



World Scientific News

An International Scientific Journal

WSN 125 (2019) 193-203

EISSN 2392-2192

Analysis of the use of alternative fuels in public transport in the context of sustainable management

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ABSTRACT

The following study addresses the subject of sustainable public transport. The essence of this concept was explained and its role in transport policy was determined. The role of public authorities in organizing public transport as well as tools to reduce the negative impact of public transport on the environment, with particular emphasis on the competences of local authorities in this area are indicated. In the empirical part, the use of alternative fuels in public transport was analyzed, as well as the most important advantages and disadvantages of individual solutions.

Keywords: public transport, sustainable transport, sustainable development

1. INTRODUCTION

The implementation of public transport, especially in the local dimension, is one of the most important tasks in the field of municipal management carried out by local government units. Collective transport is an alternative to inefficient individual communication, creating the possibility of more efficient use of available means, including means of transport, public roads and other elements, allowing for a more rational use of the natural environment, including reduction of fuel consumption, reduction of exhaust emissions, noise, etc. Possibility of efficient movement of residents determines their quality of life, shortening the time necessary to reach places of employment, education, as well as leisure and other purposes. [1]

Urban development is associated with the domination of vehicular traffic and lowering pedestrian rank. This translates into growing air pollution, which is a particularly important problem in cities. With urbanization, the phenomenon of sustainable transport has thus become significant. Essentially, the essence of this term is to provide high quality communication with simultaneous care for the natural environment. [2] The development of civilization leads to the accumulation of problems manifesting in social and biological unrest. [3] In this connection, an increase in the significance of concepts aimed at environmental protection, and in particular sustainable development, can be observed. [4]

2. THE BALANCED PUBLIC TRANSPORT

The definition of the organizer of public mass transport stipulates that it is the appropriate local self-government unit or the minister responsible for transport affairs, ensuring the functioning of public transport in a given area. [5] The commune as the organizer of public mass transport is competent (both territorially and as to the extent of transport) on the communication line or communication network in communal passenger transport. The competent authority to perform the tasks of the organizer is, in the case of the commune, its executive body - the commune head, the mayor or the president of the city. The organizer's tasks are:

- transport development planning,
- organizing public transport,
- management of public mass transport.

Organizing public transport is in particular:

- study and analysis of transport needs in public transport, taking into account the needs of disabled persons and persons with reduced mobility,
- taking actions to implement an existing transport plan or to update this plan,
- ensuring adequate conditions for the functioning of public transport (in particular in the areas of: standards for transport stops and stations, use of transport stops and stations, operation of integrated transfer nodes, functioning of the integrated tariff and ticketing system, passenger information system),
- determining the method of marking means of transport used in transports of a public utility character,
- setting rates for the use by operators and carriers of communication stops and stations, which are not owned or managed by a local government unit, located on communication lines within the organizer's area of competence,
- determination of transport stops and stations, owned or managed by a local government unit, made available to operators and carriers, as well as conditions and rules for using these facilities,
- determining communication stops and stations, the owner or manager of which is not a territorial self-government unit, made available to all operators and carriers, and informing about the rate of fees for the use of these facilities,
- preparing and conducting proceedings leading to the conclusion of a contract for the provision of public mass transport services,

- concluding a contract for the provision of public mass transport services,
- determining the charges for carriage and other charges,
- determining the method of ticket distribution for the service provided by the operator in the field of public transport.

The commune as an organizer of public transport is characterized by features that distinguish it from other organizers. In addition to tasks and competencies similar to those that other organizers have, the scope of the municipality's activities also includes tasks and competences that do not find their equivalents (including the designation and construction of some stops or negotiations of fees with owners of transport stops or stations, not being territorial self-government units). [6]

Transport services are currently a field of economy that is characterized by dynamic development. Transport activity contributes to the effective and efficient functioning of every sector of the national economy, together with the economic and social development of individual countries and regions is a factor intensifying development. Well-functioning public mass transport encourages the resignation of individual means of transport for collective transport. The actions of the authorities, which cause an increase in interest in public transport among city users, are becoming more and more important. [7]

The implementation of the concept of sustainable development in the conditions of the current economy is becoming more and more common. [8] It is recognized that the idea of sustainable development appeared in the 1960s. It was an attempt to answer questions related to threats resulting from the dynamic development of economies and exhausting natural resources, as well as growing pollution of the natural environment, fast pace of demographic growth and growing discrepancies between the well-being of highly developed countries. The progressing consumerism, globalization and enrichment of nations means that issues related to environmental protection and sustainable development are increasingly being considered in the modern world. [9] Sustainable development has been defined as a process aimed at satisfying the developmental aspirations of the present generation in a way that enables the same aspirations to be pursued by future generations. [10] Due to the multiplicity and diversity of factors affecting this phenomenon, three main areas have been identified, which should be focused on planning an effective strategy for achieving sustainable development.

These are:

- environmental protection and rational management of natural resources (including limiting environmental pollution, protection of endangered species of animals and plants, promotion of renewable energy sources),
- economic growth and fair distribution of benefits resulting from it (including facilitating access to markets for developing countries, financing development, changing irrational patterns of consumption and production),
- social development (among others, the fight against poverty, access to education, health care).

Raising ecological standards in urban agglomerations implemented as part of sustainable development is one of the main goals of numerous research projects, development programs and strategies. Due to the fact that sustainable development is a multidimensional problem, it is now the subject of interest not only for economists, but also for philosophers, ecologists, lawyers and political scientists who try to operationalize this concept for their own fields. [11]

An excellent example of such behavior is the concept of sustainable transport, which was defined by the OECD as: "transport that does not threaten human health and ecosystems and allows transport needs through the sustainable use of renewable resources in less than their regeneration rate and using non-renewable resources in quantities lower than the rate of development of renewable substitutes. The transport sector is a key sector for sustainable development because of the social and economic benefits that can be achieved through it, while minimizing its adverse effects on society, the economy and the environment. [12]

Most of the definitions of sustainable transport relate to three basic categories of issues: economic, social and ecological. [13] In addition, in national and international documents and declarations, definitions of sustainable transport refer to the concept of sustainable development. [14]

Sustainable transport is thus a transport which:

- meets the needs of the modern generation in the field of mobility,
- guarantees an improvement in the quality of life of residents,
- does not threaten human health and ecosystems,
- effectively uses renewable and non-renewable resources,
- is available and diverse in terms of means of transport,
- meets the emission standards for harmful substances and noise,
- minimizes the need to use land,
- is affordable and supports the competitiveness of regions and the economy as a whole.

Sustainable transport must be characterized by the following features:

- its functioning must contribute to improving the health of the society and raising the standard of living, - collective communication must be preferred,
- the needs of walking pedestrians and cyclists must be taken into account,
- local communities should play an important role when creating strategies, plans, transport policy
- energy prices in transport must include all costs (including external costs), which will cause rational investment decisions,
- when planning the course of transport networks, the existence of naturally valuable areas should be taken into account.

Efficient and efficient transport determines the flows of raw materials and goods, as well as the mobility of residents, thus affecting the efficiency of management and the standard of living of the population. [15]

It is therefore an indispensable factor for economic growth and socio-economic development, all the more so as cities play an important role in stimulating growth today. On the other hand, transport is one of the sectors that pose the most serious threat from the point of view of sustainable development, contributing, inter alia, to the accelerating rate of depletion of natural resources and environmental pollution. [16] At the local level, the negative external effects of transport operations in the form of congestion, air pollution, accidents, noise and vibration have become the most burdensome, as have the devastation of the landscape and taking up more and more space for transport infrastructure.

Climate change as well as high energy intensity of the sector, determining development opportunities and satisfying the current needs of the population are also important.

3. USE OF ALTERNATIVE FUELS IN PUBLIC TRANSPORT

The climate policy conducted by the European Union, aimed at limiting climate change, strongly affects the transport industry by imposing greenhouse gas emission reduction targets. According to the estimates of the European Environment Agency, the transport industry, including urban transport and municipal services, in 2015 accounted for over 25% of greenhouse gas emissions in the entire European Union¹. Urban transport, on the other hand, contributes to 1/4 of CO₂ emissions in total transport². EU guidelines, such as the White Paper of Transport of 2011³, intended inter alia to reduce pollution and improve efficiency in transport, focus on increasing the importance of public transport and reducing the role of oil-derived fuels for alternative fuels.

Currently, the fastest-growing alternative to conventional fuels in individual and public transport is electric drive. The technology itself, although it has been used in transport for many years, is still at the stage of development and improvement. Nearly all leading manufacturers of public transport vehicles are involved in the production of electric buses, constantly expanding their range of models. The increase in interest in electric-powered buses, despite their clearly higher price compared to buses with internal combustion engines, is associated mainly with significantly lower costs of fuel (energy). However, it should be noted that the total costs of their purchase and operation (construction of infrastructure, inspections, the necessity to replace parts, including expensive batteries) in some cases may exceed the total purchase and operating costs of conventional buses. Electric buses, without internal combustion engines, are considered to be the cleanest ecologically motor means of transport, which is why often the purchase price is a less important aspect.

In the area of alternative fuels, one of the most widespread fuels is compressed natural gas. CNG is used in transport, depending on the market, on a fairly large scale for at least 30 years. It is already a well-known, proven energy carrier with advanced technology and at the same time having the potential to further increase the application.

CNG fuel is often used by:

- public transport,
- municipal services.

LNG buses, similarly to CNG, allow to maintain low emissivity, while reducing noise generated during combustion in the engine. The tendency of increasing the importance of LNG in transport is evident. This fuel can be used as an alternative in means of public transport and urban service vehicles, although currently the widest application is found in freight transport (trucks). LNG is also introduced as fuel in sea and river transport, replacing mazout and diesel oil. Such a solution allows to reduce the costs of fuel purchases, but also is beneficial from the point of view of the environmental impact, as compared to traditional fuels, it allows a significant reduction of emissions of harmful substances.

Hydrogen should be considered a relatively less popular alternative fuel. It is true that it has been used in the automotive industry since the beginning of the 90s of the twentieth century, but for the most part these are projects that have not been used on a massive scale. However, the technology is constantly developed and potentially in the future may gain wider use due to the slight local impact on the environment, which is important in the case of public transport vehicles or municipal services.



Figure 1. Electric bus
[Source: <https://energia.rp.pl> (10.03.2018)]



Figure 2. Hybrid bus
[Source: <https://energia.rp.pl> (10.03.2018)]

Table 1. Comparison of functional features of public transport vehicles fueled with alternative fuels for diesel oil

Features	CNG	Electric drive
Range	> -20%	> -60%
Emission CO ₂	-15%	-100%
Emission NO _x	-80%	-100%
Emission PM	-95%	-100%
Engine noise emission	> - 2DB	> - 5DB

[Source: PKPA report, Alternative fuels in public transport, Chamber of Commerce of Municipal Transport 2018]

The goals and strategic assumptions for urban transport in Poland are an integral part of a wider plan for the development of domestic transport and should be considered first of all in this context. The main goal that the state sets before this sector is to create an integrated transport system. To create it, a number of specific objectives have been formulated. These are:

- creating a modern and coherent network of transport infrastructure,
- improving the organization and management of the transport system,
- improving the safety of traffic users and transported goods,
- limiting the negative impact of transport on the environment,
- building a rational model of financing infrastructure investments.

The most important advantages and disadvantages of the use of alternative fuels in transport, which must be taken into account when implementing such solutions, are detailed in Table 2.

Table 2. Advantages and disadvantages of using alternative fuels in public transport

Advantages	Disadvantages
Low emission of pollutants	Higher shopping price
Low fuel costs during operation	High costs of infrastructure construction
Low noise emission	Smaller range

[Source: PKPA report, Alternative fuels in public transport, Chamber of Commerce of Municipal Transport 2018]

Alternative fuels are increasingly used not only in public transport, but also in municipal services companies. Their use is justified by economic and ecological considerations, and at the same time vehicles using unconventional drives / fuels often do not differ in functionality from traditional vehicles, and in some cases have obvious additional advantages. These types of cars are usually used in cities, where they work because of their characteristics and the specifics of the conditions in which they operate. In Poland, CNG is the dominant alternative fuel for municipal utilities.

An area where the use of alternative fuels is gradually growing is the transport and logistics industry. It is still dominated by conventional fuels, but there is a growing demand for alternative solutions, also from the recipients of logistic services. Currently in Poland one of the leaders in their implementation of unconventional fuels in city logistics is No Limit. The company has been using CNG-based vehicles since 2016 in large cities, including Warsaw, Poznań, in the implementation of business-to-consumer and business-to-business services. No Limit predicts further development of the CNG fleet, which in 2018 will be submitted by several CNG delivery vehicles, and checking the potential of other fuels and drives, ie LNG (in domestic transport) and electric ones.

4. CONCLUSIONS

The concept of sustainable development, whose task is to meet the economic, social and ecological needs of society, is a factor that has a significant impact on the directions of transport development. The obligation to take into account the principles of sustainable development in socio-economic and sectoral policies, actions and strategies of the European Union gives this factor a particularly important role in defining the directions of socio-economic development, including the transport sector. [17]

One of the basic forms of transport system regulation is transport policy. Currently, the basic premises for creating European transport policy, in addition to the importance of economic transport, its role in shaping the quality of life of societies and the impact on the natural environment, also include the integration of member countries. [18]

Transport issues were exposed in all basic normative acts of the European Union, in particular in the Treaty of Rome, the Maastricht Treaty, the Amsterdam Treaty, etc. On their basis, many detailed legal regulations were issued in the form of regulations, directives, decisions, recommendations and opinions. As a member state of the European Union, Poland is also a co-creator and addressee of European transport policy.

According to the adopted transport policy arrangements, by 2030, greenhouse gas emissions should be reduced to 20% in relation to 2008 and 60% of carbon dioxide emissions should be reduced compared to 1990 data. Achievement of this goal should be favored by reducing 2030 by 50% of the number of conventional vehicles in urban transport and their elimination in the perspective of 2050. The implementation of the goal of low-emission transport is to be supported, among others, by implementing solutions provided for in the European Parliament Directive on the development of alternative fuels infrastructure.

Sustainable transport, in order to become competitive against road transport, assumes many solutions that improve the quality of mass transport services. These activities include, among others, improving infrastructure adapted to the needs of urban transport, pedestrians and

people for whom it is difficult to function in urban space. Particular emphasis is placed on the purchase of modern rolling stock or the renewal of the current one, etc. [19-40].

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