CLEAN TRANSPORT SYSTEMS INITIATIVE
EUROPEAN ALTERNATIVE FUEL STRATEGY

Report of the Joint Expert Group on Transport & Environment

with recommendations for the European Commission

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Introduction

The new energy and climate change strategy of the EU aims to limit global warming to no more than 2°C above the temperature in pre-industrial times. The central proposal of the European Commission is that, under a future global agreement, the group of developed countries should cut their emissions of CO2 and other 'greenhouse gases' responsible for warming the planet to an average of 30% below 1990 levels by 2020. The EU should take the lead by committing autonomously to reduce its own emissions by at least 20% by 2020 - a cut that should be increased to 30% as part of a satisfactory global agreement. In the longer term, greater emission reductions will be necessary and developed countries will have to cut by up to 90% of their 1990 levels by 2050.

The EU 20-20-20 climate and energy goals can be summarized as follows:

- Reduce Greenhouse gas emissions by at least 20% by 2020
- Improving the EU’s energy efficiency by 20% by 2020
- Increasing the share of renewable energy to 20% by 2020, in particular a 10% share of renewable energy in the transport sector

The new transport White Paper recommends an ambitious target of 60% reduction of greenhouse gas emissions from transport by 2050 as of 1990.

Main alternative transport fuels and drive technologies

In Europe the transport sector almost fully depends on fossil fuels, in particular oil. All experts from different member states support the idea that the transport sector has to move away from oil until 2050 either to reduce carbon emissions or to become independent of it.

In a transition period of the next two decades, the expected future energy demand in transport can most likely not be met by one single fuel/technology alone. The EU will need to focus on the development of low carbon fuels, on improving vehicle and infrastructure technology and on the development of a more efficient mobility and logistics system as there is still a large potential of cost effective energy and fuel efficiency improvements to be realised through better mobility management, especially for companies. In the next years, fuel demand and greenhouse gas challenges will require introducing on the market the use of a greater variety of primary energies. Diversification of the energy basis will be a key attribute for transport in the coming years, creating uncertainties for customers, industry and governments. On the other side activities must be focused on fuels with enough potential to deliver the needed scale and volume of transformation in terms of resource availability, energy efficiency and CO2-reductions. Nevertheless careful analysis of the scientific community indicate that not one single energy carrier alone will be sufficient for this fundamental change in the energy and transport system and
that we have to cope with uncertainties regarding long term success of different technology options.

The EU therefore needs a clear and stable long term policy perspective. Furthermore Member States will utilise different renewable energy sources compatible to the existing vehicle fleet, as the geographic and climate conditions differentiate European regions.

Nevertheless, medium term perspective must be in alignment with long term challenges and changes, including other sectors. Ultimately, the greenhouse gas impact of alternative fuels will depend on the carbon intensity of the whole fuel pathway. Thus, impacts, such as the decarbonisation of the EU power production, limitations in potential available, sustainable biomass resources and effects from direct and indirect land use change must be taken into account from the outset. Otherwise it will not be possible to evaluate the effects of alternative fuels in relation to CO2-emissions, energy efficiency and security of energy supply. The advantages and drawbacks of bridging technologies until clean and climate neutral energies are available have to be carefully assessed for all transport modes in order to achieve a real progress towards a sustainable energy and transport system.

In the longer run, an increasing electrification of certain modes of the transport sector has the potential among other systems, to reduce emissions, increase energy efficiency significantly and could potentially introduce large volumes of renewable energy in the transport sector while helping balancing the electricity system. Biomass as an energy carrier has volume limitations in general and due to its environmental and socio-economic impacts, like competition in land use for food production, water use or use in the energy sector. Biomass resources for energy use vary widely on their availability and sustainability and have to respect the preservation of biodiversity. On the other hand biofuels have indispensable advantages in energy density necessary for certain applications and transport modes like for example long distance freight transport, aviation and maritime transport. Furthermore liquid biofuels can use existing refuelling infrastructure and could create additional market opportunities for the agricultural sector. Use of lignocellulosic, algae or waste feedstock could reduce the competition with food production. In general Europe should rely mainly on domestic biofuel and electricity generation in order to reduce the dependency on imported energy. Depending on the biomass potential available the long term usage could go to high value markets, where no other technological options seems possible, like long and heavy transport on road, at sea and in the air.

The experts agree that the main alternative fuels should be available EU-wide with harmonised standards. Any new fuel should demonstrate/proof its sustainability, availability, affordability and reliability. Essential factors are:

- safeguarding energy supply
- environment protection
- energy efficiency
- CO2-reduction
- economics (market potential)
- scale and volume
- effects in other sectors
- customer acceptance
- minimizing environmental and socioeconomics impacts to ensure sustainability
Different transport modes require different options of alternative fuels. Furthermore, there should be a differentiation between short- (2020), mid- (2030) and promising long-term (2050) options. Different opinions of JEG members reflecting differences in the economic and political situation, climate and availability of resources in Europe show nevertheless a common trend in the assessment of alternative fuels. The view of most of the JEG members can be summarized in the following way:

<table>
<thead>
<tr>
<th>Short term option (2020)</th>
<th>road</th>
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<tbody>
<tr>
<td><strong>Passenger/ light duty:</strong></td>
<td>Heavy duty (city): Biodiesel blend HVO, Methane Electricity (hybrids) Hydrogen (buses)</td>
<td>Heavy duty (long distance): Biodiesel blend HVO/ Methane (dual fuel)</td>
<td>Fossil or biofuel blends, HVO</td>
<td>Electricity Hybrid/ diesel traction</td>
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mid term option (2030)

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<tr>
<th>(Blends of) Bioethanol or biodiesel (2nd generation)</th>
<th>Electricity &amp; Hydrogen Biomethane, HVO BtL/GtL (for long distance)</th>
<th>Biodiesel (1st/2nd generation) Synthetic fuels (GtL) Biomethane, HVO Hydrogen Electricity (hybrids)</th>
<th>Biodiesel (1st/2nd generation) Synthetic fuels (GtL) Biomethane/ CNG, HVO Hydrogen</th>
<th>Electricity Hybrid/ diesel traction</th>
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long-term option (2050)

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<tr>
<th>Electricity &amp; Hydrogen from renewable energy Biomethane (mainly for long distance vehicles)</th>
<th>Biofuels (2nd/3rd generation) Electricity &amp; Hydrogen from renewable energy Biomethane</th>
<th>Biofuels (2nd/3rd generation) Electricity &amp; Hydrogen from renewable energy Biomethane</th>
<th>Biofuels (2nd/3rd generation) Electricity &amp; Hydrogen from renewable energy Biomethane</th>
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Electricity Hybrid/ diesel traction

Fossil or biofuel blends CNG (inland waterways), LNG (maritime) Electricity (ferries and near coast, in ports in APU for cold ironing)
Explanation of terms according to definitions of the International Energy Agency (IA Bioenergy):

1st Generation Biofuels: are produced from (parts of) agricultural crops with high energy density like oil seeds or fruits using vegetable oil, sugar or starch as feedstock. The typical representatives of 1st generation biofuels are: biodiesel, bio-ethanol, vegetable oil and biogas.

2nd Generation Biofuels: are made from the overall ligno-cellulosic biomass (ligno-cellulosis = material containing lignin, cellulose and hemi-cellulose). The typical representatives of 2nd generation process are ligno-cellulosic ethanol, Biomass to Liquid (BtL) and bio-synthetic natural gas (bio-SNG).

3rd Generation Biofuels: includes novel technologies that are mainly in the R&D and pilot stage, such as algae-based biofuels and the conversion of sugar into diesel-type biofuels using biological or chemical catalysts.

Technology neutral approach of public authorities

Technological neutrality is seen as an important principle but must be seen in relation to basic scale and volume criteria. Alternative fuels with small potential in feedstock, energy efficiency or CO2-reduction can never be the main focus. Public authorities have to consider the “well to wheel” of different technologies for fuels in order to compare and estimate the true benefits and factors such as energy efficiency, greenhouse gas reduction potential, socioeconomic impacts, reducing energy dependency or overall costs. When developing general measures, like performance standards, this has to be set technological neutral, but for other measures (e.g. allocate funds for R&D, develop technical standards, support infrastructure build-up) technologies may need to be identified, and priorities have to be set.

Furthermore binding targets and framework conditions for different technologies are necessary to ensure and secure investments. However, in some cases it might be necessary to take technology specific measures in order to take away possible bottlenecks. The EU should consider setting environmental and sustainability criteria, and work towards a worldwide harmonization of a life-cycle assessment methodology for low-carbon fuels contributing to a secure investment environment for renewable deployment. Volume targets for specific alternative fuels are non technology neutral and as a consequence should be avoided after 2020. In this respect, the Fuel Quality Directive (FQD) is a good step. It is important to ensure that energy used by transport will deliver improvements over their entire lifecycle in terms of impacts on climate as well as other environmental impacts, such as health-relevant air pollution, acidification and biodiversity loss.

Infrastructure and vehicle fleet

The requirements for fleet and supportive infrastructure should meet the investment time that is efficient. For a fuel refinery the investment period is 50 years and for different road vehicles and vessels 10-25 years. Decisions should therefore reflect the lead time needed for the investments. The investment needs for the distribution of different fuels in road transport could be minimized with intelligent applications offering information on the availability of charging and refuelling places. For long distance haulage and transport needs EU-wide corridors and knot-spots should be defined. Electromobility should be supported by common standards for infrastructure. Maritime and aviation require a worldwide solution on the future fuels kept available in harbours,
airports and knot-spots. The quality and availability of fuels should be guaranteed to promote finance for the fleet investments.

**Communication and public information**

A main task on the political agenda - on national and European level - and one key element of a “European Fuel Strategy” is the information and education of citizens about the magnitude of the challenge to liberate the transport sector from almost 100 % of its dependency on fossil fuels. Public authorities have to play a crucial role in providing neutral, unbiased information on the options available on the market as well as on the future scenarios based on scientific facts. While presenting the magnitude of the challenge for transformation, the information should also give a comprehensive and balanced overview of the technology options under consideration levelling the changing media and producer hypes for different technologies.

This public information must be related to the communication about energy savings in so far as big drivers for energy saving are technical improvements of vehicle/transport efficiency and changes in customers/citizens behaviors. Communication must integrate economical and sociological aspects and education actions must be made in order to promote changes in citizens’ behaviors and in their individual relationship with vehicle/transport.

The information should be targeted to different stakeholders (like policy makers, energy and transport industry, transport service and infrastructure providers, mass media and last but not least the European citizens as consumer and sovereign), all being important partners to achieve the huge task of changing the energy and transport system.

Comparative assessments of fuels and propulsion technologies exist already on the regional and national, and for some technologies on European level analyzing costs, energy efficiency and emissions of different alternative fuels. Similar models could be developed for all main fuel options on a European basis including all relevant stakeholders and nationally communicated to increase the public awareness. These assessments should be done on a regular basis in order to reflect issues such as fuel cost fluctuation and electricity mixes.

New vehicles technologies, e.g. electric vehicles, have to be made more attractive to customers. A broader overview of future transport needs is necessary and how the available technologies fit into future passenger transport needs. Therefore the integration of consumer behaviour in the development process of new technologies is of utmost importance for their success on the market. Statistics indicate that users may drive shorter distances in the future, so we might need to consider different solutions for long- and short-distance transport.

**The importance of the rest of world, especially emerging markets for European competitiveness**

The objective towards a green transport system that is independent from fossil fuels is a global issue. The US, Brazil, China or Japan are making chief investments in low carbon technologies and have well developed roadmaps targeting these technologies. For the EU it is crucial to develop its own roadmap, considering its own resources in energy and raw materials. The EU should take advantage of the imminent fundamental change in vehicle technologies and energy supply using the challenge as opportunity for its industry and their potential to offer innovative transport and energy technologies on the world market. The specificity of air and sea transports, which are ruled at a worldwide level, must be taken into account. Therefore refuelling
infrastructure for alternative fuels (like for example LNG for vessels) must be available on a
global scale.

Development of clean and energy efficient technologies in these markets are important and
monitoring of developments is critical as potential business opportunities in particular for
developing and exporting clean and fuel efficient technologies may play a significant role for
preserving and generating jobs in the EU. However regional aspects and production opportunities
in Europe should not be marginalised as they may well provide sustainable regional solutions to
the problem of greenhouse gas emissions and reduction measures.

**Transport and Energy sector**

Decarbonisation of the energy sector and decarbonisation of the transport sector must work
together and complement each other. European Strategies for both, the transport and energy
sector must be coordinated as they can make use of the same alternative fuels or energy carriers.
This means that locally produced biofuels may in the future make it difficult to determine the
correct end-user as the same fuel can be used also for electricity production, heating and transport
purposes. Also electricity may be used for domestic or transport purposes at the same utility, and
the smart integration of energy and transport sectors might allow for a growing use of renewable
energy in transportation. As a consequence all end users compete on land use and biomass
resources.

Alternative fuels should be compared on a well-to-wheel basis, in order to include effects in other
sectors, including energy sector and land use, whereas vehicles with identical drivetrains could be
compared on a tank-to-wheel basis. Synergy effect of policy strategies in the field of transport
and energy, but also in agriculture and environment sectors is crucial to their effectiveness.
However, in order to secure a sustainable energy supply of the transport sector in the long term it
may, in the short term, be necessary to accept “second best” solutions in terms of cost efficiency.
Regulations are needed to ensure efficient implementation of sustainable and cost-effective
alternative energies suitable for each use.

The overall framework and objectives for the different sectors and their overall greenhouse gas
reduction goals is provided by the Roadmap for a Competitive Low Carbon Economy for 2050.
Decarbonising the transport sector is a major challenge and the increase of the share of renewable
energies is of critical importance in order to achieve greenhouse gas reduction goals for transport
and long-term sustainable mobility.

**Making new vehicles able to accept a wide range of fuel specifications**

Making new vehicles able to accept a wider range of fuel specifications or multiple technologies
seems to be reasonable, if this can be done cost efficient and without compromising
environmental performance and energy efficiency. As a bridge to new technologies and a greater
market penetration, vehicles should be able to rely on biofuels as a mid term option. However due
to production limits and competition with other land-use issues higher blends would have to be
carefully assessed with respect to population growth land use, climate change and energy
concerns.

Taking into account the perspective of restricted biomass resources and lack of alternatives,
widening fuel flexibility of conventional vehicles on the long term seems most important for
biofuels for aviation, waterborne transport and long distance road transport. There are strong
indications that the additional costs per vehicle are very limited and the market will reward the
best solutions as long as these solutions are beneficial for the users of the vehicles. Customer acceptance and cooperation with car industry is a very important aspect in this field.

In air transport, future and alternative fuels must be compliant with very high technical requirements regarding the specificities of this mode: high energy density (as close as possible to 43 MJ/kg, wide range of temperature exposure (stability at high temperatures and not freezing at very low temperatures of high flight altitudes), sustainability, same technical properties whatever the place of production worldwide, reliability, technical certification.

Centralised or decentralised use of biomethane

Although biomethane could be fed into the gas grid, costs for the upgrading to gas grid level are substantial. Thus the local utilisation of biomethane can be a viable option for producing electricity and heat or as an alternative fuel. Biomethane as a direct fuel seems to be challenging, since new infrastructure, storage and vehicles are needed. Therefore policy should not endorse separate logistics, distribution paths and utilization modes for pure biomethane. In addition it has to be kept in mind that use of biomethane as an alternative fuel will in most cases require an upgrading to gas grid level, also for local utilisation. Where a well developed CNG distribution network is present, the biomethane feeding in such networks should be privileged. Nevertheless, it should be left to communities in rural areas to decide by themselves how to use local renewable energy sources (biomass, wind, solar for mobile or stationary use) based on demand and the market situations. In general biomethane used for transport separately should be focused on large fleets with high usage (km per year) and with undistributed filling pattern (busses, trucks etc) in order to reduce infrastructure costs.

Smart Grids

Smart grids that offer possibilities to charge flexible and over the off-peak period can significantly reduce the power capacity needed for charging, balance energy systems and facilitate larger shares of renewables. These solutions can be supported with different real time metering and pricing mechanisms.

The use of battery electric vehicles in this introductory phase will also place demands for the intelligence of the grid for charging and billing procedures. The application of modern communication technologies is a decisive success factor. A harmonized and coordinated approach in Europe should be developed, securing data protection, interoperability and a discrimination free access. Intelligent on vehicle solutions should also be developed on optimal routing and charging place information and along with the general introduction of ITS in the transport sector.

Besides hydrogen as a storage medium more developed smart grid solutions where the vehicle fleet is in a role of energy storage can be an important support to an electricity system using substantial amounts of fluctuating renewable energy sources, for instance wind and solar energy. For this reason, methods of stabilizing the distribution network are under investigation and basic research is underway to enable batteries in electric vehicles to possibly fulfil the role of a decentralised energy storage device and a range of ancillary services balancing the power system in the future.

It is important to note that charging of electric vehicles needs to be controlled in one way or the other regardless of the development of the smart grid technology. Controlled charging for a large amount of vehicles is necessary to avoid grid overloads. In addition to technological solutions
this can be done through differentiated tariffs encouraging consumers to charge their electric vehicles during low consumption periods at night-time. The introduction of harmonized and comprehensive business models that integrate the charging infrastructure and the electrical system should be a priority.

For implementing vehicle-to-grid operation the acceptance of vehicle users is crucial factor as discharging might create range anxiety of consumers an important psychological barrier for electric vehicles. Therefore some OEMs expressed objections for vehicle-to-grid operation as reduced life-time due to accelerated degradation of the battery by an increase in the number of charging/discharging cycles will pose warranty problems. As batteries in electric vehicles have to achieve very high energy densities they are rather expensive and therefore other load-leveling strategies for the electricity grid or batteries for stationary seem to be more cost-effective. Introducing possible vehicle-to-grid systems are therefore a long-term R&D task needing the start of research activities now and not a customer option in the near future. Specific charging/discharging strategies must be developed and optimal temperature conditions ensured, which may require additional cooling measures (increased performance, safety and service life).

**Needed volume and management of R&D-resources**

The conversion of the existing oil-based transport system to a sustainable one requires the development and market introduction of new energy and transport technologies. To achieve this transition Europe has to increase and optimise the output of its R&D activities by increasing private and public R&D budgets as well as using available funding in a more efficient way. The priority must be energy efficiency and greenhouse gas emission intensity based on well-to-wheel analysis and diversification (reduction of oil dependency). However, other environmental impacts such as air quality, noise, biodiversity etc should not be neglected. In this context, joining research forces and implementation of cross-thematic approaches involving Transport, Energy and Environment themes are essential. R&D should be simultaneously oriented to alternative energy sources exploration and as well other key vehicle technologies which provide very important benefits in terms of energy efficiency and reduction of greenhouse gases emissions.

Long-term stability in R&D funding and legal framework conditions is important for the industry and provides confidence for investment decisions. On the other hand R&D has naturally uncertain success results and unpredictable technical breakthroughs or failures require a regular review of the policy process and sufficient flexibility in realigning roadmaps for the market introduction of alternative fuels. Therefore a continuous monitoring by a high level institution seems necessary potentially rerouting the process to reach the best solution between short term and long term. Preferably an annual review should be carried out. Basic R&D should be settled on a broad basis without restrictions – failures incorporated. Applying R&D, with focus on introducing new technologies to the market should be carried out as public-private initiatives.

Public and private budgets supporting the use of sustainable energy carriers in transport are limited. A choice is therefore needed how much money should be used for basic or applied research, demonstration projects, build-up of infrastructure and transport services, information campaigns for new technologies or subsidies for vehicle purchase or usage. The experts in the JEG esteem all these elements as relevant for achieving a sustainable transport system and they support expenditures over the whole innovation cycle.
In general incentives should be close to market conditions including the whole chain of cost (energy efficiency, environmental and socio economic costs). Information & legal framework for the citizens and enterprises must be reinforced. If technology results are viable and ready for the market, it is necessary to dedicate sufficient resources for the infrastructure and transport services. Basic research is of special importance and should be financed in particular from public budgets (companies are not willing to invest to basic research with uncertain results), whereas in applied research private companies should participate to greater extent. Besides research support is required for demonstration projects and the development of infrastructure. In the crucial market introduction phase of new vehicle technologies assistance might be needed for a limited time. Public budgets should also be invested in the promotion of public transport based on alternative fuels.

To encourage investments and development of biofuels production it is important to harmonize the sustainability criterias and the environmental life cycle analysis methodology which will be applied. After this, it will be possible to implement market incentives and to give clear orientations to potential investors.

**Support-Measures**

To support new technologies, various support schemes exist: regulatory policy measures like emission standards (additional costs for the users), monetary incentives (additional costs for the public budget = the citizens), spreading of tax signals (cost neutral for public budget if energy efficient cars get incentives paid by high-emission car owners) and finally non-monetary incentives (privileged access to parking places, bus lanes or sensitive areas).

In order to identify if potentials are marginal, small or significant, a guiding principle should be the potential or effect of alternative fuels regarding efficiency, emissions and costs/market potential.

Policy measures such as CO₂ emission standards for vehicles, the Fuel Quality Directive, the Renewable Energy Directive and the Energy Tax Directive as well as corresponding supportive fiscal measures on the national level have the potential to be a very effective tool to achieve a sustainable energy and transport system.

From a sustainable transport policy point of view measures that will promote public transport over the use of private vehicles and all those measures that will contribute to the internalisation of external costs are important.

In addition to supporting R&D for vehicle and fuel technologies, non-technological options and solutions need to be encouraged like company mobility management for passenger and freight transport, inter-, and multi-modal mobility solutions as well as opportunities to avoid traffic together with public transport as an important contribution to achieving GHG emission reductions and fuel savings.

Support measures are important to encourage early adopters in businesses and communities, like fleet operators, delivery services, etc. that use new clean and low carbon technologies and fuels to reduce CO₂ emissions and enhance the use of renewable sources.

On a national level, spreading of tax signals and certain non-monetary incentives (privileged access to parking, sensitive areas) have been proven effective as well, and should therefore also be continued. These measures may however not lead to extended use of private cars on areas where public transport is an option.
A classification for above mentioned measures might be:

a) regulatory policies for well established technologies;
b) monetary incentives for the demonstration and market introduction of newly developed technologies with a potential of becoming competitive
c) taxes as a framework to drive user choice
d) non monetary incentives to manage the mobility in specific zone.

In addition to these four categories of support measures the following list of more detailed instruments seem a valuable tool to achieve a more sustainable energy and transport system:

• Economic instruments/business-models
  o Revision of the energy taxation Directive. Introduce a carbon dioxide tax in sectors not covered by the EU Emissions Trading Scheme. This carbon dioxide tax should be levied by Member States as part of their national legislation. This is, however, not applicable to the shipping sector where the introduction of market-based measures are being developed according to an ongoing process.
  o Develop concept/business-model for multi-energy-filling stations using renewable energy
  o Supply issue for LNG (refueling infrastructures and logistic aspects)

• Legislation/standardisation
  o Mid-term-introduction of CO₂-regulation/energy efficiency regulation for heavy duty vehicles (development of adequate methodology) and appropriate tighter CO₂-regulation/energy efficiency regulation for other road vehicles.
  o Standardisation and build-up of refuelling/charging infrastructure (plugs, hydrogen, etc.).
  o Fuel quality standards.

• R&D support
  o EU Framework Programme, European Green Cars Initiative, JTI on Fuel Cells and Hydrogen

• Information
  o Vehicle labeling for CO₂/energy efficiency. A more effective labeling of Directive reflecting life cycle impact.
  o Dissemination of information on projects and measures between member states.

• European business models for technologies and travel/customer behavior and multimode transportation (e.g. battery swap, battery leasing, carsharing, easy transfer to other vehicle/mode).
• Frameworks for / benchmark of national measures as low emission zones, parking fees, innovative and green procurement.
ANNEX

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