Substantiation of the project of development of charging stations network for electric cars

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Abstract: Today, the global world market is slowly but surely and systematically developing a crisis in the extraction, processing and use of light hydrocarbons, i.e. oil and gas. It has two aspects, in particular the cost of extracting these energy sources is constantly increasing, as deep drilling of wells on land, seas and oceans is required, and the increasing combustion of these hydrocarbons pollutes the environment, contributing to global climate change. In addition, the latter has a very negative impact on human health, which requires considerable funds for their treatment, in particular, and leads to global extinction of both animals and humans in general.

An alternative to light hydrocarbons for refueling and moving cars at the moment is electricity. After all, in addition to nuclear energy, alternative "green" energy has been intensively developed recently, which is generated by the energy of the sun, wind, water, organic compounds and household waste.

According to the results of the analysis of the dynamics of electric vehicles supply to Ukraine and construction of electric charging stations for their power supply, it was established that this type of transport moves 2.25 times more intensively on the market than building of electric charging stations. This slows down the promotion of this mode of transport in the country and does not reduce the consumption of traditional fuels, including gasoline and diesel fuel. Therefore, the article is devoted to the development of the concept of building a national network of charging stations by 2025, with serial production of 200 units per year, which is based on the capabilities of the company "Elekar Group" LLC. It is substantiated the project of production of electric charging stations, which is based on the deep analysis of the market, applying M. Porter's model of competitiveness, SWOT-analysis and analysis of a life cycle of production. A conceptual model for diagnosing the competitiveness of charging stations has been developed.

Key words: circular economy, sustainable development, closed ecological and economic cycle, economic and mathematical methods and models

JEL: O1, O2, O3, O4, M1, M2

Introduction

Today, the global world market is slowly but surely and systematically developing a crisis in the extraction, processing and use of light hydrocarbons, i.e. oil and gas. It has two aspects, particularly the cost of extracting these energy sources is constantly increasing, as deep drilling of wells on land, seas and oceans is required, and the increasing combustion of these hydrocarbons pollutes the environment, contributing to global climate change. In addition, the latter has a very negative impact on human health, which requires considerable funds for their treatment, in particular, and leads to global extinction of both animals and humans in general.

An alternative to light hydrocarbons for refueling and moving cars at the moment is electricity. After all, in addition to nuclear energy, alternative "green" energy has been intensively developed recently, which is generated by the energy of the Sun, wind, water, organic compounds and household waste.

As mentioned above, due to the development of nuclear energy and alternative sources of its generation, today this type of energy is already competing in price with light hydrocarbons, and given its impact on the environment, it is generally the most promising type of energy. In particular, fast neutron reactors are being built in nuclear power, researchers are already solving problems of controlling the influence of solar radiation intensity in solar generators, and the latest generators are entering hydro and air power due to the use of nanotechnologies in the production of new materials and 3D printers for turbines production [1-8]. Ukraine has sufficient capacity of generating power and in general its energy sector was built while taking into account the discrete selection of capacity during peak hours.

Today, developed countries plan to convert the passenger car market to electric cars by 2025. Ukraine is also joining this project, as in 2018 it introduced excise-free import of electric cars into the country. In addition, the project of the Zaporizhia Automobile Plant "Komunar" is planned to be introduced in the near future in the serial production of electric cars. At the same time, if there are no problems with electricity generation in Ukraine, there are many technical and economic issues with its distribution. After all, electricity distribution systems were built in Soviet times and are concentrated near large energy-intensive enterprises. Thus, summarizing the above, it can be noted that there are almost all resources

for the introduction of the electric car market in Ukraine, but there is almost no network of gas stations for this type of transport.

Therefore, the aim of the article is to develop the concept of building a network of electric charging stations in Ukraine, which is based on the "Elekar Group" LLC company's capabilities for the production and sale of charging stations for electric vehicles. Thus, for the development of ecological transport in Ukraine, we consider it necessary to apply an integrated and systematic approach, ensuring the availability of electric vehicles for the consumer and the corresponding infrastructure.

Theoretical premises and methodology

For the development of ecological transport in Ukraine, it is necessary to apply an integrated and systematic approach, ensuring the availability of electric vehicles for the consumer and the corresponding infrastructure. The комплексный analysis of the electric car market in Ukraine performed according to the method [9-11] showed that its growth is constrained by the lack of a developed network of charging stations. In particular, the number of public stations at the end of 2020 was 2719 units. At the same time, among these charging stations, there are those that serve only electric cars of their own production. This further complicates the problem of charging cars.

The depth of this problem can be understood from the analysis of such data. In the first half of 2020, 3,384 new electric vehicles were registered in our country. This is 16% more than in the same period last year. And as in the end of 2020, almost 23,000 electric cars and slightly more hybrids have been registered, which together make up about 46,000 cars. The presented statistics show that the growth rate of the number of electric cars in Ukraine is significantly higher than the charging stations for their maintenance. In addition, according to Ukrainian law, electric chargers can be placed only on roads of state importance, which are 46.6 thousand kilometers. And the requirements for the number of gas stations on local roads, which are 117 thousand kilometers, are not defined. This limits the ability to travel on this mode of transport in the country. At the same time, it should be noted that most electric charging stations manufactured in Ukraine have a whole system of superstructures for the process of charging cars. In particular, it is the use of magnetic cards, registration in certain systems and the creation of accounts and more. Therefore, «Elekar Group» LLC develops

charging stations without using complex interfaces and reducing the number of options. At the same time, this company has developed software that allows the operator to track all processes at the station while charging cars.

The main goal of «Elekar Group» LLC is to create a single national network of charging stations with serial production of 200 units per year by January 1, 2025. The construction of its own global network of charging stations for electric vehicles will provide an opportunity to improve the infrastructure of electric vehicles in Ukraine and will help create additional opportunities for users of electric vehicles to charge anywhere. This will increase the demand for electric cars in Ukraine. At the same time, increasing the number of electric vehicles in Ukraine will help reduce its dependence on oil and gas supplies. In addition, it should be noted that this trend will help improve the environmental situation in the country as a result of reducing CO_2 emissions. It is also worth paying attention to the reduction in the air and on the ground of heavy metals from the combustion of hydrocarbons used by gasoline and diesel vehicles.

«Elekar Group» LLC can implement the above project to build an extensive system of gas stations, investing in it about 10.6 million UAH. The payback period of the project will be only thirteen months.

To assess the company's capabilities in this market, we use SWOT-analysis (Table 1), analysis of the life cycle of these products and assessment of the competitors' capabilities [9-13].

Table 1. Analysis of the advantages and disadvantages of «Elekar Group» LLC

Strengths	Weaknesses
- high quality products; - technical support from equipment suppliers; - creation of infrastructure by own forces; - use of innovative technologies in developments; - product patents; - high qualifications of the company's employees; - quality service; - competitive price for products and services.	- low production volumes; - insufficient quality and quantity of advertising of own products; - lack of European certification; - lack of working capital.
Opportunities	Threats

• increase in the product range; • production of fast car charging stations; • increasing the network of charging stations; • attracting additional investments; • increase of the distribution network in Ukraine and abroad; • start of a powerful advertising campaign.	• the initial stage of development of the electric car industry; • low education of the target audience; • increase in the price of electrical equipment; • imperfect legislation.

Source: Authors' calculations

The qualification of employees and its impact on product quality was assessed according to the method proposed in the works [9-13].

Results

It is known [9-13] that there are four stages of the product life cycle, in particular:

- entry of goods into the market;

- growth;

- maturity;

- decline.

The period of growth is characterized by a rapid increase in sales and revenue. Thus, given that the demand for electric cars in the world and Ukraine is growing rapidly, these products today and in the medium term will be in growth.

The analysis of the market of electric charging stations in Ukraine showed that the following companies work on it:

Table 2. Number of charging stations and shares of operators

Stations	Number
Number of standard and high power stations, 2719 in total	
AutoEnterprise	1113
IONITY	387
ElectroUA	380
TOKA	204
Green Fuel	200
Elekar Group	103

Eco-Factor Charge	81
Go To-U	63
RV-Net	60
E-Line	45
Yasno	23
Electro.vn.ua	21
ChargeX	13
Quick Power	11
UGV Chargers	11
ChargeU	2
Electrocars	2

Source: https://fra.org.ua/ru/st/statistika

Identifying one's own advantages over competitors will usually help increase sales and increase profits and master new market elements. To do this, these benefits need to be brought to the attention of consumers so that they are clearly oriented among a wide range of similar products and services.

To assess the competitiveness of products and services of companies for the production of charging stations, the authors proposed a criterion that reflects the rate of change of technical and economic parameters of the product of companies depending on the development of the industry. To do this, a conceptual model for diagnosing the competitiveness of charging stations (Fig. 1), the components of which are calculated based on the marketing concept

(1) $$V=f\{Pi\,\alpha_i\},$$

where V is the sales volume;

Pi (i = from 1 to 4) - marketing mix;

α_i - the weight of the parameter in the marketing mix.

Price (P_2),

$$P_2 = \sum_{i=1,n} N_i * a,$$

parameters
N1, N2…Nn

Product (P_1),

$$P_1 = \sum_{i=1,n} N_i * a,$$

parameters
N1, N2…Nn

$$Z_s = \sqrt[4]{P_1 * P_2 * P_3 * P_4}$$

Sales system (P_3),

$$P_3 = \sum_{i=1,n} N_i * a,$$

parameters
N1, N2…Nn

Marketing
communications,
(P_4)

$$P_4 = \sum_{i=1,n} N_i * a,$$

parameters
N1, N2…Nn

According to experts, in assessing the competitiveness of charging stations, the value of the significance level (α_i) of each parameter is distributed as follows: α_1 = 0.30 (range); α_2 = 0.20 (price); α_3 = 0.25 (sales system); α_4 = 0.25 (marketing communications)

(3) $$\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 1,$$

where α_i is the value of the significance level of the parameter.

The basis for determining the significance of each parameter is expert assessments based on the results of marketing research.

A comparative analysis of the parameters that directly affect it was conducted, as such a procedure is important for competitive marketing. The results of the comparative analysis are presented in Table 3.

Competitiveness parameters were compared with «AutoEnterprise», as it is the leading company in this market.

Table 3 Assessment of the competitiveness of companies

Company	Parameters																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
«Elekar Group»	8	7	9	6	8	8	6	7	9	8	9	8	9	9	8	7	7	8	5
«AutoEnterprise»	8	8	5	9	8	7	7	7	7	8	8	8	9	9	7	7	7	7	6

Source: own compilation based on https://fra.org.ua/ru/st/statistika

in paragraphs № 1… 14, Table 3 presents an estimate of the parameters that characterize the product, and in paragraphs № 15… 19 - its price. In particular, № 1 is quality, № 2 is brand, № 3 is uniqueness, № 4 is versatility, № 5 is technical parameters, № 6 is characteristics during use, № 7 is multivariance in use, № 8 - overall dimensions, № 9 - legal possibility of product replacement, № 10 - level of repair service, № 11 - service life, № 12 - warranty period, № 13 - reliability, № 14 - patent protection. Thus, the parameters that characterize the quality of the product in the company «Elekar Group» is 112, and «AutoEnterprise» - 107. Therefore, according to this indicator, the first company produces a slightly better product than the second.

The parameters that characterize the price of the product are as follows: № 15 - price list, № 16 - percentage of discounts, № 17 - preferential discount, № 18 - terms and conditions of payments, № 19 - loan terms. Thus, according to the data (Table 3), both companies have almost the same position on this indicator, as in the first company this indicator is 35, and in the second - 34.

The competitiveness of these companies was also assessed on such grounds as sales channels and product promotion in the market. Sales channels and market promotion were evaluated on eleven indicators. The sales channel on the market for the second company is estimated at 74, and the first - 72 points. However, for the promotion of products on the market, the first company was rated at 87, and the second - 74 points.

The overall assessment of competitiveness, using a conceptual model for diagnosing the competitiveness of charging stations, for the company «Elekar Group» is -17.59 and «AutoEnterprise» - 16.47. Thus, the products of the first company are more competitive than the second.

The analysis of this information and its reasonable interpretation allows experts to assess each parameter that determines competition, as well as to characterize the general condition of the company and its place in the market.

Porter's analysis of the five forces adds objectivity to previous conclusions. In particular, to assess the market, we analyzed the threats to the emergence of substitute products, new producers and suppliers, assessed the market ownership of suppliers and consumers and determined the level of competition [19].

Analysis of suppliers of materials and components is a very important aspect. After all, low-quality materials and components will contribute to the non-compliance of products with regulatory and technical documentation for their production. Complaints about the low quality of products will lead to direct losses of funds to eliminate non-conformities or even to replace products with those that meet the regulatory and technical documentation for their production. In addition, the unstable quality of materials and components will contribute to the unstable quality of the final product, which will lead to a loss of reputation in the market and to the loss of markets. Therefore, the international quality standard ISO 9001 provides a separate procedure as "supplier evaluation". Assessment of the quality of processes, in particular the process of "supplier evaluation", is devoted to works [9-18]. In particular, the approaches to process evaluation represented in these works were used by us to evaluate suppliers of materials and components.

In particular, the following requirements were set for the suppliers:

- delivery of products in time defined by contracts and quality, which corresponds to the parameters of regulatory and technical documentation for its production and specified in the contracts;
- observance of volumes of deliveries of production and its complete set;
- long-term warranty periods for materials and components;
- prompt response to complaints of non-compliance with contractual obligations;
- compliance with agreed prices;
- accessibility (territorial, informational, communication) to suppliers.

To achieve this goal, the company has developed a marketing strategy. It consists of the following factors:

- product distribution scheme;

- pricing;

- advertising;

- methods of sales promotion;

- organization of after-sales service of products;

- organizational plan;

- production plan;

- risk assessment and insurance;

- investment plan;

- calculation of the annual economic effect.

These factors, which determine the marketing strategy of the enterprise to achieve this goal, were fulfilled with specific steps, which are justified by the calculation of material costs. In particular, the focus should be on the production plan, risk assessment, financial plan, investment and calculation of the annual economic effect.

The development of a production plan begins with the calculation of the number of workers. They were usually based on production volumes, number of technological operations and their labor intensity. In particular, the number of workers was determined by formula (4):

(4) $$R_i = V \cdot T_i / F \cdot Q;$$

where:

Ri - the number of workers in each technological operation;

V - volume of output, one;

Ti - the complexity of the i-th operation, n / year;

F. - current annual working time fund, F. = 1800 hours;

Q. - performing norms coefficient, $C_{p.n.}$ = 1.

The desired area was determined by formula (5);

(5) $$St = Sp + Sa;$$

where:

St - total area of the district, m^2;

Sp - production area of the district, m^2;

Sa - auxiliary area of the district, m^2.

Production area was calculated by formula (6):

(6) $$Sp = N \bullet P;$$

N - the number of jobs at the district;

P - area per workplace, which was 8 m^2.

Calculated according to formulas (2; 3), the total area of the production district was 32.4 m^2. At the same time, the cost of renting the premises was calculated based on the cost of 1 m^2 of 34 UAH per month.

Taking into account the determined costs for the lease of the production district that was calculated according to the above formulas, the cost of materials and components, basic and auxiliary wages, overhead costs, mandatory payments to the budget, the cost of production was calculated. At the same time, together with the planned profit, the cost of production was calculated. All calculations of the cost of production were performed according to the standard current method, so they are not presented in the article, as they have intermediate character.

Risks are possible during the creation of this production and its operation. In particular, they may be related to the following factors:

- Untimely supply of raw materials and components. To prevent this, the company needs to have several suppliers for each unit of raw materials, etc.

- Rapid inflation. To minimize losses from it, the cost of production should be slightly increased, based on expert forecasts.

- The emergence of competitors in the market. It is necessary to take into account the pricing policy of competitors and improve the quality of its products and its properties to satisfy consumers in order to expand markets.

- Components for charging stations are manufactured abroad. Therefore, their price is pegged to the exchange rate of the main foreign currencies: the US dollar and the euro. It is clear that fluctuations in the hryvnia exchange rate against these currencies will usually contribute to rising prices for electric charging stations. To minimize price growth, it is necessary to reduce the cost of production, taking into account all the main factors that determine it.

To implement the program for the production of gas stations and create their network, the financial plan has been developed based on projected production volumes. They are given in the following table (Table 4).

Table 4 Projected volume of product sales

Term of production, year	Production volume, units	Production volume, UAH.
1	200	6,996,338
2	400	13,992,676
3	600	20,989,014
4	800	27,985,352
Total	2000	69,963,379

Source: Authors' calculations based on enterprise «Elekar Group» LLC data

The minimum amount of financial resources that companies need to produce the planned volume of production is defined as the ratio of annual operating costs to cash flow. It is determined that the planned production program requires UAH 433,483.2 ($ 169,88.8). At the same time, the critical volume of production at which the company receives zero profit is calculated. According to calculations, the critical amount of the minimum volume of production is 140 units per year. It was calculated by formula (7):

(7) $$N_c = S_{ctc} / Pri - S_{ch};$$

where:

S_{ctc} - conditionally fixed costs for the entire volume of production (4,484,832 UAH);

Pri - unit price (UAH);

S_{ch} - change in loss per unit of output, (UAH 2,976,6).

The calculated gross income is UAH 157,529,262 and the need for working capital is UAH 3,470,226.3. They are calculated according to standard methods.

The investment program for the production of the planned volume of gas stations is given in Table 5.

Table 5 Investment program

№	Stages	Including, UAH		Total UAH
		Year I	Year II	
1	Premises for rent	67,740	67,740	135,480
2	Acquisition of office equipment	40,000	20,000	60,000
3	Repair of office premises	37,600	30,000	67,600
4	Purchase of vehicles. Electric car - 1 unit.	40,000	40,000	80,000
5	Working capital	3,470,226.3	-	3,470,226.3
	Total	3,587,842.3	105,536	3,693,378.3

Source: Authors' calculations based on enterprise «Elekar Group» LLC data

The calculation of the economic effect (Ee) was determined by formula (8):

(8) $Ee = Prb \cdot a - (Pr + En \cdot La) + ((Ub - Un) - En \cdot (Kn - Kb)))/Pam;$

where:

Prb - the price of the base product, UAH;

a - equivalence coefficient;

Pr - the minimum price of a new product, UAH;

En - normative efficiency ratio of capital investments (0.15);

La - additional costs, UAH;

Ub, Un - annual operating costs of the consumer, UAH;

Kn, Kb - accompanying capital investments of the consumer, UAH;

Pam - coefficient of depreciation calculations;

$Ee = 127,439.2 \cdot 12.4 - (73,038.33 + 0.15 \cdot 114,150) + (574 - 0.15 \cdot (- 23,486)) / 0.154 =$ UAH 114,857.3

The planned volume of production due to insufficient funding can be reduced by 14 units.

Conclusions

For the transition to ecological transport in Ukraine, it is necessary to create systemic conditions at the macro and micro levels. According to the results of the analysis of the electric

car market in Ukraine, it was determined that its rapid growth is hampered by the lack of appropriate infrastructure, in particular the required number of charging stations for their power supply. Thus, for the development of ecological transport in Ukraine, we consider it necessary to apply an integrated and systematic approach, ensuring the availability of electric vehicles for the consumer and the corresponding infrastructure.

A project has been proposed for building a national network of electric charging stations until 2025, with serial production of 200 units per year, which is based on the capabilities of the «Elekar Group» LLC company. Calculations confirmed the economic attractiveness of this project and its prospects for the next 5 years. The conceptual model of diagnostics of competitiveness of charging stations is developed and the criterion which reflects speed of changes of technical and economic parameters of a product of the companies on manufacture of charging stations depending on indicators of development of branch is offered.

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