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**BLACK SEA
SCIENCE 2021
PROCEEDINGS**



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Odessa National Academy of Food Technologies

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2. ECONOMICS AND **ADMINISTRATION**

RECYCLING OF OLD ENGINE VEHICLES TO ELECTRIC CARS

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Abstract. *In this study, we explored the dynamics of world electric cars sales and its share in the country's foreign market. The research includes a comparison of electric cars with engine vehicles. The Ukraine import of used vehicles was analyzed to prove the need to create a modern system for the recycling of used cars with internal combustion engines to cars with electric traction. Comparative characteristics of electric cars and traditional engine vehicles were described. The main advantages of electrification of land transport in Ukraine for the development of small and medium business are determined. The main world current trends in the world electric car market were studied.*

Keywords: *electric car, internal combustion engine, car market, vehicles, electrification of land transport, recycling, economy, development.*

I. INTRODUCTION

Taking into account such factors as energy scarcity, intense environmental pollution and global economic crises, innovative vehicles such as electric cars and electric vehicles in general are among the most promising types of modern transport. Electrification of land transport is an important step towards solving financial, environmental and economic problems in the country at the present stage. Such vehicles are becoming cheaper, making them more accessible to the public. Thus, the prospects for electric cars in the near future become wider and more realistic

II. LITERATURE ANALYSIS

The problems of the electric car market and the advantages of electrification were carried out by such domestic and foreign scientists as: Burkinsky BV, Gutarevich YF, Kotlubay OM, Lifar VV, Miklovda VP, Redzyuk AM, Ryabova OV, Preiger DK, Shinkarenko VG, Yukhnovsky IR, and others. But the main aspects for recycling used cars to electric ones need further investigations

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

The purpose of this article is an analytical research of the main aspects of recycling (re-equipment) of cars with internal combustion engines (ICE) for electric cars and their competitiveness in sustainable development of economy of Ukraine.

Objectives of the study:

- to analyze the main trends in the current electric car market
- to study the vehicle market in Ukraine, taking into account foreign trade;
- to estimate the need of creation of modern system of re-equipment of used cars for cars with electric traction;
- to identify the main benefits of transport electrification for small and medium-sized businesses.

IV. RESULTS

The first electric car appeared earlier than the internal combustion engine car. It was a cart with an electric motor created in 1844. An electric car, not a petrol car, also set the speed record of 100 km/h. In New York, the first taxi network used such cars more than a hundred years ago. Later people came up with an electric starter. A gasoline car became easier to start and profitable to sell. As batteries for electric cars were allowed to manage only short distances, gasoline cars became increasingly popular. Officially, the first electric cars in Ukraine appeared in 1993: ZAZ assembled a batch of electric cars for Switzerland based on "Tavria" ZAZ-1102. Currently, electric cars are gradually filling the world car market, displacing traditional cars, and better-known car companies are switching their models to environmentally friendly fuel (Novitsky, 2017).

Such enterprises as "Karpaty", "Tochprilad", "Tyco Electronics Ukraine Limited", "SEWS Ukraine", Sumitomo Electric Bordnetze, LLC "Kromberg and Schubert Ukraine" etc. are engaged in the production of electrical stuff for the automotive industry in Ukraine (Menchynska, 2018).

The pros and cons of the electric car attract all potential owners of new generation vehicles. The popularity of electric cars in the world is because of having a number of advantages over cars with internal combustion engines (Table 1).

Table 1. Comparative characteristics of electric cars and cars with internal combustion engines

Electric car	Traditional Car
Security	
A huge number of systems starting with electronic stabilization, prevent emergency situations (airbags)	Only the latest models of cars can provide safe transportation of the passenger.
Fuel consumption	
The fully charged car can overcome 200 km.	A middle-class car with an engine capacity of 60 liters and a fuel consumption of 6 liters per km. can manage from 800 to 1000 km.
Comfort	
Останні моделі авто оснащені Інноваційним інтер'єром, пристроями для зручності під час поїздки, як власника авто, так і пасажирів. Залежить від уподобань покупця і його фінансових можливостей.	
Service	
Takes a minimum of time, they do not need cleaning. In a couple of years you will have to completely replace the battery. There are lack of gas stations for electric cars now.	Not a problem. Service is expensive.
Environmental friendliness	
Complete absence of harmful exhausts to human health.	Noise and heat pollution
Cost	
Nissan Leaf 2019 - electric car - \$ 21,500 - UAH 607,160	Nissan Rogue Sport 2.0 awd 2019 -16 \$ 500 • UAH 469,260

An extremely important advantage of electric cars is their environmental

friendliness. The absence of exhaust can effectively reduce the negative impact on the environment and nature. Motor transport is one of the most significant causes of environmental pollution (in Ukraine, the share of pollutant emissions from the use of transport is 35% of all sectors of the national economy). According to the European association Eurelectric, the electric car produces 66 g of CO₂ per 1 km, when a traditional car on gasoline - 124 g (Written, Bykonya, 2018).

However, the electricity that the electric cars use is most often obtained from non-renewable sources. In Ukraine, more than 50% of electricity is generated through nuclear energy, and it is not a safe source of energy. If we look at the situation on a national level in terms of greenhouse gas emissions, the whole country emits greenhouse gases equally not through the combustion of gasoline or diesel, but through electricity.

Thus, despite the rather significant advantages, electric cars have disadvantages (Table 2).

Table 2. Advantages and disadvantages of electric cars

Pros	Cons
Electric cars are able to provide quiet and smooth acceleration	Long charging time. Although new electric cars can be charged in most up to 80% in 40 minutes.
Local reduction of air pollution in cities.	Underdeveloped infrastructure of charging stations in Ukraine.
Due to the small number of parts and assemblies, the reliability of the electric car increases	High cost compared to gasoline and diesel. A new electric car is more expensive than its opponent.
The electric car is safer.	Decreased power reserve in winter. Due to the lack of interior heating, steering wheel and seats, the power reserve in case of low temperatures is reduced to 25-30%.
Ease of construction and management, high reliability and long service duration (up to 20-25 years).	The production and recycling of batteries, which often contain toxic components

Electricity is cheaper than other fuels, the lack of complex mechanisms, components and staff eliminates frequent breakdowns. Manufacturers are working on innovative technologies that increase the functionality of these vehicles. Popular examples of the most high-tech and popular electric cars are Nissan Leaf, Volkswagen e-Golf, Tesla (Sabinich, 2018).

The automobile industry is developing in the context of digitalization and the introduction of new advanced technologies, the growth of which belongs to electric cars in almost all segments (cars, trucks, buses) (Fig. 1). The world leaders in developing and using electric vehicles are China, Europe and the United Kingdom. Electric cars have already begun to be widely used in commercial freight.

Plug in (prefix) indicates that the vehicle's batteries can be charged from an external power source, such as a regular outlet. Acronyms PHEV (Plug in Hybrid Electric Vehicle) – hybrid car, PEV (Plug in Electric Vehicle) - electric car (Figure 1).

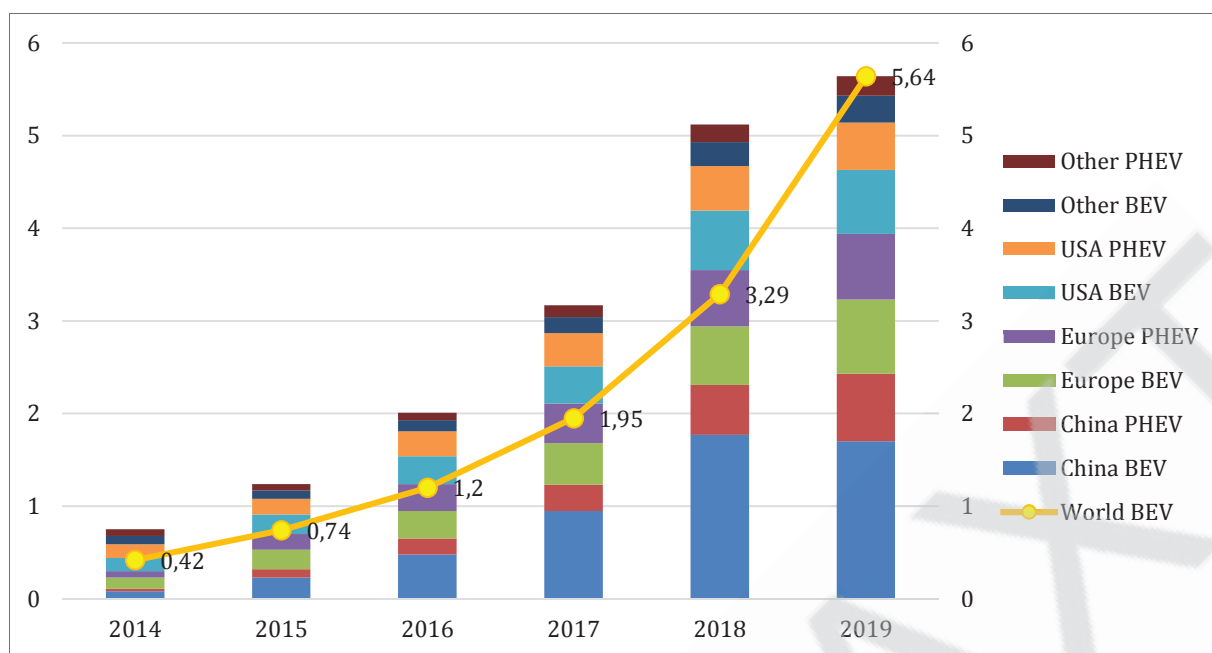


Fig. 1. Dynamics of world sales of electric cars (Electric car market share, 2019)

Growing demand for energy resources and their gradual decrease, high prices for primary energy sources against the background of environmental problems increases the replacement of vehicles with electric cars.

Electric cars account about 1.3% of car sales. Out of 1000 cars sold, 15 have an electric motor, which led to a 14% global sales growth.

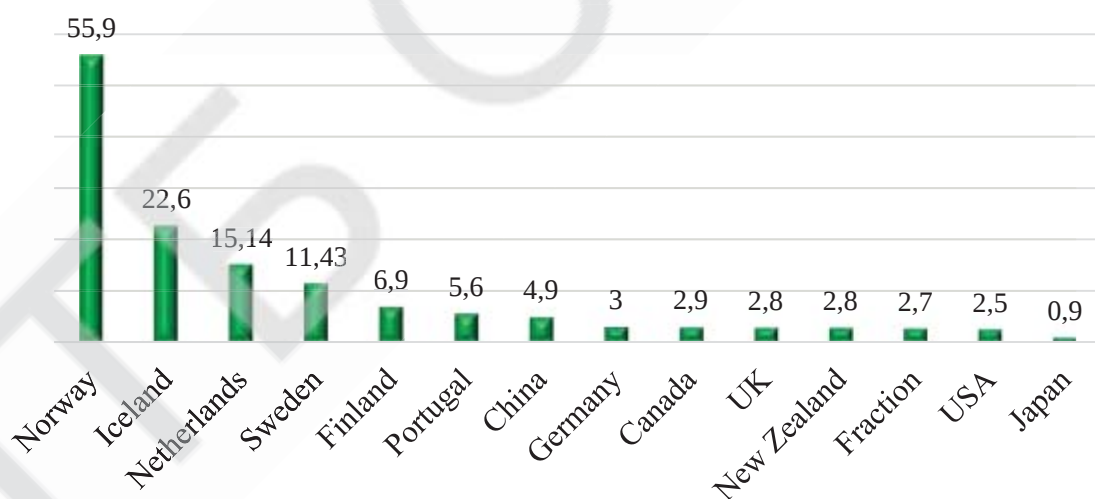


Fig. 1. The share of "electric cars" in the country's fleet, 2019.

According to government measures, in some countries the share of electric cars is much higher than in others: Norway - 55.9%, Iceland - 22.6%, the Netherlands - 15%, Sweden - 11.43% (Fig. 2).

Having analyzed the world market of electric cars from the point of companies (Poltavets, 2020) that produce electric cars, it was determined that premium brands occupy the largest share in the world EV market, but the highest sales have mass models (Table 3).

Table 3. World sales of electric cars by brand (Global EV Outlook, 2020)

	Company	Producer	Popular brands	Number of units sold (thousands)	Place	
					2019	2018
1	Tesla	USA	Tesla Model S Model X Model 3	300	1	1
2	BAIC	China	BAIC EC-Series EU-Series	111	2	2
3	Nissan	Japan	Nissan Leaf	69	3	4
4	BYD Yuan	China	BYD e5	67	4	7
5	SAIC	China	SAIC Baojun	60	5	10
6	BMW	Germany	BMW 530e	51	6	3
7	Mitsubishi	Japan	Outlander PHEV	49	7	6
8	Renault	France	Renault Zoe	46	8	8
9	Hyundai	South Korea	Hyundai Kona EV	44	9	5
10	Chery	China	Chery eQ EV	39	10	9

According to the information above, Tesla takes the first place due to the number of new registered electric cars in the world - almost 300 thousand. It is followed by Chinese brands BAIC and BYD. NISSAN (Japan) and Chinese SAIC and BAIC models are at the third stage. Daimler, BMW, Mitsubishi, Ford, Renault are trying to make up for lost time and are going to make a boom in sales of electric vehicles (Global EV Outlook, 2020).

The trend of electrification of individual transport has been formed not only in the places of production, but also in Ukraine. According to the Federation of Automobile Employers 7 700 electric cars were registered in Ukraine in 2019. That is 39% higher comparing with 2018. Regionally, Kyiv, Odesa, Lviv and Kharkiv hold the top in sale of electric cars and hybrids, where the major amount is provided by the capital and regional centers. Economists predict that the car market will increase greatly. It will help to create new opportunities for small and medium-sized businesses in Ukraine (Poltavets, 2020).

Table 4. Volumes of trade in terms of UKTZED group 87 (Means of land transport, except railway or tram, their parts and equipment) (thousand dollars)

	2017	2018	2019	2020
Export	130266	134 611	122 067	82 625
Import	3 953 941	4 223 226	5 789 521	3 834 417
Trade	4 084 208	4 357 837	5 911 589	3 917 042
Balance	-3 823 674	-4 088 615	-5 667 453	-3 751 791

Despite the fact that electric cars are not currently the main source of transportation in Ukraine and occupy a small share in the structure of the transport system, their role in our development is extremely important. They have a great potential due to their environmental friendliness and renewable energy sources.

According to the data in Table 4, the popularity of cars imported abroad is quite high. Basically, Ukrainian fleet of electric vehicles continues to be replenished by imported used cars. In 2019, the share of imported cars was 91%, while in 2018 – 82%. The main reason for demand lies in the condition of cars that were previously operated on excellent roads. Foreign cars are serviceable and well groomed. Therefore, they are suitable either for personal use or for further sale. To legalize a foreign car, it is necessary to pay a certain fee:

1. Excise duty. The owner of a car must pay 50 euros for a vehicle with an engine capacity (petrol) up to 3000 cm³, 100 euros - for a car with an internal combustion engine more than 3000 cm³. Diesel transport rates of 75 euros (up to 3500 cm³) and 150 euros (more than 3500 cm³). Payment does not apply to electric cars.

2. Import tax - 10% of the car price. For electric cars, the tax is 0%.

3. VAT (Value Added Tax). The rate is 20% of the amount of car value, import tax and excise duty. Electric cars are free from VAT until 2022.

According to Ukrainian legislation, all imported vehicles are subjected to customs clearance of frontier-crossing traffic (Zaverbny, 2019). In 2020, the situation has slightly changed:

- The procedure became cheaper for cars of Euro-5 and Euro-6.
- A minimum excise duty has been introduced.
- The ban on the import of cars for more than 10 years used has been lifted.
- Privileges for the import of electric vehicles have been extended.

In addition, until 2028, the individual income taxpayer may include in the tax deduction the cost of an electric vehicle or its recycling. Customers are offered to be exempted from paying the fee for pension insurance.

The disadvantage of the innovations is the high cost of customs clearance, which is justified by the exceptional quality of foreign cars. As for the number of imported electric vehicles, the data of the customs services show that 4100 electric cars were imported to Ukraine in January-September 2018. The total value of imported electric cars was \$49.8 million. This is almost twice as much as in 2017, when 2,500 electric cars worth \$20 million were imported. The old cars also dominate the car market. 498 out of 5,789 cars that were registered since the beginning of the year were new.

60 % of electric vehicles come from the United States. From Germany and Japan - 10% of total import. 5% and 4% of cars were imported to Ukraine from South Korea and France [4]. All other cars come to Ukraine from China, Mexico, Canada and Great Britain. The most popular brand of electromotive in Ukraine is Nissan Leaf (55%). It costs 36550 dollars. Without recharging, it can travel 363 km. From January to October 2019, the country's fleet renewed 2,763 cars of this model. Their main advantage among other competitors is a relatively low price (Vinnichuk, 2019).

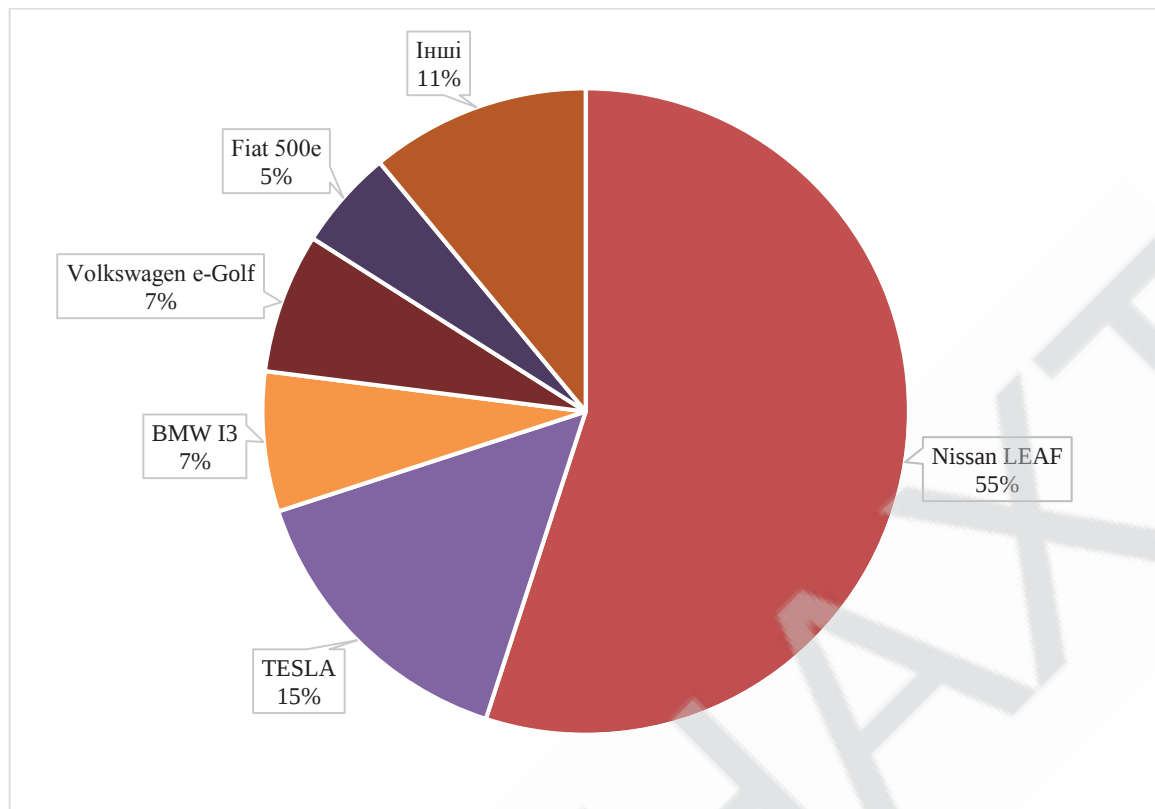


Figure 3. Market share of electric vehicles in Ukraine

The second most popular electric car in Ukraine is the American TESLA (489 cars). This brand belongs to the premium car brands. It is able to manage 500 km. on a full battery, and costs \$47,990. 5% of the total electric car market are BMW I3 cars - 297, as well as Volkswagen e-Golf, Fiat 500e, Mercedes-Benz B250e and Kia Soul (Fig. 3).

The largest importers of electric cars in Ukraine are individuals who buy cars both for their own use and for resale. In order not to overpay for imported models, there is a need to develop a system for recycling used cars with an internal combustion engine to a car with an electric motor. Re-equipment includes dismantling of the cooling system, exhaust pipe and internal combustion engine. Specialists install a controller, an electric motor, a set of batteries and a charger instead.

To perform the conversion of a conventional production car by replacing the standard engine with an electric one, it is necessary to determine the suitable car. Many factors depend on the technical characteristics, which will affect further vehicle operation. The next step is to determine the type of motor and its power. The following several types are used: DC collector motors, asynchronous AC motors current, synchronous AC motors and modern types of AC motors with valve control, etc. To ensure the maximum mileage, you need to calculate which batteries will be needed for the selected motor. It should be mentioned that the optimal range of distances sufficient for daily operation is in the range from 60 to 120 kilometers, depending on the purpose of the car. At the same time, lead-acid batteries practically do not allow exceeding the size of run in 80-90 kilometers - the increase in their capacity will lead to the weight growth of the car.

Next, you need to think about heating, air conditioning, electric car lighting and

powering all sorts of small electronics equipment. The largest part of energy consumption is heating. The characteristics of a car with an electric motor are more suitable for city use. This allows reducing the number of requirements for some design characteristics when choosing a car that is converted to an electric motor (Overchenko, Gorpinyuk, 2014).

As an example, a service has already been set up in Ukraine to change ordinary cars with internal combustion engines into electric cars. ELMOB Company offers such services. By leaving an application on the website, you will get expert advice, take a test drive and receive a contract for services. Production and delivery of batteries will take up to 90 days. Installation and testing will take 1 day. To convert an ordinary car to an electric one costs \$5,000 - that is the cheapest option. For this price, you can get a car with a 70-80 km run on a full charge with a speed of 90 km / h. A frequent demand for re-equipment is the part of commercial vehicles and used cars. It is a choice for those who want to reduce the cost of purchasing, operating and maintaining cars in their own business.

Now, supporters of eco movement, experts of technical creativity in many areas, owners of electric cars, which were engaged in house re-equipment independently, also make this replacement now. Today, there are on sale full-fledged kits for self-re-equipment of an electric car. Their cost starts from \$1,500. Growth in sales and improvement of models will eliminate the existing cons of such cars, making them with dynamic and speed properties easy in operation. Replacing the engine during the repairment does not change the characteristics of the car specified in the registration. Therefore, there is no need to register these changes in the MREV. Replacement for the purpose of car power increase causes changes of its technical characteristics: working volume, weight, type of the engine. In this case, the procedure is agreed with the NDC BDR MIA of Ukraine (Poltavets, 2020).

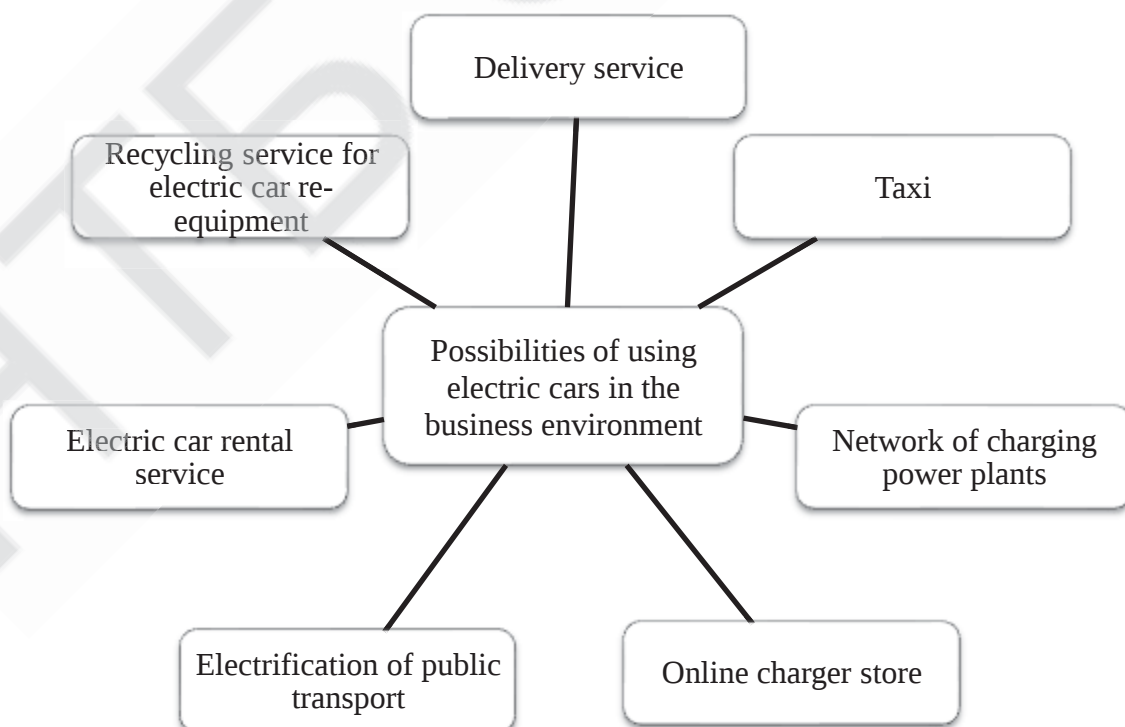


Figure 4. The use of electric vehicles for small and medium business development

Re-equipment is very important for companies engaged in the delivery of small and light goods, food delivery, taxis (Fig. 4). Electric bicycles and electric scooters are much cheaper than cars, they are more maneuverable, do not get into "traffic jams" and are great for delivering food, small parcels, goods, documents, tickets, etc. (How to make an electric..., 2019)

Electrification of transport is impossible without development of appropriate infrastructure – a network of charging stations. Thus, to promote the recycling of cars with internal combustion engines and the use of electric vehicles, it is important to develop a network of charging stations. The gas station Okko, one of the fuel market leaders, has opened 34 high-speed electric stations, which are suitable for all types of electric vehicles. Well-known American company "Tesla Motors" has announced its aiming to expand its business in Ukraine. In the near future Tesla is going to open two power plants in our country for high-speed charging of electric cars "Supercharger". The opening of networks of electric gas stations in Ukraine can be a basic idea for business and supplementary as well. For example, we can develop an environmentally friendly taxi service, or a shopping center with a recharging parking place, or a traditional gas station.

This can be not only a source of additional income, but also a powerful marketing tool to attract customers. Entrepreneurs (hotels, restaurants, supermarkets) should now take care of installing "chargers" nearby their parking (Poltavets, 2020). In addition, almost every day the range of new models of electric cars occurs. It is likely that in a few years, the house charging will be less used, and there will be more specialized refueling station. Taking into account the global electrification trend, opening an online portable charger store for electric vehicles can also be a successful business idea.

Near the rising value of private cars in operation, (including paid parking), it is important to develop environmentally friendly public transport that can cope with the increased flow of passengers and provide high-quality services.

Another option for starting a business using electric cars is a rental service. Today, there are many examples of companies that provide a full range of car rental services with a European level of service quality and standards. Services include leasing up to three years, full insurance, 24-hour Call Center for customers and other additional services. For service, registration from it is necessary to provide such documents as passport, identification code (for citizens of Ukraine) and valid driver's license (Poltavets, 2020).

Therefore, it is evident that recycling of old cars with an internal combustion engine to electromotive has many advantages for the development of small and medium-sized businesses in Ukraine. Having analyzed all information above, we propose a model of recycling cars in Fig. 5.

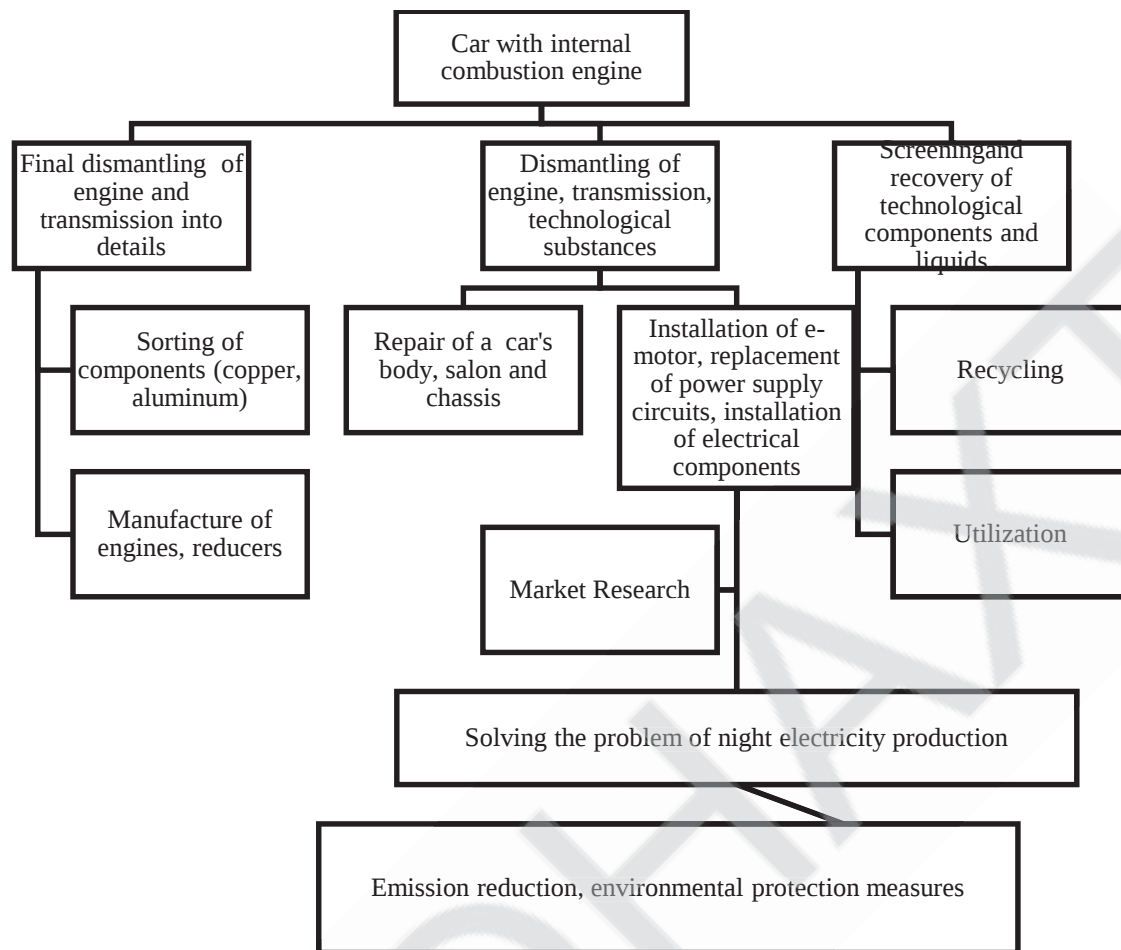


Figure 5. Model of recycling of used cars with internal combustion engines to electric cars

* developed on the basis of Gurochkina (2020)

The electrical circuit of a car with a gas or diesel engine is almost completely changed. In addition, a reduction of CO₂ emissions and the environmental protection is achieved by reducing the number of harmful industrial production one of the obstacles to the electrification of land transport is the small number of experts in this field.

The lack of education of amateur mechanics is often a problem at the stage of realization of a ready-made electric car. An important issue is the difficulty of funding. In Ukraine, it is difficult to find investors, especially for technology projects. They want to see the final example and the project control at once. Underdeveloped production of necessary electric components in Ukraine has a negative impact on the transport industry. We do not have enough batteries and electrical equipment plants, as a result - most equipment must be purchased abroad.

V. CONCLUSIONS

Thus, in this paper we investigated the world market of electric cars, determined the advantages of this type of transport over traditional cars. The process of electrification of land transport in Ukraine and its impact on the development of small and medium business is evident. The electrification of land transport is an important

step towards solving important financial, environmental and economic problems in the country at the present stage.

Therefore, due to the difficult economic situation in the country, the issue of developing energy-efficient and environmentally friendly modes of transport and suitable infrastructure is extremely important. One of the areas that will allow small and medium-sized businesses to develop is the promotion of vehicles among the population and the gradual transition of transportation to electric traction engines. The proposed system provides new opportunities for business development in the field of car service and car recycling, which will attract the attention of entrepreneurs and future investors. Further research should focus on the technical and economic description of such investment projects.

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