European Copper Institute
Copper Alliance

Electromobility Vision Paper

May 2018

Context

Back in 2011, in its Whitepaper on Transport, the European Commission had already concluded that the phase-out of conventional cars by 2050 was necessary to achieve the Paris Agreement on decarbonization.

However, road transport currently contributes about one-fifth of the EU's total GHG emissions, having increased by 20.5% since 1990. It's a similar picture with final energy consumption. Road transport uses 24% of EU final energy, having grown 28% from 1990.

The good news is that a zero emission technology is ready today for market uptake: the battery electric vehicle (BEV). From day one it reduces GHG emissions by a factor three[1] and completely cuts local air pollutant emissions to the environment . As the decarbonization of the electricity is quite ahead of the general schedule, it is likely that the mass uptake of BEVs could lead to the full decarbonization of the road transport sector well before 2050.

Moreover, electrifying road transport is also the most cost-effective way to achieve energy efficiency since a BEV electric vehicle is an asset with an average life of 15 years and an efficiency 2.5 times greater than an ICE vehicle – an efficiency that will further improve as renewables take up an increasing share of electricity generation.

Copper is one of the key materials that makes this transition possible. On average a BEV contains three times more copper than an ICE vehicle. Half of this copper is used for the battery system. Copper is also heavily used in the generation of renewable electricity and the infrastructure necessary to charge electric vehicles.

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1 On a well-to-wheel perspective compared to an equivalent internal combustion engine (ICE).

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Benefits

A combustion-engine vehicle emits **3 times more CO_2** than a battery electric vehicle, 4 times in 2030 (well-to-wheel emissions, based on EU average energy mix, details in Annex I)

> Road transport accounts for 20% of EU CO2 emissions, with a 20,5% increase in 2015 compared to 1990[2], and continuing to grow[3].

A battery electric vehicle is **2.5 times more energy efficient** than a combustion-engine car. 3.3 times in 2030 (well-to-wheel, based on EU average energy mix, details in Annex I)

> Road transport consumes 24,4% of final energy in EU[4], with a 28% increase in 2015 compared to 1990 and increasing[5].

5.4% of deaths in Europe are due to **air pollution**[6]. If the city of Rome would electrify its fleet for public and light duty goods vehicles, NO_x emissions and $PM_{2.5}$ would decrease by 34% and 22%[7].

For speeds below 30 km/h, **battery electric vehicles emit significantly less noise** than internal combustion engine vehicles[8]. For people aged over 65, the mortality due to urban noise could be even bigger that the one due to $PM_{2.5}$[9].

Electromobility improves energy security. The EU imports 87% of its oil demand, of which 47% goes to road transport[10].

Vision for Light-Duty Vehicles

Battery electric vehicles are on the market today offering **a real range over 300 km** (e.g. Opel Ampera-e, Renault Zoe, Tesla Model 3).

Parity for total cost of ownership between battery electric vehicles and internal combustion engine vehicles can be reached before 2020 (based on a mileage of 60,000 km)[11].

In case of a home with a private parking spot, **a 3.7 kW wallbox suffices** to replenish the energy consumed during the day in less than 3 hours overnight[12] (details in Annex II).

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2 https://ec.europa.eu/clima/policies/transport/vehicles_en

3 https://www.eea.europa.eu/publications/analysis-of-key-trends-and/

4 http://ec.europa.eu/eurostat/statistics-explained/index.php/Consumption_of_energy 2015 Transport account for 33,1% final energy https://www.eea.europa.eu/data-and-maps/indicators/transport-final-energy-consumption-by-mode/assessment-8 Road transport represents 74% of final energy in transport.

5 https://www.eea.europa.eu/data-and-maps/indicators/transport-final-energy-consumption-by-mode/assessment-8

6 http://documents.worldbank.org/curated/en/781521473177013155/The-cost-of-air-pollution-strengthening-the-economic-case-for-action

7 http://www.aria.fr/PDFs/25ans/05_Vehicule%20Electrique.pdf

8 http://www.compett.org/documents/Conferencepapers/Noise_from_electric_vehicls_state_of_the_art_literature_survey.pdf

9 https://www.sciencedirect.com/science/article/pii/S0013935114004629?via%3Dihub

10 http://ec.europa.eu/eurostat/statistics-explained/index.php/Oil_and_petroleum_products_-_a_statistical_overview#Imports_of_crude_oil

11 http://www.beuc.eu/publications/beuc-x-2016-121_low_carbon_cars_in_the_2020s-report.pdf page 3.

A problem occurs when travelling long distance: there are only few and slow charging points. Our proposal: **150 kW chargers every 50 km along the TEN-T core network** (with a BEV efficiency of 15 kWh/100 km, it takes 6 minutes to add a 100 km range).

In case of residential parking on the street, cities should foresee specific parking spaces for electric vehicles with a 3.7 kW pole, with a procedure similar to the one to allocate parking spaces for handicapped drivers.

In case of professional urban transport (taxis and small vans), foresee a 7.4 kW point at the depot/parking/street for overnight charging and 150 kW charging centers within urban areas.

Vision for heavy-duty vehicles

Road public transport (buses): Already several models available with overnight charging at the depot.

> **The total cost of ownership for electric buses is already lower than for diesel models**[13].
>
> **12 large cities have already committed** to procure only zero-emission buses from 2025 onwards[14].

Other aspects

Life cycle assessment (CO_2):

> Emissions in gCO2-eq/km: battery electric vehicle based on EU 2015 grid mix= 88 vs diesel = 216[15].
>
> Life cycle global warming emissions in gCO2/mile for a full-size gasoline car: 580 vs full-size 265-mile battery electric vehicle: 280[16].

Around 260,000 net jobs could be generated in EU by 2030[17].

> With 35% electric vehicle sales share in 2030, 90% of electric vehicles sold in the EU should be produced locally in order to maintain employment within the automotive sector[18].

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12 http://www.trt.it/wp/wp-content/uploads/2012/12/driving-and-parking-patterns-final_online.pdf page 62 average daily driven distance 60 km, with a BEV efficiency of 15 kWh/100 km it's possible to replenish the energy consumed in less than 3 hours of overnight charging.

13 https://data.bloomberglp.com/bnef/sites/14/2018/05/Electric-Buses-in-Cities-Report-BNEF-C40-Citi.pdf

14 http://www.c40.org/press_releases/mayors-of-12-pioneering-cities-commit-to-create-green-and-healthy-streets

15 https://www.transportenvironment.org/sites/te/files/publications/TE%20-%20draft%20report%20v04.pdf

16 https://www.ucsusa.org/sites/default/files/attach/2015/11/Cleaner-Cars-from-Cradle-to-Grave-exec-summary.pdf

17 https://europeanclimate.org/wp-content/uploads/2018/02/Fuelling-Europes-Future-2018-v1.0.pdf

18 https://www.transportenvironment.org/sites/te/files/publications/Briefing%20-%20How%20will%20electric%20vehicle%20transition%20impact%20EU%20jobs.pdf

Main drivers

Regional & national level:

- **Zero emission vehicle mandates** (for example China 10% in 2019, 12% in 2020 and probably 20% in 2025)
- **Bans on diesel and petrol vehicle sales** (already in place in UK, France, Netherlands and others)[19].
- **150 kW charging network** along main roads.
- **Consumer awareness** (mainly by carmakers marketing campaigns) and model availability[20].

Local level:

- **Low and zero emission areas**[21]
- **Pollution charges** (circulation tax and public parking)[22].

19 http://www.leonardo-energy.org/resources/389

20 https://www.transportenvironment.org/sites/te/files/publications/2017_09_Carmakers_goals_EVs_report_l.pdf

21 http://urbanaccessregulations.eu/

22 http://www.acea.be/uploads/publications/CO2_tax_overview_2016.pdf
http://www.cleanair-europe.org/fileadmin/user_upload/redaktion/downloads/BUND/10_B2_Update_Guideline_-_Parking_Management_EN.pdf

ANNEX I. GHG and energy efficiency comparison

Year	Primary Energy Factor (entire supply chain)	CO2 at power plant level per unit of net generation	CO2 on lifecycle basis at LV level	CO2 on lifecycle basis at LV level
		gCO2eq/kWh	gCO2eq/kWh	gCO2eq/MJ
2015	1,9	326	429	119
2030	1,35	226	298	83

Notes:

- PEFs from https://ec.europa.eu/energy/sites/ener/files/documents/final_report_pef_eed.pdf page 5
- 2015 GHG from European Commission and Eurostat data. Made available through EUenergyApp (http://energypost.eu/eu-energy/)
- 2030 GHG from COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT Accompanying the document Proposal for a Directive of the European Parliament and of the Council amending Directive 2012/27/EU on Energy Efficiency http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016SC0405R(01) , tables 8 to 17
- To obtain CO2 on lifecycle basis we have used a conversion factor of 1,315 for all the years. This is the 2013 value, that should reduce for the 2030 scenario due to a higher penetration of RES.

	Code	Year data	WTT energy	TTW energy	WTW energy	ratio ICEV/BEV	WTW GHG	ratio ICEV/BEV
			MJ/ 100km	MJ/ 100km	MJ/ 100km		gCO2eq / km	
Conventional gasoline	COG1 2020+ DISI	2009	26	142	168		125	
BEV EU-mix low voltage	EMEL3 2020+	2009	86	38	124	1.4	57	2.2
BEV EU-mix low voltage	EMEL3 2020+	2015	34	38	72	2.3	45	2.8
BEV EU-mix low voltage	EMEL3 2020+	2030	13	38	51	3.3	31	4

Notes:

- Figures for 2009 from https://iet.jrc.ec.europa.eu/about-jec/sites/iet.jrc.ec.europa.eu.about-jec/files/documents/wtw_app_1_v4a_march_2014_final.pdf
- WTW energy for BEV calculated as TTW x PEF.
- WTW GHG for BEV calculated as TTW energy x CO2 on lifecycle basis at LV level / 100 km.

ANNEX II. 3,7 kW wallbox / pole specifications

- Wallbox, connected to home meter where possible; in older installations, an extension of the meter and an inspection of the electrical installation may be required;
- One connector type 2 in mode 3, and a Schuko for category L vehicles.
- With an user functionality to set:
    - charging intervals during the day
    - minimum and maximum state of charge of vehicle battery
    - for wallbox, priority of home load over the electric vehicle