Transportation development towards the energy independence and CO2 reduction

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Abstract: This paper describes the results of the research realized in the scope of energy independence and CO2 reduction in the transport sector. The analyses of the research focused on new methods of CO2 reduction and search new methods and technologies of transport biofuels production. Biomass, biofuels and new technologies become a challenge for researchers in the transport sector.

1. Introduction

The transport sector is one of the fastest growing energy demand of the branch of worldwide economy. Transportation is very closely related and associated to oil sector. We can produce electricity from many different fuels but 96% of transportation runs on fuel made from oil [1]. The challenge that faces today from the world of science is finding a solution to increase the independence from oil and to reduce CO2 emission in the transportation. By 2030 heavy-duty vehicles will have become the largest transportation demand segment just like aviation and marine transport which grow significantly. The trend mentioned above is shown at Figure 1.

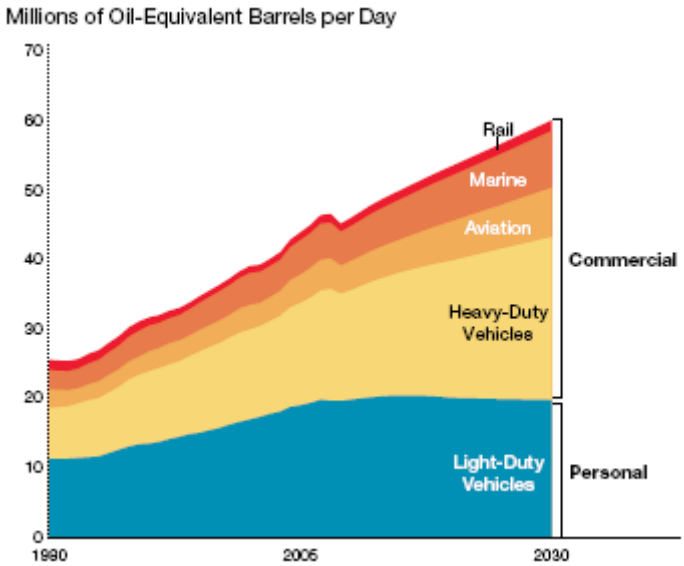

Fig. 1. Global transportation demand by sectors and types

Reducing emission of CO2 is a global priority developed among others at a conference in Kyoto. By 2020, the sectors not covered by the system of emissions trading, such as transport (except aviation, which will be covered by the scheme in 2012), agriculture, waste and households should to reduce their emissions by 10 % compared to 2005 levels [2]. Because different countries are at different stage in their economic development CO2 emission patterns through 2030 vary enormously between OECD and non-OECD country groups.

Growth in CO2 emission will be dominated by China, India and others non-OECD countries while through 2030 and beyond OECD countries will lead more efficient and smaller carbon and oil consumption. There is significant potential for reducing consumption, especially in energy-intensive sectors such as construction, manufacturing, energy conversion and transport [3]. Estimate of CO2 emission is shown at Figure 2.

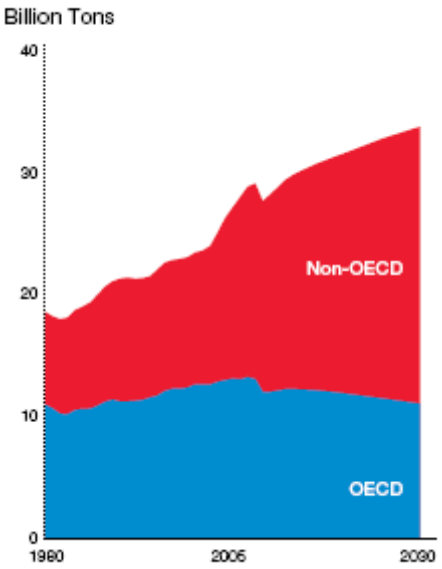

Fig. 2. CO2 emission in OECD and non-OECD countries

The pollution reduction is also important subject of scientific and academic research. The solution is in developing of clean fuels. Clean fuels in the process of complete combustion emit only carbon dioxide and water vapor without any burning residues or emission of black smokes. The clean fuels contain the lowest amounts of aromatics, either as single or multiple benzene rings, beside the minimum traces of sulphur and nitrogen compounds. Clean gasolines are free from alkylated lead compounds, which are used to achieve the requested octane numbers. [4] The research realized under grant of Ministry of Science and Higher Education in Poland focused on new methods of CO2 reduction and search new methods and technologies of transport biofuels production. Interest in environmental protection had already begun in the 70s of the previous century, after the first energy crisis and the development of the Environmental Report for the Elite Club of Rome. At the beginning of last decade, in 2001 and 2003 two important directive promoting the use of renewable energy sources for use in electricity, 2001/77/EC [5] and Directive 2003/30/EC [6] - latter concerned the promotion of transport bio-fuels were developed and implemented. Unfortunately not met indicative targets set in Directive 2003/30/EC, as it was not mandatory and there were many barriers to the development of biofuel sectors. Therefore, instead of 5.75% biofuels in transport by 2010 achieved rate was 4.8% in terms of energy. Taking into account the experience gained from previous implementations of the Directive 2003/30/EC, and as a result of growing environmental awareness of the EU Directive 2009/28/EC [7] was (and related directives) to promote the use of renewable energy. According to this directive, Poland adopted a mandatory duty not less than 15% share of renewables in total final energy use by 2020. Special attention was paid to the transport sector, for which in 2020 set the objective indicator of 10% share of renewable energy (in energy terms) in total transport fuels used. Transport is one of the branches of the EU economy, in which CO2 emissions are increasing at a rapid

pace. Also in the Polish case, the transport sector, especially road transport requires, has special efforts because of the growing greenhouse gas emissions. The Directive imposes the recognition of the implementation of compulsory targets for biofuel to meet the strict criteria for sustainable production and a correspondingly high rate of emissions reduction, which mainly affects the emission of CO2. This means that the target of 10% biofuels share in transport fuel market should be made only in a sustainable manner, i.e. without the negative social and environmental consequences. Establishing criteria for sustainable production means, therefore, that the quality rather than quantity will be put at first place in pursuit of this goal. This opens up a wide scope for innovation in improving the quality of biofuel. The second indicator, the reduction of C02 emissions, is an indicator which is changing dynamically over time. Requirements (described in the Directive 2009/28/EC) in this field are increasing as follows:

1. after the 1st quarter of 2013 r, the reduction of CO2 emissions should not be less than 35%
2. after 2016, reducing CO2 emissions should not be less than 50%
3. after 2017, reducing CO2 emissions should not be less than 60%.

These indicators are difficult to achieve by Polish producers of transport biofuels. For example, bioethanol produced in the 2-phase system (agricultural distillery-transport-company-transport-dehydrating plant blending) has reduced CO2 emissions of just about 20%. In the case of advanced biofuel production plants to reduce CO2 emissions 1. generation reaches 50%. It can be concluded that all 1. generation transport biofuels, to which Poland has a substantial production capacity (in most modern, created after 2004) after 2016, will not meet the requirements of the Directive 2009/28/EC. It should take steps to improve this disadvantage after analyzing the existing facilities, possibly to work to build 2.generacji biofuels (high CO2 emission reduction), or produced from different waste materials. If we do not adapt production capacity to the requirements of Directive 2009/28/EC we will bear concrete, measurable impact, reducing revenues to the firms, capacity utilization, reduce agricultural production in the sectors of transport biofuels, and the whole country (and limited tax revenue to the state budget, the penalty Directive 2009/28/EC for failure and derivatives).

2. Methodology

The methods of this research were the qualitative research and experimental research. Qualitative research methods was used primarily as the prelude to quantitative research. This method was used to define the problem, generate hypotheses, identify determinants, and develop quantitative research designs in the next step of research. Desk research method was involved to gather data that already exists either from internal sources of the enterprises, publications of governmental and non-governmental institutions, from free access data on the internet, in professional newspapers and magazines, in annual reports of companies and commercial databases [8]. In order to determine the technical condition and the degree of engine wear the research experiment was conducted . Conditions of active experiment allow you to control the value changes in the set of excitations in a very wide control limits is often difficult to achieve in reality, or even impossible to achieve. Experiment allows for comprehensive research and obtaining as much information about the behavior of an object as well as the controlled modification of parameters of the test system. To accomplish this method of testing was necessary to develop and build a laboratory bench. The concept of the test station was based on the use of the injection system Common Rail diesel engine used in the OM611 produced by Daimler-Chrysler. The material of the injection was a rapeseed oil as biofuel give lower emissions of toxic compounds [9].

3. Discussion

We can achieve sizeable benefits by working with environmental issues in a systematic, cohesive and organized way. There is no one single solution if it comes to cutting carbon dioxide emissions in an effective way. Rather, it's all about a range of measures. It is necessary to optimize every link the chain – every little bit counts and every single detail is important. One of the way to reduce CO2 is using engines with higher level of effectiveness and vehicles with higher degree of efficiency to carry the goods. The new generation of engines is characterized by, among others, mature motor control of ancillary units, a new generation of electronic power steering, engine off system when not needed to operate, and Brake Energy Regeneration system. Design strategy was to get more power with less weight and lower fuel consumption. All together also provides a lower exhaust emissions. The diesel engine of heavy commercial vehicles is the most energy efficient engine for the transport of goods. For example: based on the scientific facts that for every litre of diesel fuel that is burned, roughly 2,5kg of CO2 are produced, a fully loaded truck (40 tonnes) using 32 litres of fuel per 100km produces roughly 80kg of CO2. To compare car and vehicles transport we can notice that: if a car would have to carry 40 tonnes with a fuel efficiency of 8 litres per 100km and its normal weight of 1,5 tonnes, the car would produce over half a tonne of CO2, or six times more than a heavy commercial vehicle.

4. Results

Already recognized as a reference in the development of advanced petrol and diesel engines, the group of researchers at SGGW (Warsaw University of Life Sciences) has introduced key technological innovations (e.g. common rail), along with the associated systems to control pollutant emissions. The project concerned the study of combustion of rapeseed oil and its mixtures with additives in a test chamber with variable parameters of air and fuel supply

Fig. 3. Common Rail Research Station -Laboratory at Warsaw University of Life Sciences

The objective of the research: to cut fuel consumption and protect the environment by reducing CO2 emission were achieved. Advantages: better fuel economy, lower fuel consumption, low emissions, engine is softer, lower noise level compared to traditional solutions, ease of obtaining high performance engine. Drawbacks of the system: system requires high-quality diesel fuel as a small contamination can cause damage to the injectors working under great pressure, high prices for parts in case of failure.

5. Conclusion

Potential future source of energy used in transport is electricity, biofuels, synthetic fuels, methane (natural gas) and, as a supplement – liquid LPG. Road transport over short distances should be covered by electricity; at medium distances by eg methane, in the case of long routes the best will be biofuels or LPG.

Reducing CO2 emissions in the transport sector is a priority in the European Union. In order to facilitate the measurement of emissions, the European manufacturers of commercial vehicles have developed a calculator that allows to determine the level of actual CO2 emission of trucks and buses before they would be purchased. Market realities play a key role in reducing CO2 emissions in road transport, so accurate tool will soon assist potential buyers in the decision to choose energy-efficient vehicle, with optimal parameters tailored to the specific area of transport. Emissions in the individual utility cars (trucks, LCV, buses) is varied and depends on primarily on the total weight of the vehicle, its shape and the type of carriage performed. Therefore - in contrast to passenger cars - we can not determine the average CO2 emissions for a single commercial vehicle. The method used in the calculator is a computer simulation carried out based on actual tests, using trucks and buses nearly all categories, ranging from city buses and garbage trucks through vehicles, a vehicle for ending long-distance transport. Each car emits different value of CO2.
Biomass could offer near-term business advantages and more strategic, long-term value. The benefits obtained from biomass power generation, such as waste reduction, emissions offsets, and local economic growth, can enhance the technology's overall appeal to utilities. The future of biomass electricity and energy generation depends also on biomass integrated research which offers high energy conversion efficiencies and will be further developed to run on biomass produced fuels.

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