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Assessing electric vehicle impacts: the need for up-to-date electricity data

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Ratios of fossil, renewable and nuclear energy are rapidly changing in European countries, and the grid mix fluctuates daily. Electricity data is of key importance to life cycle assessments of electric cars – for example, their greenhouse gas (GHG) emissions will be higher when charged from a high-fossil mix. A new analysis suggests that accurate assessments require new, up-to-date electricity emissions data.

Transportation accounts for a quarter of the EU's total GHG emissions. Electric vehicles are central to the low-carbon transition. In life cycle assessments (LCAs) – which aim to reflect the resources consumed by products and processes and their environmental impacts – electricity is a dominant contributor to electric vehicle impacts, both in their use and materials production. For example, to decrease their weight, electric cars may contain more aluminium than current conventional vehicles, and over half the CO_2 emissions from aluminium production derive from consumed electricity, according to the reference database Ecoinvent. In addition, the real emission intensity of electric-vehicle use is directly linked to the emission intensity of the electricity drawn in during charging, which varies substantially depending on the time and place.

Life Cycle Assessment Standard ISO 14044 does not specify which electricity data to use for LCAs, but indicates that their selection depends on the goal of the LCA study. For example, some countries import electricity. Therefore, consumption data, rather than within-country production data, is best for the electricity in the use phase of an appliance. Consumption data including imported electricity is available at Electricity Map, an online resource for electricity CO_2 data. Meanwhile the locally produced mix, rather than country/regional averages, may be most relevant in factory manufacturing. Using the most precise data possible (supplier-specific) is recommended in the EU Product Environmental Footprint method, paired with minimum criteria related to contractual instruments.

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Accurately calculating carbon emissions from electricity production in near-real time is a complex issue. Ecoinvent, the European reference Life Cycle Database and GaBi are leading LCA databases that, for electricity, source country-level data from the International Energy Agency or European Network of Transmission System Operators for Electricity (ENTSO-E) to produce models with adjustable inputs for this purpose. Due to the range of factors involved, however, the researchers highlight that for some countries these tools report carbon-intensity figures that vary by 20–30%. However, country-average information exists, which can provide helpful insights.

Meanwhile, rapidly-changing production mixes and downward trends in GHG emissions[1] mean these databases, founded on information from 2008–2014, are now outdated. For instance, average electricity-production carbon emissions for the EU dropped 11% from 2013–2016, according to the European Environment Agency[2], and fell by as much as 34–38% in some individual countries. This trend is continuing – the latest figures from the EEA show that Denmark has recorded an 84% decrease between 1990 and 2020 and Slovakia a 78% decrease, for example[3]. Assessment of innovations, especially involving emissions mitigation, should use projected electricity data and take account of the increasing decarbonisation of the power sector, say the researchers.

Another issue is that the production mix varies over short time periods – for example, between day and night – and fluctuations are becoming more prominent with growing percentages of solar and wind power. In Germany, daily carbon intensity may vary from 250–730 grams of carbon dioxide equivalent per kilowatt-hour of electricity generated[4], for instance. This must be considered, as more car charging may take place overnight, when the mix may be more or less carbon intense than daytime, perhaps when wind power contribution peaks on winter nights. To be accurate, any assessment of emissions from the use of electric vehicles should use time-dependent carbon intensity data taken during the time of recharging, instead of averages. Current smart-charging and data-sharing technologies would enable that, when applied properly.

The researchers highlight the challenges of determining impacts related to nuclear power. In terms of GHG emissions, electric vehicles have a great advantage in countries with a high share of nuclear power in their electricity mix (e.g. France and Belgium). However, different approaches for quantifying the environmental impact and risk of nuclear power may strongly affect the overall LCA findings. The researchers argue that the choice of such approach is essentially a subjective decision, taking into account various aspects of nuclear waste management, but recommend

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SCIENCE FOR ENVIRONMENT POLICY

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using a single indicator endpoint system. These weight multiple environmental impacts in addition to GHG emissions to give a single rating, to aid decision making without having to choose which impacts are most relevant.

EU Product Environmental Footprint Category Rules – which standardise the calculation of environmental impacts for specific product categories – are not yet available for electricity in the European market, and other databases offer different information. While life cycle assessments acknowledge data uncertainties, the researchers posit that there is an urgent need for a new impact database based on measured emissions data, kept continuously up-to-date, transparent and with open access. The researchers suggest it is based on the European Pollutant Release and Transfer Register, incorporating import and export data (from ENTSO-E). To this end, the researchers advocate full disclosure of emissions data from electricity systems in EU Member States. They note that a dataset based on actual emissions in the EU has been calculated[5], but further development is needed.

Further information

Regarding the European Commission's proposal of the revision of the Renewable Energy Directive: to assist in the availability of transparent information on carbon intensity in the recharging of electric vehicles and to incentivise consumption of electricity during low-carbon electricity's temporal availability; the EC has included requirements for making available carbon-intensity data of the electricity system in real time across the EU at bidding zone level (i.e. the largest geographical area in which market participants are able to exchange energy without capacity allocation).

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