

Policy Summary

How »green« are electric vehicles regarding the charged electricity?

Plug-in electric vehicles (PEV) are considered a promising option to reduce greenhouse gas emissions in transport. This is especially true if the electricity used for charging comes from renewable sources. In this context, a new study by Fraunhofer ISI and the ESA² GmbH provides an overview of existing studies and presents additional data on the electricity contracts of users and charge point operators (CPO) – to illustrate the share of contracted renewable electricity (RE) in PEV charging for home, work and public (slow and fast) charging. The results show that the share of contracted renewable electricity in PEV charging in Europe is much higher than assumed when using the European grid mix.

Electric cars can contribute to greenhouse gas emission reduction

Currently, the numbers of plug-in electric vehicles (PEV) are rising in Europe with a share of more than 17% on all registered passenger cars in 2021 including plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV)³. PEV can offer noteworthy greenhouse gas (GHG) emission reductions on a life-cycle base compared to internal combustion engine vehicles if mainly charged with renewable electricity (RE)^{2,4,5}.

However, only a few studies have analysed the actual electricity contracted for charging, including the different charging locations such as home, work, and public charging (slow and fast). The present study of Fraunhofer ISI and ESA² combines new survey data with a literature review of existing studies to derive

- the share of PEV charging at different locations in Europe (EU27, UK, Norway, Iceland) and
- **2.** the share of contracted renewable electricity (RE) in charging at these locations.

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Sabine Preuß Fraunhofer ISI, Karlsruhe Robert Kunze ESA² GmbH, Dresden Patrick Plötz Fraunhofer ISI, Karlsruhe Martin Wietschel Fraunhofer ISI, Karlsruhe Two studies in Europe were conducted, one with PEV users and one with fleet managers, to fill the data gaps identified in the literature review. Since the survey's response rate differed largely between countries, the survey analysis focused mainly on data for Germany and Spain. After analysing and transforming the data with the help of a cluster analysis, we received the targeted data for Europe. Based on the performed cluster analysis, the data of one country can be transferred to other countries in the same cluster.

Majority of the charging processes are done at home or at work

Supporting previous studies, our results indicate that PEV are mostly charged at home, followed by charging processes at work. The results show that on average 64% of all charging processes in Europe are done at home (Germany: 59%, Spain: 58%), 18% are performed at work (Germany 14%, Spain 10%) as well as 12% at public slow charging stations (Germany: 14%, Spain: 21%) and 6% at public fast charging stations (Germany: 12%, Spain: 10%). It is noteworthy that the percentages represent the charging frequences and not the charging amount. Concerning the share of contracted renewable electricity (RE) in charging at the different charging locations, 63% of European PEV users have a 100% RE tariff at home to charge their PEV (Germany: 84%, Spain: 56%). For work charging, the share of 100% RE tariffs across Europe is 60% (Germany: 81%, Spain: 41%), the RE share for public slow charging is 62% (Germany: 85%, Spain: 41%) and for public fast charging 57% (Germany: 75%, Spain: 41%). To arrive at this European share of contracted renewable electricity for the total PEV charging in the EU27, the UK, Norway and Iceland, all country-specific shares of charging locations (available via the conducted surveys and existing data) were multiplied with the related RE share and weighted by the PEV share of the corresponding country on the EU-wide PEV numbers. For countries without a reliable data base regarding the RE share, we integrated the RE share of the balanced national mix¹.

Registered battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV) per country in 2020



90 per cent of all BEV and PHEV in Europe are registered in only ten countries

64%

processes in

Europe are

of all charging

done at home

Vehicle category M1: Carriage of passengers, with no more than eight seats in addition to the driver seat (passenger cars) Source: European Alternative Fuels Observatory 2021 (EAFO_2021)



In order to find similarities between countries, data was transferred from one country to another in the same cluster.

Charging electricity comes more often from renewable ressources than expected

This led to the result that the share of RE in charging electricity lies above the balanced national mix: Of all PEV charging processes in Europe, 62% are performed with renewable ressources – across all charging locations (compared to 46% when integrating the balanced national mixes in the same calculation). Thus, focusing on the use of RE at home presents an important element for reducing the carbon footprint of plug-in electric vehicles. The country- and cluster-specific data of this study might present a valuable data base for further research. From a methodological point of view, adding survey results refines the data on the RE share across Europe.

The collected data should be updated regularly

Further research should focus on extending the survey data to receive a valid data base for more European countries. In addition, due to the rapid PEV developments, we suggest to update the data on a regular basis and to collect new survey data in all European countries in the near future. It is noteworthy that the survey data on the share of RE in charging electricity present contracted RE - without distinguishing whether the RE tariff contains only Guarantees of Origin (GO) or whether they have guality requirements for renewable electricity production that go beyond that. In general, the environmental benefits of GO are often weak because no additional RE plants are built and no kind of physical or temporal link to an electricity supply must exist. They are based on the implementation of Directive 2009/28/EC of the European Parliament and of the Council.

To conclude, this study presents recent data that start closing the identified gaps regarding shares of charging locations and respective shares of contracted renewable electricity for plug-in electric vehicle charging. It introduces a scientific methodology to combine existing and newly collected survey data to ultimately arrive at the currently best available data base for an European-wide calculation of the GHG emissions caused by PEV charging.

Results of the cluster analysis

- **Cluster 4** Norway, Sweden
- **Cluster 3** France, Germany, UK
- **Cluster 2** Czech Republic, Greece, Italy, Portugal, Spain,

Cluster 1

Austria, Belgium, Denmark

Most of the analyzed charging processes were performed with renewable ressources

Literature

- 1 AIB Association of Issuing Bodies (2021): European Residual Mixes. Results of the calculation of Residual Mixes for the calendar year 2020. Online: https://www.aib-net. org/ sites/default/files/assets/facts/residual-mix/2020/ AIB_2020_Residual_Mix_Results.pdf
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- 4 IEA International Energy Agency (2021). World Energy Outlook 2021.
- 5 Märtz, A., Plötz, P., & Jochem, P. (2021): Global perspective on CO2 emissions of electric vehicles. Environmental Research Letters, 16(5), 054043.

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