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To the Issue of Decision-Making Analysis in Environmental Management on the Example of the Transition of a Car Park to Electric Traction

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***Abstract*-The work is devoted to the problem of the transition of road transport to one of the types of alternative energy sources – solar panels. Questions of expediency of these actions from the point of view of ecology are considered.**

Keywords-Environmental management, car, electric car, systems approach, solar panelsponent

I. INTRODUCTION

Speaking about the goal of technical progress and economic development of society, we mean meeting the needs of the population, improving their quality of life. To this end, we purposefully change the environment. Unfortunately, on this way we have side effects, expected (which we often neglect) and unforeseen. These negative side effects of the activities of our generation lead to conflict with the interests of future generations. The need for balance between the interests of present and future generations in their basic formulation first appeared in the report of the UN Commission "Our Common Future" in 1987. And it is not only about the availability of natural resources in an amount not less than the current generation has, but also that the quality of life should be at least as good as the population of developed countries today.

The concept is called the concept of sustainable development. The implementation of this concept required from countries legislative initiatives and standardization of the approach at the international level. So there appeared "ecological" standards, as well as the model of environmental management (Environmental management systems). The latest version of the national standard of the Russian Federation is "Environmental Management System. Requirements and application guide." [1]. Thus, the basic concept is deployed at the level of a specific organization. But, as indicated in the text of the standard, the standard itself does not guarantee an optimal level of environmental results, but depends on the field of activity, the stringency of regulatory requirements and the level of undertaken obligations.

However, this standard recommends that organizations apply a system approach and risk-oriented thinking.Let us dwell on the concept of a system approach.

II. MAIN PART

The system approach is a methodology in which an object is considered as a system. What properties should an object have (it is not only about organization, but also about the object of activity) so that it can be classified as a "system"? There are many definitions, like definitions of I.V. Blauberg and E.G. Yudin [2]. A system is a certain set consisting of interdependent parts, each of which participates in creation of characteristics of the whole. At the same time, three levels automatically appear: supersystem, system and subsystem. All organizations are systems. Regardless of the type of system, they must have such properties as integrity, structuredness and hierarchy, as well as integrity. In our case, for an organization, we always have an open system, which means another important property – a connection with the environment.

So, the objects of environmental management are the products that company produces and the technological processes that company uses for manufacturing, packaging, transportation, etc.

As stated in the standard: "An organization should define physical and organizational boundaries of the environmental management system area." [1]. Defining the physical and organizational boundaries of the environmental management area is an extremely important aspect. Incorrect definition of boundaries, such as not including the stage of product recycling in the environmental management area, can lead to exactly the opposite results in an ecological sense. It happened with the use of nuclear power plants as an energy source.

It is important to conduct an analysis of such risks as early as possible, even at the concept stage, in order to avoid failure to achieve environmental goals and financial losses. Let us show with the help of our assessments that one of the absolutely correct ideas about reducing air pollution by exhaust gases can hardly be successfully solved by replacing gasoline and diesel engines with electric ones. In addition, the problem here is not in too short mileage from charging to charging and short battery life. These technical problems will be solved sooner or later. We are talking about incorrectly defined boundaries of the system in which only an automobile with the corresponding engine type is included as an object. As a result, the society received a falsely optimistic conclusion, on the basis of which automobile enterprises concentrated their efforts on the development of electric cars.

Let's illustrate our opinion about the failure approach on the example of the Netherlands. Why the Netherlands? This is a high-tech country with a high population density. The country's leadership has adopted the concept of using a larger share of "green" energy from outside. On the other hand, the level of environmental demands of the population is very high, which is demonstrated by the growing success of the "greens" in elections to both central and local authorities. Of course, we needed statistical information for our calculations, which we took from official online statistics resources, including the Netherlands.

The number of private cars (excluding "clean" electric vehicles) n = 8222974, plus 2.2 million cars in enterprises. The share of electric vehicles in the Netherlands according to the international agency [3] is 6.4%. This share includes "hybrids", which are the majority.

The use of electricity by the Netherlands is approximately 126 billion kWh per year (data from the Netherlands in 2015), of which 109 billion kWh was used by enterprises.

The simplest and easiest estimates can be made on the basis of the energy approach. How much energy cars consume depends on the type of engine.

We assume that cars are mainly used in the city and that 30% of cars have a small displacement and a small consumption (c) of fuel (about 5 liters per 100 km), 50% of cars have an engine of average power and consumption of about 7 liters of fuel per 100 km, and 20% of cars have a powerful engine and consumption of about 10 liters per 100 km. With daily use of a car, we take an average mileage of 25 km per day, and per year (taking into account weekends and holidays) m = 8750 km. This number is in good agreement with the data of insurance companies for which the standard car insurance corresponds to a mileage of 10 thousand km per year.

Calculate the amount of fuel consumed per year:

$$A_p=(0{,}3*c_1+0{,}5*c_2+0{,}2*c_3)*m*k=25*10^9\,l \qquad (1)$$

Now let's make calculations for enterprises. According to statistics in the Netherlands, the fleet of cars and special equipment at the enterprises is 2.2 million cars and approximately half of them (0.9 million) are trucks and heavy vehicles. Of course, vehicles at the enterprises work more intensively. We will take for assessment the daily mileage of 200 km for light motor vehicle and 500 km for trucks. Companies rarely buy compact or too powerful cars, so our assumption that the entire fleet of cars consists of cars of average power looks believable.

Calculate the amount of fuel consumed per year:

$$Aent=c2*m*k=6{,}4*109l.$$

The calculation takes into account the number of working days per year (for the Netherlands it will be 355 days).

Further assumptions for our assessment consist of the percentage of the types of special equipment. Let's suppose that 80% are trucks, 10% concrete trucks and 10% construction vehicles.

For calculations, we use the data from the Internet resource rusterex.ru/. For special equipment, the consumption rates (n) are given in l/per hour, considering that the intensity of use is 5 hours, we obtain the consumption = 5n*pi/day. For concrete trucks the consumption is 40 l/per day, for construction equipment (for example, CAT brand) is 80 l/day. Thus, for vehicles such as concrete truck we get a year consumption of:

$$A_{con}=c_{con}*m_{days}*k_{con}=1{,}3*10^9 l \qquad (2)$$

For other construction equipment

$$A_{const}=c_{const}*m_{days}*k_{const}=2{,}6*10^9 l \qquad (3)$$

Consumption for trucks varies significantly depending on engine power and load capacity and is in the range from 30l/100km to 80l/100km. Take the average value cav = 55l/100km. Taking into account the daily mileage (estimated by us) of 500 km per day, we get the fuel consumption for the year:

$$A_{tr}=c_{tr}*m_{tr}*k_{tr}=101{,}5*10^9 l \qquad (4)$$

Efficiency of petrol internal-combustion engine is approximately equal to 0.2, and the calorific value of petrol is approximately qp = 44MJ/l. We assume that half of all passenger cars (including companies' cars) in the Netherlands have a gasoline engine. With this assumption, useful work can be assessed as follows:

$$E_l=0{,}5(A_p+A_{ent})*q_p*efficiency=138*10^9MJ=38{,}4*10^9\text{ kWh} \qquad (5)$$

In accordance with our assumption the second half of the car fleet, all trucks, as well as heavy construction equipment, have diesel engines.

Efficiency of diesel internal-combustion engine is higher (we take it equal to 0.25), and the calorific value of diesel fuel is approximately qd = 43 MJ/l. In this case, we have:

$$E_d=(0{,}5(A_p+A_{ent})+A_{tr}+A_{con}+A_{const})*q_d*efficiency \qquad (6)$$

$$E_d=(0,5(25+6,4)+101,5+1,3+2,6)*43*0,25*10^9=1301*10^9 \text{ MJ} =360,4*10^9 \text{ kWh} \quad (7)$$

It is almost 400 billion kWh per year for the entire fleet of cars. These are the energy costs for the implementation of the main function of the system - "car". This energy is spent on overcoming resistance to motion and useful work. The costs for losses within the system are taken into account.

If we use “clean” electric cars (both in the constructive sense and in the ecological one), the energy balance will change (for example, due to differences in weight and design changes), but not significantly, because with equal mileages, under the same conditions, on the same roads, the loss of energy to overcome the resistance to motion will be about the same. The electric car uses the energy of the battery, but where does this energy come from? From a power station. The “green” energy of solar panels on the roof of a house at spring and summer may be enough for a short run of a small car in the city to go shopping, but for other purposes and, moreover, in the industry it is clearly not enough.

So, it turns out that in the case of transition of the entire vehicle fleet to the electric motor, we should increase the number of power stations almost 3 times. Given the fact that more than 50% of power stations are thermal, the idea of replacing vehicles with electric power sources vehicles will lead to a tremendous environmental impact on the atmosphere. Yes, we get “pure” electricity by burning “dirty” coal, oil or gas ...

Question number two: what about air pollution? Hypothetically, we have an environmentally friendly transport with electrical traction, but at the same time, we come to the need to increase the capacity of power stations. Let’s assess again.

A gas-fired power station produces approximately 0.11 kg of carbon dioxide per kWh of electricity. That is, at the present time, with the needs of, let’s say, the Netherlands, 130 billion kWh with 7.2 million tons (if 50% of the stations operate on gas) carbon dioxide discharge in the air. With a threefold increase in power of the station the emissions into the atmosphere will triple and will be about 22 million tons of carbon dioxide per year.

On the other hand, a car that uses gasoline and diesel fuel emits an average of 125 kg of carbon monoxide, which is approximately 1.3 million tons of carbon monoxide per year for the car fleet of the Netherlands, which has about 10.5 million cars. It is this value that we could have won when switching to electric vehicles, but in reality, our idea of switching to electric traction would cause a tremendous environmental impact on the atmosphere.

What can we win? Clean air in the cities. Yes, this is a substantial plus, if we drive cars with internal combustion engines out of the cities. But what about construction equipment? We agree with the author of the article [4] that the construction equipment and long-distance tractors are safe from usage of electricity.

III. CONCLUSION

Why is our answer about the profitability of switching to electric cars differs dramatically?

When describing an object as a system, the division into system, subsystem and supersystem is carried out incorrectly. Namely: consideration of a car begins with an electric car with a charged battery. The next chain is correct: higher efficiency of electric motor, etc. As a result, we get an optimistic conclusion, but wrong one.

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