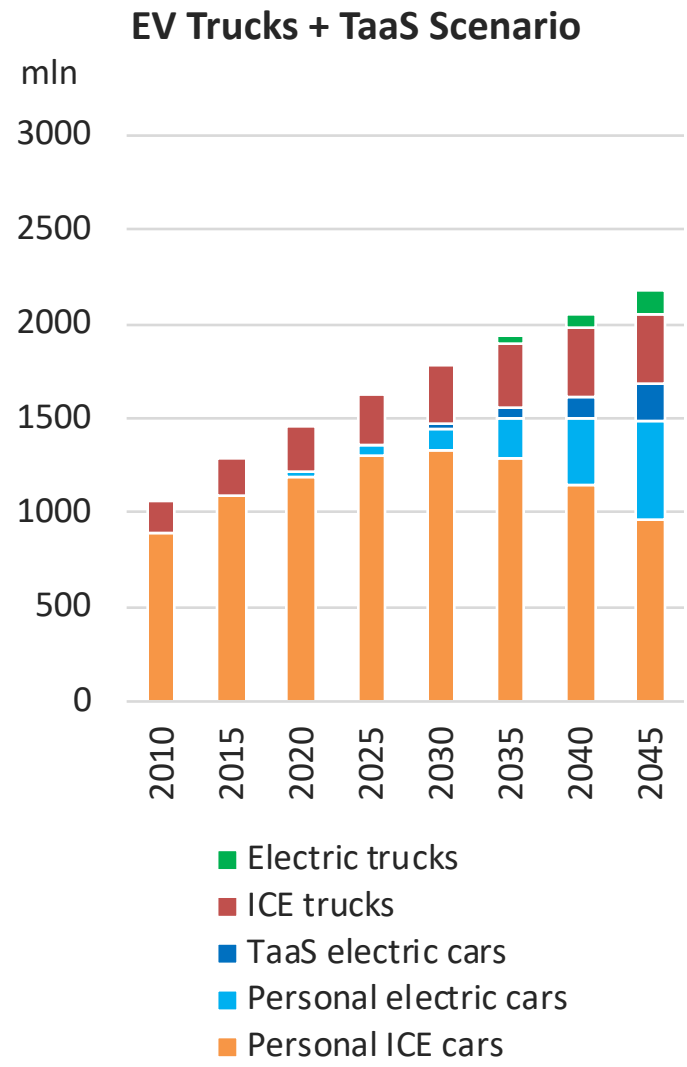
Due to the greater mileage and fuel consumption, the replacement of one truck by an electric analogue gives 5 times more significant effect than the replacement of car

We assume that each TaaS electric car may replace 4 personal ICE cars, but due to a 4-times increase in the average mileage. This is also a way to make electric car cheaper for consumer

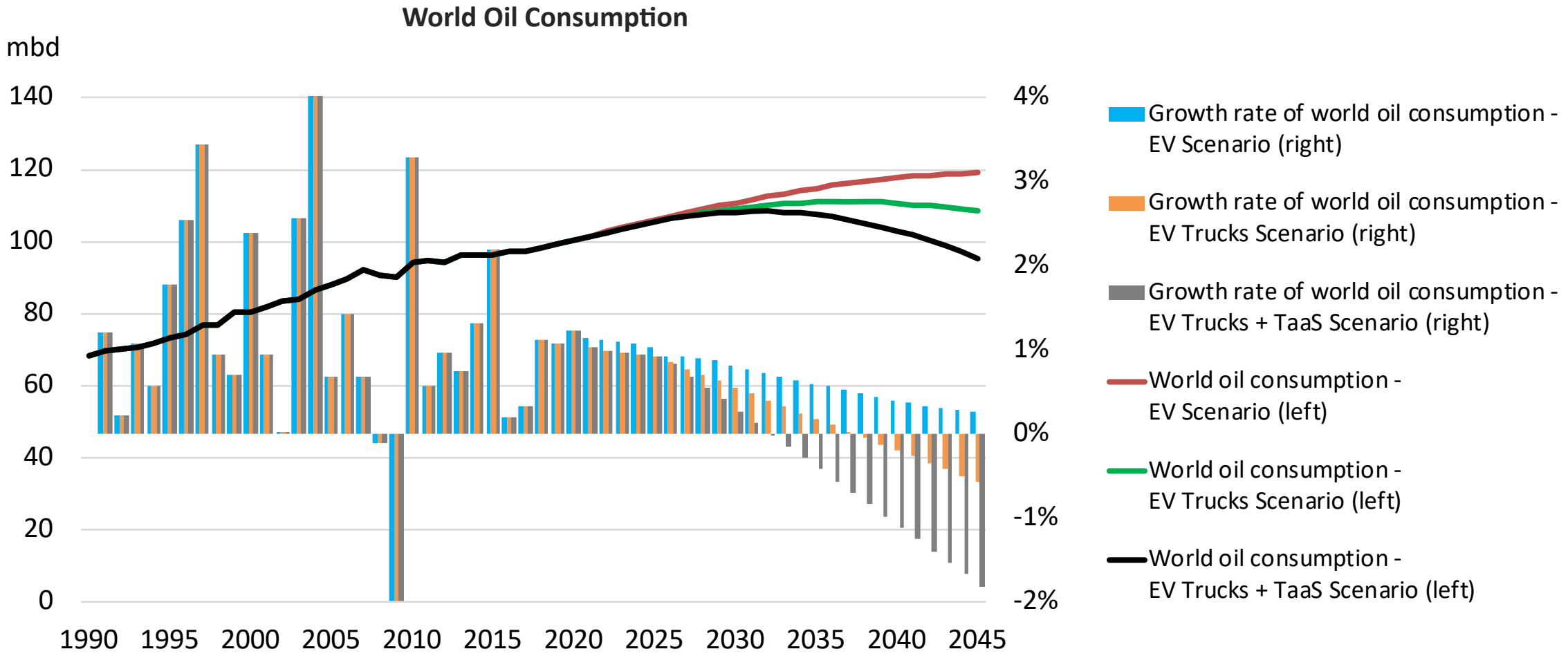
Scenarios of EVs spread: World cars and trucks fleet





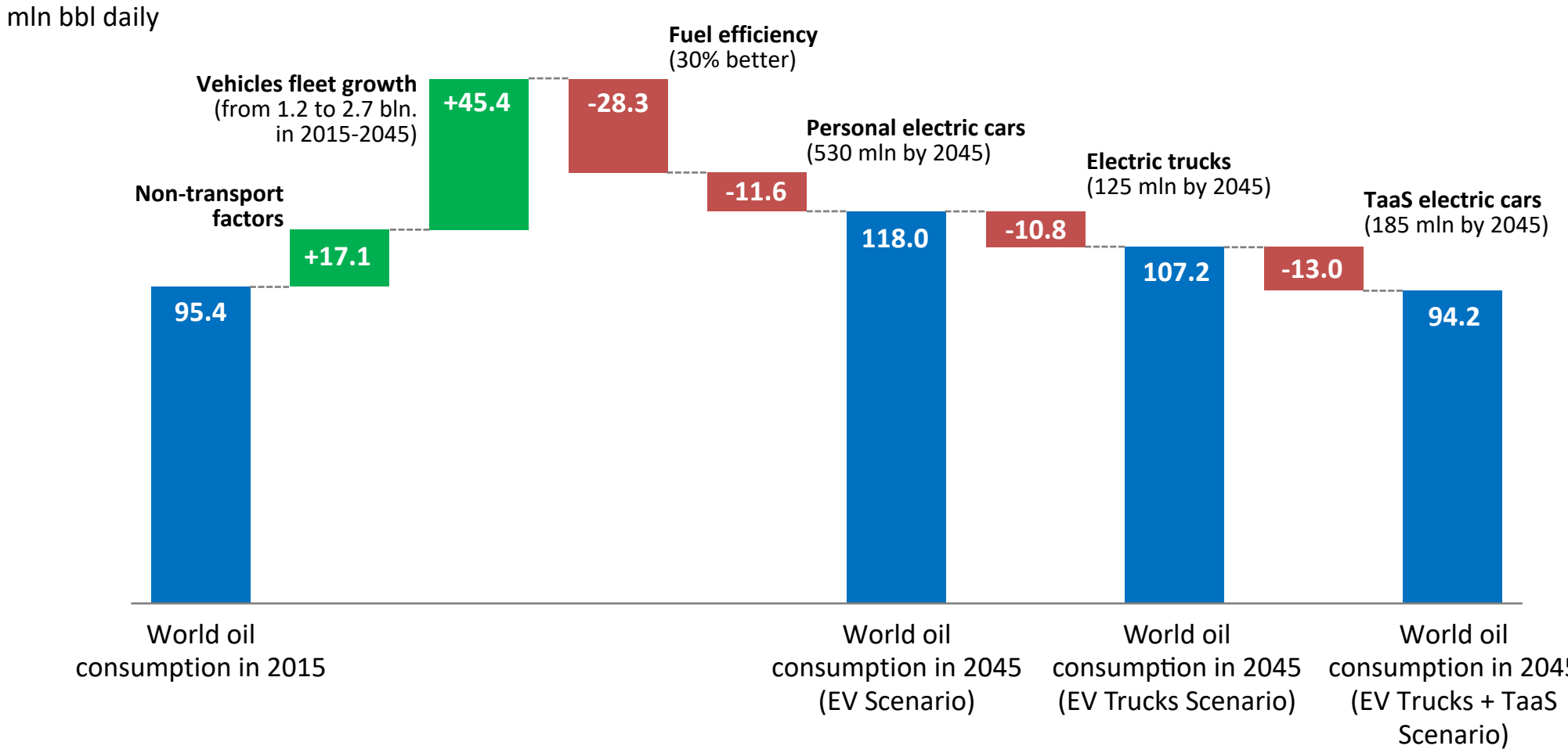


Scenarios of EVs spread: World oil consumption



Source: IEA, IEF RAS estimations

Factors of change in world oil consumption in 2015-2045



Source: IEF RAS estimations

Taxation of electricity consumption

Today the oil industry provides considerable revenues to the budgets of many countries, and the share of taxes in the gasoline / diesel price can exceed 50%. If in the long term EVs replace ICE cars, how will countries replace the falling oil taxes to fill the budget?

Few obvious options:

1) to do nothing with it. In this case we have pure negative tax flow
2) special tax (excise) for electricity since electricity becomes a motor fuel. But this means the higher electricity price

If countries apply electricity tax, for example in the US electricity price will increase by 35%; in Germany – by almost 40%.

The problem is that such option generates a negative impact:

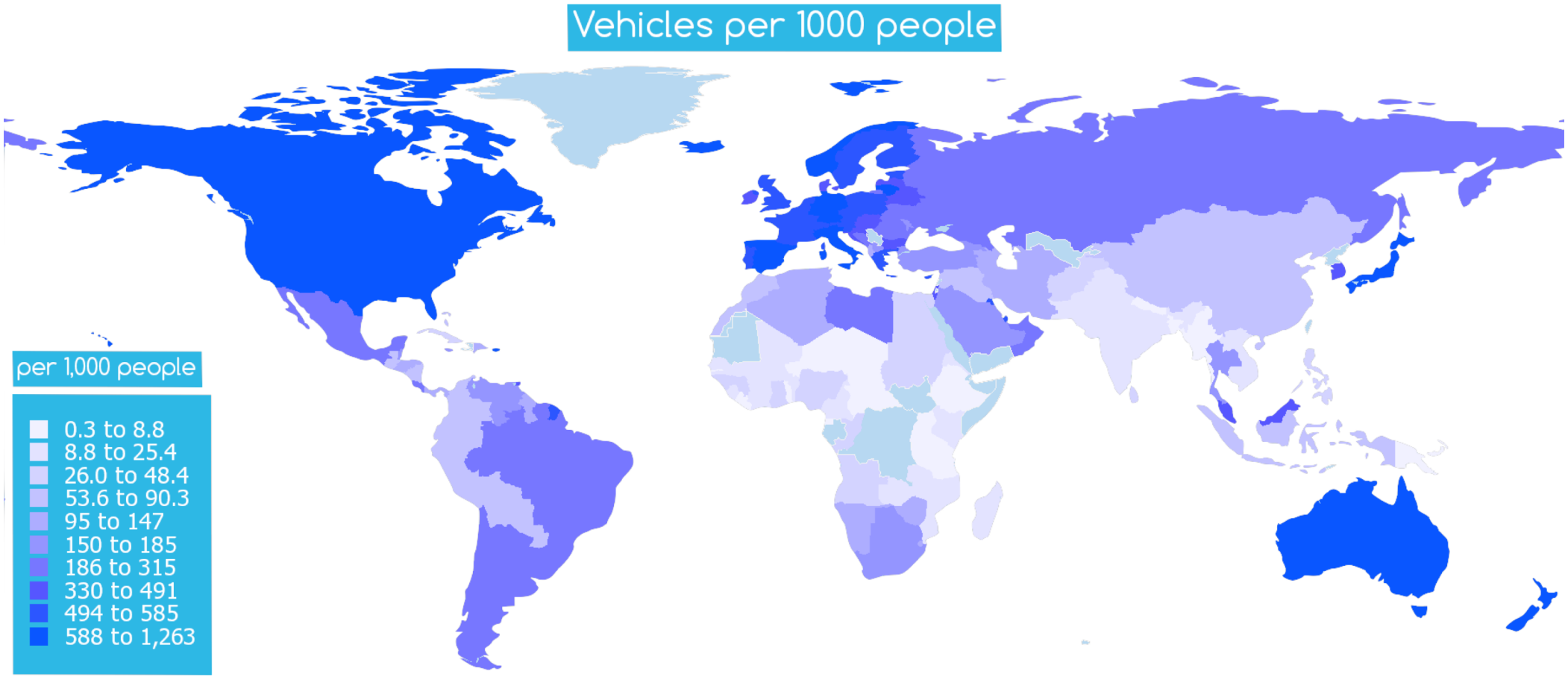
a) on the economic efficiency of electric cars
b) on the whole economy as electricity is consumed everywhere

US case. Taxes related to oil consumption amount to about $110 bln:

- *oil production, transportation and refining sectors provide $32 bln*
- *motor fuel retail taxes provide $77 bln*

At the same time, the output of the electric power industry is about $300 bln. With $110 bln of tax output should be increased by 35% to $410 bln

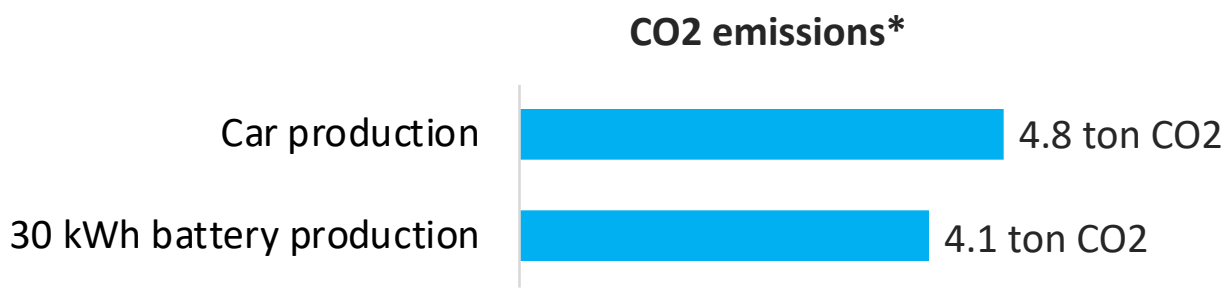
Used ICE cars market



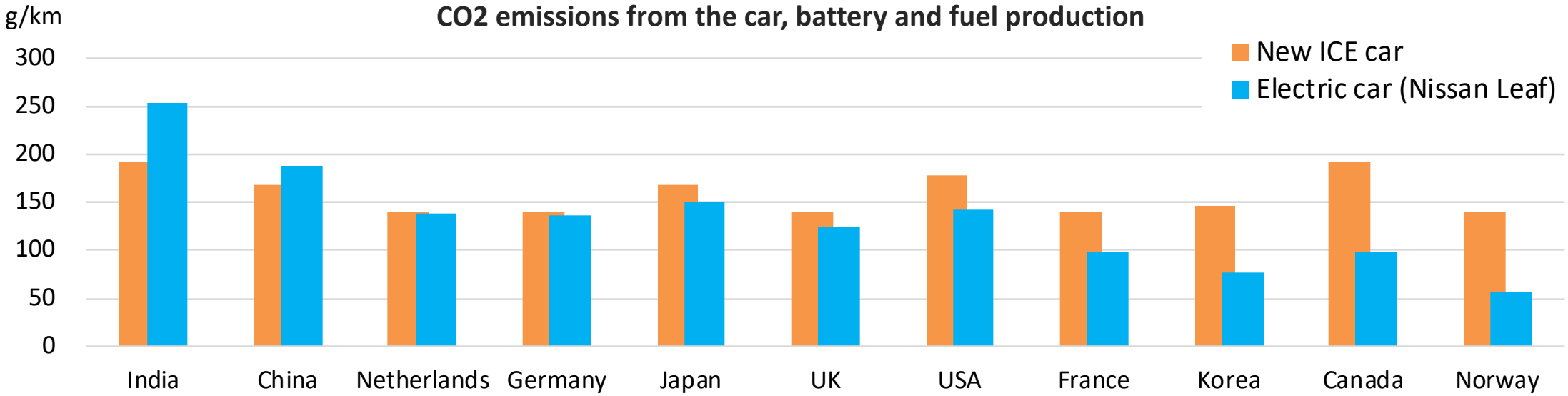
EVs spread creates the prospects for a wide market of used ICE cars with origin from OECD countries

Source: World Bank

About zero emissions of electric cars



- Battery production requires almost as much CO2 emissions as a car production
- Most of batteries are produced in Asia using ”dirty” electricity and materials
- Today EV producers give the battery warranty for 8 years or 160,000 km



** Based on* “The Life Cycle Energy Consumption and Greenhouse Gas Emissions from Lithium-Ion Batteries” by Mia Romare and Lisbeth Dahllöf, ivl 2017

Input-Output slide

What we try to do with all of this:

- forecasting of technological coefficients and redistribution of value added in the economy with electric cars; analysis of changes in the structure of costs, outputs, incomes *(materials, mining, battery and car production, fuel sector)*
- analysis of changes in the trade flows *(materials and equipment, new and used cars, fuels)*
- estimation of the real CO2 emissions of the economy with electric cars taking into account full intersectoral interactions

We can handle it only by using input-output tools

Thank you for your attention

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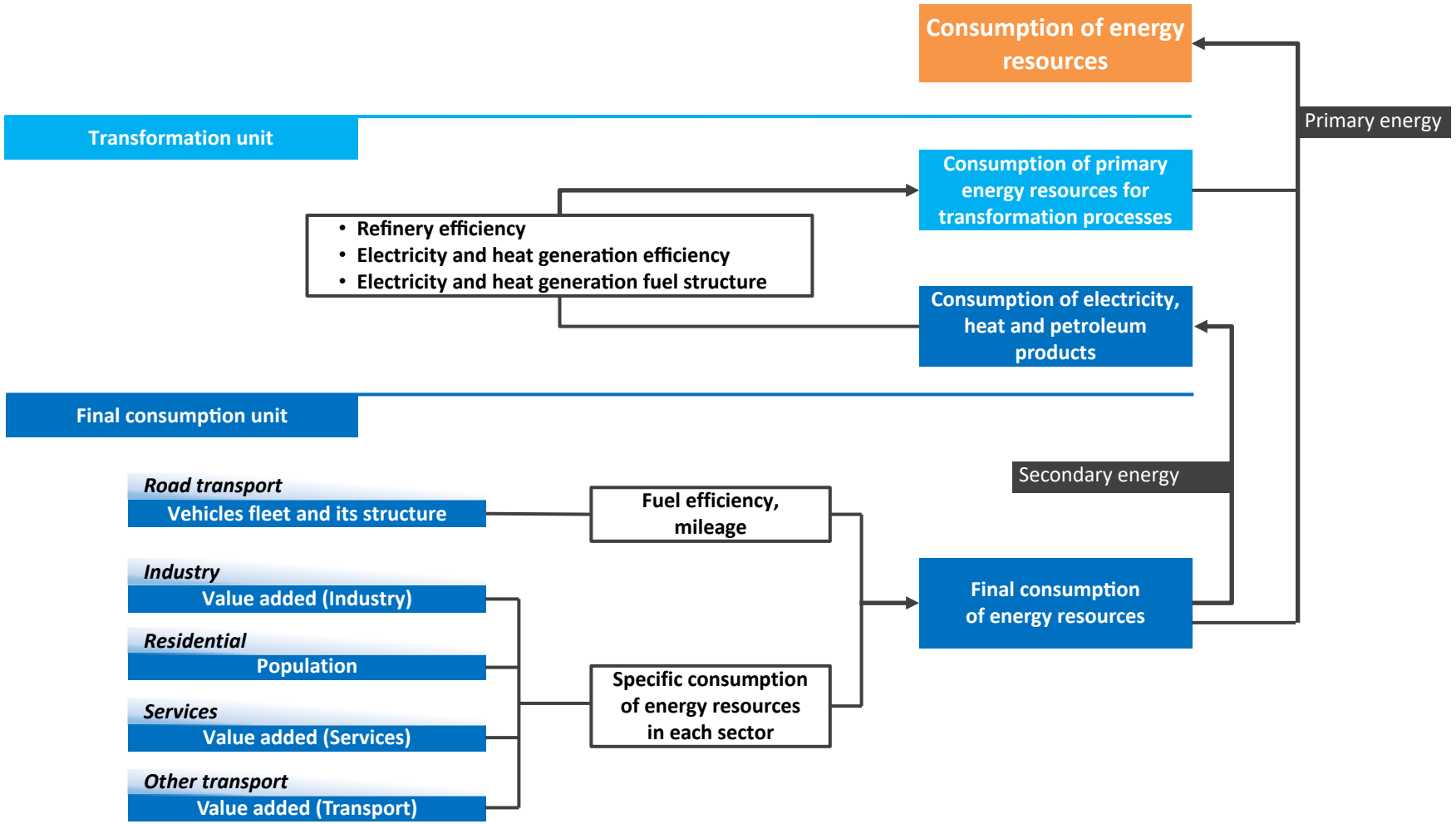
Key points

- Electric vehicles spread is likely to be slow and may have wide range of trajectories
- In order to fulfill the goals declared in the Paris Agreement, the price of electric car for consumer should be $24,000 by 2030 (35% below today's level)
- In the most optimistic scenarios for electric vehicles, they will reduce global oil consumption by 35 mbd. In this case world oil consumption by 2045 will be comparable to current level of about 95 mbd
- Electric vehicles spread will provide a lot of different impacts on the world economy, including negative

Additional: IEF RAS Model of world energy consumption forecasting



Countries and regions

EU + 43 countries + 6 regions of other countries

Energy resources

Primary: coal, natural gas, oil, nuclear, hydro, solar, wind, biofuels, other renewables

Secondary: electricity, heat, petroleum products (gasoline, diesel, fuel oil, kerosene, naphtha and LPG, other)

Exogenous parameters

Energy: electricity and heat generation efficiency and structure, refinery efficiency, road transport fuel efficiency, mileage

Non-energy: GDP and its structure, population, vehicles fleet and its structure

Consumption sectors

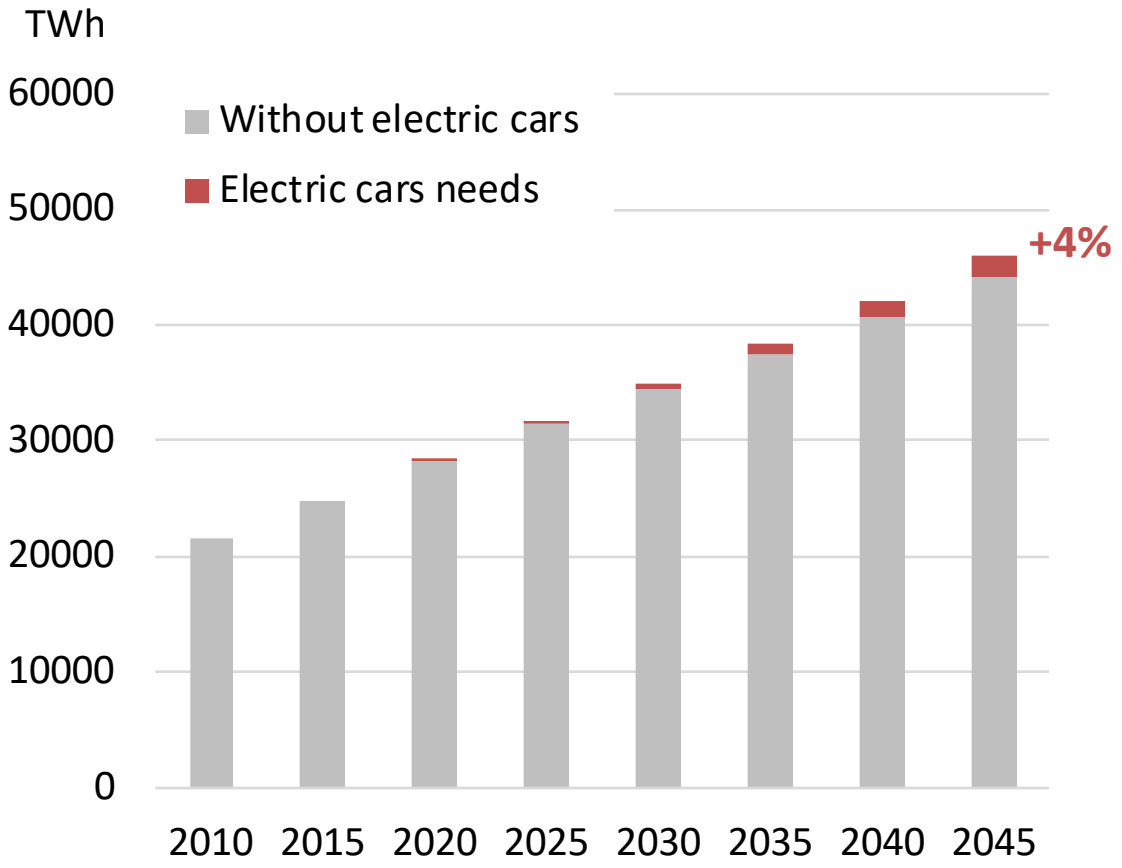
Final consumption: industry, transport (road, air, rail, other), residential, services, chemistry, non-energy consumption

Transformation: electricity and heat plants, refineries, other transformations

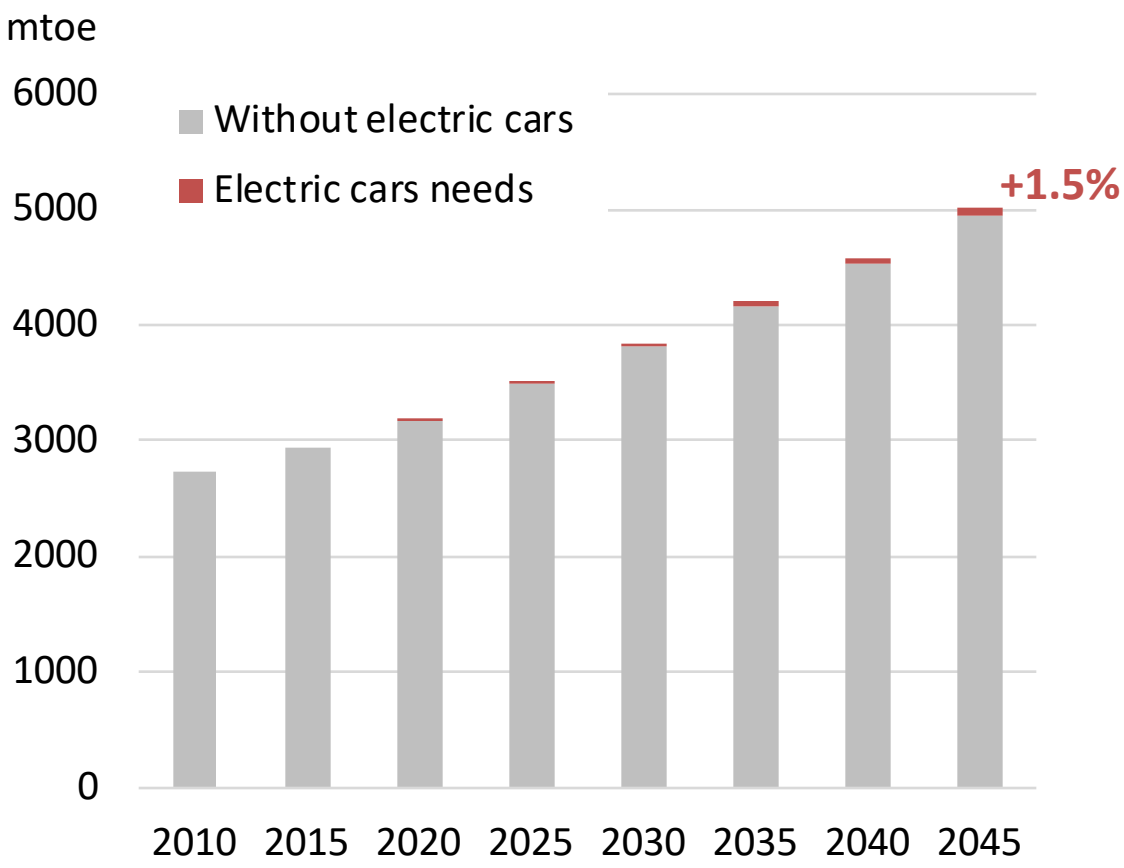
Database: IEA

Additional: electricity for electric cars

World electricity production



World natural gas consumption



Source: IEF RAS estimations