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Technical assessment of the EU biofuel sustainability and feasibility of 10% renewable energy target in transport

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Renewable energy progress report

{COM(2015) 293 final}

1. ASSESSMENT OF THE SUSTAINABILITY OF EU BIOFUELS

1.1. Environmental impacts

In 2012, Member States reported net savings in greenhouse gas emissions resulting from the use of renewable energy in transport were around 34 Mt CO2-equivalent[1]. While most of the emissions reductions came from the use of biofuels, a portion of the CO2 savings reported by the Member States stemmed from the use of renewable electricity in transport, especially in the rail sector[2,3].

The current methodology contained in Annex V of the Renewable Energy Directive offers several options to improve the GHG performance of first generation biofuels. These options have been validated and more widespread use can be expected also through changes in existing biofuels chains. Through the calculation of actual values biofuel producers can take into account better than default greenhouse gas performance, for example through the use of renewable energy as process input and through carbon capture and re-use.

The largest sample of data available from the German "Nabisy" representing about 7 Mtoe of biofuels for both the German as well as other markets shows average GHG savings according to the Renewable Energy Directive methodology for all registered biofuels of 51% in 2013, up from 47% in 2012[4]. This means that, through reporting of actual values, current biofuels meet already now on average the future GHG saving requirement. The (few) actual data from other Member States roughly match the default values established in Annex V of the Renewable Energy Directive. Voluntary Schemes confirm the feasibility of the present sustainability requirements (at least 35% of GHG saving, increasing to 50% in 2017). However, it should be noted, that this does only refer to the GHG saving requirement in the Renewable Energy Directive which covers only direct emissions and does not include potential impacts from indirect land use change (ILUC). A political agreement has recently been reached on the amendments to the Renewable Energy Directive and Fuel Quality Directive to reduce the potential impacts by ILUC in future[5].

Action to mitigate indirect-land use change is likely to increase the use of biofuels from waste and residues which have typically significantly higher GHG savings than

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1 Direct savings, therefore not including emissions from indirect land use change.

2 For methodology and calculation assumptions see *Renewable energy progress and biofuel sustainability, ECOFYS et al, 2014* available on: http://ec.europa.eu/energy/en/studies

3 The GHG savings reported by Member States in the 2013 renewable energy reports are calculated on the basis of Renewable Energy Directive methodology. This methodology has some limitations: no LULUCF is taken into account, nor perfect substitution of an arbitrary fossil fuel mix.

4 http://www.ble.de/SharedDocs/Downloads/02_Kontrolle/05_NachhaltigeBiomasseerzeugung/Evaluationsbericht_2013.pdf?__blob=publicationFile

5 Commission's proposal COM (2012) 595, 2012/0288 (COD)

those based on food and feed crops[6]. Some of them are commercially available since some time already whereas others are coming to the market.

Based on analysis of the biofuels consumption and production and trade statistics on biofuels and their feedstocks, the total acreage required to produce the biofuels consumed in the EU in 2012, is estimated to amount to 7.8 Mha. The real acreage is probably much lower, but a more accurate figure would require detailed insight in current production chains. Of this, 4.4 Mha (56%) is within the EU and 3.5 Mha (44%) outside the EU. Accounting for macro-economic dynamics, the additional acreage to produce the same volume of biofuels, in comparison to a situation without EU biofuel consumption, was estimated to be 1.6 Mha, because the world's agricultural system has accommodated the demand shock in several ways besides expanding land[7].

In 2012, the EU dedicated 3 percent of its total cropland to the production of feedstock for biofuels consumed in the EU. Outside the EU, on average less than 0.5 percent of cropland was devoted to EU biofuel feedstock production in main biofuel producing countries exporting to the EU except for Argentina, which devoted 3 percent of its croplands to EU biofuel consumption. While the total amount of land worldwide under cultivation for biofuel production continues to grow, the amount of land used for biofuel exports to the EU has actually declined on a land per energy basis, with 0.16 Mha/Mtoe required in 2012 compared to 0.18 Mha/Mtoe in 2010[8].

Habitat destruction due to both direct and indirect land use change, as well as intensified agricultural cultivation methods are the greatest risk to **biodiversity** caused by biofuel production. For biofuels and feedstocks sourced outside the EU and for the replacement of agricultural crops formerly produced in the EU but diverted to biofuel production, there is a potential for a greater impact depending on the type of crops, the previous land use, and the intrinsic biodiversity values in the region.

The biodiversity risk for Indonesian and Malaysian palm oil, however, is high because the palm oil supplying the EU comes primarily from sensitive areas like Borneo and Sumatra, where palm oil is a significant driver of deforestation. While the clearing of natural forests to plant oil palms is not permitted by the EU biofuels sustainability criteria, the indirect effect of EU biofuel demand could be associated with forest fragmentation and related impacts on habitats in the region.

US maize used for EU ethanol also poses a potentially high risk to biodiversity, as ethanol demand is driving farming into threatened ecosystems, as well as promoting increased runoff and agrochemical waste which threatens the biodiversity along the Mississippi-Missouri river basin as well as the Gulf of Mexico[9].

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6 While the use of these waste and residues – that would otherwise feed into soil organic matter formation by biological processes in the soil – should be kept compatible with maintaining appropriate levels of soil organic matters.

7 ECOFYS et al, 2014.

8 ECOFYS et al, 2014

9 ECOFYS et al, 2014

The Commission is required by Article 17(7) of the Renewable Energy Directive to report on the ratification and implementation of eight International Labour Organization conventions, the Cartagena Protocol on Biosafety to the Convention on Biological Diversity (CBP) as well as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) within the EU as well as in other major producers of EU biofuel and biofuel feedstock[10]. With the exception of the US, most countries outside the EU supplying biofuels or feedstock have ratified and implemented the conventions, and there have only been nominal changes since the last progress report. US, Canada, Argentina – all major suppliers of the biofuels to the EU – are not parties to the Cartagena Protocol. Efforts across the board must continue to encourage all countries to become Parties and fully apply these conventions and the Cartagena Protocol. The EU is fully committed to play an active role in ensuring that these international conventions deliver on their objectives and are implemented in full.

Increased biofuel production also led to an increase in **water consumption**, with 14.0 km3 of water used for EU biofuel production in 2012. This represents a 21 percent increase when compared to 2010 levels. The relationship between biofuels volume and water consumption, however, is far from linear as water consumption varies greatly depending on crop and location. The majority (8.6 km3) of the water consumed for biofuel production took place within the EU, while most of the remainder (2.1 km3) was used for soy production in Argentina. While water consumption for biofuel production remains very small compared to total water use in agriculture, caution should be taken in areas with water scarcity where biofuel crop production would risk exacerbating existing pressures on water resulting from agricultural production, as well as with regard to the potential impact of downstream runoff in irrigated areas[11].

Biofuel production also impacts **soil, water, and air quality**, primarily during the production of biofuel feedstock. The most important soil quality risks are associated with the cultivation of Indonesian and Malaysian palm oil as palm plantations drive deforestation and peatland drainage which not only contribute to biodiversity loss, but also to soil carbon oxidation and soil erosion. For other crops and in other regions, however, the impact of biofuel cultivation on soil quality is mixed. For example the cultivation of winter rapeseed for biodiesel production within the EU provides good soil cover and actually reduces erosion. The increased cultivation of maize in the EU and the US, partially driven by the demand for ethanol, has led to the expansion of maize cultivation on to grasslands and pasture which increases the risk of soil erosion. In the EU, the conversion of permanent grassland to cropland is restricted under the Common Agricultural Policy. Increased demand for biofuels also leads to increasing monoculture systems, which adversely affects soil quality[12]

Biofuels production impacts water quality through the use of pesticides and fertilizers, as well as through erosion. As with soil quality, the most important risks to water

[10] In addition, the Convention on Biological Diversity itself has a work stream on biofuels and biodiversity (https://www.cbd.int/agro/biofuels/decisions.html)
[11] ECOFYS et al, 2014.
[12] ECOFYS et al. 2014, IPCCs Fifth Assessment Report.

quality are related to palm oil cultivation and processing. Rape seed, wheat, and maize are all relatively resource intense crops, demanding high amounts of agrochemicals for every unit of bioenergy produced. Runoff from these crops can have important risks to water quality, especially in the case of US maize impact on water quality in the Gulf of Mexico, as well as pressures on European surface and ground waters[13].

The production, use of burning and of agrochemicals in biofuel production also impact air quality. Within the EU, NH3 or ammonia emissions from fertilizers, especially in the cultivation of resource intense biofuel crops such as rapeseed, maize and wheat, can have an important impact on air quality. Although NH3 emissions have been falling slightly in the last 10 years despite the increase in biofuel production, ammonia still is a major contributor to the formation of secondary particulate matter[14].

Outside the EU, the widespread burning and semi-accidental forest fires in the vicinity of Indonesian palm oil plantations are arguably the most serious air quality risk related to biofuel production, however, these are not directly driven by EU biofuels since those cannot be sourced from areas associated with the clearing of natural forests as this is not permitted under the Renewable Energy Directive. Emissions from the burning of Brazilian sugar cane fields have also been a serious air quality concern, but the ongoing mechanization of the sugarcane harvest process is expected to lead to the near term phase out of field burning[15].

1.2. Economic, social and development impacts

Biofuel production has been associated with concerns related to **food price volatility**, and the Commission carries out regular monitoring of the biofuel and food price impacts as required under the Directive[16]. As illustrated in figure 1 below comparing global annual biofuel production with a food price index, there was a common trend between increased biofuel production and higher commodity prices between 2004 to 2007. However, after 2008, this common trend no longer appears with biofuel production continuing to rise while commodity prices move in the opposite direction. Indeed, fossil fuel and fertiliser prices show very strong price surges over the same period, and they are both important cost components in the production of food crops.

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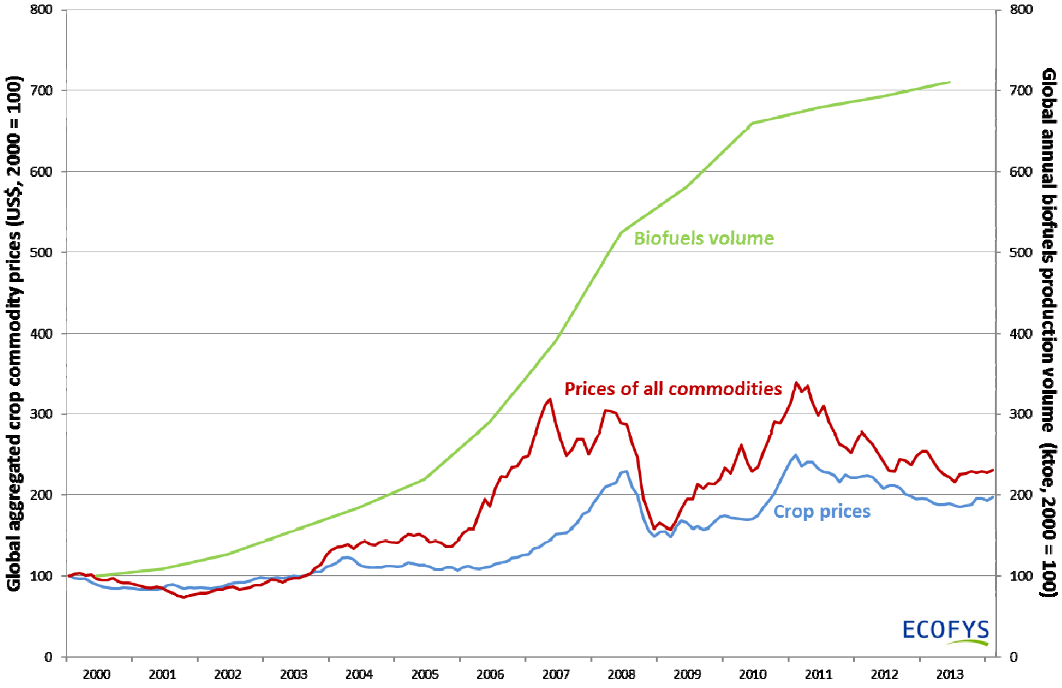
13 ECOFYS et al, 2014.

14 Achieving future reductions of particulate matter concentration critically depends on reducing also ammonia emissions. To tackle this, the European Commission has presented, in December 2013, the Clean Air Policy Package (http://ec.europa.eu/environment/air/clean_air_policy.htm).

15 ECOFYS et al, 2014

16 Article 17 and 23 of the Renewable Energy Directive.

Figure 1. Global crop commodity prices. Aggregated price of all commodities and biofuel production volume in 2000-2013



Source: World Bank (2013)[17]

Based on the 2014 results of back-casting scenario analysis estimating the market impacts of historical EU biofuel development, it appears that EU biofuel consumption has contributed little to the increase of commodity prices between 2006 and 2008 and 2010 and 2011, and rather reinforced other, existing, stress factors. Overall, the analysis suggests the expanding use of biofuels in the EU contributed only 1-2% to the historical cereal price increases. For other food crops, including oil crops, the price increases simulated in 2008 and 2010-2012 due to biofuel production were 10-16 percent when all world countries were considered and 2-3 percent when only EU biofuel production was simulated. Thus, the role of EU biodiesel production has also been quite modest in pushing up other food prices, such as prices of oilseeds and vegetable oils[18].

The spike in commodity prices also affected the consumption of grains, especially in less developed countries. When cereal consumption levels for food are compared using the back-casting model, the results show an overall reduction of global cereal consumption for food purposes of about 18 Mt by 2012 when compared to consumption levels in a scenario where biofuel production held steady at year 2000-levels. Of this 18 Mt reduction, nearly two-thirds comes out of consumption in less

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17 World Bank (2013) monitor on commodity prices versus global biofuels production volume, both normalised. Biofuels production volumes are calculated as the sum of biodiesel and bioethanol production in the EU (according to Eurostat) and the rest of the world (according to US EIA Energy Information Administration).

18 IIASA modelling within ECOFYS (2014)

developed countries. Given the priority placed on biodiesel production in the EU, however, the relative impact of EU biofuel consumption on overall grain for food consumption levels is relatively small compared to the impact of the total commodity price spike, accounting for less than 2 million tons in lost food consumption[19]. Searchinger et al. (2015)[20] find that the models used in the past for assessing the impact of biofuels estimate that roughly 25 to 50% of the net calories in corn or wheat diverted to ethanol are not replaced but instead come out of food and feed consumption. The 2 million tons lost in food consumption thus seem plausible based on the relatively limited use of grains as feedstock for ethanol in the EU.

Ultimately, high food prices increase the cost of food for consumers, but they also increase income for farmers, who represent an important portion of the population in less developed countries.

The growth of biofuel cultivation has also fuelled speculation that this new market was contributing to large scale **land acquisitions** with negative socio-economic impacts, colloquially known as "land grabbing." As the EU currently accounts for around 20 percent of the world biofuels market and produces around 75 percent of the biofuels it consumes domestically[21], it is difficult to accurately estimate the extent to which the attractiveness of the EU market has had on biofuel projects outside the EU. A recent ECOFYS study estimated that *maximally* around 10 percent of biofuel projects outside the EU have been developed with the EU market in mind. And many land acquisition projects launched in early 2000s failed and did not materialise in real biofuel production projects[22].

As Member States continue down the path to the 2020 objective, the Commission's regular monitoring of the EU biofuel origin and consumption trends since 2010 tend to suggest that, although there is some impact of increased biofuel consumption on food prices, the overall impact of the EU biofuel market is relatively small compared to the other systematic factors driving global commodity prices like reduced reserves, food waste, speculation, oil prices, transportation issues, storage costs, and hoarding.

2. ASSESSMENT OF PROGRESS TOWARDS 10% TARGET FOR RENEWABLE ENERGY IN TRANSPORT

Based on 2013 data, half of Member States (Sweden, Finland, Slovakia, Poland, Austria, the Netherlands, Hungary, Italy, France, Ireland, Germany, Denmark, Czech Republic, Bulgaria) has achieved at least 5% or higher share of renewable energy in transport. These Member States were on track towards 10% renewable energy target for transport[23]. In the remaining Member States important progress remains to be achieved.

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19 Idem

20 https://www.sciencemag.org/content/347/6229/1420.full

21 ECOFYS et al., 2014.

22 Assessing the impact of biofuels production on developing countries from the point of view of Policy Coherence for Development, AETS, 2013

23 Eurostat 2013 data.

One reason for this is the slower than planned progress in deployment of conventional biofuels and in developing advanced biofuels. In fact, in 2013 the biofuels consumption declined in the EU due to the changing conditions of the global biofuels market and uncertainty on the EU market. Up to 2020 the situation in advanced biofuels is expected to improve and several countries are projected to progress well. However, for others, and for the EU as whole, the need for urgent policy and financial measures to advance the development and market entry of advanced biofuels is evident. Such measures should also target electricity use in transport, especially for road transport, and the use of fuel cells[24].

Evaluation of renewable energy use in transport on specific Member State markets

Despite the fact that the 10% renewable energy transport target is being equally applied to all Member States, available renewable energy potentials differ from one Member State to another. Some Member States will be required to import biofuels or other renewable energy forms to meet the 10% binding renewable energy target. Luxembourg imports all biodiesel and ethanol and 62% of its final energy is consumed in transport. For Malta and Cyprus the share of transport in their final energy consumption is similar to that of Luxembourg. Bulgaria and Slovenia are also highly import dependent (90-98% of biofuels are imported).

In the case of **Luxembourg**, it does not appear to be additionally burdened, nor is its competitive advantage reduced through the obligation of a renewables target in transport. As the only support scheme in Luxembourg for renewable energy use in transport is a quota system for biofuels, the renewables target in Luxembourg is mostly fulfilled by consumption of biofuels. In fact, the market situation for fossil fuels is the same as for biofuels. Almost 100% of all fuels (biofuels and fossil) are imported. Therefore, no additional burden from the 10% renewable energy target for transport arises. **Cyprus** (65% of biofuels used in transport were imported) is in a similar situation as Luxembourg. A mandatory biofuel quota is imposed on oil companies to meet the 10% transport target. The market situation (high dependence on imports) for petroleum related products is similar to that of biofuels. Biofuels are even partly produced locally which reduces the security of supply concern for Cyprus. Only double counting[25] biodiesel is used in transport sector in **Malta**, and the country does not seem to be additionally burdened by the renewables target in transport. A biofuel obligation has been in place since 2011 stimulating biofuel imports, however this is not different for other transport fuels as the country is used to import its energy.

Feasibility of the 10% target in the context of global food availability and affordability

As already explained in previous chapter, the EU biofuel policy coincided with the initial commodity price volatility in 2006-2007 before the EU biofuel sustainability criteria were introduced through the Renewable Energy Directive. After 2008, this common trend is no longer visible with biofuel consumption continuing to rise while commodity prices have moved in the opposite direction.

[24] ECOFYS et al., 2014.

[25] In accordance with Art. 21.2. of the Renewable Energy Directive.

Developing countries as net importers are often most vulnerable for transmission of price fluctuations and in those countries also the impact on food security is more severe than for developed countries, even if the latter are also net importers.

The way domestic and global price fluctuations impact local consumers also differs for different countries. With crops comprising a small share of the final cost of food in high-income countries, the impact of price effects on food consumers is smaller[26]. In low-income countries, where expenditure on raw grains and vegetable oils comprises a much larger share of the household food budget, a given increase in crop prices will have a much larger impact on food consumers.

In the longer term, however, high prices are beneficial since they provide opportunities and higher profitability for agricultural markets (which are, most of the time, also in developing rural regions). Moreover, biofuel production creates opportunities to generate income and as a boost to development of agriculture practices/technologies[27].

Biofuel consumption may continue to have some influence on the global food prices and food affordability, but according to the EU monitoring since 2008, this impact is marginal compared to other factors such as oil prices, weather and climate induced stress, and speculation impacts. On the basis of monitoring of EU biofuel consumption and its impacts carried out since 2008, the Commission does not expect that the EU 10% renewable energy target for transport for 2020 will significantly impact the global food prices and food affordability in developing countries.

Availability and prospects of renewable energy technologies for transport by 2020

Advanced biofuels

The majority of double counted biofuels in the EU are produced from used cooking oil or animal fat. In 2013, the highest consumption of 'other biofuels' (mainly vegetable oils used pure), was reported in Hungary (15%) and Finland (13%)[28]. The biofuel industry argue that double-counting provisions have so far only assisted the deployment of inexpensive conversion of used oils and fats, whereas an advanced ethanol development would require respective mandatory sub-targets[29]. Following the adoption of amendments in the Renewable Energy Directive and Fuel Quality Directive on ILUC, Member States will have to set non-binding national targets for advanced biofuels[30].

26 World Bank (2011)
27 FAO (2008), FAO/BEFSCI, 2012
28 *Eurobserv'ER 2014.*
29 Biofuels International, 2012a
30 Commission’s proposal COM (2012) 595, 2012/0288 (COD).

A number of EU production facilities have already been producing advanced biofuels since 2009, often in conjunction with other bio-based products[31]. Despite the important and continuous progress during the past 5 years, including the opening of commercial production facilities, the development of large-scale production capacity for advanced biofuels in the EU is still slow. It was hampered by technological challenges, feedstock availability, financing and political uncertainty. The most viable business model will in most cases be based on an integrated biorefinery approach that produces both biofuels and a range of other bio-based products.

Electricity and other fuel use in transport

The share of renewable electricity is expected to increase significantly until 2020 and beyond. Given the move towards a low carbon electricity mix, both electrification of transport and the use of renewable hydrogen could contribute to the decarbonisation options of the transport sector.

Around 38 000 electric vehicles were registered in the EU in 2014, up by 57 % compared to 2013. The largest number of registrations was recorded in France (more than 10 700 vehicles), Germany (around 8 500 vehicles) and the UK (around 6 700 vehicles). Nevertheless, electric vehicles continue to constitute only a very small fraction of new registrations (0.3 %). Indeed, the amount of electricity used in non-road transport, e.g. in rail transport, is and will be much more pronounced[32].

Fuel cell propelled cars start to be commercially available and major car manufacturers have announced that they will produce such cars at commercial scale in the future. Currently, the use of hydrogen in transport is negligible and also no significant contribution is expected for 2020. Some Member States have national strategies for the deployment of hydrogen infrastructure for the coming years, therefore some market uptake could still be expected. In some countries, also **biomethane** is used as a transport fuel. Currently, its contribution is very limited but its use might have potential.

Other alternative GHG-poor fuels are currently in development phase. Fuel production from synthetic gas generated water, CO2 and solar energy or green electricity is developed for application to cars and aviation fuel. Another alternative are marine biofuels, however, further research in this area is still required.

Cost-efficiency of the measures to be implemented to achieve the transport target

In most of the Member States the current remuneration ranges cover the gap in the generation costs between fossil fuels and biofuels. The overall trend towards 2020 is that most Member States will use obligations as their main policy measure to ensure sufficient biofuel consumption. Tax reductions and subsidies have been phased out or

[31] e.g. *Inbicon* in Denmark, *Beta Renewables* in Italy, HVO biodiesel is produced by *Neste Oil* in the Netherlands and Finland, methanol produced from glycerine and biogas by BioMCN in the Netherlands, *Borregaard* in Norway, *Chemrec* in Sweden and *Chempolis* in Finland producing ethanol and chemicals from cellulose biomass

[32] EEA (2015).

reduced in several Member States over the past years and it is expected that this trend will continue towards 2020.

Obligations are cost-effective measures to ensure a certain amount of biofuels on the market. For governments it is a policy measure with low direct budgetary impact, which ensures the desired amount of biofuels to reach the market, as long as the fine or buy-out price is sufficiently high.

A more technical element which could limit the total amount of biofuels used in the transport sector is the blending percentage possible. However, public acceptance and industry implementation of higher blends would be necessary steps for increased use of biofuels through the current infrastructure.

Conclusions

Achieving the 2020 target for renewable energy in transport certainly remains technically feasible and the remarkable progress achieved already in some Member States testifies to this. The provision in the Renewable Energy Directive that waste and residue-based biofuels count double towards the transport target has proven to be effective in some Member States in achieving the 2020 transport targets. An increase in the share of renewable electricity in non-road transport together with a minor contribution from electrification of road transport could further contribute to progress in the next years.

However, given the debate about conventional biofuels and the fact that there are no alternatives to biofuels in heavy duty road transport and aviation, additional initiatives will be required, as of 2015. Member States must therefore do more to promote advanced biofuels and enable electrification of their transport fleet. Electrification will also help integration of variable renewable electricity, if administered in a clever manner. Improved funding of research, development and demonstration, cooperation between Member States but also partnerships within the industry, involving both fuel suppliers and consumers, will help fostering the necessary transition.