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FINANCE & STRATEGY

ARE BATTERY ELECTRIC VEHICLES ALWAYS THE GREENER CHOICE?

PART 1:
Electric Vehicle CO_2 Emissions Depend on How the Electricity for Charging is Generated

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YOUR COUNTRY'S ENERGY MIX – IS IT BEV-READY?

It is no secret that the fight against global warming requires action to reduce CO2 emissions. The passenger road transport segment alone contributes to circa 10% of the global total.

Numerous countries have responded by creating incentives for battery electric vehicle (BEV) usage by encouraging consumers to switch from cars powered by internal combustion engines (ICE). A few examples of the policies currently in place for new BEVs are:

Country	Value of Incentive / Vehicle
Germany	Up to €9,000
Poland	Up to c.€8,000
France	Up to c.€7,000
Italy	Up to c.€5,000
Spain	Up to c.€5,000
United Kingdom	Up to €3,000

Source: European Automobile Manufacturers Association

BEVs are often presented in the webpages of car manufacturers and government agencies that regulate the road transport sector as being a zero-emission solution relative to internal combustion engines. But this is not entirely true, as the electricity used to power the car is typically generated with a combination of (zero emission) renewables and nuclear power, and natural gas, oil, and in some cases, coal.

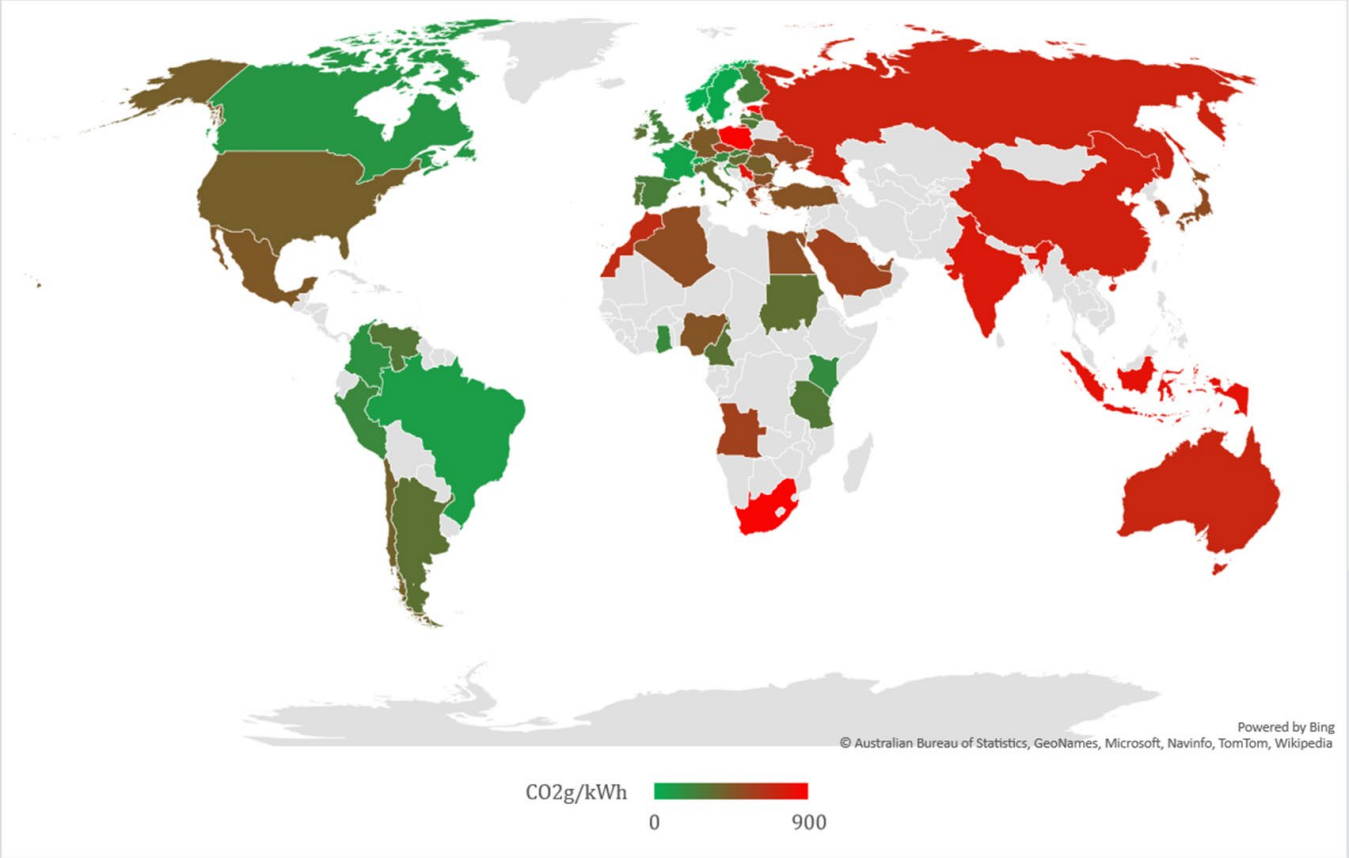
The amount of CO_2 generated by a BEV is therefore dependent on the relative contribution from these sources to the country's energy mix. As will be shown below, CO2 emissions from BEVs can actually be worse than ICE vehicles in countries which still use a substantial amount of coal to generate electricity.

The goal of this article is to provide clarity on this subject. Certain countries have a cleaner mix than others and therefore are, as of today, ready to promote large-scale deployment of BEVs. On the other hand, countries with a higher percentage of combustion-based generation should firstly improve the fuel used for electricity generation, before seeking radical changes in the types of cars on the road.

How Clean is Your Country's Energy Mix?

The map below presents CO2 emissions arising from electricity generation in 2018. It covers 61 countries, which are ranked from green (low intensity) to red (high intensity). There are striking differences between Europe and Asia. China for instance emits over 700 grams of CO2 per kWh of electricity produced, whereas Norway, France or Sweden are 10 to 50 times less intense.

Figure 1: CO_2 emission intensity from electricity generation



Source: CO_2 omissions from fuel combustion by sector and electricity generation per country based on 2018 IEA and OR&P analysis. Grey countries = no data available.

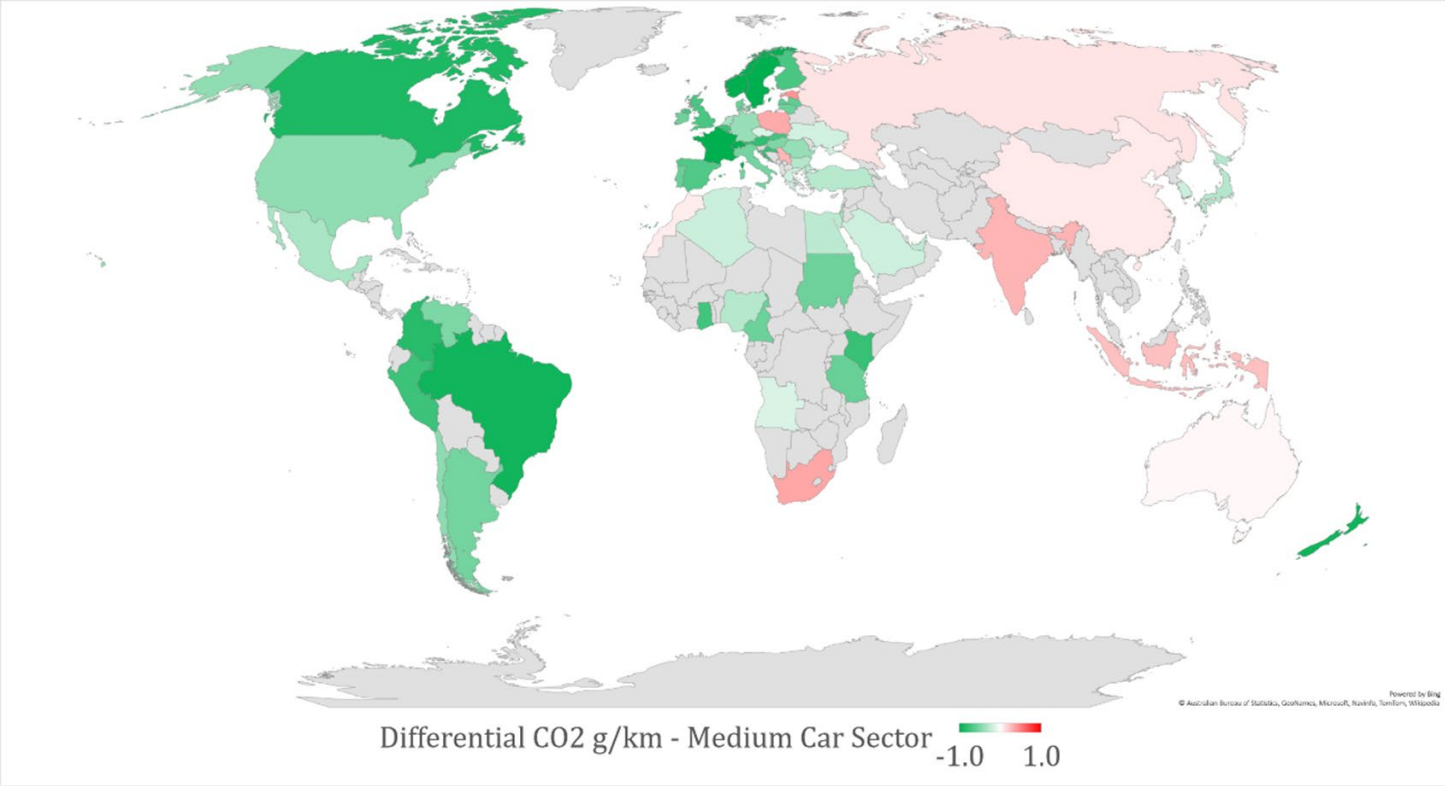
The key factor determining CO2 emissions from electricity generation in a given country is the relative amount of coal or oil usage in power plants. Countries with an elevated dependency on coal or oil tend to have higher levels of CO2 emissions per kWh. Gas tends to become a problem only in those countries that overly rely on it, for instance, Egypt or Russia, where electricity from gas is 47% and 78%, respectively.

It should therefore be readily apparent that introducing a BEV in Poland, South Africa or China, does not, for instance, have the same impact in terms of CO2 emissions, compared to Norway, France or Colombia.

Is Your Country's Energy Mix Sufficiently Clean to Justify Using BEVs Today?

In the map below, the same 61 countries previously reviewed are colour-coded: Green areas show where a medium size BEV would produce less CO2 per km than an equivalent petrol engine car, while red is where the electricity consumed by a medium size BEV would produce more CO2 than an equivalent car using a petrol engine.

Figure 2: Medium size BEV vs a corresponding petrol engine version of a similar vehicle – differential CO_2 g/km



Source: IEA data and OR&P analysis. This analysis considers electricity distribution and charging losses and included Peugeot e-208 / Citroen e-C4 and Peugeot 2081.2 PureTech75 / Citroen C4 Cactus PureTech 110. Grey countries = no data available.

If 'on-the-road' emissions caused by the fuel/energy consumed by the vehicle are examined in isolation, without also taking into consideration CO2 emissions related to manufacturing of the car batteries, incentives for BEVs may be misplaced. Our analysis demonstrates that the current energy mix in some countries is not ready to accommodate medium size fully electric cars and if BEVs were introduced on the road, it would do nothing to reduce emissions of CO2. Importantly, this is also the case in some developed economies (such as Germany and Japan) where the CO2 emission benefits of a BEV are marginal. Even worse, the impact in Poland, India, China or Russia is clearly the opposite of what policy makers would expect or desire.

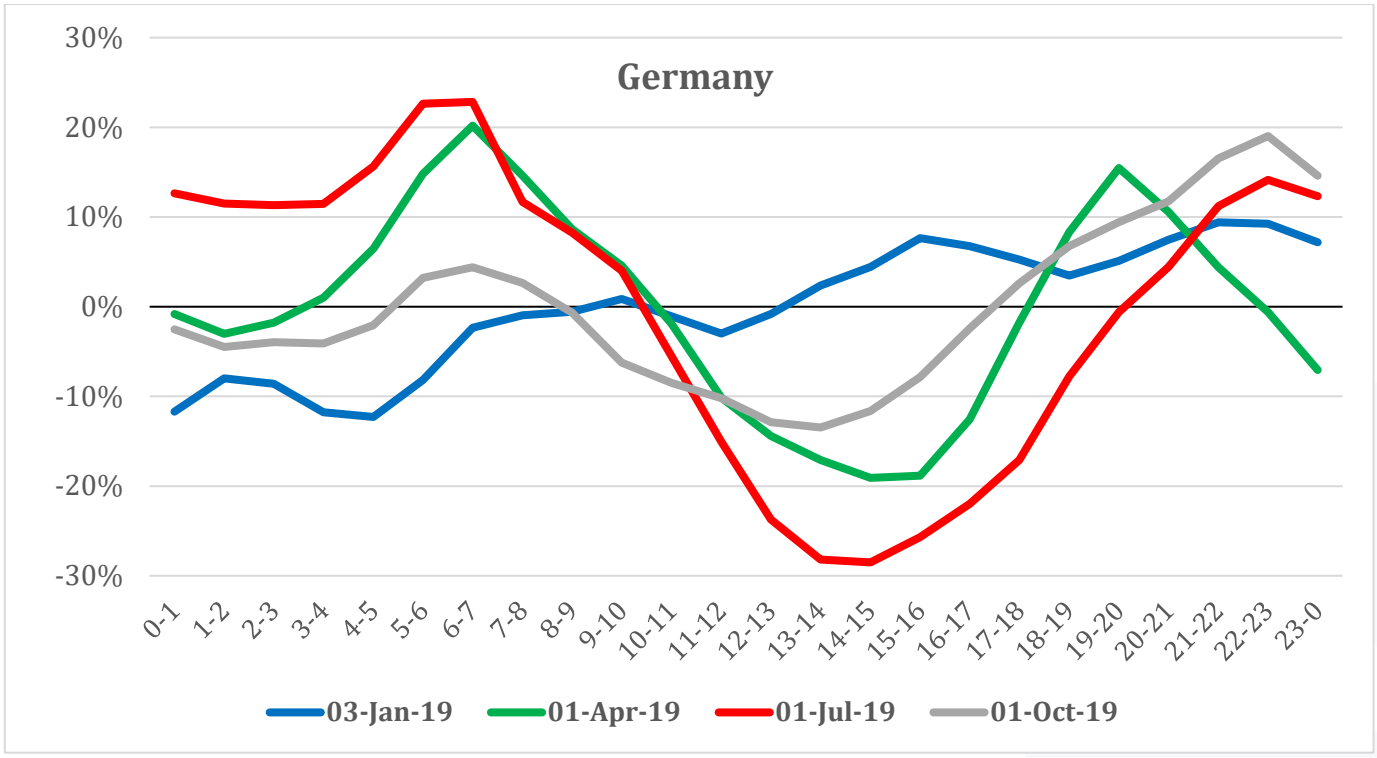
While driving a fully electric vehicle in France or Norway represents an undisputable improvement in terms of CO2 emissions, a BEV is the equivalent of a "coal-engine" car in Poland or South Africa.

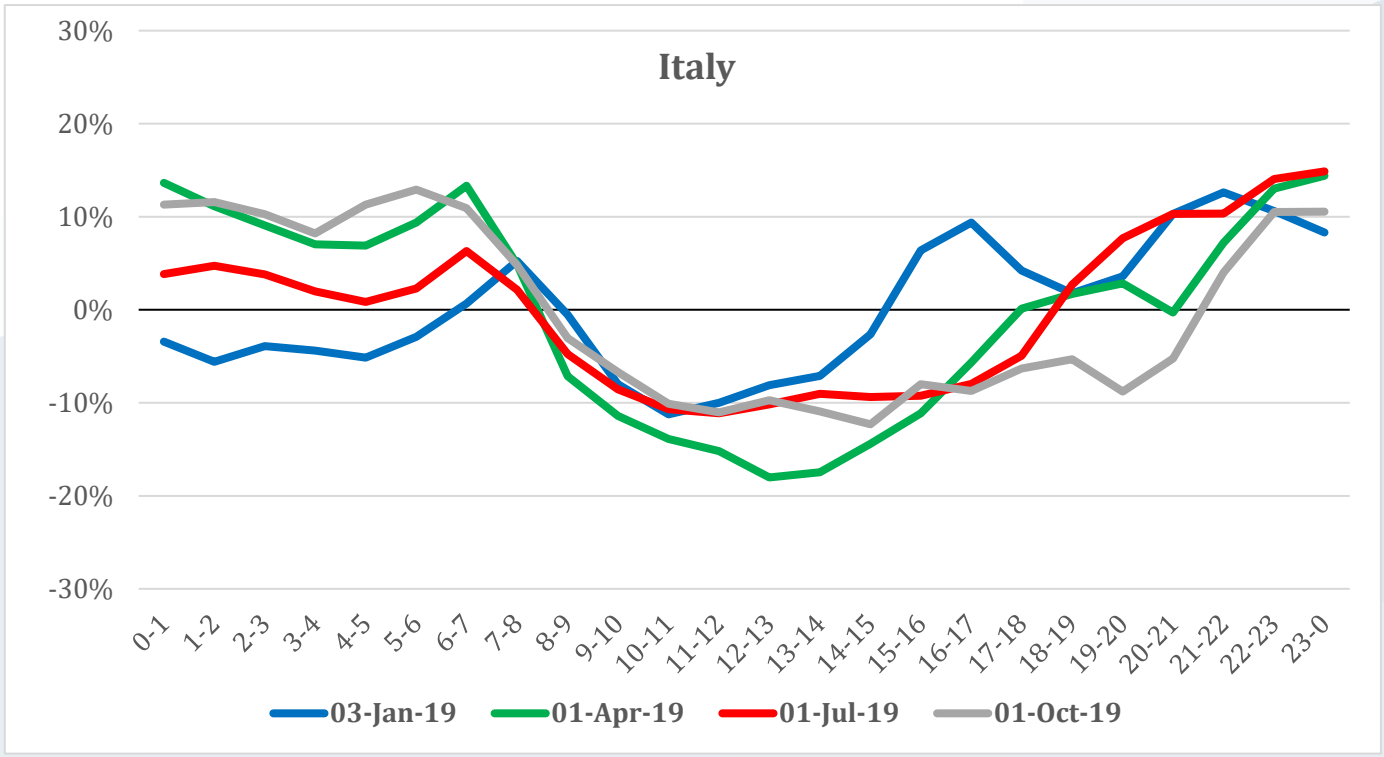
The Impact of When BEVs are Charged by Their Owners

At present, a BEV's owner is usually encouraged to charge his vehicle when arriving at home in the evening. Very few employers provide parking facilities equipped with a charging station and on-the-road charging points are still rare, especially in countryside areas.

Yet, photovoltaic (PV) power plants will make a null contribution in the evening hours. Unless the country can rely on a large wind turbine fleet, operating consistently during those hours (see the case of Germany on the 3 January 2019 in chart below), the electricity supplied during the evening tends to be more CO2 intense.

Figure 3: Hourly evolution of CO_2 emissions produced by electricity generation = Percentage deviation from the average of the day in Germany & Italy





Source: ENTSO E hourly production data and OR&P analysis. % represents the average hourly emissions of the given day.

In Germany, where the CO2 emissions of a medium-sized BEV are only marginally lower than the respective petrol version, the electricity produced in the evening could be up to 30- 40% more intense than during the central hours of the day. If the owner of an electric car consistently charges the car in the evening, it would severely compromise the expected reduction in CO2 emissions.

Users should be given the opportunity to charge their cars from work in order to optimise the emission savings of their vehicles. A large deployment of high power en-route charging stations will be necessary, but the required infrastructure does not exist today.

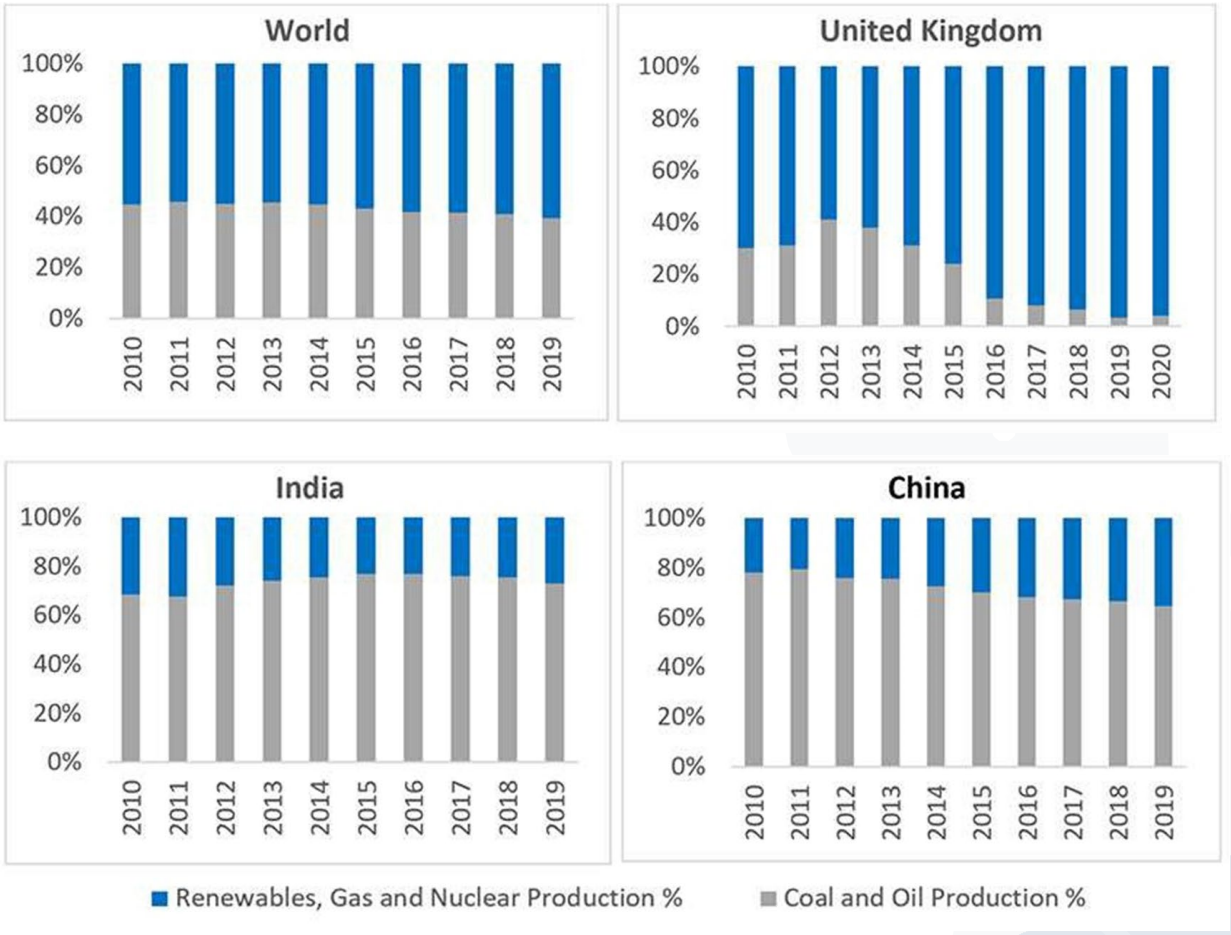
The important role played by wind and hydro power in changing the electricity mix is therefore evident. Governments that intend to facilitate the penetration of BEVs in their local market should prioritise hydro, wind or nuclear. If no other alternatives are available, gas would be the preferred next option. This would supply the cleanest possible electricity in the 6pm to midnight timeframe and limit the contribution of coal-fired plants.

Is the World Getting Rid of Coal?

Over the last five years, many countries have endeavoured to reduce the contribution of coal in their electricity mix, for example, the United Kingdom, which has reduced its reliance on coal from over 40% in 2012 to circa 2% in 2020.

The transition is more difficult for developing countries where local authorities struggle to strike a balance between the requirements of international agreements regarding CO2 and GHG emissions, and the increasing need to supply sufficient power to their fast-growing economies. For instance, China and India, as of today, still rely on coal-fired plants to satisfy over 60% and 70%, respectively of their internal electricity demand.

Figure 4: The contribution of coal and oil-fired power plants to electricity generation



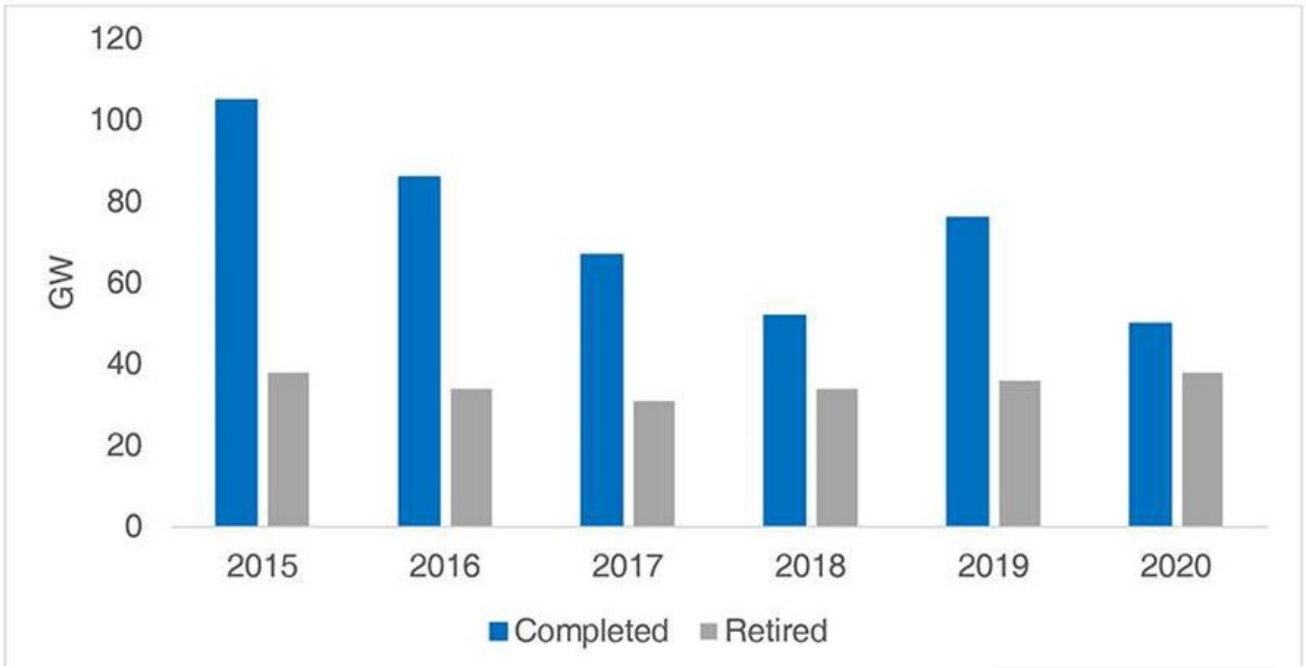
Source: OR&P analysis based on Our World in Data data.

Although certain countries have been particularly successful in shifting towards cleaner sources of power generation, the global coal and crude oil contribution has only been reduced marginally, from 43% in the year of the Paris agreement in 2015, to 39% in 2019, according to Our World in Data. Worldwide, coal still plays a major role in electricity generation. The global installed capacity of coal-fired power plants has continued to increase, according to Global Energy Monitor's. In 2020 a total of 37.8 GW of coal plants were retired, most of which were in the US and Europe, but 50 GW of brand-new plants were brought online.

China alone introduced 38 GW of additional generation capacity, while, amongst others, an additional 6.7 GW were constructed by Germany, Poland, the Czech Republic, Japan and India.

The pipeline of future coal plants projects is also substantial; currently over 179 GW are under construction and circa 320 GW are under development.

Figure 5: Newly completed and retired coal-fired power plants



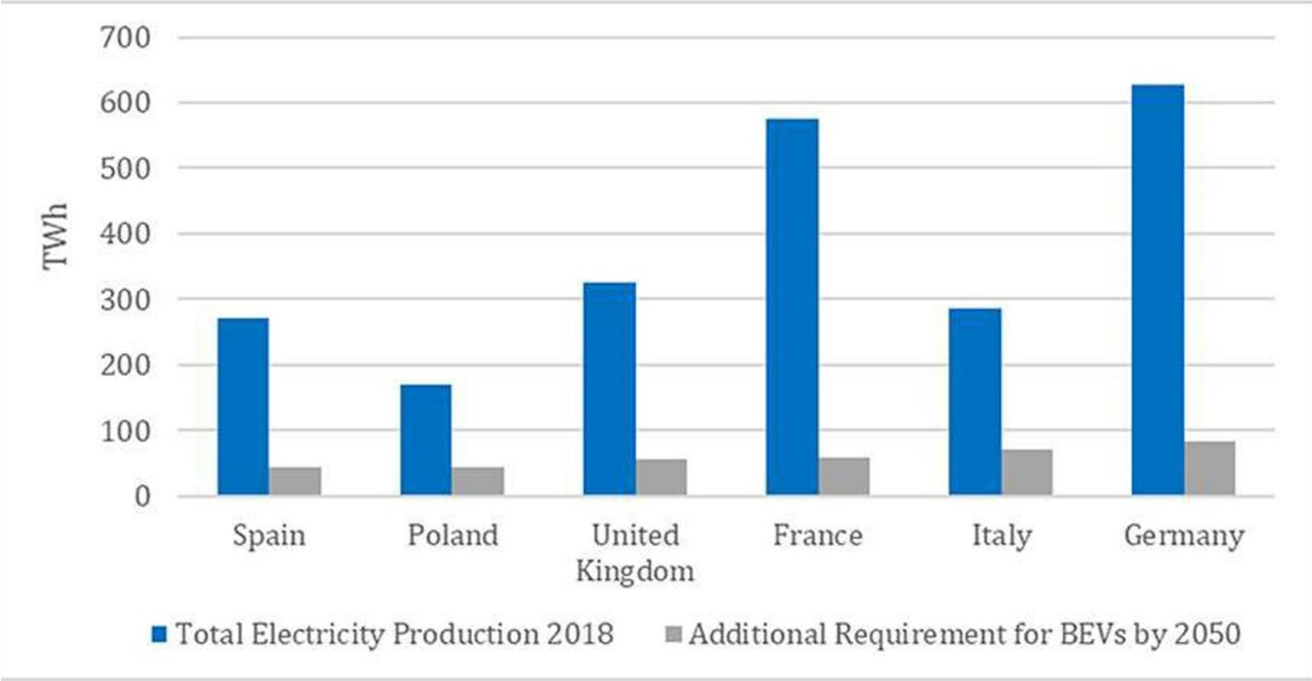
Source: Global Energy Monitor, Boom and Bust 2021, Tracking the Global Coal Plant Pipeline

CONCLUSIONS

The situation is both clear and complex at the same time. More BEVs on the road will require additional power generation capacity. The challenge for some countries will be to reduce the CO2 emissions associated with electricity production, while simultaneously expanding capacity without relying on coal. For instance, if the current vehicle fleet were to be converted to BEVs by 2050, electricity generation in Germany would have to supply an additional 85 TWh per year.

Poland, with one of the highest power generation CO2 intensities in Europe, would need an additional 44 TWh of capacity to support an entire car fleet made of BEVs. It is remarkable that the country has only just awarded its first ever license for the construction of an offshore wind farm to Ørsted A/S and RWE AG in April 2021. This is part of a plan to develop a total of 11 GW of offshore wind power which will not be completed earlier than 2040, according to S&P Global Market Intelligence. This additional generating power will only be sufficient to support the potential new demand associated with the BEV fleet and not to fade out coal from the existing mix.

Figure 6: Current total electricity generation vs future incremental demand from BEVs



Source: Eurostat, European Automobile Manufacturers Association, Our World in Data and OR&P analysis

Introducing electric vehicles in countries with a sufficiently clean energy mix seems a straightforward choice, but this is not the case everywhere. It is clear that BEVs are, as of today, a significant challenge for certain coal-dependent countries.

While from a technical perspective the overall efficiency of an electric motor is several times higher than a traditional petrol engine, the environmental benefits from deployment of BEVs will only be achieved if combined with policies that ensure coal-based power generation is phased out and replaced with more sustainable sources of electricity.

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