

Ecodriving, that is how to combine ecology and economy

Many persons associate ecodriving (because of the name) with the combination of two issues – ecology and driving. A missing Polish equivalent of this term induces to use this term frequently, and sometimes to abuse it. 'Ekojazda', 'ekokierowca' (ecotravel, ecodriver) are the names, which could replace the use of English version, while the definition itself is much broader and more complicated. Generally, this is the idea and philosophy of the entire vehicle use technique. Ecodriving originated at the end of 1990s in Germany and in Scandinavian countries. Its introduction was intended primarily to respect economical and safe driving, and to achieve the situation of smoother traffic in cities. Ecodriving is also considered a less stressing method for drivers teaching. It minimises the risk of accidents with respect to other traffic participants. These assumptions best affect individual drivers, which was reflected for example in generally available publications (like 'How to drive economically' by Aleksander Sowa, in Polish).

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Ecodriving was advertised automatically to a large extent, primarily as a response to the growing fuel price. Starting from 2000 the ecodriving was more and more often presented in the automotive media and newspapers as an opportunity to reduce the operating cost. The entire technique boils down to savings not only of fuel, but also of the vehicle consumables. Broad studies on the effective use of fuels and differences in the ecodriving application for normal driving can be found in many scientific papers, e.g. [1].

Ecodriving is used now increasingly often not only by individuals, which is caused by a dynamically changing fuel prices (many drivers starts appreciating the ecodriving as a form of fuel saving), but also by enterprises having a large fleet of vehicles. The transport costs, related to the amount

of used fuel, are 40% of company expenditures [2]. Therefore even small fuel savings at a large fleet of vehicles give great benefits to the entire sector.

In the case of ecodriving the growing social awareness in the field of ecology and of respect for the environment is an important issue. People talk more and more about the use of alternative energy sources and the possibility to use them every day [3]. In addition, increasingly more restrictive exhaust gas emission standards make that an individual customer, when buying a vehicle, starts paying attention not only to the price, but also to the fuel saving and to the air pollution. The situation, in which one of car manufacturers manipulated exhaust results in certain of its engines, to be treated as more 'ecological' according to standards, was a good example, having a strong response in the media. Perhaps a few decades ago the consumers

► Streszczenie

W niniejszym artykule zaprezentowano ogólny przegląd literatury z zakresu *ecodrivingu*. Zaprezentowano ogólne sformułowania związane z tą tematyką oraz jej historię i cele. Artykuł ten ma również charakter zapoznawczy i wprowadzający do tematyki ekorejzdy oraz podsumowujący najnowsze osiągnięcia w dziedzinie ekologicznych technologii. Tekst ten ma swoje odniesienie również do logistyki i transportu zbiorowego. Przyjęto założenie, iż *ecodriving* zmniejszył koszty użytkowania pojazdów, co poskutkowało lepszą organizacją i optymalizacją procesów transportowych. Zaprezentowano również ogólną historię wprowadzenia norm emisji spalin EURO.

► **Słowa kluczowe:** *ecodriving*, normy EURO, Komisja Europejska

► Summary

Ecodriving, that is how to combine ecology and economy

This paper presents a general review of literature on *ecodriving*. General expressions related to the issue as well as its history and objectives have been presented. The paper is also intended to educate and introduce to the *ecodriving* issue, and to summarise the most recent achievements in the field of ecological technologies. The text refers also to the logistics and public transport. An assumption was made that the *ecodriving* has reduced the costs of vehicles use, which resulted in better organisation and optimisation of transport processes. Also a general history of exhaust gas emission EURO standards introduction has been presented.

► **Keywords:** *ecodriving*, EURO standards, European Commission



Photo MB

would not be so interested in this matter, as today. Because of that the public pressure on the manufacturers results in extensive design changes in vehicle drive systems.

Ecodriving may be presented as a circular connection of four factors (Fig. 1).

Benefits of ecodriving

The main idea of ecodriving is the saving, and hence respect for energy. We can distinguish the saving of:

- time – because as a result of certain driving principles application it is possible to achieve a smooth traffic and a greater road capacity,
- energy – reduction of the consumed fuel amount (from 15% to 25%),
- service cost – because of the ecodriving a vehicle user less frequently replaces tyres as well as brake blocks and discs.

Because of the savings, primarily of the consumed fuel, the demand for it on a global scale goes down. Through such actions we move to the second benefit, which is a lower exhaust gas emission. In most general terms, the reduction of exhaust gas emission results in the improvement to the quality of people life, first of all in places highly technologically developed. Recently papers have been published, which contain a simulation of the transport environmental impact study [4].

The savings and the exhaust gas emission reduction result also in a lower stress and tiredness of road

Ecodriving starts being appreciated not only by individual drivers, but also by companies having a large fleet of vehicles as a form of fuel saving Photo: Siemianowice Śląskie Śląska street

users. Ecodriving affects not only drivers by the traffic calming, teaching them to anticipate certain phenomena on the road, but also other traffic participants. Safety of pedestrians or bicycle riders can

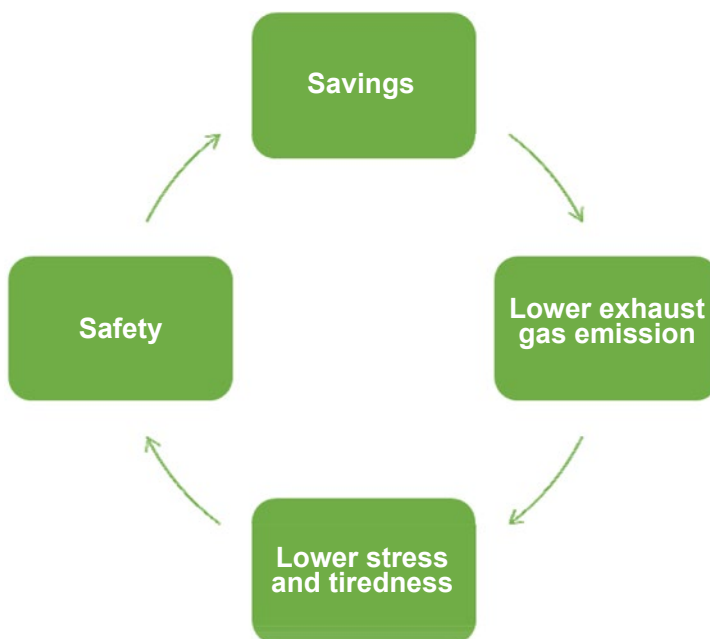


Fig. 1. Circle of benefits in ecodriving. Source: own study based on [http://www.ecodriver.pl/korzysci]



The basic document, referring to the ecodriving, is the ‘White Paper on Transport’. It was approved by the European Commission in 1992, while in 2011 the ‘Transport 2050’ strategy was additionally implemented under its framework, hence a subtitle ‘Towards a competitive and resource efficient transport system’ appeared in the paper. This quote does not refer directly to ecodriving, while one of its goals: ‘Halve the use of ‘conventionally-fuelled’ cars in urban transport by 2030; phase them out in cities by 2050; achieve essentially CO2-free city logistics in major urban centres by 2030’ is already a reference to ecologically oriented solutions within ecodriving.

be such an example. Ecodriving is intended to teach drivers to use vehicles skilfully and to use their driving support systems.

The benefits circle closes at the moment of moving from the safety aspect to the savings aspect, and in more detail – to total cost aspect. The reduction of road accidents number or avoiding destruction of goods caused by non-skilful driving results in greater savings in a company, but also in the national and global economy.

European documents and standards

Ecodriving was assumed, apart from the operating costs cutting, to improve the situation related to the deteriorating condition of the natural environment. The development of this philosophy was linked in time with signing the ‘Kyoto Protocol’ in 1997, which supplements the ‘United Nations Framework Convention on Climate Change’. Ecodriving was to become an indirect instrument, reducing the greenhouse gas emission.

The first actions aimed at this idea dissemination occurred in 2001 by the ‘Ecodriving-Europe’ programme initiated by the European Commis-

sion. Poland participated only in the next project, ‘Ecodriven’ in 2006. ‘Ecowill’ was the last completed project – it comprised 13 countries, including Poland.

The implementation of the ‘Kyoto Protocol’ and later changes in the European Union legislation forced the manufacturers to apply another technology, in terms of exhaust gas emission, at the engines development. The introduction in 1993 of exhaust gas emission standards, so-called EURO standards, was the most important factor resulting in those changes.

EURO standards are standards for permissible exhaust gas emission for brand new vehicles, which are sold by car dealers throughout the European Union. They originated as the ‘European Directives’ series and under the next amendments become more and more restrictive for the manufacturers. They apply to the emission of the following substances: nitrogen oxides (NO_x), hydrocarbons (HC), carbon oxides (CO) and particulate matter (PM). They were regulated for lorries, cars, trains, tractors, and also for agricultural machinery and barges. Instead, they do not apply to ships and aircraft. For those vehicles standards are different and have other values. Their control takes place via the technical inspection at the moment of engine starting and its standard operation. However, the legislation is not retroactive, therefore the standards adopted after the date of manufacture do not apply to vehicles that are already in use.

Manufacturer’s non-compliance with those requirements results in the ban of selling a specific make in the EU area.

Now there are six types of standards, and the most recent of them was introduced in 2014 and applies to heavy motor vehicles. This is the EURO 6 standard. Directive EEV existed between EURO 5 and EURO 6 standards, which was not perceived as officially as the EURO standards. Table 1 (bold characters) gives an example of permissible exhaust gas emission values in individual EURO standards for vehicles with petrol and diesel engines, the EEV directive was omitted.

Ecodriving and drivers skills

Ecodriving is aimed at the reduction of energy consumption by the application of a set of regulations based on the laws of physics, which should allow a reduced demand for power. These regula-

[g/km]	EURO 1	EURO 2	EURO 3	EURO 4	EURO 5	EURO 6
	2,72/ 3,16	2,2/1	2,3/ 0,64	1/ 0,5	1/ 0,5	1/ 0,5
HC	-	-/ 0,15	0,2/ 0,06	0,1/ 0,05	0,1/ 0,05	0,1/ 0,09
NOx	-	-/ 0,55	0,15/ 0,5	0,08/ 0,25	0,06/ 0,18	0,06/ 0,08
HC+ NOx	0,97/ 1,13	0,5/ 0,7	-/ 0,56	-/ 0,3	-/ 0,23	-/ 0,17
PM	-/ 0,14	-/ 0,08	-/ 0,05	-/ 0,009	0,005/ 0,005	0,005/ 0,005

Table 1. Permissible exhaust gas emission values in individual EURO standards for vehicles with petrol and diesel engines. Source: NGK.de

tions do not require a technological support, but cooperation with drivers. The problem is, that an ecological driving is a quite complicated task, in which many factors interact, such as safety, speed adaptation etc. The determination, which factors affect the energy consumption is one of main issues related to the ecodriving systems. Ericsson [5] shows that to save fuel it is necessary to avoid sudden accelerations and high driving speeds. Johansson [6] suggests non-violent braking, as seldom as possible use the first and second gear and increasing the top gear use. Instead, Kuhler [7] defined in his paper a set of nine variables, affecting the energy consumption and the pollutants emission to the air. The fact, that most ecodriving suggestions do not take into account the environmental aspect, is their drawback. It is necessary to emphasise here, that 90% of CO pollution originate just from the road traffic [8]. The adaptation of the ITS network to the V2V communication, to optimise various processes in V2V systems, to exchange the information about the road conditions, is an additional objective that should be set by engineers, apart from the construction of more and more economical vehicles [9]. Because just the information transfer becomes key not only in the logistic sector. In addition, new ideas originate, to connect the vehicle on-board equipment with the newly constructed ITS networks, to make the information transfer even more efficient [10].

Exhaust gas free cities

The basic document, referring to the ecodriving, is the 'White Paper on Transport'. It was approved by the European Commission in 1992, while in 2011 the 'Transport 2050' strategy was additionally implemented under its framework, hence a subtitle 'Towards a competitive and resource efficient transport system' appeared in the paper. This quote does not refer directly to ecodriving, while one of its goals: 'Halve the use of 'conventionally-fuelled' cars in urban transport by 2030; phase them out in cities by 2050; achieve essentially CO₂-free city logistics in major urban centres by 2030' is already a reference to ecologically oriented solutions within ecodriving.

Ecodriving, started by the Scandinavian countries in the past decades, has now developed and rooted in the conscience of increasingly large group of road users. Ecodriving is related to the logistics via transport, and more precisely – via a transport service. Owing to solutions in the field of ecodriving, it is possible to directly reduce the transport costs. The development of ecodriving concept in transport companies and a change of regulations related to the exhaust gas emission standards by new vehicles started a new road toward more economical and ecological vehicles. Because of a transport policy change in the field of sustainable transport and ecological transport it is possible to state that the ecodriving issues are a must in the logistic sector.

Summary

The importance of ecodriving permanently grows, which is proven by using it as a significant component of transport processes cost cutting. Principles defining the style of driving enable not only the savings of consumed fuel, but also result in the consumables life extension, such as friction shoes, tyres, and even operational liquids. So it is possible to state that ecodriving is a significant source of operating costs cutting for a fleet of vehicles. In addition, there are studies confirming the influence on the improvement to the safety in transport and the reduction of the transport congestion as a result of 'smooth' driving. As a result of the reduction of fuel consumption and of harmful combustion products emission the ecodriving results also in a reduced environmental impact. ■



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Bibliography

1. Kamal; Mukai; Murata; Kawabe: *On Board Ecodriving System for Varying Road Traffic Environments Using Model Predictive Control* 2010.
2. *5 konkretnych zalet eco drivingu*, „Transport i Spedycja”, wyd 6 (46), grudzień 2015 – styczeń 2016.
3. Knez M., Sternad M., *Solar energised transport solution and customer preferences and opinions about alternative fuel vehicle- the case of Slovenia*, „Transport Problems”, vol. 10, issue 3, Gliwice 2015.
4. Łatuszyńska M., Strulak-Wójcikiewicz R.: *Computer simulation of transport impact on environment*, „Transport Problems”, vol. 9, Issue 1, Gliwice 2014.
5. Eriksson E., *Independent driving pattern factors and their influence on fuel-use and exhaust emission factors*, „Transportation Research Part D: Transport” Elsevier 2001, 325-345J.
6. Johansson H., Gustafsson P., Henke M., Rosengren M., *Impact of EcoDriving on emissions. International Scientific Symposium on Transport and Air Pollution*, Avignon 2003.
7. Kuhler M., Kartens D., *Improved driving cycle for testing automotive exhaust emissions*. SAE Technical Paper Series 780650, 1978.
8. Nagurney A., *Congested urban transportation networks and emission paradoxes*, „Transportation Research Part D: Transport and Environment”, vol. 5, 2000, nr 2, p. 145-151.
9. Xiuzheng Z., Ligu Z., *Ecodriving for Reduction of Bus Transit Emission with Vehicle's Hybrid Dynamic Model*, 2015.
10. Kulik A., Dergachov K., Firosov S., Kharina N., *Development of technical solutions for realization of Intelligent Transport Systems*. „Transport Problems”, vol. 8, issue 1, Gliwice 2013.