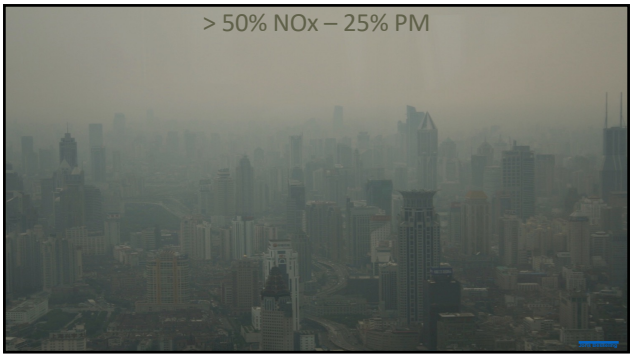
VUB mobi ELECTROMOBILITY RESEARCH CENTRE

E-mobility in Europe:
challenges and opportunities

Prof. Dr. ir. **Joeri Van Mierlo**
Director of MOBI - Electromobility research centre

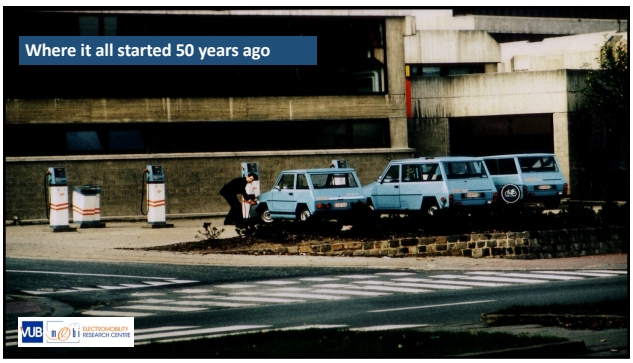
1

2



3

4



5

THE LARGEST ELECTROMOBILITY RESEARCH HUB IN EUROPE

6

Battery Innovation Centre

Chemical Lab
- Dry Room
- Pilot line
- *In-Situ* XRD

Battery lab
- 300+ cell-level channels
- 12 climate chambers
- 42 impedance spectroscopy

7

Powertrain innovation lab

- Vehicle dyno-roll bench (200km/h)
- Multiple electrical machines group (450kW)
- Smart and V2X (100kW)

- Semiconductors reliability characterization
- EMC test cabinet
- High Temperature gate bias test facility

8

Smart Village Lab

9

ELECTRIC & AUTONOMOUS VEHICLES

Socio-economics

Life Cycle Assessment

Total cost of ownership (TCO) calculations

Consumer monitoring

Charging infrastructure planning models and tools

Virtual reality acceptance testing

10

Flanders Alliance for Climate Technologies

500 FTE

8 RGs **3** Fac

20MC yearly R&D turnover

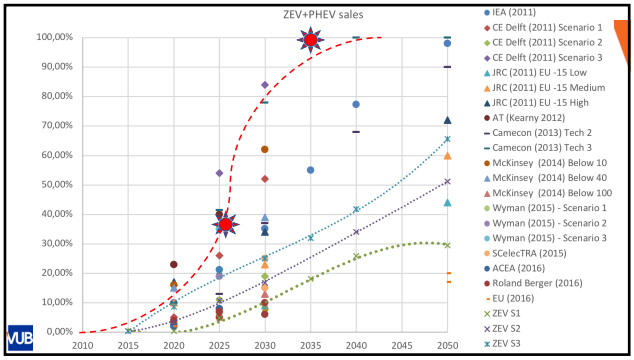
11

International collaboration

12

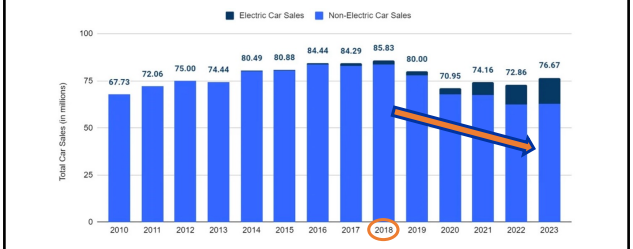
Emobility market

13



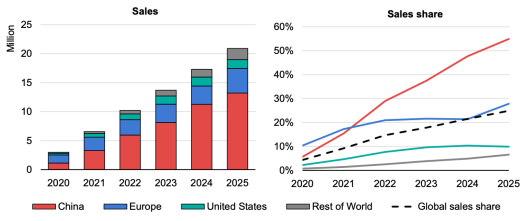
14

Global Number of cars sold



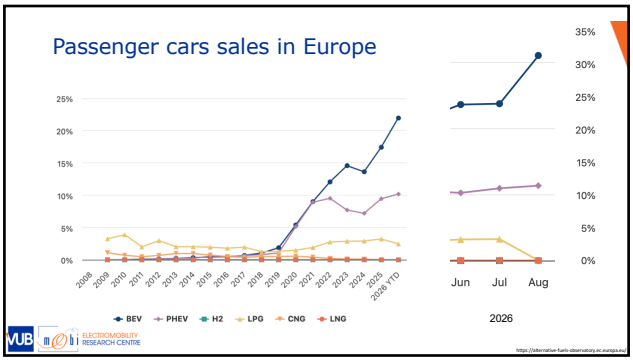
15

EV market



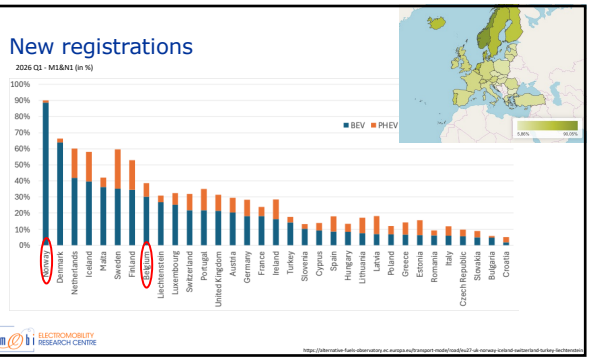
16

Passenger cars sales in Europe

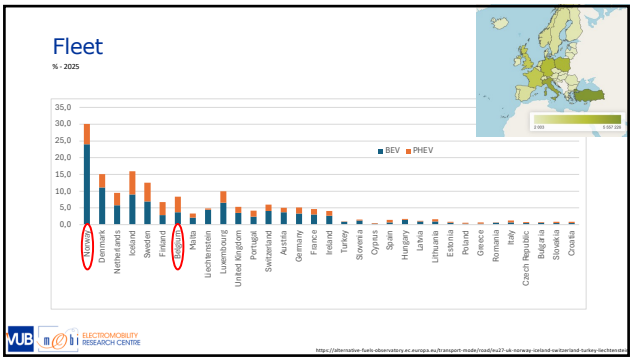


17

New registrations

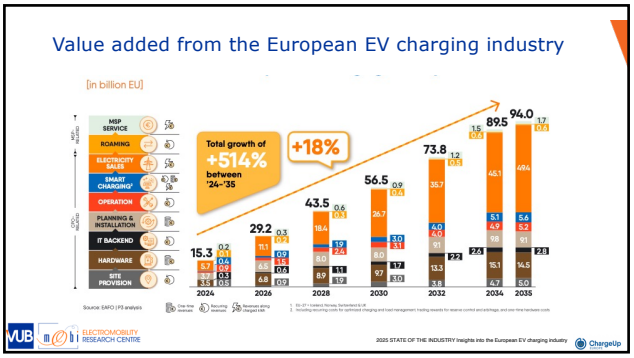


18

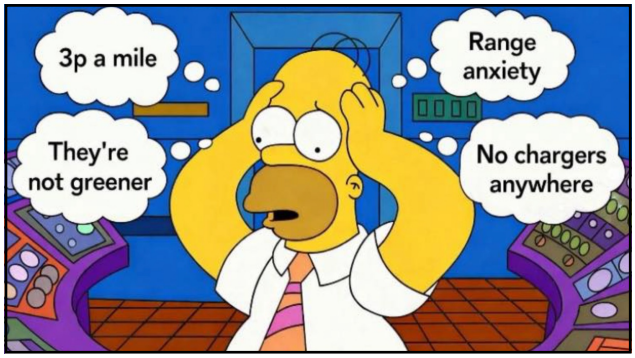


19

20



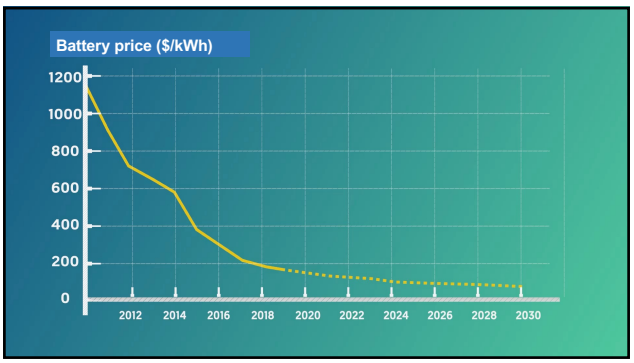
21



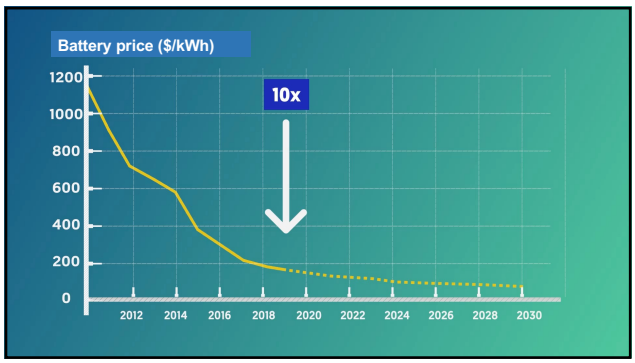
22

23

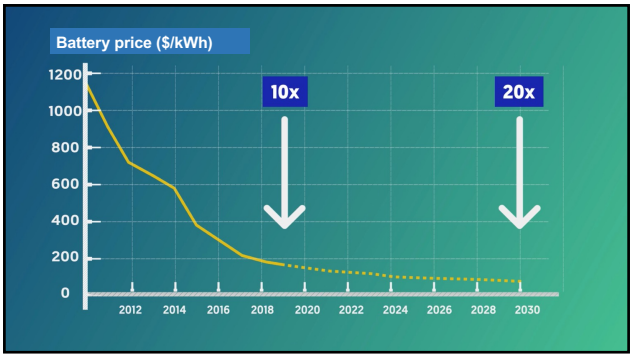
24



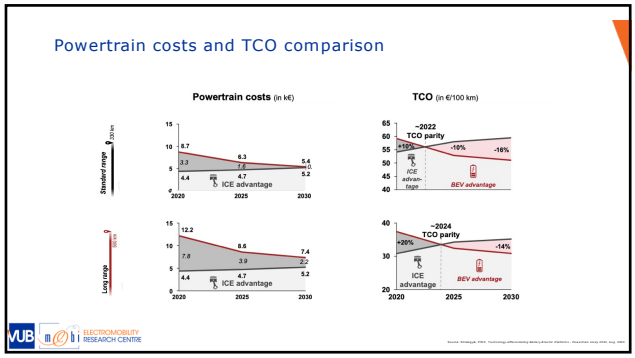
25



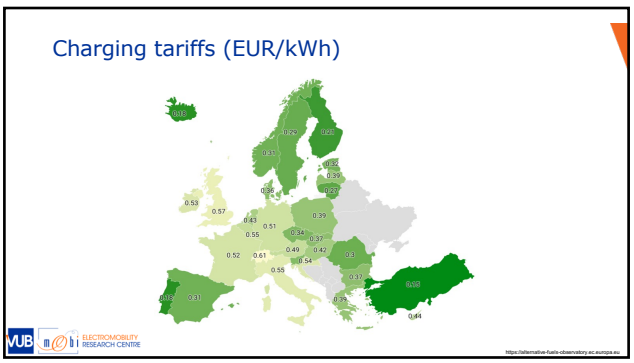
26



27

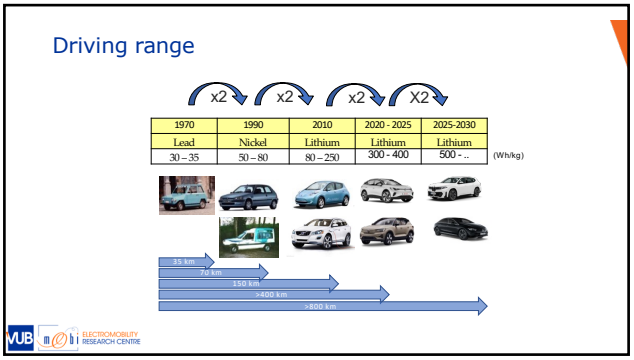


28

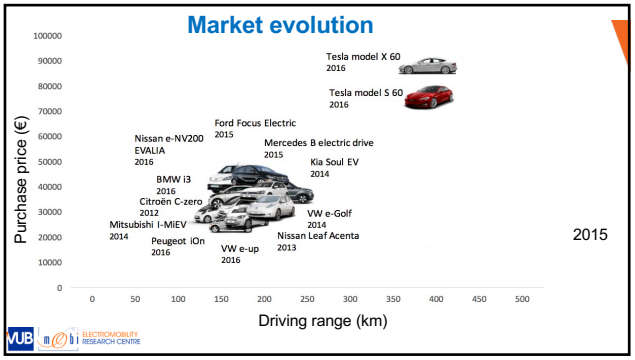


29

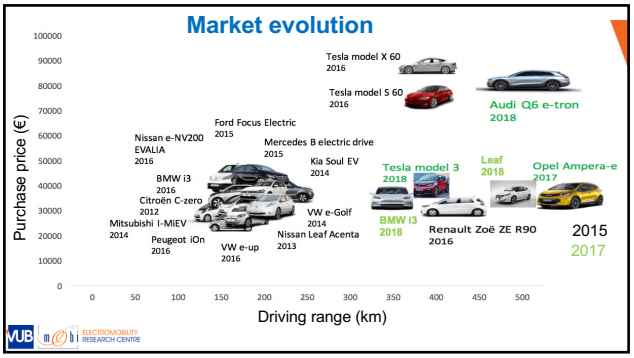
30



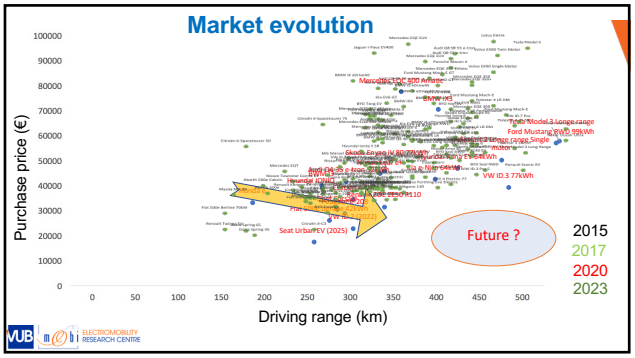
31



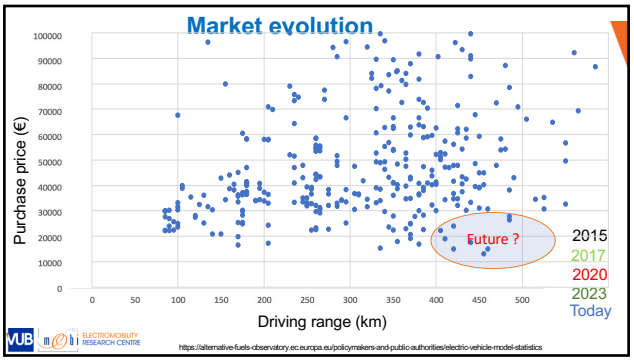
32



33



34



35

36

Batteries

37

Battery pack

38

	NMC (Nickel-Manganese-Cobalt)	LFP (Lithium-Iron-Phosphate)
Typical Energy Density (Wh/kg)	*180–265*	*120–205*
Cycle Life	*1,000–2,000 cycles*	*2,500–5,000+ cycles*
Thermal Safety	Medium (higher fire risk)	High (very stable)
Fast-Charging Performance	Very good	Good
Low-Temperature Performance	Good	Moderate
Use of Rare / Critical Materials	Contains **nickel + cobalt**	No nickel, no cobalt
Cost per kWh	Medium–High	Low
Energy Efficiency	High	Moderate–High
Typical Applications	Long-range EVs, performance vehicles	Mass-market EVs, buses, stationary storage
Maturity Level	Highly mature	Highly mature

39

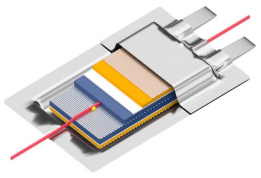
Future trends in battery developments

- Imbeded sensors for BMS
- Self-healing batteries
- Cobalt free cathode
- Silicon anode material
- Solid state electrolyte
- Sodium batteries
- Reuse, Repair, Remanufacture and Recycle

40

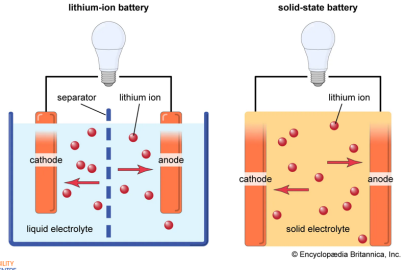
Self Healing

Integrated Sensors



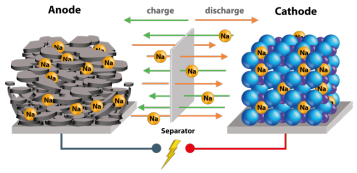
41

Solid state battery



42

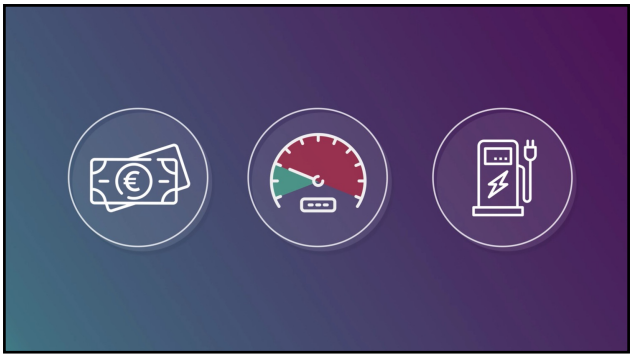
Sodium batteries



43

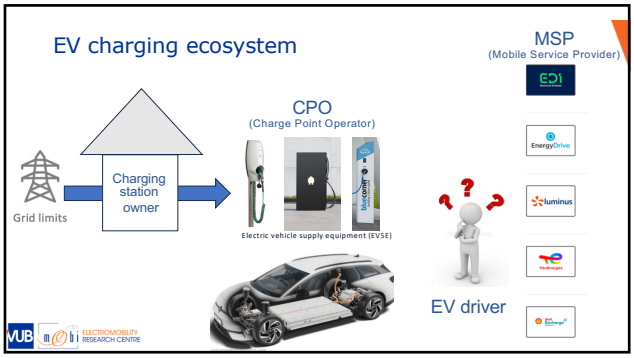
	NMC (Nickel-Manganese-Cobalt)	LFP (Lithium-Iron-Phosphate)	Sodium-Ion (Na-Ion / Natrium)	Solid-State
Typical Energy Density (Wh/kg)	*180–265*	*120–205*	*90–175 +*	*300-500 +*
Cycle Life	*1,000–2,000 cycles*	*2,500–5,000+ cycles*	*1,500–3,000 cycles (early data)*	*1,000-5,000+ (technology dependent)*
Thermal Safety	Medium (higher fire risk)	High (very stable)	High (very stable)	Very high (non-flammable electrolyte)
Fast-Charging Performance	Very good	Good	Moderate (improving)	Excellent
Low-Temperature Performance	Good	Moderate	Good to excellent	Good to excellent
Use of Rare / Critical Materials	Contains **nickel + cobalt**	No nickel, no cobalt	No lithium, nickel, cobalt; abundant materials	Reduced Nickel/Cobalt
Cost per kWh	Medium–High	Low	Very low (expected)	Very high today
Energy Efficiency	High	Moderate–High	Moderate	High
Typical Applications	Long-range EVs, performance vehicles	Mass-market EVs, buses, stationary storage	Small EVs, two-wheelers, grid storage	Premium Long-range EVs
Maturity Level	Highly mature	Highly mature	Emerging / scaling	Pre-commercial

44



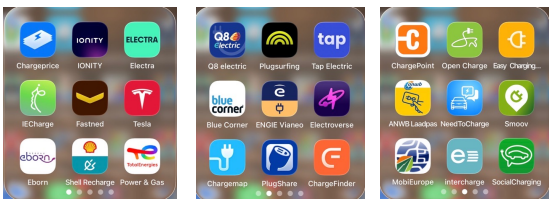
45

EV charging ecosystem



46

How to charge?

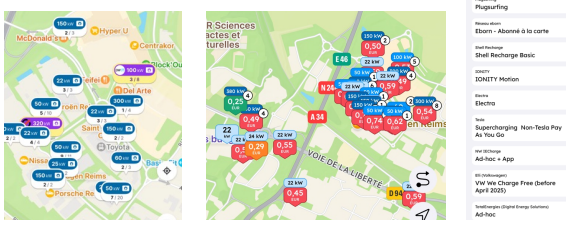


47

And to pay?

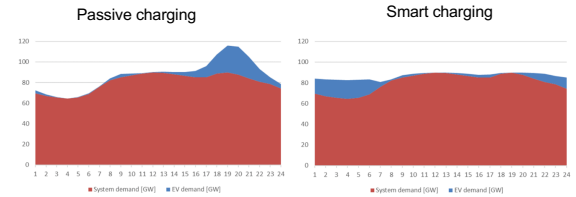
48

Consumer information



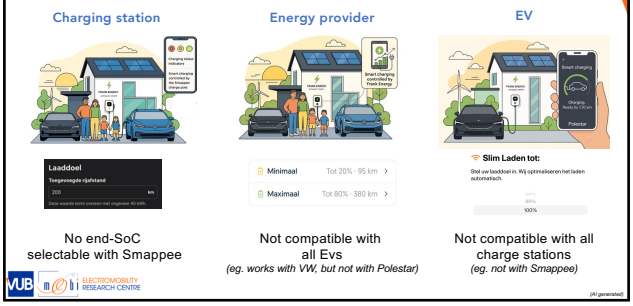
49

Smart charging



50

Smart charging – who is in charge?



No end-SoC selectable with Smappee

Not compatible with all Evs
(eg. works with VW, but not with Polestar)

Not compatible with all charge stations
(eg. not with Smappee)

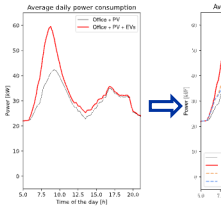
51

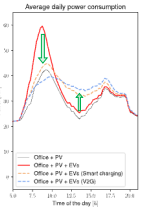
52

53

54

EMS for Smart charging and V2G





- Increase self-consumption of PVs
- Lower capacity tariff costs
- Lower grid reinforcement
- Lower energy costs

VUB ELECTROMOBILITY RESEARCH CENTRE

Van Kriekinge, G.; De Cauwer, C.; Sapountzoglou, N.; Coosemans, T.; Messagie, M. Peak shaving and cost minimization using model predictive control for uni- and bi-directional charging of electric vehicles. Energy Reports 2021, 7, 8760–8775. Published Elsevier Ltd, 304, https://doi.org/10.1016/j.egyr.2021.11.283

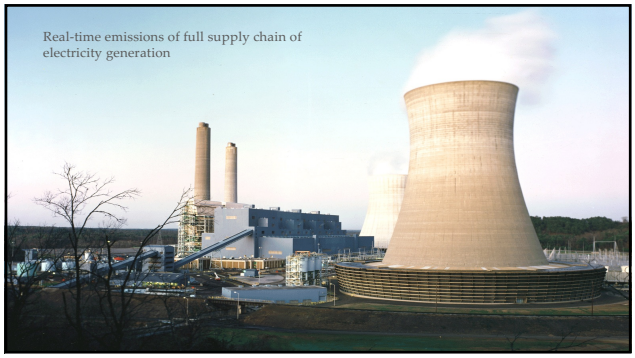
55

Impact on the environment

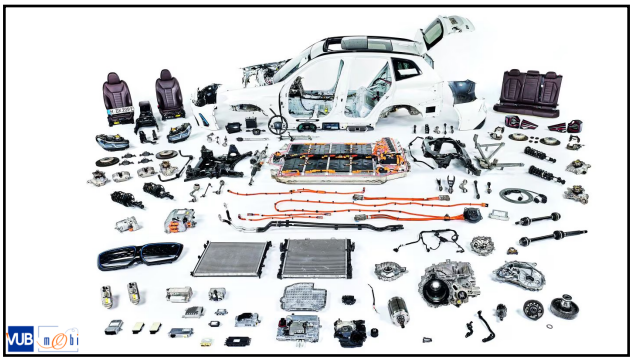
VUB ELECTROMOBILITY RESEARCH CENTRE

56

57



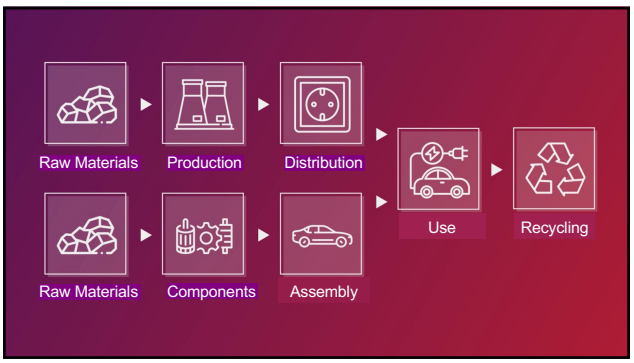
58



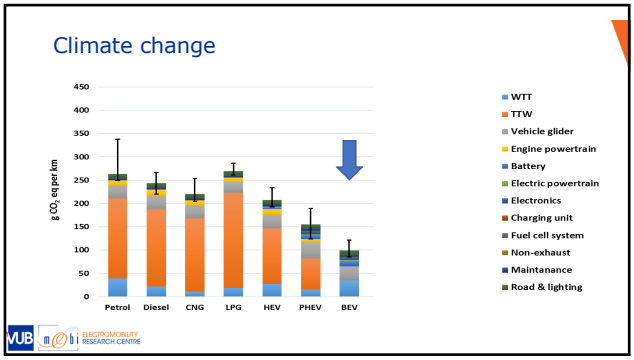
VUB

59

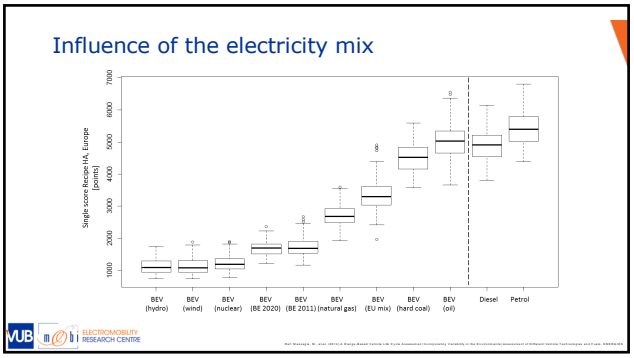
60



61

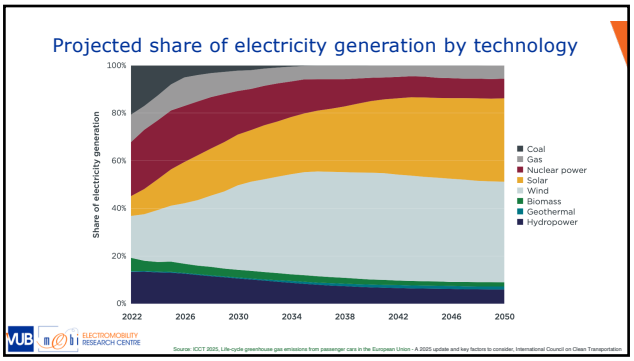


62

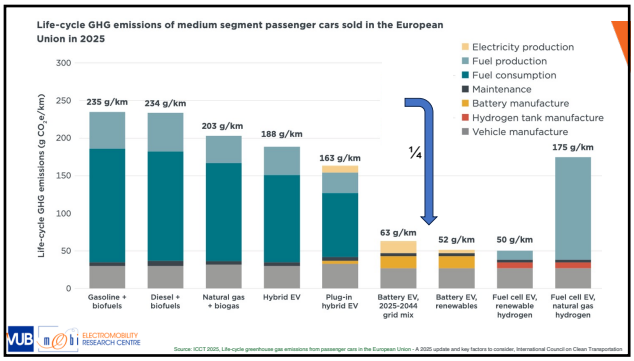


63

64



65



66

3p a mile
Range anxiety
They're not greener
No chargers anywhere
NONE EV DRIVERS

67

EV DRIVERS

68

VUB
mobi
ELECTROMOBILITY
RESEARCH CENTRE
Prof. dr. ir. Joeri Van Mierlo
"It is hard to foresee the future, but together we can build it"
+32 2 629 28 03
Joeri.Van.Mierlo@vub.be
mobi.research.vub.be

69