Principles of Energy-effective Land Use in Automobile Transport in Ukraine

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Abstract. The article studies contamination of the environment with motor transport and the objects of road infrastructure. It considers the experience of the European Countries in implementation of investment programs to modernize the transport and the infrastructure as a whole by their "ecologization" and "green transport" to minimize the negative impact on nature and preserve the competitive opportunities. It contemplates on types and sources of bio-fuel used in European countries determines the opportunities to grow the plants for alternative fuel production in Ukraine. The concept of "greening" in relation to the transport system of Ukraine have been considered, as in the scientific literature this concept is quite new. The authors outline the basic issues of the National transport strategy for the period till 2030 on the necessity to reduce the emissions of greenhouse gases into the atmosphere with movable sources, raising a share of public transport and electric vehicles, electrical buses, muscle-driven vehicles (bikes). The directions of providing the "greening" principle of the transport system of Ukraine have been offered. The necessity of introducing the "reservation" concept for the land of automobile transport to the following normative legal documents have been substantiated: National transport strategy till 2030, State strategy of development of highways, perspective plans of construction, reconstruction or expansion of highways and others. The article contains a plan of actions to decrease the influence of transport on the environment, namely through the implementation of power-saving technologies, the use of alternative fuels, renewal and extending possibilities to use electric transport. The comparative analysis of economical and ecological aspects of different types of transport – “green vehicles”.

1. Introduction

The motorway system, as an integral part of the united transport system of the country, is constantly developing in recent years. The flows of vehicles on the Ukrainian roads are increasing. The rapid growth in the number of vehicles, the intensity of motion, the network of international and national transport corridors, is, on the one hand, positive for economic values of the country. However, on the other hand, it harms the environment and health of people.
2. Presentation of the main research material

The principle of "greening" is based on activities related to the production, distribution and consumption of goods and services of all activities kinds and lead to an increase in human well-being over time. At the same time, no ecological damage is caused to the environment at such a level that may threaten future generations with complete or partial destruction of the biological diversity of nature. [2]

The concept of the automobile transport system of Ukraine has recently appeared in the scientific doctrine, so there is no unanimity in its interpretation. However we may admit that this is “the process of penetration of ideas, knowledge, laws of ecology, ecological thinking, penetration of ecological aspects into all spheres of activity and management of the transport system of the country.. This principle in the transport system ought to be provided in two ways.

The first principle includes measures at the stage of operation of transport complexes, the alternative fuels use, ensuring the use of environmentally friendly materials in the design and construction of transport facilities [1, 5].

The European community has understood the negative effect of an outdated and inefficient transport system. It's now on the way of a fight with its consequences. The countries of the European Union are actively implementing quite large-scale investment programs to modernize the transport and infrastructure as a whole through ecologization thereof and the "green transport" to minimize the negative effect on the environment and to preserve the competitive opportunities [10].

The European community has replied to the environmental challenge with the "green transport" – vehicles of any kind with a low negative effect on the environment. The EU countries are actively implementing the large-scale and long-term investment programs to modernize the transport and infrastructure by "ecologization" thereof to minimize the adverse effect on the environment and preservation of competitive position [3, 6].

Studying the foreign experience of protecting nature against the emissions of motor transport, one can see, that they not only make and use of electric cars. Instead, the countries of the European Union, as well as the USA, Canada, Australia, Brazil are actively implementing the programs aimed to get and use alternative kinds of fuel, namely – bio-fuel made of plants (Figure 1).

![Figure 1. Types and sources of biofuel abroad.](image-url)
Nowadays, the EU countries use widely just two types of bio-fuel: bio-ethanol and gasoline, and bio-diesel for diesel motors. World corporations, namely DuPont and British Petroleum, are implementing such fuel as bio-buthanol. Both bio-ethanol and bio-butanol come from the plants (corn, wheat, sugar beet, sugar cane, sorghum, and barley). Some producing countries, like Spain, Greece, Italy use sunflower oil, while the majority of European countries – canola oil. While burning, the biofuel also emits СО₂, although it is not harmful to plants and animals, is almost completely processed in water and soil. Within 28 days, the germs process almost 99% of biofuel [14].

The use of this kind of fuel could improve both environmental (by reducing emissions into the environment) and economical situation (due to the development of sales areas, increasing scopes of production, creation of additional working places in Ukraine, etc.).

Studies have shown that the use of alternative fuels and energy, which are used both in rolling stock engines and to meet the needs of stationary facilities of the transport complex have both advantages and disadvantages [1].

The development of alternative sources of fuel is topical for Ukraine, and the government has been supporting it for a long time. This support is documented in the Order by the President of Ukraine “On Measures to Develop the Production of Fuel from Biological Raw Stock” dd. September 26, 2003 [12] and the Law of Ukraine “On Changes to Some Laws of Ukraine to Stimulate Production of Motor Mix Petroleum” dd. January 01, 2011 [11]. Due to the ecological situation, the reformation of the transport policy is still in process. Thus, the EU settled the task to reduce the number of public transport means using a traditional fuel by 50% till 2030, and refuse from them completely by 2050.

According to the National Transport Strategy for the Period till 2030 [7], we have to reduce the volumes of greenhouse gas emissions from the movable sources by 60%, compared to 1990; namely – by increasing the share of public transport and electric transport, electric buses, muscle-driven vehicles (bikes). The aggregate volumes of emissions into the atmosphere from movable sources shall drop by 70% (from the level of 2015). The strategy stipulates the increase in the use of electric transport and electro mobiles, namely – the share of the first mentioned in the local transportation to 75% (by 2030); the increased use of alternative fuel from 10% to 50% (by 2030).

The necessity of changing for electric cars and their natural efficiency is substantiated in table 1.

According to the Ministry of Infrastructure of Ukraine, where there are over 9.2 bln. transport units, each emitting 0.00023 t СО₂/km and travelling approximately 100 km/day [8].

**Table 1** The positive effect of electric vehicles in Ukraine

| Value                                      | Units          |
|--------------------------------------------|----------------|
| СО₂ emitted by a vehicle daily             | 0.00023*100*9.2=211.600 t |
| СО₂ emitted by a vehicle annually          | 211.600*365=77.234 t  |
| СО₂ absorbed by one tree in a year         | 120 kg         |
| Trees needed to absorb all СО₂ emissions of all Ukrainian vehicles | 77.234/0.12=643.62 mln. |
| The areas absorbing the emissions:         | 643.62*0.005=3218083 ha |
| 50 m² – one tree (0.005 ha)                |                |

Thus, if Ukrainian consumers replace their cars with electromobiles, significant environmental profit would be achieved.

The Ukrainian government stimulates the population to use vehicles with electric motors, providing assistance to them. For instance, according to the Law of Ukraine “On Changes to the Tax Code and some other Regulations of Ukraine to Improve Administering and Re-consider Rates of the Specific Taxes and Duties in Ukraine” of January 01, 2019 [13], the import of electric motor vehicles into Ukraine is exempted from VAT and customs duty till the end of 2022. According to the experts, this makes the electric car 17% cheaper [9].

We can determine the perspectives of electric cars compared to petroleum vehicles through a calculation of their cost recovery period. For the comparison, we took two cars, very similar in their technical characteristics, KIA Soul (Electric) – as of the moment of the purchase its cost was
approximately 810 thousand UAH, and KIA Soul produced in the same year (500 thousand UAH). For calculations, let us accept the daily distance of each vehicle as 100 km. The cost recovery period of each vehicle could be determined using the equation [8]:

\[
CR = \frac{Cost + S}{Year},
\]

where the \( CR \) is the cost recovery period in years; \( Cost \) is the cost of a vehicle, for which the cost recovery period shall be determined, UAH; \( S \) issavings through the nature of energy sources, UAH; \( Year \) – days in a year.

For visual clarity, the values of calculation of the cost recovery period for the two vehicles are provided in Table 2.

| Value                                | KIA Soul (Electric) | KIA Soul |
|--------------------------------------|---------------------|----------|
| Cost of the vehicle, UAH             | 810,000 UAH         | 500,000 UAH |
| Fuel consumption per 100 km          | 27 tWhour           | 9.6 l    |
| Cost of a power unit, UAH            | 1.68 UAH/kW         | 30 UAH/l |
| Cost of 100 km trip, UAH             | 27*1.68=45.36       | 9.6*30=288 |
| Cost of 1 km, UAH                    | 0.4536              | 2.88     |
| Savings per 100 km, UAH              | 288-45.36=242.64    | -        |
| The cost recovery period, years      | (810,000/242.64)/365=9 years | -        |

Hence, the cost recovery period for KIA Soul (Electric) is 17 times less, compared to a petroleum-motor vehicle. The cost of fuel for an electric vehicle is 17 times less, compared to the petroleum one. This fact is one of the most important ones for a consumer, for money-saving. Besides, these vehicles have less moving parts, and it reduces the frequency of visiting technical services.

The second direction might be provided by introducing the reservation of automobile transport land and its implementation at the legislative level, which will allow to form a new paradigm of the institutional environment for the development of this sector at the state level.

American scientists M.-K. Billy, L. Smith, J. Scott, S. Fox characterize land reservation as one of the functions of planning. That is why it is necessary to pay special attention to the perspective organization of transport lands in order to determine the social, ecological, socially necessary and economically feasible form of their use and adjacent territories [2].

It's worth to emphasize, that in the situation of the rapid technical, technological, and scientific development, the number of cars is constantly growing. It stipulates the growth of the network in international and national motor corridors. Therefore, the matter of the building and repair to the motorways and minimization of their impact on the environment is becoming more and more topical. These works demand the strict following of environmental standards.

To control these matters, Ukraine has the “Building Regulations SBR B.2.3-218-007:2012. Ecological requirements to the motorways. Designing”. They settle the design requirements for building, reconstruction, and overhaul of common motorways and artificial constructions. Especially topical are those relating to environment protection [6].

These industrial regulations are aimed at the development of projects for building, reconstruction, and overhaul of common motorways, considering the need to protect the environment, ensure constant development, and overcome depression in some regions. The purpose of the regulations is to improve the state road network and transport infrastructure, to ensure the proper level of using the motorways in Ukraine.

The basic impact of motorways and artificial constructions on the environment, solutions to prevent them are described in the SBN B.2.3-218-007:2012 [4] in a form of types and solutions. (table 3).
Table 3 The impact of motorways of environment, designing* [4].

| Impact type                              | A solution to reduce the impact                                                                 |
|------------------------------------------|-------------------------------------------------------------------------------------------------|
| Air contamination                        | Noise barrier panels                                                                           |
|                                           | Design of 1st and 2nd category of roads, in circumvention of the settlements                    |
| Contamination of territories, soils with building materials | Establishing a certain schedule for motor transport                                             |
| Erosions of soils due to the artificial constructions | Preferable use of low-evaporating materials                                                     |
|                                           | Planting green areas                                                                           |
| Low road safety                           | Installing the discharge facilities                                                             |
| Roadsides contamination                   | Designing bridges                                                                               |
| Contamination of water objects with motorway sewages | Organization of bypasses                                                                        |
|                                           | Installation of the respective road signs                                                       |
|                                           | Arranging additional road junctions                                                            |
|                                           | Arranging sites for vehicles to stop and park                                                   |
|                                           | Sewages purification                                                                           |
|                                           | Distribution of the sewages along the whole length of the road                                 |

It should be mentioned that the expediency of the measures stated on table 3 shall have a significant effect of the environmental situation, namely: elaboration and creation of naturally-safe constructions and building materials, improved constructions of the vehicles to reduce the harmful emissions, created an algorithm to monitor the environment and roadsides, improving the methods to manage the environment protection and transport flows to reduce the emissions of the transport.

3. Conclusion
The authors have proposed an action plan, such as using of alternative fuels, design with environmentally friendly materials, construction, reconstruction of transport infrastructure, and on the other - the inclusion of "reservation" of lands for motor transport to such normative-legal documents: National Transport Strategy until 2030, State Strategy for Road Development, long-term plans for construction, reconstruction or expansion of roads, Norms for allocating land for construction (reconstruction) of roads. The principles of the proposed plan are based on global market trends in the energy-saving technologies use in transport, the development of which, according to our calculations, in one year will save 782,414 billion UAH from funds spent today on the transport system of Ukraine. Using of “green transport” in Ukraine is increasing every year. Herewith in 2013 the number of electric cars was 50 units, in 2018 was 6740 units, which has been increasing of about 20% annually. The fuel consumption of an electric car is less than 17 times lower than that of a petrol car, and this fact is one of the biggest advantages for the consumer in terms of cost savings. On the other hand, a significant environmental effect is achieved. The processing of CO₂ emissions in the country for the year would require an area of 32.18 thousand km² and the use of cars on alternative fuels will reduce these areas by up to 10% and reduce harmful emissions into the environment 35%. Thus, high environmental friendliness combined with high payback creates conditions for the mass use of “green transport” as a preservation of energy efficiency of the Ukrainian transport system.

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