ZESZYTY NAUKOWE POLITECHNIKI ŁÓDZKIEJ
Nr 1228 ORGANIZACJA I ZARZĄDZANIE, z. 73 2019

DANIEL JAN KOWALSKI
Faculty of Production Engineering, Warsaw University of Technology

ADAM DEPTA
Department of Management, Lodz University of Technology

SUSTAINABLE DEVELOPMENT IN ELECTROMOBILITY

The article presents the importance of compliance with the principles of sustainable development in the automotive industry. Explains the term electromobility, electromobility development plan and the origin, meaning and principles of the concept of "sustainable development" with an visualisation of its validity on examples. The concept of sustainable mobility is discussed on the example of the BMW Group. The paper also presents the speed of development of the electric car industry in the world since 2011, along with their forecasts for the future.

Keywords: sustainable development, electromobility, electric vehicles.

1. Introduction

The Electromobility Development Plan [26] aims to create appropriate conditions that will contribute to the development of electromobility, the flourishing of industry and services related to this sector in Poland. The potential of the broadly understood market of products and services offered by electromobility is highlighted in numerous forecasts regarding its development [2, 18, 3, 31, 12], because it is a rapidly growing sector of the economy encompassing the local and global market [21]. According to research, it is expected that in 2040 out of 2 billion cars [13] in the world, 500 million cars will be electric cars. In addition, in 2018 about 2 million electric vehicles were sold and in 2040 it is estimated that there will be about 41 million of them [23, 27].

The term electromobility covers complex of issues related to electric cars dedicated for public/mass use (e.g. buses, trams, trolleybuses) and individual (two- and four-track options), such as: technique and exploitation (transport technologies, charging points, equipment infrastructure), economy, environment, law and social issues that occur throughout the entire product life cycle. The depletion of non-renewable raw materials [4] used, inter alia, for the production of energy and fuels (gaseous and liquid) – the ecological aspect (excessive CO_2

gas emissions, noise, water pollution and others) has a negative impact on the environment and human health. These factors force the automotive industry to introduce changes in the drives used, i.e. successive displacement of internal combustion engines by alternative solutions, which will contribute to reducing excessive extraction of non-renewable natural resources and reducing emissions of harmful substances and noise [5, 1, 6, 9]. The use of electrical technology is an impulse to start the transformation of the power and transport sectors in the field of sustainable development.

2. Sustainable development

For the first time, the concept of "sustainable development" appeared at the Environmental Conference in Stockholm in 1972 [23]. Then in 1983, the United Nations established the World Commission on Environment and Development (WCED), also known as the Brundtland Commission, which consisted of more than 20 representatives representing the countries of the North and the South, like among others: Germany, the United States, Japan, Zimbabwe, Guyana, India, its key tasks include [19]:

- matter-of-fact assessment regarding the pace of economic and social development, the state of the natural environment and the selection of real activities to prevent uncontrolled and accidental steps and the correction of past mistakes,
- strengthening international cooperation in the field of natural environmental protection and a significant increase of activities in limiting the disorderly economic development obtained through excessive degradation of the natural environment and the threats that grow with it.

In 1987, the Commission ended its activity with the Our Common Future report published by Oxford University Press, which presented, among others definitions of sustainable development in the following terms: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [29]. In addition, the report was based on three principles such as [19]:

1. The inevitable limited of the rate of economic growth that arises as a result of threats of uncontrolled extraction of depleted natural resources,, especially energy resources, and the resulting from the process negative threats that deepen the destruction of the natural environment.
2. Focusing activities on streamlining and developing technologies that will reduce the consumption of energy sources, which is economically justified.
3. The inevitable equalization of the level and quality of life of residents around the world due to the large disproportion in the standard of living of poor and rich people.

Two issues are important for sustainable development [25]. The first is the observation that economic development alone will not make it possible to solve the problems that affect the world, therefore complementary action of three areas is necessary: economic, social and environmental. Focusing on one aspect only leads to dysfunction of other areas. This is evidenced by a historical mistake noticed by Hans Carl von Carlowitz, who lived at the turn of the 17th and 18th centuries, the creator of the concept of "durability" [22], associated with excessive demand for wood raw material in industry (e.g. for heating furnaces, ore processing, modernization mine) and in military operations (shipbuilding), what led to its deficit, and thus a diametrical increase in prices and bankruptcy of some part recipients. In addition, high profits from the sale of wood and the possibility of obtaining areas for cultivation contributed to the mass grubbing up of forests.

Carlowitz noticed that due to the far-very distant material benefits, an average group of citizens showed a lack of interest in rebuilding the forest and at the same time an increase in interest in arable fields, which enabled them to generate annual profits, which he opposed. "He was of the opinion that the development of trade and processing must serve the common good" according to the view of the "sustainability triangle": "the economy is to create the well-being of society" [22, pp. 10]. The concept of "sustainability" Hans Carl von Carlowitz was taken over and formed the basis for new learning at the beginning of the 19th century at the German Forest Colleges. The remedial actions based on the ideology of "sustainability" slowed down forest degradation and solved the problems of scarcity of this raw material. German forestry has gained worldwide recognition, and as a result this concept has been taken over by scientists from various countries. There was also English translation in the form of Sustained Yield Forestry.

Tab. 1. Key events that influenced the emergence of sustainable development

Year	Science	Policy
1972	Report – limits of growth	Stockholm Environment Conference (Human Environment)
1980		Report World Conservation Strategy – International Union for Conservation of Nature and Natural Resources (IUCN)
1983		Organisation – World Commission on Environment and Development (WCED)
1987		Report Brundtland
1991		Report " Caring for the Earth" IUCN
1992	Report new growth limits	Environmental Conference in Rio
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Source: own study based on Ewa Mazur-Wierzbicka, Koncepcja zrównoważonego rozwoju jako podstawa gospodarowania środowiskiem przyrodniczym, 2005, pp. 36.

In the 1980s, environmentalists became interested in the term "sustainable" and this concept was once again introduced into the political debate [33]. Key events in the area of science and policy that had an impact on the emergence of sustainable development are presented in Table 1.

The second observation is that the character of sustainable development is based on mutual relations and obliges us to cross geographical boundaries as well as institutional actions aimed at coordinating strategies and appropriate decisions [25].

The basic rule for sustainable development is the need to consider the "three pillars": economy, society and the environment. Regardless of the context, the fundamental concept remains unchanged: economic systems, people and the environment are interconnected. Underestimating these interdependencies over the years, taking historical errors as an example, creates the basis for turbulence and crisis. Regardless of the diversity of countries and their economic, social, political and historical roots, the fundamental principles of sustainable development should be respected by all. Undoubtedly, economic development is important, but development alone is not enough, because without knowing and understanding all the factors that affect a better quality of life, poverty will not be solved in a sustainable way. It is worth emphasizing that universally economic development is identified with generally accepted prosperity, better health care, living conditions and other benefits, but hardly anyone is interested: how is this level achieved, who is the main beneficiary and who is excluded and remains far behind.

2.1. Interpretation of sustainable development

The definition of "Sustainable Development" presented earlier in the article belongs to the simple and clear. Analysing literature sources, it turns out that often the essence of the concept of "Sustainable Development" is not understood by the majority of society and part of the scientific community [3]. The adjective "Sustainable" has several translations into the native language, which shows the ambiguity of its dimension. The purpose of the article is not to resolve disputable points regarding the concretization of the concept of sustainable development and translation, therefore no comparisons are presented. In order to organize and understand the concept, reference is made to the basics through examples.

In the literature on the subject, the term "sustainable development" is translated into Polish in many ways, including eco-development, durable development, continuous development, etc. It is reasonable to use the translation of Sustainable Development, because translation as e.g. eco-development, is inappropriate, because "sustainable development" is a broader concept than eco-development. The Brundtland Commission treats the issue of "economic, social, cultural, and environmental development problems as an interdependent and contingent whole,

based in parallel on the belief that man is the subject of sustainable development and has the right to a healthy and productive life in harmony with nature" [15]. The concept in this translation is contained, among others: in the Basic Law – the Polish Constitution art. 5 of 2 IV 1997, which states: "The Republic of Poland (...) ensures environmental protection, guided by the principle of sustainable development" [20] in legal acts in the field of energy law [30], environmental protection [31] in the Sustainable Development Strategy adopted by the European Union in 2001 [7], which was verified in 2006 and communicates that "has enabled the realization of a long-term vision of sustainable development that combines mutually supporting economic growth, social cohesion and environmental protection" [11].

In directional literature, in addition to the multiplicity of translations, the concept of sustainable development can be inspired by a multitude of different definitions. Examples of selected definitions can be found in Table 2.

Tab. 2. Examples of the definition of sustainable development

Definition	Such socio-economic development, in which the process of integrating political, economic and social activities takes place, maintaining natural balance and durability of basic natural processes, in order to guarantee the possibility of satisfying the basic needs of individual communities or citizens of both the modern generation and future generations.	Authorship Environmental Protection Law
	The concept of Sustainable Development should be equated with the continuous development of specific sectoral policies, in particular environmental, economic and social policies. For the rational development of individual sectors, their harmonization or synchronization is necessary. The main segment here is to be environmental protection and the environment, which are some paradigms for economic and social development.	Rosicki 2010, pp. 46
	The essence of sustainable development is the lasting improvement in the quality of life of contemporary and future generations achieved by shaping the right proportions in managing three types of capital: economic, social and natural.	Piontek 2000, pp. 181

Source: based on Pabiś Ł. (2017), Zrównoważony rozwój w kontekście nowych koncepcji zarządzania publicznego: New Public Management i Public Governance (nowego zarządzania publicznego i zarządzania partycypacyjnego), Zeszyty Naukowe Politechniki Częstochowskiej Zarządzanie No 25 t. 2, pp. 10.

The existing situation is caused by the fact that the idea of the concept of sustainable development is given to unceasing analysis, extensions and modifications, as a result of which the concept is not "precisely defined" [24].

2.2. Sustainable development in the BMW Group

"At BMW Group, we believe that sustainability is an investment in our future." [34] This message appears on the BMW Group website, and the noble concept is implemented in a comprehensive manner. The scope of activities covers all company structures, and employees are involved in the implementation of the idea of sustainable development. The company sets long-term goals in selected areas of activity. To be able to implement the assumptions, company consistently perfects his strategies. As evidenced by the efficient use of resources and the gradual reduction of CO_2 emissions levelin the BMW fleet. By 2020, the company intends to reduce carbon dioxide emissions by 50% compared to 1995. Activities have also focused on reducing energy consumption. Currently, more than fifty percent of the energy consumed worldwide by the BMW Group is being sourced from renewable sources. The concept of sustainable mobility was realized by introducing a fully electric car – BMW i3.

2.3. Electromobility in numbers

Interest in electric cars in the world is growing successively. In 2018, the global fleet of electric cars exceeded 5.1 million [16]. The forecasts for 2019 are optimistic, as it expects to register 2.6 million new vehicles of this type [10], which will allow to obtain over 7 million fleet in the world. China is currently the largest electric vehicle market, followed by Europe and the United States. The numbers of electric vehicles detailing the three largest customers together with other countries in 2013-2017 are shown in Figure 1.

In 2013, there were fewer electric vehicles in China than in Europe and the United States. In 2016, the number of electric vehicles in China increased significantly, becoming the largest electric vehicle market in the world. Some forecasts indicate that China will remain a leader with shares oscillating between 57%-70% in 2030 [17]. The intensive development of electromobility in China is caused by the actions of the Chinese government, which stimulates the sale of electric vehicles manufactured in the country by introducing a surcharge for their purchase. Government also introduced restrictions for combustion cars – a ban on moving in the capital on days when smog standards are exceeded. Internal Combustion scooters in many other cities in this country are also covered by the restriction. In Europe, a notable country is Norway, which has the most advanced electric vehicle sales market, as in 2018 over 49% of new cars sold are electric cars.

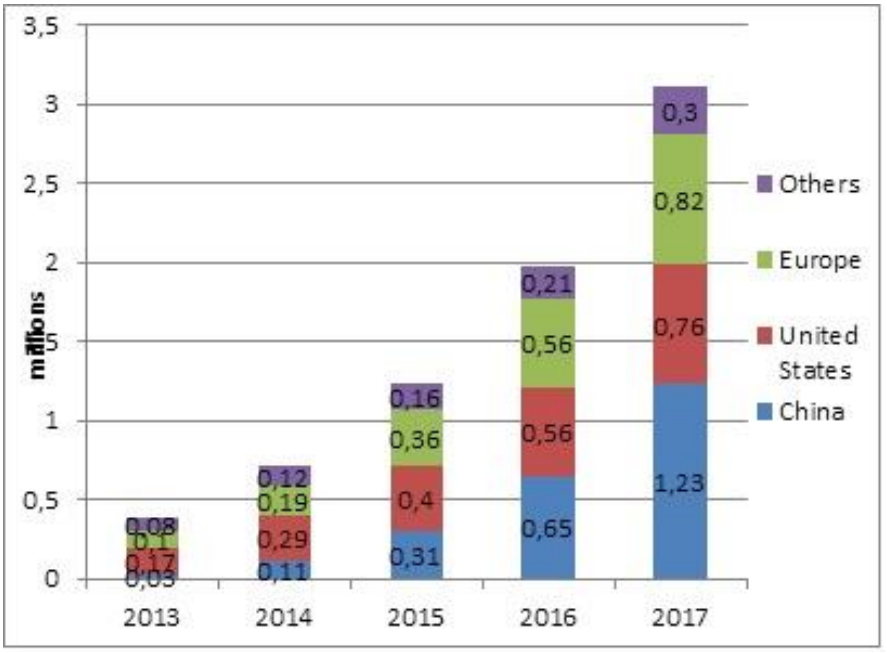

Fig. 1. Number of electric vehicles in 2013-2017
Source: based on Global EV Outlook 2018 www.iea.org/gevo2018/.

The percentage ratio of different types of cars sold in Norway in 2011-2018 is shown in Figure 2.

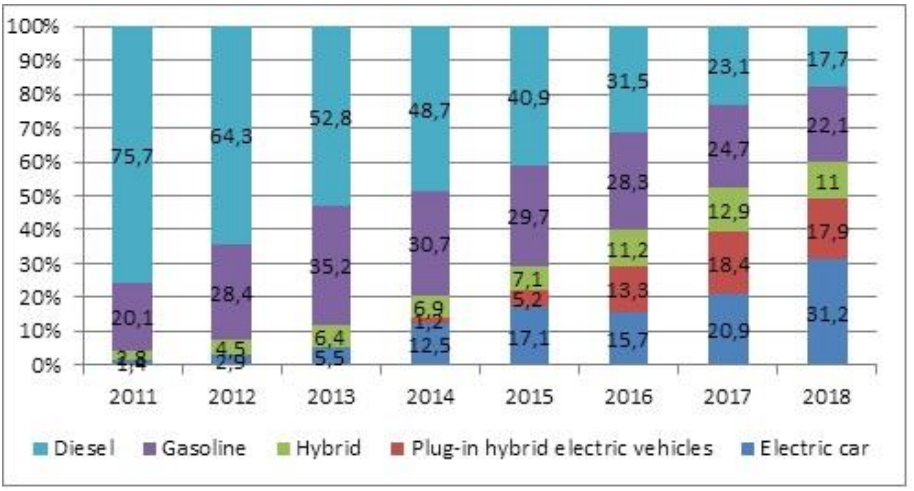

Fig. 2. Percentage of different types of cars sold in Norway in 2011-2018
Source: own study based on Elektromobilność w praktyce (2019), PSP.

In Norway, since 2011, traditional propulsion has been successively replaced by alternative solutions.

Electric vehicles are getting better but some barriers discourage their purchase, i.e. high car prices, relatively short range, long charging time, small number of charging points, etc. Undoubtedly, the situation is changing in favor and development of this branch of industry through, among others subsidizing the purchase of electric vehicles by some countries, such as China, making them cheaper than combustion cars, and by increasing battery capacity and dropping their prices by 85% since 2010. It should be noted that in terms of development, charging infrastructure is also very important. In 2011, 28,000 charging points were recorded worldwideThere are over 500,000, and in Europe over 150,000. Their number is constantly growing.

According to the International Energy Agency, a significant impact on the future development of electromobility has, among others [16]:

- public policy, because it plays a key role in stimulating the sale of electric vehicles, including through economic instruments, standards that allow reducing the cost difference between electric and combustion vehicles, supporting charging infrastructure and introducing standards for fuel consumption and CO_2 emissions, etc.,
- technological progress, which includes significant cost reductions, e.g. decrease in the price of batteries,
- private sector investments in the area of electromobility, e.g. previews of electrifying the car market by leading car companies.

The persistent interest in electric vehicles will lead to a reduction in demand for petroleum products by 127 million tons of oil equivalent (Mtoe) (about 2.5 million barrels per day [mb/d]) in 2030 at the same time, electricity demand will increase to 640 terawatt hours (TWh) or in other forecasts 1110 TWh [16]. In addition, the development of electromobility will increase the demand for new materials in the automotive industry. Cobalt, lithium, manganese production is expected to increase by 2030. The use of materials will depend on the progress of technology.

3. Summary

Electromobility is a rapidly growing branch of the economy. A favourable political environment, technological development and charging infrastructure will benefit and accelerate change. It is important that the changes take place in line with the adopted idea of sustainable development. Compliance with this comprehensive concept will enable "economic growth, social cohesion and environmental protection". It should be noted that the above concept is meet with a wave of criticism and rejection by some, as it is considered illusory, irrational with unlikely

implementation [28]. This position is caused, for example, by apparent reforms, so it is important to emphasize the fact that all actions affect us and our generations.

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ZRÓWNOWAŻONY ROZWÓJ W ELEKTROMOBILNOŚCI

Streszczenie

W artykule przedstawiono znaczenie zgodności z zasadami zrównoważonego rozwoju w branży motoryzacyjnej. Wyjaśniono termin elektromobilność, plan rozwoju elektromobilności i pochodzenie, znaczenie oraz zasady koncepcji „zrównoważonego rozwoju" z wizualizacją jego ważności na przykładach. Koncepcja zrównoważonej mobilności została omówiona na przykładzie grupy BMW. Artykuł przedstawia również szybkość rozwoju branży samochodów elektrycznych na świecie od 2011 roku wraz z ich prognozami na przyszłość.

Słowa kluczowe: zrównoważony rozwój, elektromobilność, pojazdy elektryczne.