Strategies Regarding Development of Road Transport to Diminish Fuel Consumptions and Environmental Impacts

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Abstract: This research paper presents an overview of strategies focused on emission controlling related to motor vehicles and road traffic. Transport sector produces a variety of emissions, some of them being a direct greenhouse gas effect (mainly CO₂) others, as, NOₓ, VOC, CO, and O₃ having an indirect influence on warming, and particulates (PM). A part of these components have a warming effect, others have a cooling effect that need a careful analysis. As the lifetime of emission components differs, so does their impact on warming and cooling. The greenhouse gas emissions from transport is expected to rise to between 30 and 50%, by 2050 (today it is around 20-25%) and the radiative forcing is expected to increase.

The mobility of tomorrow will be more efficient: environment-friendly, quieter, safer and it will use clean resources.

Effective road transport scenarios must meet multiple objectives referring to motor vehicle and road traffic, such as:

- Reduction of CO₂ emissions in order to diminish the impact on climate changes;
- Drastic reduction of chemical pollutants and noise emissions;
- Preservation or increase of power train’s energetic parameters;
- Providing security of fuel supply;
- Developing an effective sustainable mobility policy.

The options for achieving long-term (2050) CO₂ emission reductions of 65 to 95% in the transport sector are: fuel CO₂ efficiency; vehicle efficiency; driving efficiency; traveled distance.

Reviewing long-term climate targets, passenger cars and light vehicles’ emission reduction of up to 95%, the analysis on fuels becomes very prominent. New fuels should be very low-carbon or zero-carbon fuels, meaning that well-to-tank CO₂ emissions are very limited. Thus, a substantial part of the climate mitigation challenge is shifted towards the energy production and refinery sectors.

Some scenarios of long-term development show combinations of vehicle types and fuel types, as:

- BEVs in combination with electricity obtained from (1) fossil fuel with carbon capture and storage (CCS) and (2) biomass, solar, wind, hydro, nuclear and others;
- FCEVs in combination with hydrogen from (1) fossil fuel with CCS and (2) biomass, solar, wind, hydro, nuclear and others;
- ICEV’s hybrids in combination with advanced biofuels.

Heavy-duty vehicles can be divided into long-haul trucks, distribution trucks and buses. CO₂ emission reductions of 65 to 95% can be achieved by fuel efficiency; vehicle efficiency, driving efficiency and traveled distance.

The options for medium term (2020) for decreasing of the net greenhouse gas emissions (CO₂) can be obtained by using active technologies determined by the decreasing of fuel consumption or by changing the fuel’s nature and characteristics. Biofuels constitute a central pillar of sustainable mobility. They have the advantage of not requiring essentially new engines or a new infrastructure, since they can be added to fossil fuels in a controlled form. They can be obtained by using alternative fuels. Such alternative fuels can be: methane (NGV); LPG; biofuels as methyl or ethyl esters (biodiesels), biogases (digester gas, wood gas, gas from biomass gasification, ...), alcohols from biomass (methanol, ethanol, ...), vegetable oils, animal fats, etc., or even hydrogen.

Key-Words: environment, engine, pollution, emission, modelling, optimisation, noise, traffic flows
1. Introduction

European urban areas face a number of major environmental challenges that scale and intensity can vary, thus, in this case, a common set of issues can be identified. They are related to poor air quality, traffic volumes and congestion, high levels of ambient noise, lack of recreational areas, high level of greenhouse gas emissions or other factors of this kind. These environmental challenges constitute a major problem and have significant impacts on human health, environment and economic performance. Likewise, it is generally agreed that transport is one of the major contributors to pollution of the atmosphere.

The large majority of European citizens live in an urban environment and this urban mobility accounts for 40% of all CO₂ emissions of road transport and up to 70% of other pollutants caused by transport. The emission increasing was observed for both categories: passenger transport and freight transport. The values of this phenomenon are mainly due to an ever growing transport demands, characterised by large increases in passenger kilometres and tonne kilometres. As for the passenger road transport, a relative decrease in the use of public transport is also noteworthy. Even the high level of efficiency on the passenger cars has not been sufficient to counteract this trend. As for the freight road transport, an increased share of road freight transport as opposed to other transport modes supplements the increased transport demand for goods. Therefore, the modal shift can lead to a wrong direction.

In March 2007, the EU’s leaders endorsed an integrated approach on climate and energy policy that aimed to combat climate change and increased the EU’s energy security while strengthening its competitiveness.

In the category of greenhouse gases (GHG), the biggest natural greenhouse gas is water vapor (around 0.4% of the atmosphere), and alone, it is responsible for around 60% of the reflection of radiation from the atmosphere on the Earth.

Water vapor emissions originating in evaporation from the ground and transpiration from plants can be increased under the effect of climate warming but without a significant contribution to the greenhouse effect because these phenomena are localized in the lower levels of the atmosphere. Also, other gases naturally present in atmosphere, representing less than 0.1% of the atmosphere, contribute to the greenhouse effect. In this 0.1%, particularly active gases can be found: carbon dioxide (CO₂) weighs in at 25%, ozone (O₃) at 8%, methane (CH₄) and nitrous oxide (N₂O) 6%. In this category, fluorinated gases of industrial origin (PFC, HFC and SF₆ formulae) also can be included.

Anthropogenic greenhouse gases (those due to human activity) amplify the natural greenhouse effect.

The greenhouse gas, the most commonly produced by human activities, is carbon dioxide (CO₂). It is responsible for 63% of the global warming caused by human activities.

The primary greenhouse gases produced by the transportation sector are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and hydrofluorocarbons (HFC).

Carbon dioxide, a product of fossil fuel (coal, oil and gas) combustion, Nitrous oxide is formed in the engine during combustion process, hydrofluorocarbons originate from air conditioning and refrigeration systems used in car, bus, truck, and rail.

The CO₂ emissions from transport, can be measured precisely by multiplying the quantity of fossil fuel used by the corresponding emission factor (example: 2.9 for gasoline, 3.0 for kerosene, or 3.1 for diesel fuel).[1-5]

The scientists appreciate that the atmospheric lifetimes are estimated to be: for CO₂ 50-200 years, for CH₄ 9-15 years, and for N₂O 120 years.

Road transport contributes about one-fifth of the EU’s total emissions of carbon dioxide (CO₂), the main greenhouse gas. CO₂ emissions from road transport increased by nearly 23% between 1990 and 2010, and without the economic downturn growth could have been even bigger. Transport is the only major sector in the EU where greenhouse gas emissions are still rising. Light-duty vehicles - cars and vans - are a major source of greenhouse gas emissions, producing around 15% of the EU’s emissions of CO₂.

The EU has adopted the European Strategic Energy Technology Plan (SET-Plan) having two major timelines:

- The first line is due to 2020: the SET-Plan provides a framework to accelerate the development and deployment of cost-effective low carbon technologies. With such strategies, the EU is on track to reach its 20-20-20 goals of a 20% reduction of CO₂ emissions, a 20% share of energy from low-carbon energy sources and 20% reduction in the use of primary energy as results of improving the energy efficiency.

- The second line is due in 2050: the SET-Plan provides a limitation of climate change to a global temperature rise of no more than 2°C, in order to reduce EU greenhouse gas emissions by 80-95%.

For the transportation sector, the SET-Plan targeting to accelerate the development and the use at large
scale of the low carbon technologies will have influences upon the current R & D activities and achievements in Europe. The SET-plan proposes a new innovation model based on a collective approach to be applied to research, development and demonstration planning and implementation in the EU countries.[12]

The transport sector has the second biggest greenhouse gas emissions in the EU, after energy. More than two thirds of transport-related greenhouse gas emissions derive from the road transport.

In other sectors, greenhouse gas emissions decreased by 15% between 1990 and 2007, while the emissions from transport increased by 36% during the same period. Despite the improved vehicle efficiency, this increase occurred because the amount of personal and freight transport had increased. From the EU’s total emissions of carbon dioxide (CO₂) road transport contributes with about one-fifth.

One of the main priorities in EU climate change policy is the reduction of CO₂ emissions on new road vehicles.

<table>
<thead>
<tr>
<th>Vehicle categories</th>
<th>Year 2015</th>
<th>Year 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO₂ [g/km]</td>
<td>Fuel [l/100 km]</td>
</tr>
<tr>
<td>Car LDV</td>
<td>130</td>
<td>5,6</td>
</tr>
<tr>
<td>Van</td>
<td>175</td>
<td>7,5</td>
</tr>
</tbody>
</table>

Table 1 The target for CO₂ emission and fuel consumption

As for cars, manufacturers are obliged to ensure that their new car fleet should not emit more than an average of 130 grams of CO₂ per kilometre (g CO₂/Km) by 2015 and 95g by 2020. This is compared with an average of almost 160g in 2007 and 135.7g in 2011.

To limit average CO₂ emissions on new passenger cars sold in the EU to 120g/km by 2012 is one of the major goals. The Commission will assess the feasibility of the target suggested by the European Parliament of reaching 70 g CO₂/km by 2025.

In May 2011, the EU adopted the legislation to reduce emissions from vans (‘light commercial vehicles’), similar to that implemented for passenger cars in 2009. The Vans Regulation will cut emissions from vans to an average of 175 grams of CO₂ per kilometer by 2017 – including a phase of reduction in 2014 - and to 147g CO₂/km by 2020. These cuts represent reductions of 14% and 28% respectively compared with the 2007 average of 203 g/km.

The EU fleet average of 175 g/km will pass through several phases between 2014 and 2017. In 2014, an average of 70% of each manufacturer's newly registered vans should comply with the limit value curve set imposed by legislation. This proportion will rise to 75% in 2015, 80% in 2016, and 100% in 2017 and in the future.

Trucks and buses as heavy-duty vehicles (HDV), are responsible for about a 25% of CO₂ emissions from road transport in the EU and for a value around 6% of total EU emissions. Despite some improvements in fuel consumption efficiency in recent years, HDV emissions are still rising, mainly caused by the increasing road freight traffic. The EU’s future strategy meant to decrease HDV fuel consumption and CO₂ emissions provides a number of actions to be considered, such as:

- Improving vehicle efficiency using new engines, materials and design;
- Using cleaner energy through new fuels and power train systems;
- Improving mobility by better use of infrastructure networks and more efficient fleet operation, being supported by information and communication systems.

Significant CO₂ savings are expected from a new approach of charging of the road network for heavy vehicles.

The second element takes into consideration the consumers’ needs, as they are determined to have the choice among the most fuel-efficient cars, EU legislation requires mandatory labelling and provision of consumer information at the point of sale about each car’s fuel economy and CO₂ emissions.

The third element of this strategy is the fiscal one. The European Commission has proposed a legislation requiring the Member States to apply car registration taxes and/or circulation taxes to be related of at least 50% of the tax to the level of a vehicle’s CO₂ emissions.

Research and development

A strong program of interdisciplinary research and technology development can advance the effectiveness of the transportation sector in addressing climate change. This research includes both fuels and vehicles.

The studies present, in general, four strategies to reduce transportation GHG and pollutant emissions:

- Introducing low-carbon fuels;
• Improving vehicle fuel economy;
• Increasing transportation system efficiency and
• Diminishing carbon-intensive travel activity.

2. Introducing Low-Carbon Fuels
Fuel quality is an important factor in reducing greenhouse gas emissions caused by transport. It ensures that air pollutant emissions from vehicles be optimally reduced; a single fuel market is established; and vehicles operate correctly everywhere in the EU. The European legislation requires a reduction of the greenhouse gas intensity of the fuels used in vehicles by up to 10% by 2020 – according to the Low Carbon Fuel Standard.[10, 11]

Using biofuels derived from agricultural crops absorbing carbon during their growing process, can help to reduce CO₂ emissions from transport by substituting conventional fossil fuels. Consequently, the EU’s SET-plan set itself an indicative target of achieving a 5.75% share for biofuels in the petrol and diesel market by 2010. Thus, most Member States have introduced fuel tax exemptions in favour of biofuels.

Using biofuels should take into account the following facts:
• the greenhouse gas emissions must be at least 35% lower compared to the use of the fossil fuel. From 2017, the increase need be up to 50% and from 2018 the saving must be at least 60%;
• the raw materials for the biofuels cannot be sourced from land with high biodiversity or high carbon stock.[20]

Fluorinated industrial gases have a global warming effect being of hundreds or even thousands times greater than that of CO₂. Under these circumstances, the EU takes measures confronting the ever-growing problem of leakage of fluorinated gases from the air conditioning systems of cars and other road vehicles.

Low-carbon fuel strategies include the development and introduction of alternative fuels that have lower carbon content and generate fewer transportation GHG emissions. The alternative fuels include ethanol, biodiesel, natural gas, liquefied petroleum gas, synthetic fuels, hydrogen, and electricity. Alternative fuels strategies have primarily been investigated and quantified for the light-duty vehicle (LDV), although some advances could potentially be applied to other vehicles as well.

For the industrial sector, the main technological objective under SET – Plan is to bring to commercial maturity the currently promising technologies and value-chains.

Taking in account this objective, the action is the optimization of value chains within thermo-chemical (high temperature transformations) and biochemical (biological and chemical processes) pathways.

The thermo-chemical pathways provide five generic value chains to be optimized:
1. Production of synthesis gas (syngas) as an intermediary product to create liquid fuels (e.g. gasoline, naphtha, kerosene or diesel fuel) and chemicals;
2. Production of bio-methane and other bio-synthetics gaseous fuels through gasification processes;
3. Optimization of syngas combustion process to produce heat and electrical power;
4. Optimization of the production of bioenergy carriers such as bio-oil and solid intermediates;
5. Co-processing of biomass and bio-energy carriers with petroleum oil.

Within the biochemical pathways, the following three value chains will be optimized:
1. Production of ethanol and higher alcohols and co-products from lignocelluloses feedstock (forest and agricultural biomass, urban municipal solid waste and either residues or dedicated crops);
2. Synthesis of hydrocarbons (e.g. diesel and jet fuel) through biological and/or chemical process from biomass containing carbohydrates.
3. The micro-organism (algae, bacteria)-based production of bioenergy carriers (e.g. bio-oils) from CO₂ and sunlight, and further upgrading into transportation fuels (e.g. biodiesel and aviation fuels) and valuable by-products.[17,18]

The prospects for alternative fuel are mixed and synfuels and biofuels are used as blending materials. Gas-to-liquid is expected to be profitable technology designed only for reserves in isolated locations where pipeline transport is not feasible. Instead natural gas usage can be applied only in those regions where pipelines exist or are to be developed.

Primary energy efficiency takes into account all energy use “from the well to the wheel”. These analyses estimate:
• the greenhouse gas emissions,
• the energy efficiency,
• the industrial costs
of powertrain options and automotive fuels.

The well-to-wheel (WTW) analyses can be focused on:
• fuel production (well-to-tank analysis-WTT);
• vehicle operation (tank-to-wheel analysis-TTW) (Fig.1).
They permit the evaluation of the current and future direction of alternative powertrains and fuels.

Fig. 1 Well-to-wheel (WTW) analysis

GHG emissions for each type of WTW analysis can be estimated with the amount of process fuels consumed for the activity and GHG emissions per unit of process fuels used. The three GHGs should be combined with their global warming potentials (1 for CO₂, 23 for CH₄, and 296 for N₂O, respectively).

Fig. 2 Comparison of energy density of various energy carriers.

The compressed natural gas vehicle (CNGV). Natural gas can be used in all classes of vehicles - motorcycles, cars, vans, trucks, buses, lift trucks, locomotives, even ships and ferries. Natural gas can be used either by converting an existing gasoline or diesel engine, or by using a purpose built natural gas engine. Some benefits of the natural gas can be mentioned: reduced greenhouse gas emissions and reduced particulate and NOₓ emissions. It can be used in all vehicle classes, derived from renewable sources (biogas), minimal processing or refining requirement, safer than most liquid fuels, noise reductions of as much as 50%, widespread availability of natural gas, lower cost, reduced engine wear, all these being now available.

There are currently more than 12 million NGVs worldwide (October 2010) and NGV is thought to increase at least ten-fold, to 50 million vehicles by 2020. [13]

Liquid biofuels, as the only direct substitute for oil in transport, have a justifiably high political priority. Constant growth in the transport sector did not permitted the stabilisation of greenhouse gas emissions, in spite of the efforts undertaken by the industry.

The European Commission has identified the following main objectives of biofuels policy:
1. Greenhouse gas saving;
2. Security of supply;
3. Employment.

Biofuels are an option to contribute to greenhouse gas (GHG) emission reduction, to diminish of oil dependence, the security and diversification of energy supply, and rural development. The future of biofuels development depends on a large extent on policy support and technology deployment of new promising options using lignocelluloses biomass, aquatic biomass, etc. and to establish a fair, level playing field with fossil fuels concerning GHG emission calculations.

Biofuels production provides new options for using agricultural and energy crops, agro-forestry residues and waste streams, although environmental, social and economic concerns need to be taken into account.

Fig. 3 CO₂ Emission S I engine fueled by alchol

Research data show the evolution of emissions of a spark ignition engine using different technologies and fuel-based alcohol (Fig. 3), [9]. Hydrogen has the advantage of being produced from any primary energy source. For hydrogen, as a transportation fuel, all GHG emissions occur in the WTT portion, making it particularly attractive for CO₂ capture and storage [14].

Fuel quality is an important element in reducing greenhouse gas emissions from transport. EU legislation requires the greenhouse gas...
intensity of vehicle fuels should be cut by up to 10% by 2020.

3. Increasing Vehicle Fuel Economy
3.1. Introduction
Vehicle and fuel efficiency strategies comprise developing advanced engine and transmission designs, lighter-weight materials, improved vehicle aerodynamics, and reduced rolling resistance, which would result in lower fuel use and reduced transportation GHG emissions. Many of these technological improvements (such as hybrid-electric powertrains, truck aerodynamic improvements, and more efficient gasoline engines) are well developed and could be further incorporated into new vehicles. For a long-term, propulsion systems relying on more efficient power conversion and low- or zero-carbon fuels (such as hydrogen fuel cells or plug-in hybrids) may be developed.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Technologies applied</th>
<th>Reduction GHG emission [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDV</td>
<td>Advanced SI engines</td>
<td>8-30</td>
</tr>
<tr>
<td></td>
<td>Advanced Diesel vehicles</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Hybrid electric vehicles</td>
<td>26-54</td>
</tr>
<tr>
<td></td>
<td>Plug in electric hybrid vehicles</td>
<td>46 – 75</td>
</tr>
<tr>
<td></td>
<td>Hydrogen fuel cell vehicles</td>
<td>40-84</td>
</tr>
<tr>
<td></td>
<td>Battery-electric vehicles</td>
<td>68-87</td>
</tr>
<tr>
<td>HDV</td>
<td>Aerodynamic structure, trailer side skirts, low-rolling resistance tires, aluminum wheels, and planar boat tails</td>
<td>10 - 15</td>
</tr>
<tr>
<td></td>
<td>Combined new powertrain and resistance reduction technologies</td>
<td>10 - 30</td>
</tr>
</tbody>
</table>

Table 2, Technologies applied to reduce GHG

3.2. Internal combustion engines powertrain
The conventional fuels based on petroleum will continue to be in the front of line of mobility in the coming years, due to the main properties consisting in the extremely high energy density, ensuring large distances covered by using a relatively small volume of fuel instead, the simplest scenario remains to develop more efficient combustion engine technology.

Different studies show that the internal combustion engines (ICEs) have the potential to increase the fuel efficiency by 2020 – ICE gasoline by up to 30 percent (at 50 percent higher production costs) and ICE diesel by up to 20 percent (at 15% higher production cost). Diesel engines become the strongest powertrain in the majority of future scenarios for Europe, due to the difference of 5 to 8 % over SI engine, resulting from a fuel efficiency advantage of 15 to 20 % and diesel’s higher cost.

There are two ways to achieve the tasks regarding diminishing of: fuel consumption, pollutant and CO2 emissions:
- improving the internal combustion engine processes using the latest technologies;
- using new fueling systems and alternative fuels in ICE.

Road traffic causes a number of environmental problems: noise, congestion, and emission of NOx, CO, CO2, and particulate matter. Despite the reduced life road transport exhaust emissions across the European continent, there have been no significant improvements in concentrations of PM$_{10}$ and nitrogen dioxide (NO$_2$). As exhaust emissions decline, tire and brake wear contributes to total road transport emissions of air pollutants. The Euro 5 standard for light and heavy duty vehicles was implemented and the next standard, Euro 6 will be released in 2014 for both categories of vehicles.

The Euro 6 proposal, in force in the coming years, lays down common EU rules on heavy motor vehicles, particularly, the proposal foresees a reduction of 80% in nitrogen oxides (NOx) and of 66% in particulate matter (PM) emissions compared to the Euro 5.

The NOx emission reduction from Euro 6 will increase the health benefits by approximately 60 – 90% relative to Euro 5.

Several new energy-efficient propulsion systems are currently being investigated by scientists, governments, and car manufacturers to achieve the proposed limits, as:
- GDI and diesel engines;
- Turbo/super charging;
- Highly active intake systems;
- Electronically controlled valve actuation/timing;
- Drive by wire systems;
- Cylinder deactivation;
- EGR;
The most difficult environmental problem to solve may be the expected greenhouse effect, primarily caused by the emission of CO₂.

Technical innovations, such as the catalytic converter and improved fuels, decreased the emission of VOC, NOₓ, SOₓ, and lead due to road transport during the last 15 years while the limited improvement in vehicle fuel economy was offset by a growing demand for transportation.

A long-term solution for mitigating CO₂ emission in the transport sector would be the use of renewable fuels instead of fossil fuels. Fuels and electricity from renewable sources are, however, still relatively expensive and the supply is limited.

Applying new technologies for combustion CO₂, pollutant emissions and fuel consumption can decrease.

The homogeneous charge compression ignition (HCCI) engines were developed to combine the advantages of the spark ignition engines with the advantages of the compression ignition engines. The result is an engine with low raw emissions and high fuel economy. The compression ratio is higher, similar to the compression ratio of the diesel engines, with benefits on the fuel consumption. The load is controlled by modifying the quality of the mixtures. The air-fuel mixture is homogenized before the combustion, so there are no zones with rich mixtures, leading to lower soot emissions. Due to the high air excess ratio the temperatures from inside the cylinder are lower, and they determine lower nitrous oxides emissions. Different strategies were used to obtain the homogeneous combustion. The HCCI combustion may be achieved in two modes: starting from a gasoline engine or starting from a diesel engine.

When the HCCI combustion is obtained by modifying a conventional diesel engine, some measures have to be taken to avoid the premature auto ignition of the air-fuel mixture due to the high compression ratio. This can be achieved using cooled EGR gases. When the HCCI combustion is obtained starting from a gasoline engine some measures have to be taken to increase the temperature of the air-fuel mixture. This can be achieved by increasing the compression ratio and trapping a part of the burned gases in the cylinder (internal EGR).

Due to the homogeneous charge and compression ignition, the combustion is almost simultaneous in all the charge. The burning speed is lower than in the conventional engines but, as the whole mixture is burning at the same time, the heat release is shorter. Then, the HCCI engines can work only at partial loads. [9,14,15,16,17]

**Alternative propulsion systems**

An important element of this endeavour is the development of alternative powertrains replacing the internal combustion engine (ICE). The expected and easily applied alternative powertrains designed for a short-coming future are divided into three categories:

- The hybrid electric vehicle (HEV);
- The fuel-cell vehicle (FCEV);
- The battery-powered electric vehicle (BEV).

In order to compare the system efficiency of vehicles using different energy carriers the primary energy efficiency is used as a measure for comparison.

The alternative powertrains can be included into four main categories that can be easily developed: hybrids, fuel cell, battery powered. The hybrid electric vehicle (HEV) will be the most successful alternative powertrains, but hybrid ones will remain at high costs.

Usually, the term "hybrid vehicle" is used for a vehicle combining an internal combustion engine and an electric motor. More appropriately, such a combination should be called a hybrid- electric vehicle (HEV).

One of the main motivations for developing HEVs is the possibility to combine the advantages of the purely electric vehicles, in particular zero local emissions, with the advantages of the ICE-based vehicles, namely high energy and power density. HEVs can profit from various possibilities for improving the fuel economy with respect to ICE-based vehicles.

In principle, it is possible to:

1. downsize the engine and still fulfill the maximum power requirements of the vehicle;
2. recover some energy during deceleration instead of dissipating it in friction braking;
3. optimize the energy distribution between the prime movers;
4. eliminate the idle fuel consumption by turning off the engine when no power is required (stop-and-go) and,
5. eliminate the clutching losses by engaging the engine only when the speeds match.

Hybrid-electric vehicles are classified into three main types:

- Parallel hybrid: both prime movers operate on the same drive shaft thus, they can power the vehicle individually or simultaneously;
b) Series hybrid: the electric motor alone drives the vehicle. The electricity can be supplied either by a battery or by an engine-driven generator;

c) Series-parallel, or combined hybrid: This configuration has both a mechanical link, like the parallel hybrids, and an electrical link, like the series hybrids.

The electric energy storage system is usually an electrochemical battery, though supercapacitors may be used in some prototypes.

The Fuel cells vehicle. In the next 15 years, fuel cells vehicle will be in continuous development, to be competitive with classical vehicles, due to the high costs and the lack of a hydrogen supply infrastructure. Fuel cells using hydrogen can now achieve nearly 60 % efficiency in vehicle systems, more than twice the efficiency of spark ignition engines, and substantially higher than even hybrid electric power system. Fuel economy measured according to standard driving cycles for the latest FCEV models is between 85 and 96 km/kgH2. Some of them claim values up to 110 km/kgH2 for their latest models, with driving ranges extending up to 690 km.

The battery-powered electric vehicle (BEV) is purely electric propulsion systems (electric vehicles, EVs, or battery-electric vehicles, BEVs) are characterized by an electric energy conversion chain upstream of the drive train, roughly consisting of a battery (or another electricity storage system) and an electric motor with its controller.

Typical values for the energy consumption are 15-30 kWh/100 km, which means that the overall efficiency ranges from 40 to 60%.

The system has a low energy storage capacity compared to petrol/diesel engine and has a restricted driving range of BEVs. A battery in a BEV should store up to 30 kWh to afford the vehicle an acceptable range.

The batteries can be divided into two categories, according to the type of the electrolyte:
1. Ambient-temperature operating batteries have either aqueous (flooded) or non-aqueous electrolytes.
2. High-temperature operating batteries have molten or solid electrolytes.

Supercapacitors (also named electrochemical capacitors or ultracapacitors) store energy in the electric field of an electrochemical double layer. Supercapacitors are also potentially useful as secondary energy storage systems in HEVs, providing load-leveling power to electro-chemical batteries which may be downsized.

When different energy carriers with varying degrees of energy losses during fuel production are compared and distribution is used and primary energy efficiency analysis becomes necessary (Fig. 2), [12].

4. Strategies for transport development

Efficient and effective urban transport can significantly contribute to achieving objectives in a wide range of policy domains for which the EU has an established competence. Mobility in urban areas is also an important factor for growth and employment and for sustainable development in the EU areas.

The urban mobility policy must cover both passenger and freight transport. [6]. The urban transport policy EU can be summarized as follows:

− Satisfy sustainable transport demand;
− Support well-balanced regional development;
− Ensure fair market regulation;
− Support transport integration;
− Improve quality and service centers;
− Protect human life and the environment;
− Apply prices compared with actual performance and costs.

4.1 Increasing Transportation System Efficiency

System efficiency strategies reduce the energy use and GHG emissions of travel by optimizing the design, construction, operation, and use of transportation networks. Traffic management strategies are aimed at reducing congestion, thus leading to more efficient vehicle operation (smoother, moderate-speed traffic flow) and reduced fuel consumption. Most management measures are based on an information infrastructure (“Intelligent Transportation Systems,” or ITS) that provides real-time traffic information to system operators and/or users; however some, such as traffic signal optimization, can be done without extensive information systems. Intelligent Transport Systems (ITS) apply information and communication technologies to transport. Computers, electronics, satellites and sensors are playing an increasingly important role in our transport systems. ITS as such are instruments that can be used for different purposes under different conditions. ITS can be applied in every transport mode (road, rail, air, water) and services can be used by both passenger and freight transport.

The ITS for public transport comprises those
systems that are installed on public transport vehicles as well as at terminals, stops and similar. IT systems which ensure that public transport services can be planned, scheduled and managed to do efficient operations.

**Main ITS applications for CO2 reduction**

1. Transport demand / Mode choice:
   - (multi-modal) travel information, journey planning
   - car-sharing, ride-sharing;
   - road charging, integrated ticketing;
   - access management;
   - logistics, fleet management (avoidance of empty runs).
2. Efficiency of traffic:
   - traffic management;
   - travel information, navigation;
   - public transport priority;
3. Driver behavior:
   - eco-driving support, navigation.

**4.2 Reduce Carbon-Intensive Travel Activity**

These strategies would reduce on-road vehicle-distance traveled by diminishing the need for travel, increasing vehicle occupancies, and shifting travel to more energy-efficient options that generate fewer GHG emissions.

The attractiveness and safety of walking and cycling should be supported by local and regional authorities by ensuring that these modes be fully integrated into the development and monitoring of urban mobility policies. More attention should be paid to the development of adequate infrastructure. Initiatives in cities, companies and schools can promote cycling and walking, e.g. through traffic games, road safety assessments or educational packages.

**4.3 Transportation Planning and Investment**

Transportation planning and investment decisions can integrate transportation and land use planning to reduce travel distances, fund low carbon alternatives, and improve the operating efficiency of the multimodal transportation network.

The UTDS elaborated in 2007 specified a more efficient cooperation of sub-sectors and a uniform set of objectives of services. Priority objectives in UTDS are, as follows:

- Development of passenger transport;
- Development of transport of goods;
- Development of transport infrastructure;
- Horizontal topics.

**4.4 Price of carbon emissions in transportation sector**

Policies on the price of carbon emissions affect all strategies by encouraging use of low carbon fuels and energy efficient vehicles, improving efficiency in transportation systems, and reducing travel demand.

European policies provide penalties payment for low excess emissions of CO2, if the average CO2 emissions of a manufacturer's fleet exceed its limit value in any year beginning with 2014, the manufacturer has to pay an excess emissions premium for each van registered. This premium amounts to €5 for the first g/km of exceed, €15 for the second g/km, €25 for the third g/km, and €95 for each subsequent g/km. From 2019, the first g/km of exceed will cost €95. This value is equivalent to the premium for passenger cars.

As a long-term tendency, a target of 147g/km is specified for 2020.

Heavy-Duty Vehicles (HDV) represents about a quarter of EU road transport and CO2 emissions being 6% out of the total EU emissions. In spite of some improvements in fuel consumption efficiency in recent years, HDV emissions are still rising, mainly due to the increasing road freight traffic.

**5. Conclusions**

Strategies of developing road transport by controlling automotives’ emissions to reduce local and global environment impact are influenced by a complex of European, national and local policies, such as:

1) Implementing and reinforcing EU environmental legislations in order to diminish GHG and gaseous pollutants, particulates, noise emissions due to road traffic;
2) Financial policy supporting development of low carbon fuels;
3) Implementing a policy of taxation for CO2 emission, promoting a lower taxation for new vehicles which fulfill the requirements;
4) Investments for infrastructure to result in an improvement of management of urban road traffic flows, air quality and noise CO2 reduction;
5) Introducing alternative mobility means in urban area in order to diminish carbon intensive travel activities;
6) Implementing new energy-efficient powertrains by financial policy supporting R&D activities of vehicle fleet for the new generation endowed to satisfy the newest levels of pollution and reduction of GNG.
References:
[2]***Transport at a Crossroads. EEA Report no.3/2009 ISSN 1275-9177


[12]*** Commission for European Communities, Towards a European Strategic Energy Technology Plan COM(2006), Brussels 2007


