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A NEED FOR NEW ENERGY CAPACITIES IN THE TRANSITION TO ELECTRIC VEHICLES IN THE PERIOD UNTIL 2030

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Abstract

Switching to vehicles which use electricity is an irreversible process. It is considered the gradual transition to electric automobiles, and the provision of the needs for available electricity for their operation and use at the end of the period 2030. The following two scenarios are reviewed – of automobile manufacturers and of the stated state policies. According to each of the scenarios, the total number of estimated sales of electric vehicles, by year, is derived. From there, the total number of electric vehicles in the last year of the 2030 period is derived. Reducing the cost of batteries, which are a major component and add about 30 percent of the value of vehicles, will lead to a drastic reduction in the price of the production. For the purposes of this study, it is assumed that by the end of this period, there will be a swicth to the use of new technologies and this will reduce electricity consumption per 100 kilometers by at least 20% . The consumption of the Tesla Model 3 from 2021 of 14.9 kWh / 100 km is taken as a basis and from which, for the needs of this study, is assumed an average consumption in 2030 of 12 kWh for a car.

The average values for the annual runs for 2021 of all types of road motor vehicles, according to their purpose are used.

Keywords: electric automobiles, growth, energy consumption, batteries, transport, mobility

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Introduction

In the "Transport" sector, the twenties of the 21st century, are the period of active switching from fossil fuels to electric vehicles.

In the review of the worldwide electric automobiles development, there is a lack of research on the amount of energy, which will be needed to power them in 2030. Sales of electric vehicles so far, worldwide, are expected to reach between 20% and 35% of all the sold vehicles. Here comes the need to put into operation and use new energy-saving capacities for electricity production. A need

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for new infrastructure is being to accommodate this new electricity demand for manufacturing facilities to transport infrastructure.

Electric cars are the real alternative to conventional Road Motor Vehicles with internal combustion engines. By replacing conventional internal combustion engines, the prerequisite for tackling global environmental pollution will be created. It is for these reasons that many countries are considering actually supporting this transition with measures to promote these alternatives. These future measures to promote the use of electric vehicles will undoubtedly create the conditions for their rapid entry into the urban environment, which will for sure increase the demand for electricity and strain the charging infrastructure. There is an objective possibility that the existing electricity infrastructure will not be able to accommodate this increasing demand, which will lead to the necessity for governments to create the conditions for the expansion of the transmission network and to transform the current portfolio of electricity generation to ensure the stability of the transmission electricity system.

Within this analysis, only battery electric vehicles (BEVs) with a capacity of more than 20 kWh will be considered. Battery Electric Vehicles (BEVs): vehicles 100% are propelled by electric power. BEVs do not have an internal combustion engine and they do not use any kind of liquid fuel (Sanguesa et al., 2021). Plug-in hybrid vehicles (PHEVs) and fuel cell vehicles (FCEVs) powered by hydrogen fuel will be excluded.

A real precondition is being created for increasing the consumption of electricity worldwide, which must inevitably lead to an increase in the production capacity.

The wide adoption of lithium-ion batteries used in electric vehicles will require increased natural resources for the automotive industry (Baars et al., 2021).

Main headings

At the present moment, the share of electric vehicles worldwide is about 1% of all vehicles. And even in the conditions of the pandemic in 2020 and 2021, a record increase in sales is observed. In August 2021, sales of electrified vehicles in the EU outpaced those of diesel ones. A clear growth trend is observed in the coming months until the end of the year. A real prerequisite is being established for a rapid transition to electric and hybrid propulsion in vehicles, dictated by the increasing environmental requirements for road motor vehicles.

The rapid transition to electrically powered vehicles creates the conditions for an increase in electricity consumption and puts the transmission system at risk of not being able to handle this load. It is necessary for this potential demand for electricity in the period up to 2030 to be correctly calculated. The main emphasis

is placed on the real possibility that this demand will be met by new capacities for the production of renewable energy.

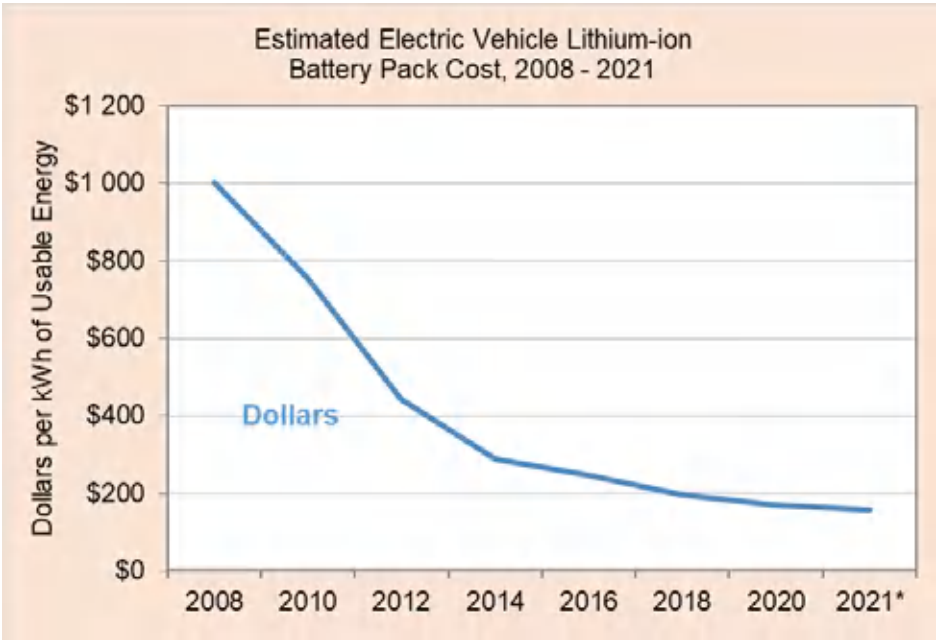
The main factors for a rapid transition to all-electric vehicles are related to the reduction of production costs and one-time mileage on a single charge. The main challenges in reducing the total cost of electric vehicles and creating a real need for their mass consumption are:

- Reducing the price of batteries;
- Increasing the volume to the total weight of the battery;
- Compatibility of charging stations and increase of charging capacities.

The total cost of acquiring electric vehicles and their future operation are of crucial importance when deciding to switch to a Battery Electric Vehicle (BEV):

The cost of producing batteries is a key factor in rapidly reducing the price of electric motor vehicles and their entry into the market. The main problem, at the moment, is the lack of cheap electric vehicles for the mass consumer. There is a complete lack of vehicles in the European market in the price range below € 10,000, which is still a necessary condition for the difficult transition to electrified motor vehicles. With identical models of leading manufacturers, electrically driven transmissions are more expensive by an average of 5,000 €. The prices of batteries installed in these vehicles reach up to 30% of the total price, and the trend in recent years is for it (the price) to decrease.

Expectations for a rapid transition to road motor vehicles powered by electricity are also related to the rapid introduction of new technologies for battery production. A prerequisite is being created for lighter and cheaper lithium-ion / Graphite / NMC / batteries. New technologies have managed to create batteries with a service life of up to 15 years and the ability to charge between 3000 and 5000 cycles. If in 2013 the average production price for lithium-ion batteries is approximately 1237 dollars /kwh, then in 2021 the production costs for such a battery are around 157 dollars/ kwh. According to the US Department of Energy, production costs have decreased by 87% in the last 13 years (Vehicle Technologies Office, 2021).



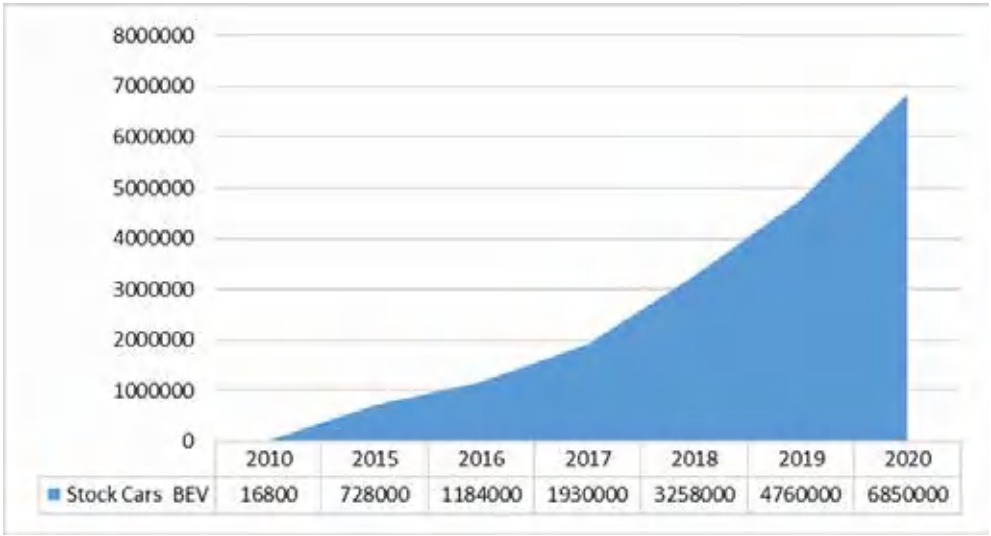
Source: US Department of Energy

Figure 1: Price for production of 1 kwh for lithium-ion / Graphite / NMC / batteries for the period 2008 – 2021

The expectations are for the prices to continue to decrease, reaching prices of approximately $ 80 / kwh by 2030.

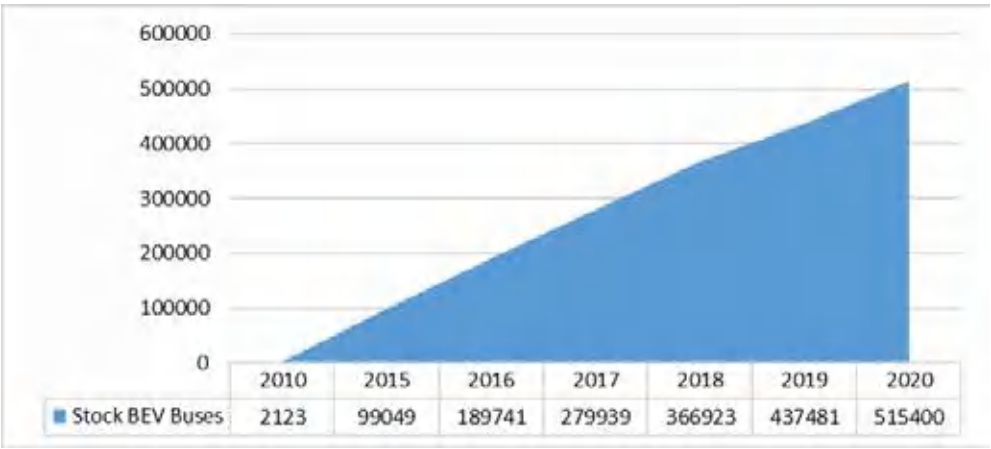
The decline in the prices for electric automobile batteries below $ 100 / kwh is the key factor in reaching a production price equal to gasoline ones. At the beginning of last year, battery manufacturers stated their expectations for these levels of production costs to be reached in the period 2023 – 2024. On the other hand, Volkswagen have announced that they have reached the production cost of a battery of 100 dollars per kwh in the VW ID.3 model (Volkswagen AG, 2022), which may change the trend towards faster reduction of the total price of electric vehicles. However, the high raw materials and the negative effect of the COVID-19 pandemic in 2022 are expected to slow down this process of drastic price declines.

Sales of **battery-powered electric vehicles (BEVs)** have been growing annually in the past 10 years. In 2010, the number of electric automobiles worldwide was just under 23.400, including all available: cars, trucks, buses and vans. Five years later, in 2015, the number reached 899,644 vehicles. In the following years, annual growth of over 60% is achieved, which led to the availability in 2020 of about 7,824,000 electric automobiles.



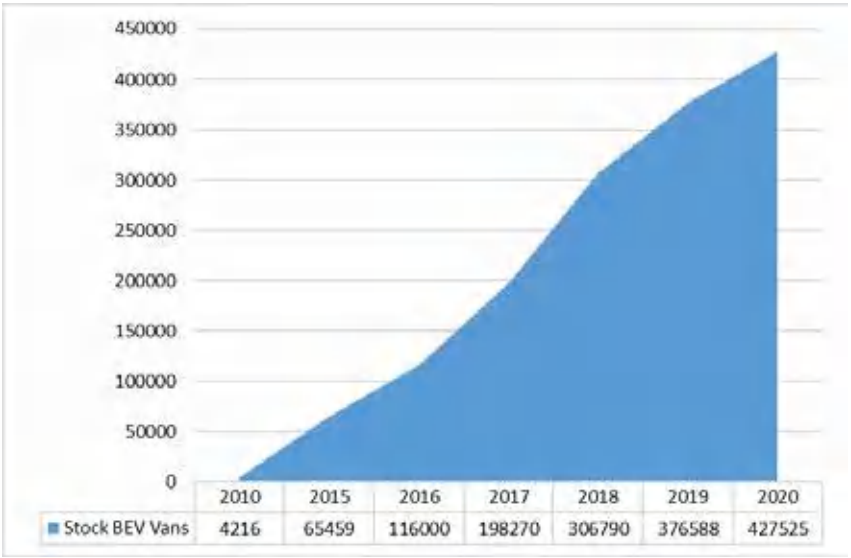
Source: International Energy Agency (IEA)

Figure 2: Sales of electric automobiles worldwide for the period 2010 – 2020



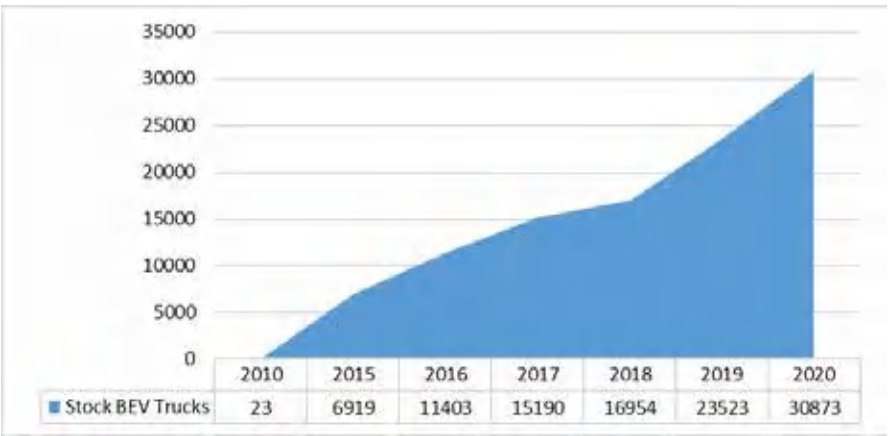
Source: International Energy Agency (IEA)

Figure 3: Sales of electric buses worldwide for the period 2010 – 2020



Source: International Energy Agency (IEA)

Figure 4: Sales of electric vans worldwide for the period 2010-2020



Source: International Energy Agency (IEA)

Figure 5: Sales of electric trucks worldwide for the period 2010 – 2020

According to the International Energy Agency (IEA), the transition to electric vehicles will continue over the next 10 years (IEA, 2021).

Major global manufacturers have announced a shift to all-electric vehicles - after 2030 - Volvo will produce only electric cars, Volkswagen will reach 70%,

Ford will sell in Europe entirely electric cars, many of the other manufacturers will have to adjust to the new development trend.

In 2021, there was a clear trend towards price increase for the electric energy, which in turn led to higher costs for charging in public charging stations for all-electric vehicles. It is expected that this trend of price increase will be controlled by the introduction of both: new energy capacities and that of projected consumption. Of course, the lower cost of charging at home is maintained due to the use of night tariffs for electricity and subsidizing household consumers.

Two scenarios for the development of the sales of electric vehicles in the period 2020 – 2030 can be considered:

1. The optimistic scenario is based on the policies announced by governments to move to 40% of sales of electric cars in 2030.

It is expected that by 2025 automobiles will grow to about 41 million worldwide. As in the period 2025 – 2030, sales growth will remain stable and will reach about 135 million automobiles.

On the other hand, Vans are expected to grow to approximately 3 million by 2025, and by 2030 their number should increase to approximately 15 million.

Buses are extremely important for reducing pollution in cities and therefore they are expected to catch up quickly. Multiple countries are announcing policies for a mass shift to environmentally friendly urban transport and, consequently, intercity transport. If in 2020 the percentage of electrified buses was a little over 1%, in 2025 it is expected to increase to 6.5% or approximately 1.7 million buses. The trend is that in 2030 the electrification of buses will reach approximately 16-17% or approximately 4.1 million units.

Trucks are the slowest growing sector in electrified vehicles, in 2020 sales were modest in number – about 7,000 units. In 2025, their number is expected to increase to about 300,000, and in 2030 to reach about 2 million trucks powered entirely by electricity. All this is due to the lack of large batteries and hence the lack of opportunities for large transitions with loads.

For the period 2019 – 2021, the growth of newly registered electric buses and trucks in China is high, while the low levels of new registrations in Europe and the United States continue. The new European initiative for the introduction of environmentally friendly buses is expected to give the necessary impetus to the transition to electrically powered Buses.

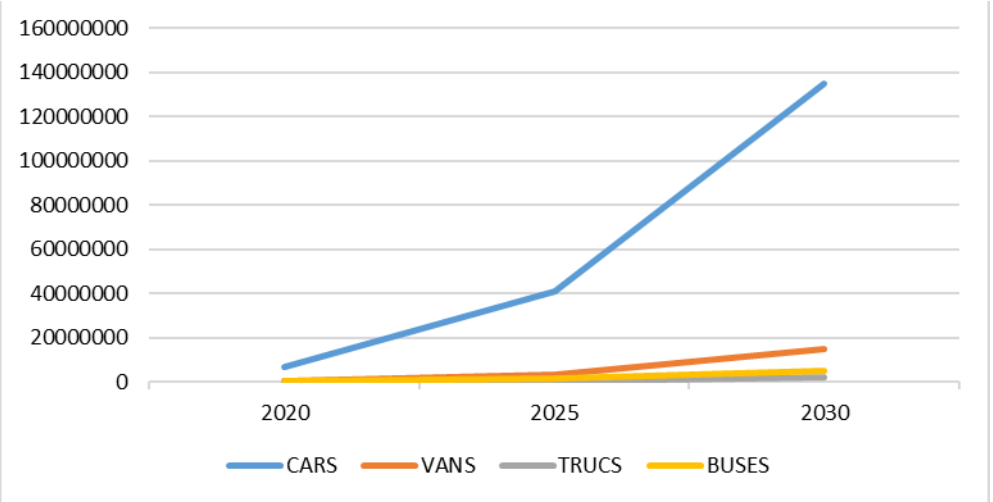


Figure 6: Optimistic scenario – Total number of electric vehicles worldwide for the period 2020 – 2030

The expectations are that in 2025 approximately 46 million electric vehicles will be on the roads, and by 2030 their number will have reached over 157 million.

The average mileage of a car under normal operating conditions is between 20,000 and 30,000 kilometers. According to Tesla Model 3 – the model with the lowest electricity consumption per 100 kilometers in 2021 – namely about 14.9 kwh per 100 kilometers in mixed driving mode (Tesla, n.d.).

Data from a Tesla Model 3 car is used – because it is a mid-range family car, as used by average statistical families. As of mid-2022, this car has the lowest energy consumption in its class for a distance traveled of 100 km.

Methodology

For the study, we will assume that in the next 5-10 years the trend of introducing new technologies will continue, and it will lead to about 20% lower energy consumption. It is expected that in 2030 it will reach a consumption of about 12 kwh per 100 kilometers for electric automobiles.

For the purposes of this study, it will be assumed that the average energy consumption of a car and a Van are the same – equal to 12 kwh/100 km.

The total annual electricity consumption will be calculated in accordance with the following formula:

Electricity demand = Number of automobiles X travelled annually km X Average consumption of 100 km

- The annual consumption of Cars will be approximately 324,000 GWh for 2030, with an average annual mileage of 20,000 km.

Electricity demand = 324 000 GWh

- The annual electricity consumption of Vans is approximately 54,000 GWh, with an annual mileage of about 30,000 km and consumption of 12 KWh per 100 km.

Electricity demand = 54 000 GWh

- The annual electricity consumption of the Buses is approximately 100,000 GWh, with an annual mileage of about 100,000 km and consumption of 20 KWh per 100 km.

Electricity demand = 100 000 GWh

- The annual electric consumption of Trucks is approximately 60,000 GWh, with an annual mileage of about 120,000 km and consumption of 25 KWh per 100 km.

Electricity demand = 60 000 GWh

Table 1 shows the annual consumption of electric vehicles, according to their type.

Table 1: Electricity consumption for charging electric vehicles for 2020 /according to IEA data/ and for 2030 /in an optimistic scenario/

Demand/ GWh	CARS	VANS	BUSES	TRUCKS	TOTAL
2020	15300	5400	13200	300	34200
2030	324000	54000	100000	60000	538 000

Source: Author

In 2030, according to the **Optimistic option**, new electric capacities will have to be provided for approximately 538,000 GWh.

2. The pessimistic scenario is based on the expectations of automobile manufacturers for moderate demand for electric automobiles and the gradual complete replacement of automobiles with internal combustion engines.

Many major automobile manufacturers predict that by 2030 they will not be able to achieve the set goals. The reason for this is the expected drastic increase in the price of electricity, and hence an increase in production costs, which cannot be covered by subsidies for the purchase of new electric vehicles.

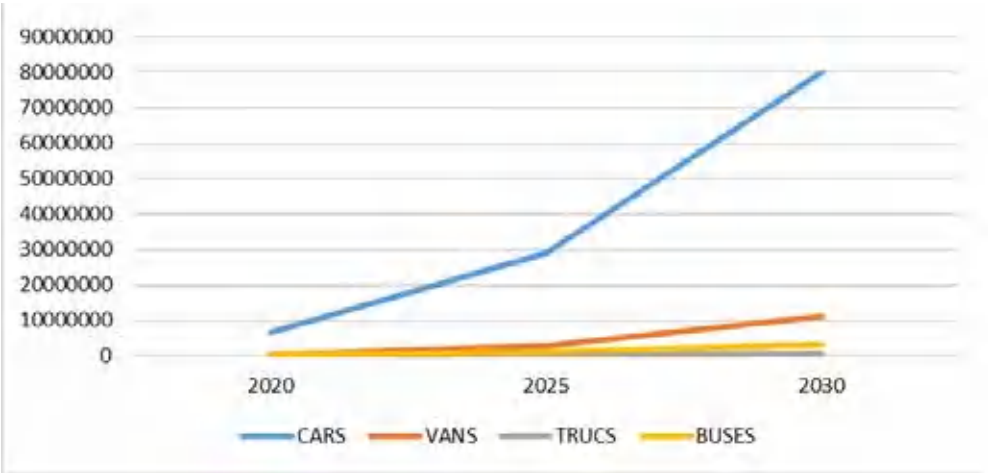


Figure 7: Pessimistic scenario – Total number of electric vehicles worldwide for the period 2020 – 2030

Table 2: Electricity consumption for charging electric vehicles for 2020 /according to IEA data/ and for 2030 /in a pessimistic scenario/

Demand/ GWh	CARS	VANS	BUSES	TRUCKS	TOTAL
2020	15300	5400	13200	300	34200
2030	192000	39600	64000	25800	321 400

Source: Author

- The annual consumption of Cars will be approximately 192,000 GWh for 2030, with an annual mileage of 20,000 km and consumption of 12 Kwh per 100 km.

Electricity demand = 192 000 GWh

- The annual electricity consumption of the Vans is approximately 39,900 GWh, with an annual mileage of about 30,000 km and consumption of 12 KWh per 100 km.

Electricity demand = 39 900 GWh

- The annual electricity consumption of the Buses is approximately 64,000 GWh, with an annual mileage of about 100,000 km and consumption of 20 KWh per 100 km.

Electricity demand = 64 000 GWh

- The electric annual consumption of Trucks is approximately 25,800 GWh, with an annual mileage of about 120,000 km and consumption of 25 KWh per 100 km.

Electricity demand = 25 800 GWh

In 2030, according to the **Pessimistic scenario**, new electric capacities of approximately 321,400 GWh will have to be provided.

This means that during the next 5 to 10 years, new energy capacities will have to be built from renewable sources to cover electricity consumption. This task is quite possible after the rapid development of the installed capacity of photovoltaic plants in 2020.

New capacities of 134 GW were installed worldwide in **photovoltaic power plants** throughout the entire 2020. The leader in the construction of these new energy capacities is China with 48 new GW built, followed by the USA and the European Union with 19 GW each. On the other hand, there is a very slow growth of the built solar parks worldwide, where real growth of 45 GW is reported**.**

Wind power plants (turbines) also mark an expected huge increase in newly built capacities up to about 108 GW in 2020. The main capacities were installed in China – 71.7 GW. Unfortunately, a serious backlog of installed solar parks, worldwide, is observed. This is due to the economic stagnation following the COVID-19 pandemic and the slowdown in supply chains.

In 2020, worldwide, from renewable sources new capacities for about 280 GW were added. The forecast is for a smooth growth until 2026 with values of installed new capacities from 300 to 330 GW annually. The conclusions are that if a faster installation of new sources, for clean energy production, is not achieved, it will not be possible to catch up with future consumption in the optimistic scenario of about 538,000 GWh on an annual basis. This would lead to a real shortage of electricity and hence the increase in prices. The optimistic scenario is more possible given the pace of adoption and insertion of new technologies and the rapid increase in fossil fuel prices. The rapid introduction of electric powered vehicles may face the energy transmission network with the inability to absorb the transmission of the produced energy. This will create future problems and pose a real danger of slowing the growth.

Conclusions

Energy distribution systems are faced with new challenges in the period up to 2030, caused by the massive introduction of electric vehicles in the coming years. The logical question which arises is: will it be possible in this short period of time to implement new production capacities and create a new energy transmission network capable of taking on more future consumption?

The widespread use of new technologies in the production of lithium-ion batteries will create a precondition for the rapid decline in prices and hence the availability of all-electric vehicles. Henceforth, it is expected that by 2030 the **Optimistic** sales scenario will be realized, with total consumption reaching approximately 538,000 GWh. The introduction of new installed capacities worldwide must continue in order to cover this future consumption.

Although the share of electricity produced from renewable sources in 2020 reached 28% of the total volume, and is expected to increase by approximately 12% on an annual basis by 2030, more efforts are needed to install new capacities in order to cover all consumption needs. A clear trend is being created of rapid penetration of electric vehicles and from there an increase in the necessity to implement new energy capacities to cover these new realities. The new trend towards a transition to fully electric vehicles will require the installation of new facilities for which we must be prepared. In countries with well-developed automobile charging infrastructure, a sales growth in the upcoming years is expected. This will create conditions for high consumption in these regions.

Manufacturing must meet market desire for high energy and power densities, safety, and battery longevity to have longer trips without having to recharge Evs (Rajaeifar et al, 2022).

This study has the following limitations: On the one hand, this study does not analyze the time intervals for the use of electric vehicles. It is quite possible that in certain peak time zones, there will be a shortage of produced and delivered energy. Second, the recovery of energy from the vehicle itself is not taken into account. On the other hand, this study is limited, as it cannot predict the power transmission system constraints in all regions. Such limitations are inevitable, because it is not possible to predict the consumer sentiment according to the production and transmission capacity of each region.

The expected rapid development of the production of electric vehicles can lead to new challenges for resource consumption and risks in the production and supply chains. It is highly probable that by slowing down the pace, on an annual basis, when installing new energy efficient sources for electricity production, that there will be a shortage of capacity. This would lead to a real possibility of increase of the energy prices and slowing down the transition to the use of electric vehicles.

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