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ELECTRIC VEHICLES: impact on the world economy and energy sector

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Electric cars create 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

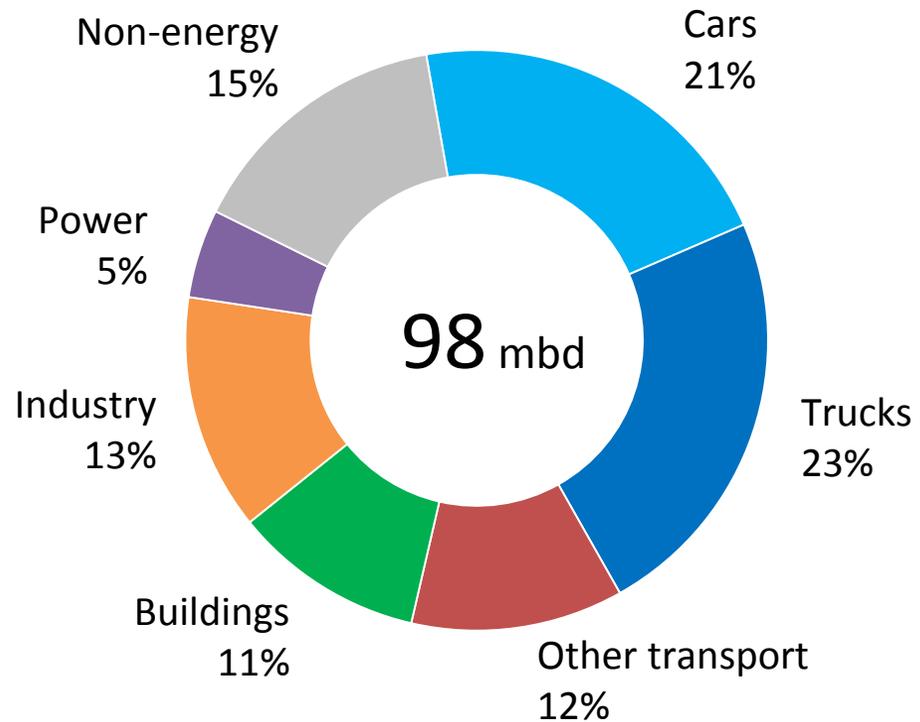
Some of these issues were discussed at Inforum 2016 by Philip Ulrich and Dr. Ulrike Lehr (*Economic effects of an increasing market penetration by electric drives – structural changes in a scenario analysis*).

Here we try to discuss few other points



3 Let's check the scale

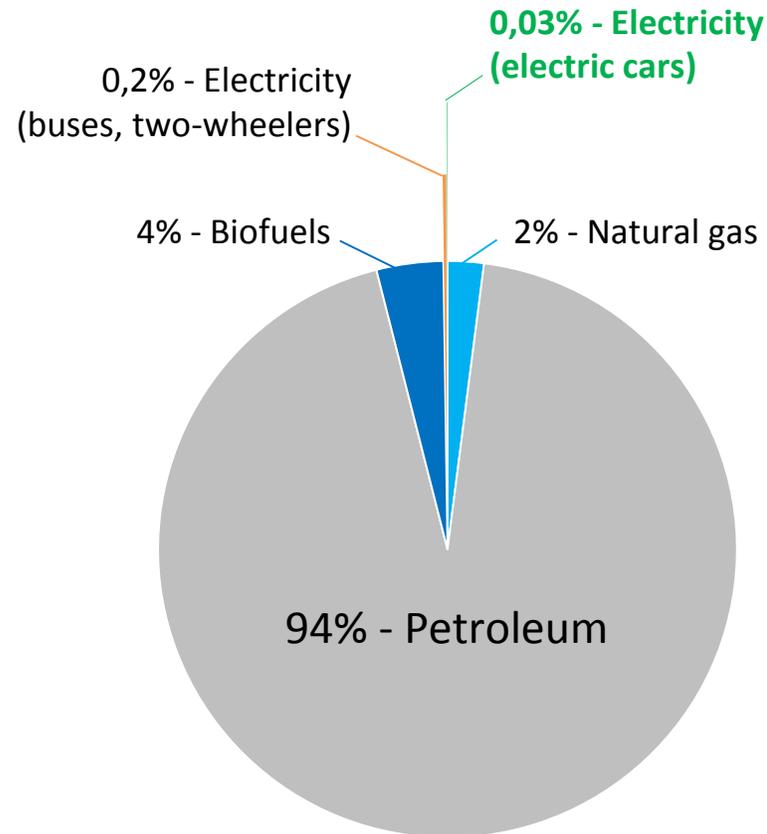
World oil consumption in 2017



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



Structure of road transport energy consumption in 2017

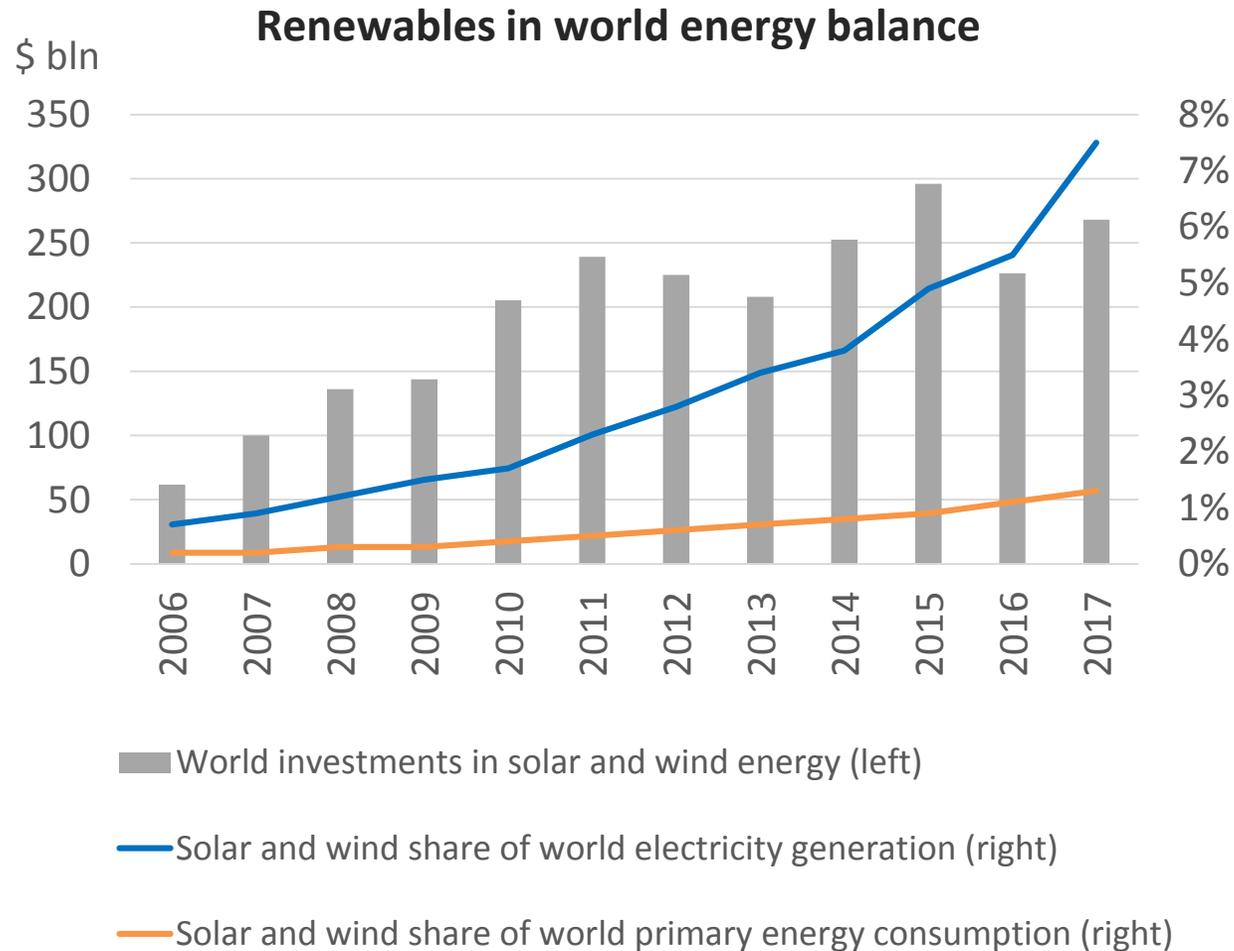


By the end of 2017 electric cars provided:

- 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

5 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%

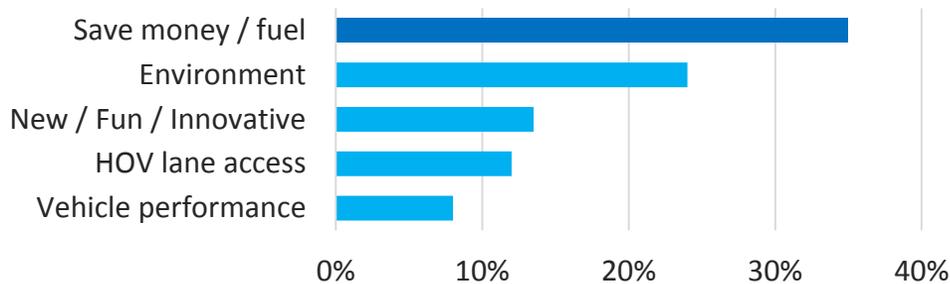
Energy consumption is inert. Structure change of 1% is great result



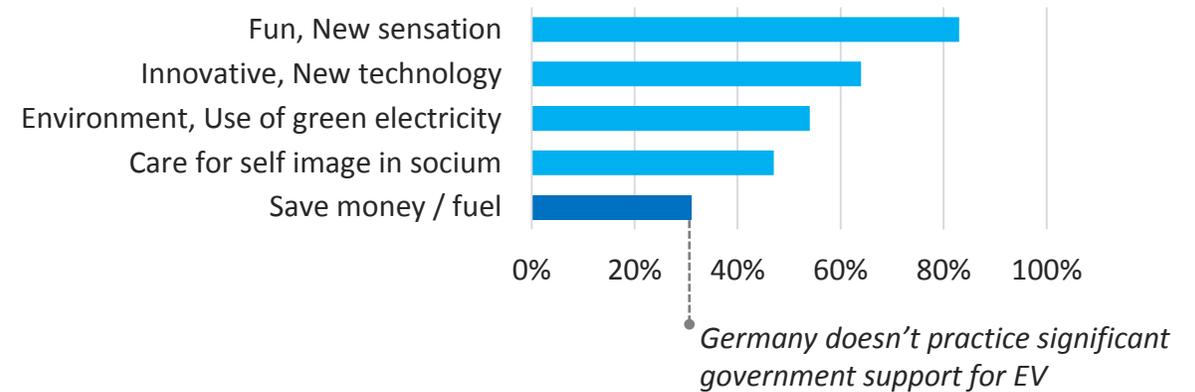
6 Why do people buy EVs?

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

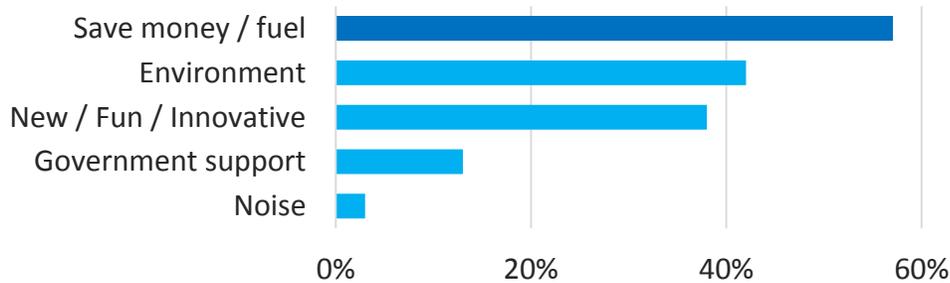
Main reason for buying EV – US, California



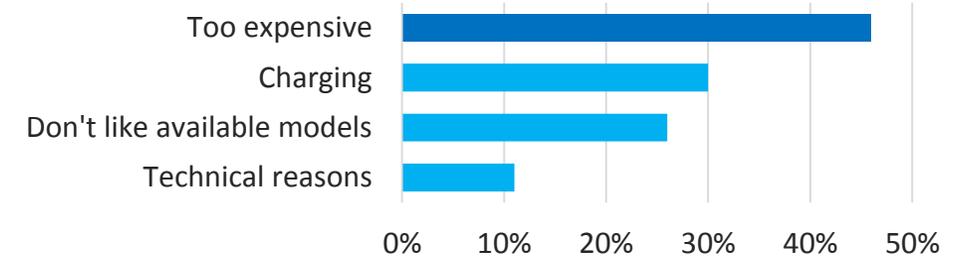
Reason for buying EV – Germany



Reason for buying EV – UK

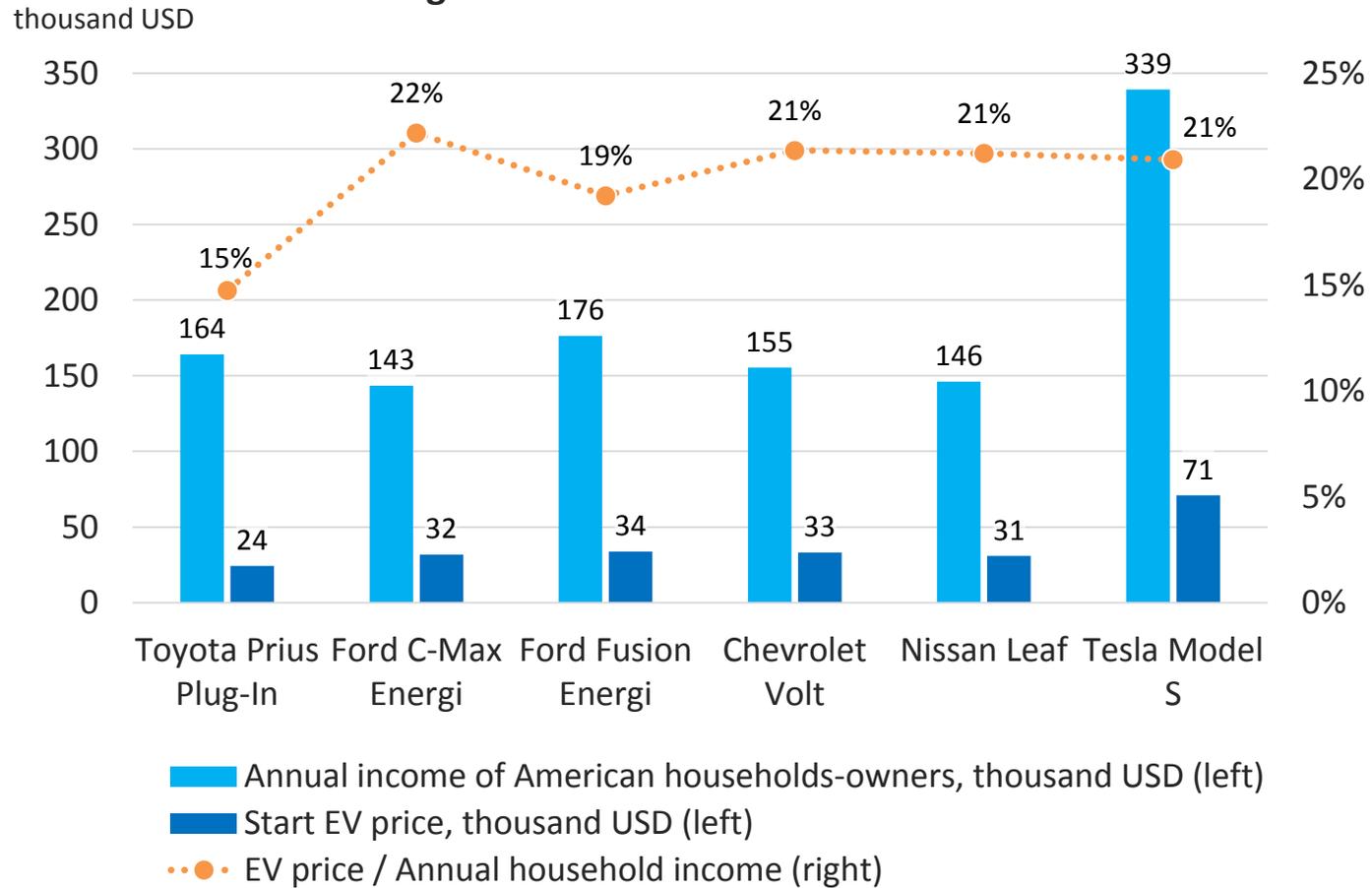


Reason for not buying EV – Germany



7 Who buys EVs?

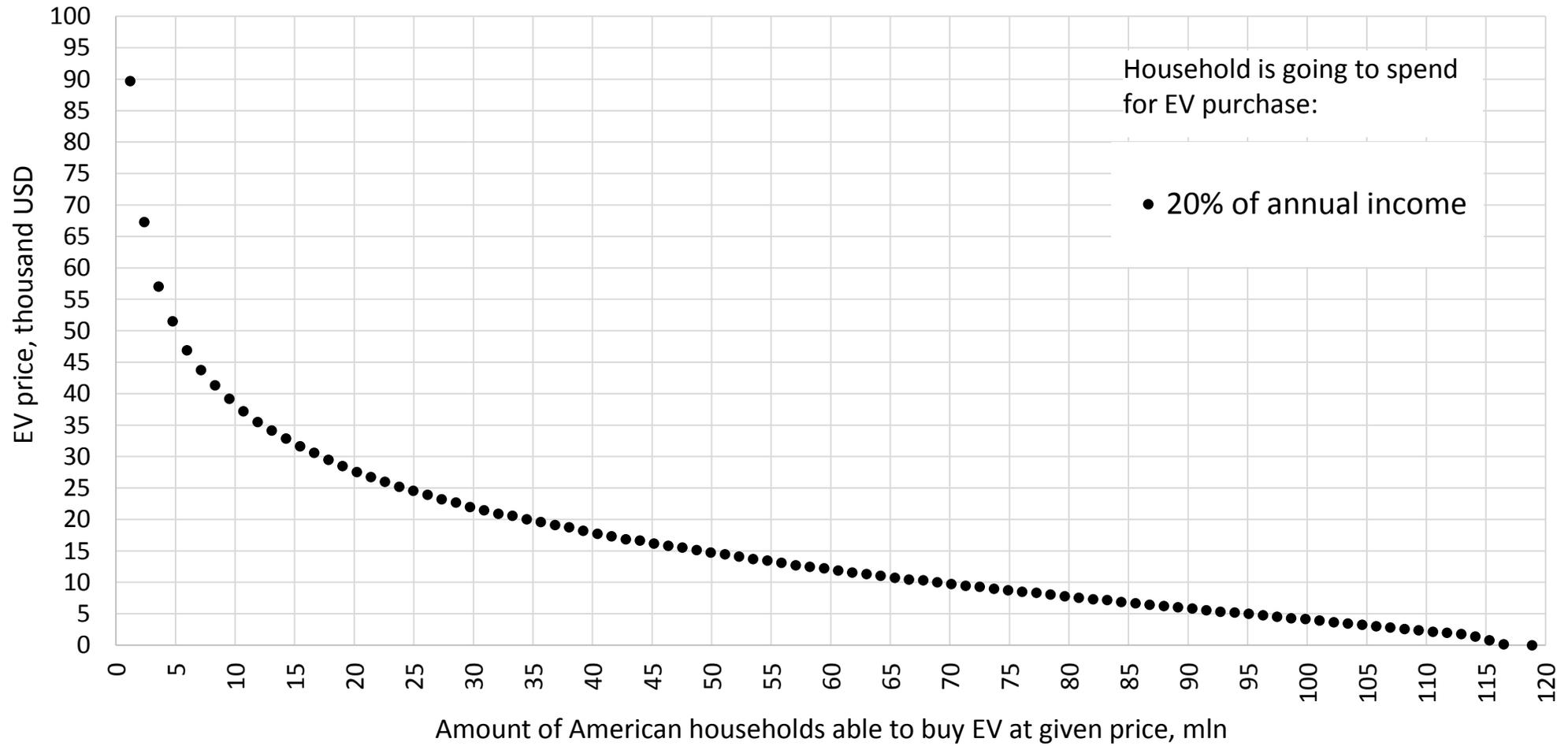
Annual income of American households that bought different models of electric cars



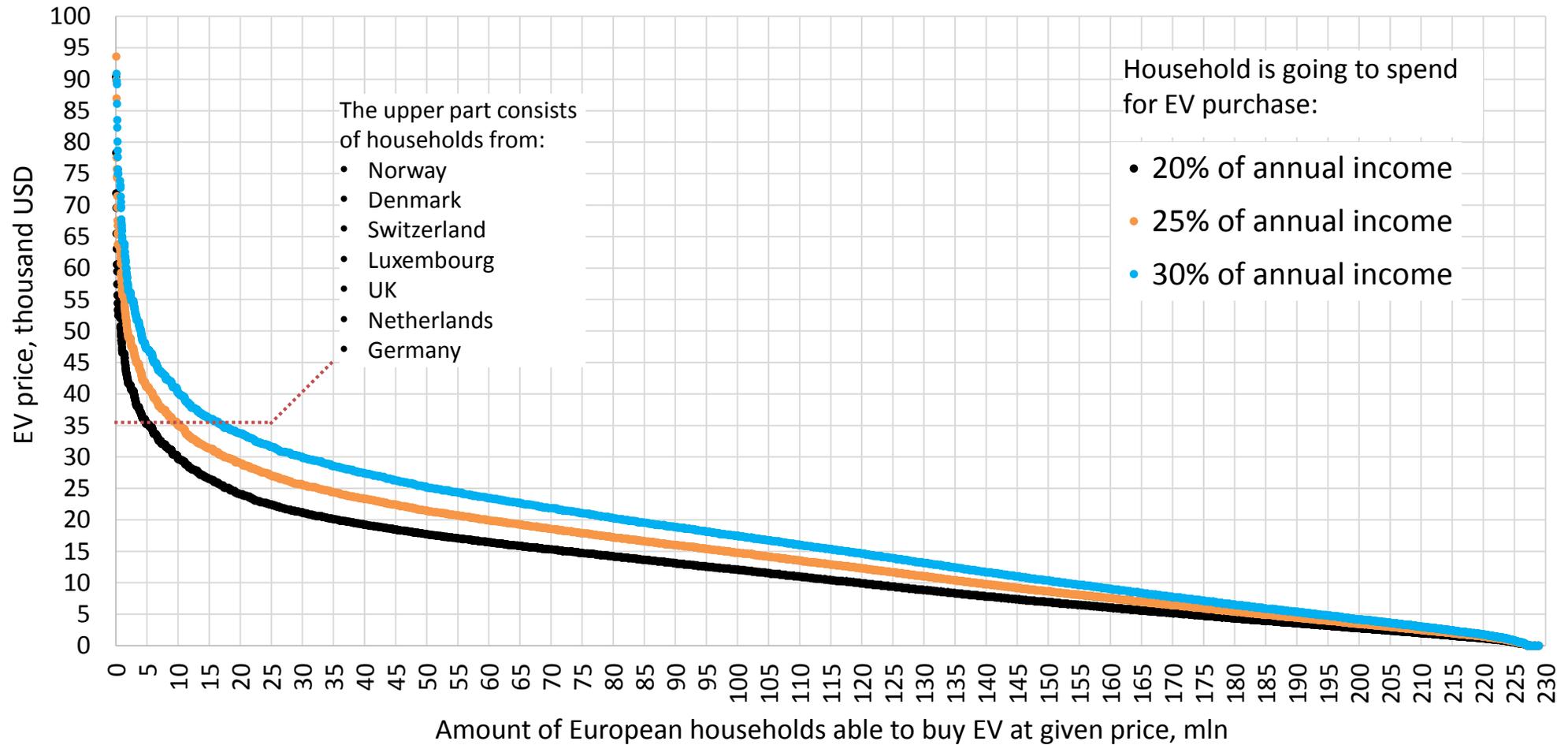
1. Today electric car is a choice for households with annual income of at least \$140,000
2. Price of electric car purchased was about 20% of annual income of households-buyers. And this is valid as for relatively cheap models (by the standards of EVs) with price of 30-35 thousand USD, and for more expensive 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



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



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



10 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



11 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 |

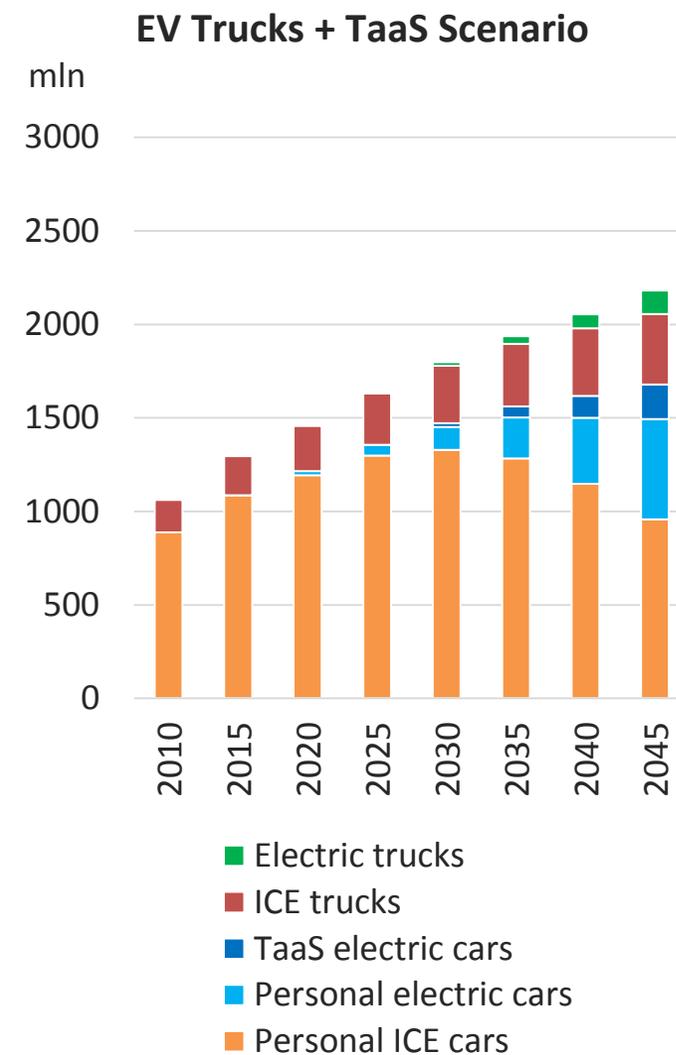
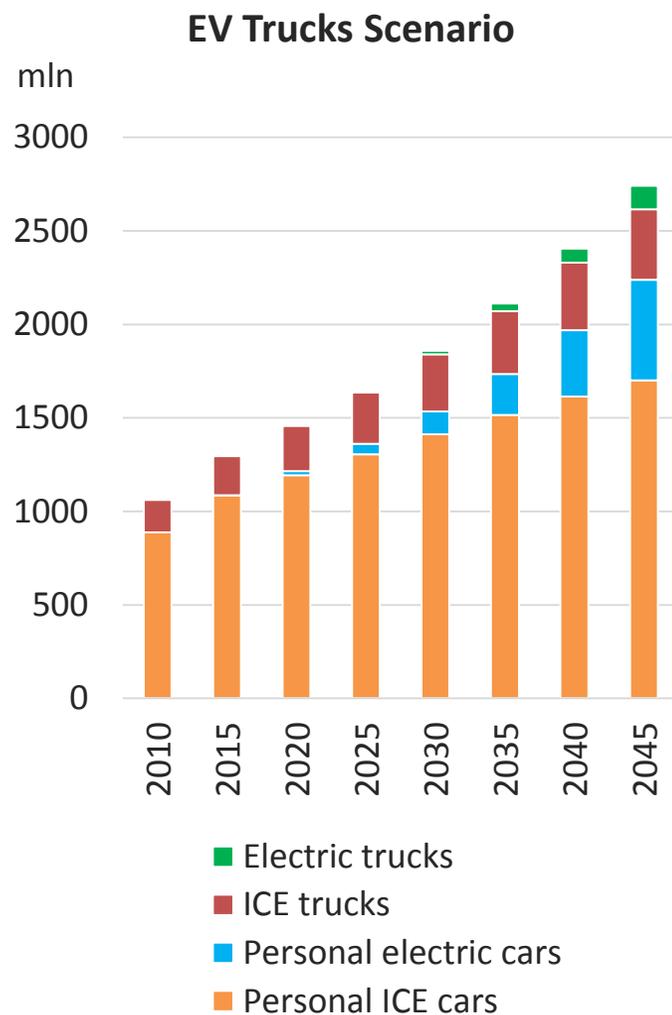
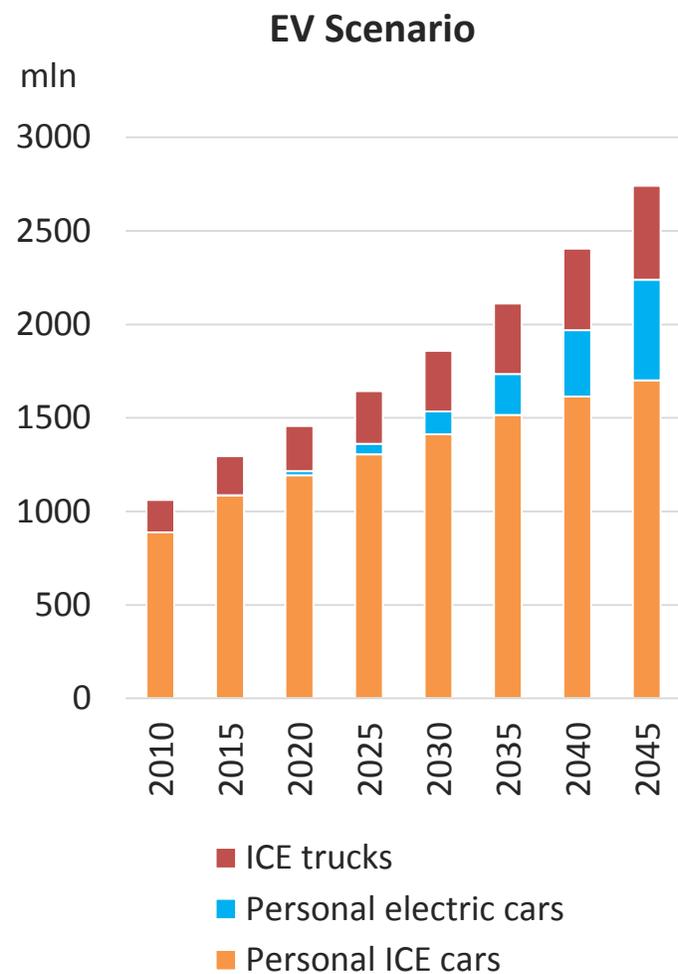
The effect of personal electric cars spread is not very impressive. A multiplier is needed

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

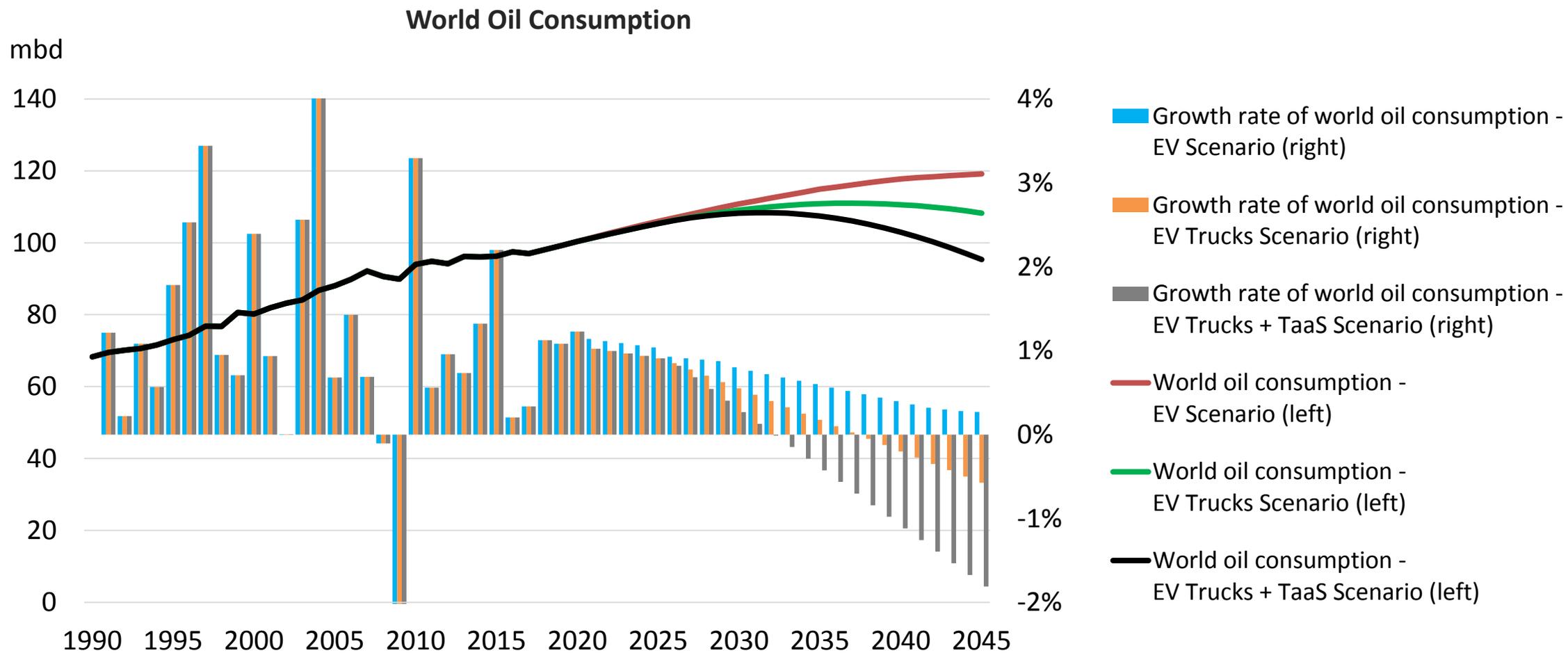
We assume that each TaaS electric car may replace 4 personal ICE cars, but due to a 4-times increase in the average mileage. This is also a way to make electric car cheaper for consumer



12 Scenarios of EVs spread: World cars and trucks fleet

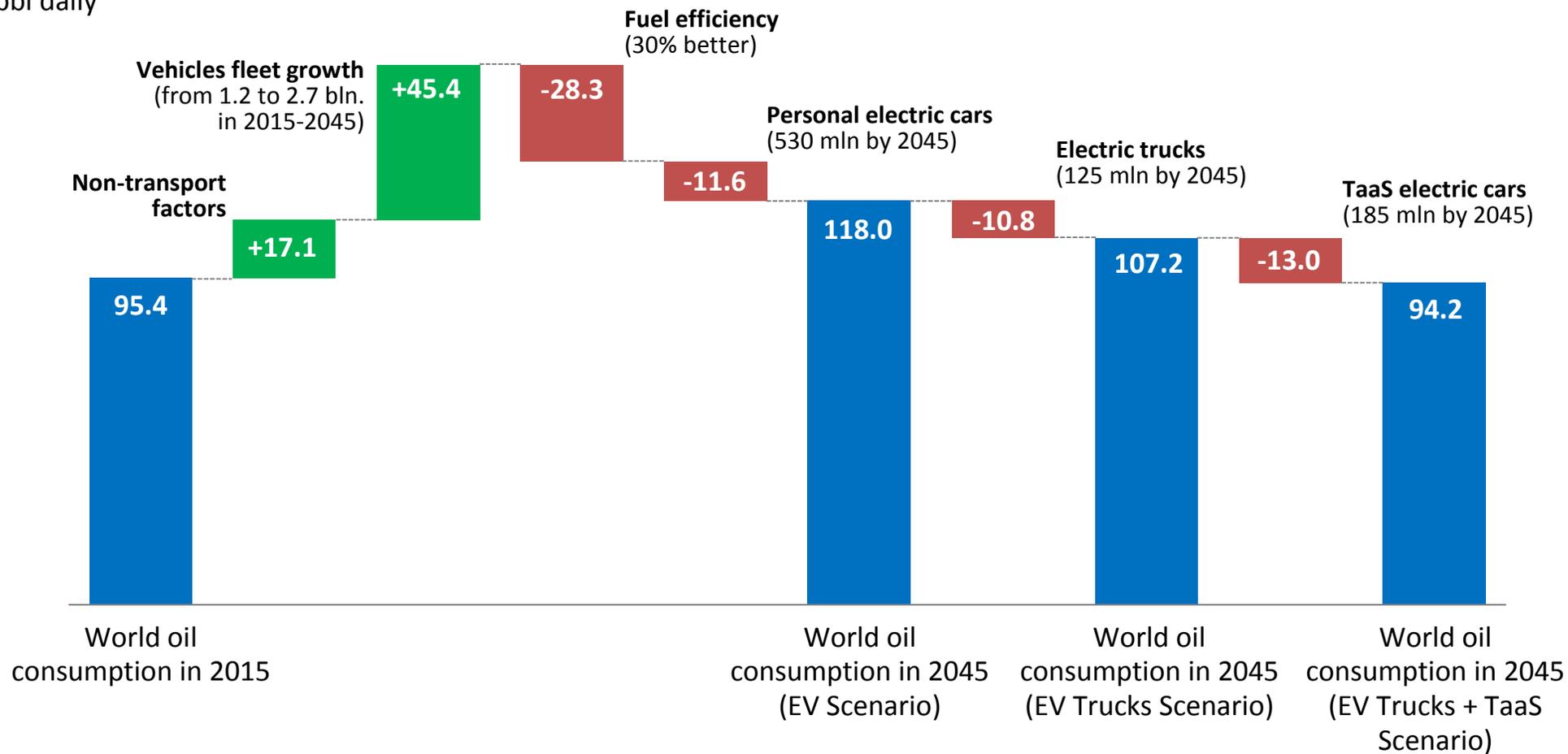


13 Scenarios of EVs spread: World oil consumption



14 Factors of change in world oil consumption in 2015-2045

mln bbl daily



15 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

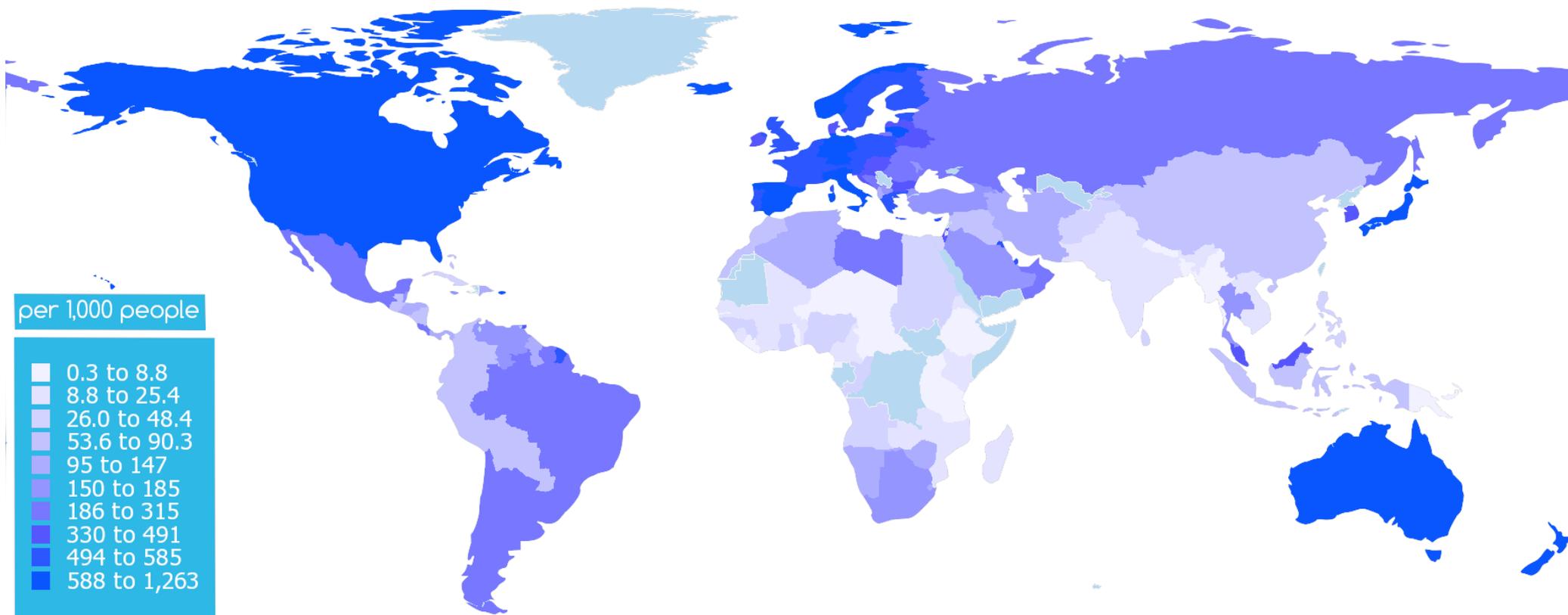
US case. Taxes related to oil consumption amount to about \$110 bln:

- *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



Vehicles per 1000 people



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

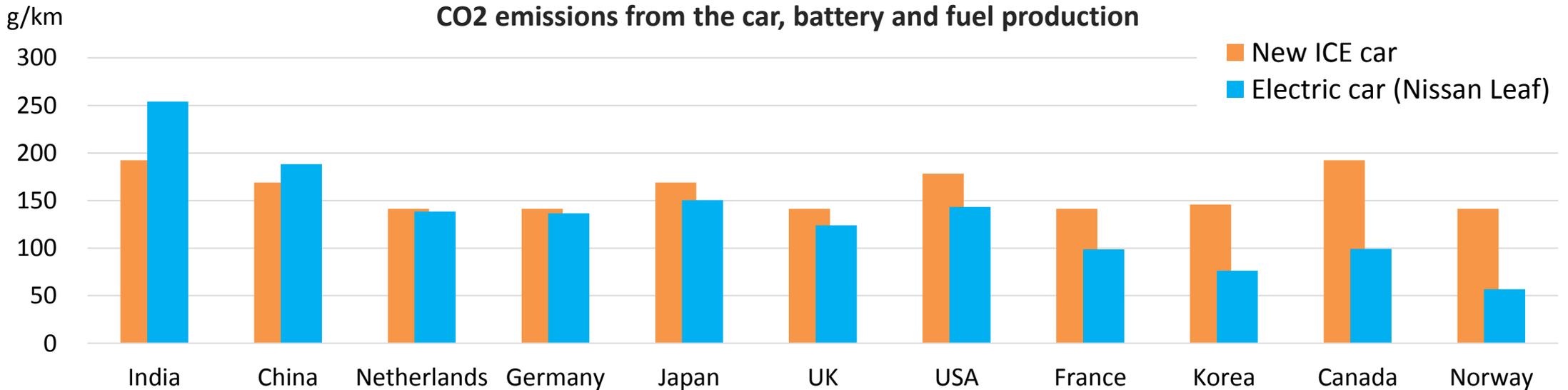


CO2 emissions*



- 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

CO2 emissions from the car, battery and fuel production



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

