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SOUTH-EAST EUROPE ENERGY BRIEF

Monthly Analysis

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Global Current and Future Status of EVs: The Case of SE Europe

Plug-in electric vehicles (PEVs), including full battery electric vehicles (BEVs[1]) and plug-in hybrid electric vehicles (PHEVs[2]), have been gaining traction thanks to their ability to deliver multiple environmental, societal and health benefits. According to the IEA **(1)**, these include:

- **Energy efficiency:** EVs are three-to-five times more energy efficient than conventional internal combustion engine (ICE) vehicles. This provides unmatched energy efficiency improvement potential for vehicle road transport.
- **Energy security:** Electric mobility boosts energy security as it transitions the road transport sector from its strong reliance on oil-based fuels. It reduces dependence on oil imports for many countries. Furthermore, electricity can be produced with a variety of resources and fuels, and is often generated domestically.
- **Air pollution:** Thanks to zero tailpipe emissions, EVs are well suited to address air pollution issues, especially in urban areas and along road networks, where a large number of people are exposed to harmful pollutants from road transport vehicles.
- **GHG emissions:** Increasing electric mobility in association with a progressive increase in low-carbon electricity generation can deliver significant reductions in GHG emissions from road transport relative to ICE vehicles. In addition, EVs can play an expanded role through their use to provide flexibility services to power systems and act in concert with the integration of variable renewable energy sources for electricity generation.
- **Noise reduction:** EVs are quieter than ICE vehicles and hence contribute to less noise pollution, especially in the two/three-wheeler category.

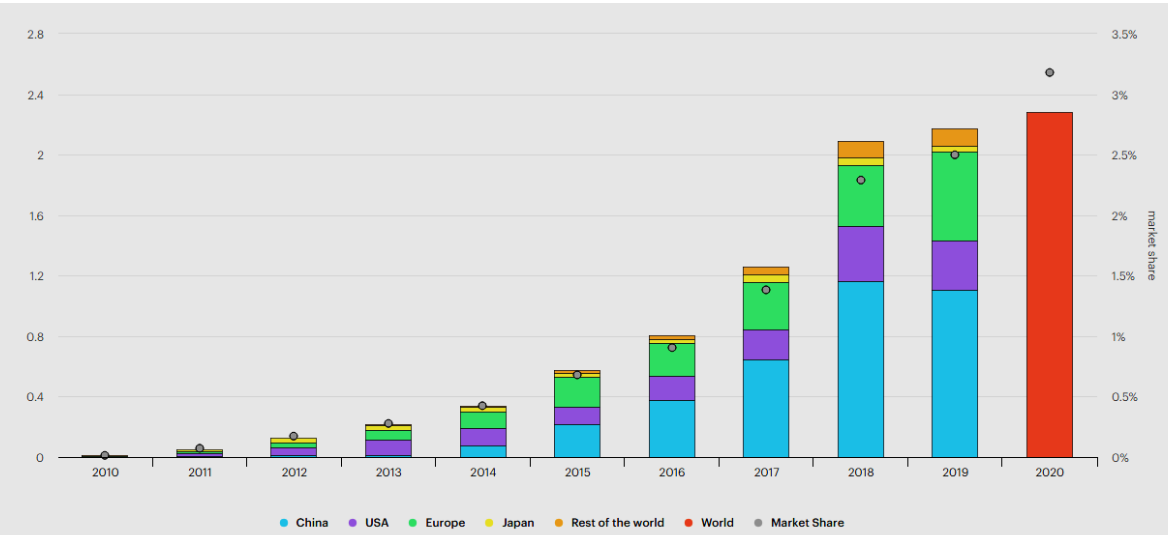
[1] Battery Electric Vehicles (BEVs) are fully powered by an electric motor, using electricity stored in an on-board battery that is charged by plugging into the electricity grid.

[2] Plug-in Hybrid Electric Vehicles (PHEVs) have an internal combustion engine (running on petrol or diesel) and a battery-powered electric motor. The battery is recharged by connecting to the grid as well as by the on-board engine. Depending on the battery level, the vehicle can run on the electric motor and/or the internal combustion engine.

- **Industrial development:** EVs are crucially positioned as a potential enabler of major cost reductions in battery technology, one of the key value chains of strategic importance for industrial competitiveness, given its relevance for the clean energy transition.

These and other advantages of electric vehicles have led to growing global deployment and increased understanding of the challenges and opportunities of electric mobility over the last decade. While in some countries the transition to electric mobility is still at an early phase, in several of the world's largest car markets the EV fleet is expanding at a fast pace (see Figure 1). The cost of batteries and EVs is dropping and EV infrastructure is being installed in many places, which supports the case for EVs across transport modes (buses, taxis and shared vehicles, light-duty vehicles (LDVs), two/three-wheelers and heavy-duty vehicles with short range requirements such as urban deliveries).

Figure 1: Global Electric Car Sales (in Millions) by Key Markets, 2010-2020



Source: IEA

The range of models from which consumers can choose has also continued to expand as manufacturers have launched new vehicles and announced the roll out of several new models in the near future. Nevertheless, effective policies are important to decrease the upfront investment cost gap, to promote charging infrastructure and to ensure a smooth integration of EV charging demands into power systems. The foundations for enabling the transition to electric mobility across several large economies having been laid and thus, the next years by 2030 can be characterized as the decade for electric mobility.

Impact of Electric Mobility on Energy Demand

Based on IEA's data, the global EV stock consumed almost 80 TWh of electricity in 2019, around 40% more than in 2018. The bulk of this consumption was to power the large electric two-wheeler fleet in circulation, particularly in China. The growth of the EV fleet is expected to lead to increased electricity consumption in all major global regions.

In 2030, in IEA's Stated Policies Scenario, the global electricity demand from EVs, including two-/three-wheelers, is expected to increase about sixfold from 2019 levels to 550 TWh. It is anticipated to rise nearly eleven-fold relative to 2019, to almost 1,000 TWh in the Sustainable Development Scenario. While today EVs account for a small fraction of global total final electricity consumption (less than 0.5%), the picture is likely to change in the future. Table 1 shows that EVs in the assessed countries/regions will account for at least 1% of total final electricity consumption in the Stated Policies Scenario by 2030 and minimum 2% in the Sustainable Development Scenario.

Table 1: Share of Electricity Consumption Attributable to EVs by Region and Scenario, 2030

Country/region	2019	Stated Policies Scenario, 2030	Sustainable Development Scenario, 2030
China	1.2%	3%	3%
Europe	0.2%	4%	6%
India	0.0%	2%	3%
Japan	0.0%	1%	2%
United States	0.1%	1%	4%

Source: IEA

These projections suggest that EVs are likely to play an important role for power systems in the near term. In advanced economies, the increasing demand of electricity from EVs is expected to happen in a context that sees the total electricity demand stagnating or even reducing due to energy efficiency improvements. On the other hand, in emerging economies, the consumption from EVs will be embedded in a context of fast growing electricity consumption from all sectors. Understanding when EVs are charged and at what power rate is important in order to manage the smooth operation and security of power systems. Figure 2 indicates that about three-fourths of the electricity consumed by EVs in 2030 in the Stated Policies Scenario is expected to be provided by slow chargers.

Implications for Automotive Batteries

Trends in EV Battery Size

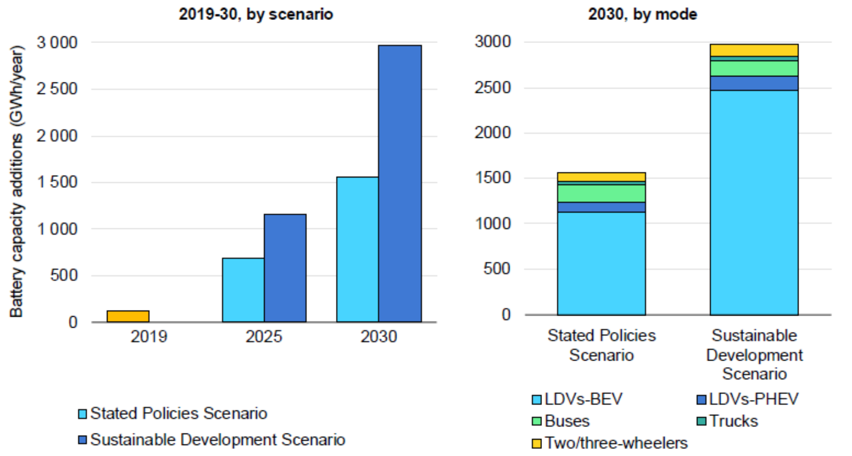
The demand for batteries used for automotive applications is expected to grow in the period to 2030 in both the IEA's Stated Policies and in the Sustainable Development scenarios. Increasing sales volume of electric passenger light-duty vehicles (PLDVs) is the main driver as it is the increasing size of the required batteries and electrification of other modes, such as buses and trucks.

In 2019, the average battery size used in BEVs increased by 14% relative to 2018, in line with previous years. Average battery sizes for new BEVs range from 48 kWh to 67 kWh for cars. For PHEVs, the average battery size has been roughly constant over the past five years at around 11 kWh, equivalent to an electric range of around 50-60 km. There are two reasons for the increased battery size of BEVs over the past year: the change in the incentive structure in China that favours long-range vehicles, and the availability of the Tesla Model 3, which proved popular among EV consumers and is equipped with an above average battery capacity. The trend of increasing battery capacity is expected to continue, with BEVs reaching an average driving range of 350-400 km by 2030, which corresponds to battery sizes of 70-80 kWh.

Automotive Battery Capacity Demand

In the IEA's Stated Policies Scenario, the global EV battery capacity (for all transport modes combined) is estimated to increase from around 170 GWh per year today to 1.5 TWh per year in 2030. In the Sustainable Development Scenario, demand of 3 TWh is projected, driven by increased electrification, particularly heavy-duty vehicles, and a higher share of BEVs in EV sales, as shown in Figure 2. Despite ambitious electrification in the Sustainable Development Scenario, modes other than cars would account for only 11% of overall battery demand in 2030. This highlights the centrality of electric cars in the battery market over the next decade. An important variable in this projection is the share of BEVs and PHEVs in overall EV sales.

Figure 2: Annual Global Battery Capacity Additions from EV Sales, 2019-30



Notes: For cars, battery capacity ranges increase to 70-80 kWh in 2030 for BEVs and to 10-15 kWh for PHEVs. For LCVs, battery capacity increases to 80-100 kWh in 2030 BEVs and to 15-17 kWh for PHEVs. The higher values are applied mainly in North America and the Middle East. Buses are assumed to use batteries of 250 kWh; two-wheelers use batteries of 3-4 kWh. Battery packs are assumed to have capacities of 150 kW for medium trucks and 350 kWh for heavy trucks.

Source: IEA

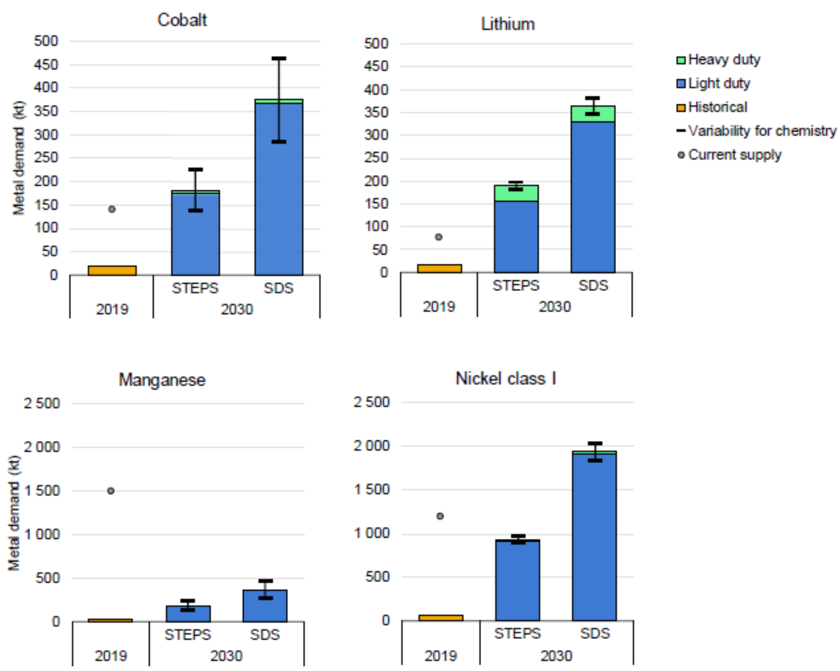
Demand for Battery Materials

Increased numbers of EVs and wider driving ranges will push up demand for batteries and thus, on the key materials needed to make them. The nature of the material demand will vary according to the development of battery chemistry. Given the evolving nature of lithium-ion technology, the chemical composition of batteries has been rapidly changing and is expected to continue to evolve at least over the coming decade. In the first-half of the 2010s, batteries with higher energy density used cathodes with high cobalt content, while more modest performances were obtained with lithium iron phosphate (LFP) cathodes. Since then, the trend has been to increase energy density and to reduce the reliance on cobalt due to its price volatility and risky supply chain.

In 2019, it is estimated that 48% of new batteries for electric cars use cathodes with at least 50% nickel content, meaning that both high cobalt content and LFP batteries have decreased their market share. This trend is expected to continue over the coming decade, despite large uncertainties on the speed of adoption and the widespread use of high nickel content battery chemistry. In terms of anode chemistry, pure graphite anodes account for the vast majority of current supply, but silicon doped chemistries, which enable higher energy densities, are beginning to be used and are likely to increase their market share in the future. The uncertainty in cathode chemistry is reflected in the material demand projections associated with the two scenarios.

According to IEA's estimates, the material demand for the batteries of the EVs sold in 2019 was about 19 kilotonnes (kt) for cobalt, 17 kt for lithium, 22 kt for manganese and 65 kt for nickel (see Figure 3). For battery needs in the Stated Policies Scenario, cobalt demand expands to about 180 kt/year in 2030, lithium to around 185 kt/year, manganese to 177 kt/year and class I nickel (> 99% nickel content) to 925 kt/year. In the Sustainable Development Scenario, higher EV uptake leads to 2030 material demand values more than twice as high as the Stated Policies Scenario. The choice of the cathode chemistry significantly affects the demand for metals, particularly on cobalt which varies by plus or minus 22%. By 2030, heavy-duty EV applications have a sizeable impact only on demand for lithium (16% of demand) among the materials analysed, because they are expected to be mostly equipped with lower energy density LFP cathodes for the next decade.

Figure 3: Annual Demand for Materials for Batteries from EV Deployment, 2019-30



Notes: kt = kilotonnes; STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario. Future demand for materials for battery manufacturing relative to the scenario projections is based on the global battery capacity shown in Figure 3.7 and the following assumptions of the shares for cathode chemistries in LDVs. For the low cobalt case: 10% NCA, 10% NMC 622 and 80% NMC 811. For the high cobalt case: 11% NCA and 76% NMC 622, 13% NMC 811. The central value is an average of these two cases. The share of cathode chemistries for heavy-duty vehicles is assumed to be 95% LFP and 5% NMC 622 in the low cobalt case, while 80% LFP and 20% NMC 622 in the high cobalt case. The share of metals in the battery for the types of chemistry analysed is indicated in Table 6.1 in the *Global EV Outlook 2018* (IEA, 2018a). The current supply of nickel refers to class I nickel.

Source: IEA

Impact on Electricity Distribution Systems

Widespread vehicle electrification will impact all the components of an electricity system: generation, transmission and distribution networks. At a local level, EV charging can significantly increase and change the timing and magnitude of electricity loads on distribution networks and possibly impact cables, transformers and other components, as well as power quality or reliability. This is particularly critical for high power charging and in cases where many EVs are concentrated in specific locations, like clustering of residential light-duty vehicle charging or depots for commercial fleets.

Impacts of Residential EV Charging

Residential EV charging represents a significant increase in household electricity consumption that can require upgrades of the household electrical system. Unless properly managed, it may lead to demand that exceeds the maximum power that can be supported by distribution systems, especially for legacy infrastructure and during times of high electricity utilisation (e.g. in peak hours or on extreme days) **(2)**. For instance, the Norwegian Water Resources and Energy Directorate indicates that an average increase in residential load of 5 kW would overload more than 30% of distribution transformers in Norway **(3)**. In Germany, the market share of residential load of more than 10% EV may be leading to bottlenecks **(4)**.

Clustering effects[3] in EV uptake can trigger local overloading of residential distribution transformers where vehicles are typically charged, resulting in a need to accelerate distribution system upgrades **(5)**. This is exacerbated for higher power charging: level 2 charging (typically using a 220 to 240 Volt power source delivering maximum 19 kW) significantly increases the peak load and stress on distribution transformers compared to level 1 charging (typically using a 120 V power source delivering maximum 1.9 kW) **(6)**. Moreover, EV charging can negatively impact power quality and require upgrades or re-design of distribution networks **(7)**.

Controlled charging helps to minimise the impact of EV charging on residential distribution networks. However, price signals are usually offered to consumers over a large geographic region, often at the scale of an entire country, with the intent of reshaping overall system

[3] EV adopters can be consumers with similar socio-demographics, which tend to live in the same area. Moreover, neighbour effects support the adoption of new technologies like EVs.

load. At the local level, multiple consumers responding to the same signal might cause "rebound peaks" that can overstress distribution systems, calling for co-ordination among consumers connected to the same distribution network. For example, direct EV charging control from an intermediate aggregator allows for active network management for shifting load between feeders in response to the effect of anticipated EV charging demand relative to local network constraints **(8)**.

Impact of Commercial EV Charging

Commercial and publicly accessible EV charging can involve higher power levels. This is particularly the case for direct current fast charging (DCFC), which today is typically at 50 kW per plug. Though power levels are rapidly increasing and often being installed with many charging plugs at a particular location which could lead to possible megawatt level loads, roughly equivalent to a peak load in a large hotel. Moreover, DCFC stations are often located in areas where electricity systems are less developed (e.g. along highways). Much higher power levels (up to 1 MW or more) might be needed for heavy truck charging, but those applications are still in an early market phase and currently most electric heavy-duty vehicles (e.g. primarily buses) are charged at depots overnight. Nevertheless, DCFC may also be directly connected to a medium-voltage grid which avoids grid congestion issues on the low voltage network on which slow chargers are usually connected.

The impacts of integrating fast EV charging with distribution systems are geographically and case specific. Distribution grid impacts and upgrades could be prevented via controlled, staggered charging systems based on the needs of commercial fleet or via distributed energy storage or other flexibility measures. Even in cases where upgrades would be required, they would not necessarily be cost prohibitive, especially for widely utilised stations. Power systems can be cost effectively upgraded to accommodate fast EV charging in many cases.

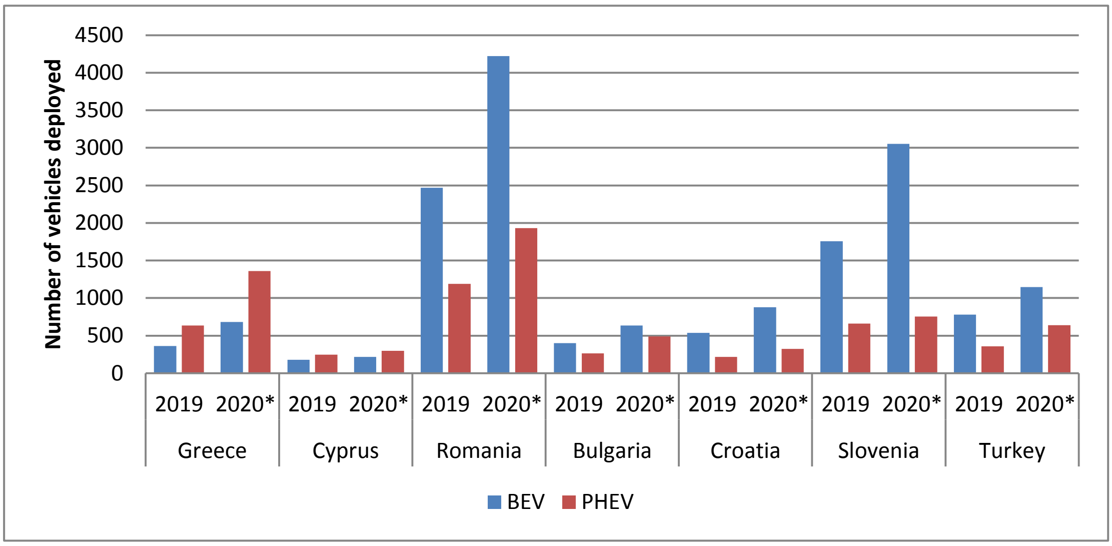
Electric Mobility in SE Europe

Currently, the development of electric vehicles in SE Europe is at a nascent level, but it is expected to grow over the next decades. In this context, there are several actions that are already ongoing such as the European project "Comprehensive fast-charging corridor network in SE Europe" **(9)**.

This Action is the second phase of a Global Project aiming at deploying and operating a comprehensive multi-standard, open-access fast and ultra-fast charging corridor for electric vehicles in SE Europe. The Action will contribute to the implementation of National Action Plans for the deployment of alternative fuels infrastructure. The objective is to set up a multi-standard open-access fast charging network in Croatia and Romania. It covers 3 TEN-T corridors, namely the Mediterranean, Rhine-Danube and the Orient/East-Med Core Network corridors. During the Action, 69 multi-standard fast charging stations (50 kW DC and 22 Kw AC) will be deployed, 53 in Romania at 25 sites and 16 in Croatia at 6 sites. Furthermore, 4 ultra-fast charging stations (minimum 150 kW DC) will be deployed, 3 in Romania and 1 in Croatia. Charging stations will be powered by energy from renewable sources, such as wind or solar power.

Based on data from the European Alternative Fuels Obervatory (EAFO), the automotive industry of the SE European region, mainly located in Turkey, Romania and Slovenia, has not yet made a significant turn in EV manufacturing. Figure 4 shows the number of Plug-in Electric Vehicles (PEVs), including BEVs and PHEVs, in selected SEE countries for 2019 and 2020, highlighting the nascent stage of their development. Indicatively, the total number of PEVs in SE Europe stood at 10,049 in 2019, when the total number of PEVs reached 1.75 million in Europe over the same year and exceeded 7.1 million globally.

Figure 4: PEV Fleet in Selected SEE Countries, 2019 and 2020*



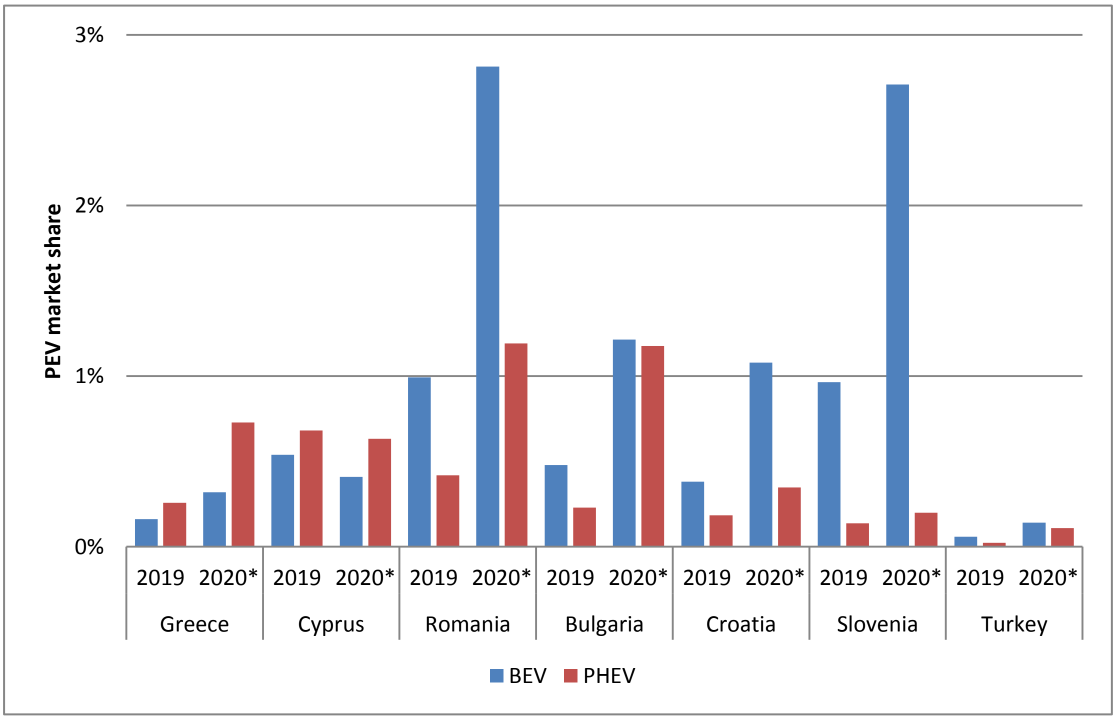
Note: *Data available until October 2020

Source: EAFO

In addition, the market share of PEVs in the selected SE European countries, as shown in Figure 5, averaged 0.54% in 2019, which is low, compared to European and global levels. More specifically, the 2.6% market share of PEVs in global car sales constituted a record in 2019. In particular, China (at 4.9%) and Europe (at 3.5%) achieved new records in EV market share in 2019.

Most notably, regional markets with more developed EV charging network, such as Slovenia and Croatia, have seen a higher penetration of BEVs to their motor vehicle market. On the contrary, markets, such as Greece and Cyprus, which exhibit delays in the deployment of adequate EV charging infrastructure, have a more developed market for PHEVs. Currently, based on data for 2019 and 2020 (Jan-Oct), the regional market size for PHEVs stands at approximately 50% of the market size of BEVs. Furthermore, 2020 has been a significant year for the sales of EVs in SE Europe, as the regional fleet rose by 65.4% during the period of January-October.

Figure 5: PEV Market Share (%) in Selected SEE Countries, 2019 and 2020*



Note: *Data available until October 2020

Source: EAFO

Discussion

Power grids face a new and important challenge: the oncoming mass penetration of PEVs. Nevertheless, the architectures of transmission and distribution grids are still focused on traditional design and operational rules. Consequently, it is necessary to predict the adequate solutions for the problems which are going to arise in the electrical and production grids as well as to quantify the effect on their commercial operation as a result of the gradual integration of EVs into the network **(10)**. For instance, major congestion problems may appear in already heavily loaded grids as well as voltage profile problems mainly in radial networks, particularly if the peak load periods coincide with EV charging periods.

In SE Europe, the EV deployment is still at a very early stage, even though it shows significant annual growth. The main barrier for further penetration of electric mobility in the region is the inadequate publicly accessible charging network, which, however, shows signs of development through large and small private initiatives as well as initiatives from local municipalities, businesses and institutions.

The automotive component industry, being a very significant economic activity in SE Europe, must also adapt to the EV transition. The related regional markets associated with internal combustion engines, transmission systems, fuel systems, exhausts, forging components and small general parts are expected to be negatively affected by the transition to gearless, fuel-less, robust new vehicles. However, important segments of the regional manufacturing activity, such as wiring, electric component's development, electronic architecture systems and components and telematics, are expected to attract new investors and expand their growth prospects.

Moreover, the RES and electricity distribution industry is expected to be driven by the acceleration of electric mobility in the near future, with numerous new projects undertaken for new capacity installation and grid enhancement to facilitate "green" power to the electrified on-road transport. Finally, it should be noted that SE Europe has highly trained engineering professionals, who can help meet the requirements of EV R&D operations in the region. **(11)**

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