EUA-EPUE
European Platform of Universities in Energy Research & Education

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EUA-EPUE Response to SET-Plan Consultation

Key Action No. 8: "Strategic Targets for bioenergy and renewable fuels needed for sustainable transport solutions in the context of an Initiative for Global Leadership in Bioenergy"

BACKGROUND

This response provides the perspective of the European Platform of Universities in Energy Research & Education (EUA-EPUE) to the consultative process on the European Strategic Energy Technology Plan (SET Plan) - Key Action No. 8 “Strategic Targets for bioenergy and renewable fuels needed for sustainable transport solutions in the context of an Initiative for Global Leadership in Bioenergy”.

EUA-EPUE responds to the consultation from the perspective of the universities’ role in society. Universities constitute a significant part of the research capacity in Europe. At the same time, they educate the highly skilled work force of our societies. In the area of energy, they are working towards adapting curricula to better educate and train the next generation of human resources to work in the field.

QUESTIONS

For the main expected outcome: To make specific recommendations on the priorities/targets proposed in the issues paper(s)

- Do you agree with the targets set in the issue paper?
- Do you think that the level of ambition is correct?
- Are there any standing issue(s) in the way to reaching the proposed targets/priorities?

It may be useful to understand the broader context in which these targets/priorities need to be achieved. If possible, we suggest that the following is addressed as well:

- *What are your specific recommendations on prioritising R&I activities on these issues (and building where appropriate on relevant existing initiatives)?*
- *Who are the best placed actors to implement the targets/priorities (Industry, EU, Member States, regions, groups of countries/organisations/etc.)?*

General introduction

- The issues paper provides a good summary of the situation and key challenges faced by bioenergy and renewable fuels needed for sustainable transport solutions. Specifically, the versatility of bioenergy is identified as a key characteristic as it allows the substitution of electricity, heat and liquid transport fuels (including aviation).
- The substitution of fossil fuels with liquid biofuels is considered a key option to improve energy supply security and mitigate Greenhouse Gas Emissions (GHG) in the transport sector. However, it should be noted that the GHG saving performance of liquid biofuels compared to fossil fuels has increasingly been debated due to a large number of, partially uncertain, parameters and impacts, as well as methodological issues. It is therefore important to explicitly address the impact of the differences in input assumptions of biofuel production and reference systems, co-product uses and allocation methods and possible effects and uncertainties in e.g., N_2O emissions induced by feedstock cultivation for biofuel production.
- The paper addresses other renewable fuels for transport. In the assessment renewable H_2, Power to Gas (PtG) and Power to Liquid (PtL) are highlighted as promising technologies to decarbonise

the transport sector. There are however a couple of points that are missing or could be further highlighted in the issues paper:

- Renewable H_2 has an important role on decreasing GHG emissions of Renewable Jet Fuels (RJFs). RJFs are a cornerstone of decarbonising the aviation sector. In these fuels, H_2 is a key contributor to their life-cycle emissions (when RJFs are based on residues and lignocellulosic crops).
- The GHG performance of PtG or PtL is highly dependent on the source of electricity (e.g. to produce H_2 via electrolysis) and the source of the CO_2. When fossil CO_2 is used, the GHG performance of the fuel will depend on the source of electricity and the (fossil) fuel that is displaced. However, using bio CO_2 (e.g. from a biomass power plant) instead of fossil CO_2 can result on production of alternative fuels with a neutral GHG. This would make the option more robust and the benefits less dependent on the system boundaries.
- The statement that renewable H_2 could displace fossil fuel hydrogen used in refiners and therefore reduce in the short term GHG emissions is debatable. System analysis will be needed to understand the system implications (where, when, how) of these options. It is also important to assess the economic feasibility of the option.

- The issues paper lists the most important barriers for large scale deployment of bioenergy technologies. The use of biomass substituting non-energy uses of fossil energy carriers e.g. the replacement of coking coal in steel industries and the production of bio-based products (besides fuels) is only partially addressed in the paper. In the long term, the role of biobased chemicals is expected to grow and might become a strong competitor for biomass resources with bioenergy generation. It remains important to understand where and how biomass sources can be used most efficiently and with the higher gains both, at the process and system level.
- In paragraph 3 “Specific, sectorial developments”, section "barriers to address" (pp. 5-7) expresses concerns about the availability and renewability of bioenergy for large scale deployment. These concerns should be better translated in paragraph 5 “Targets”. This paragraph should indeed take into account that, in order to achieve accurate and ambitious targets, a clear assessment of the resource availability is necessary.
- The paper looks at the use of residual biomass as a way to improve the sustainability of bioenergy. However, there is not yet agreement on the economic potential and logistics to collect these resources (at the scale that would be needed) in an economic and ecological sustainable way.

Do you agree with the targets set in the issues paper?

- The strategic targets provide a background for the development till 2030. Clearly missing is a pathway onwards in the timeline 2030 - 2050 which would be essential to emanate a stable framework for long term strategic development.
- The issues paper states in page 8 that “to ensure sustainable use of biomass to bioenergy, it is critical to obtain a substantial GHG reduction by replacing fossil energy (at least 100 milliontonnes CO2)”. It is advisable to consider that life-cycle emissions alone do not guarantee the overall sustainability performance of bioenergy. Sustainability concerns are also related to direct Land Use Change (LUC) and Indirect Land Use Change (ILUC), threats to biodiversity, water resources and food supply security. Focusing only on GHG provides a narrow view on sustainability.

Strategic targets in bioenergy

1. Improve performance in the production of bioenergy
    - Obtain net efficiency of biomass conversion to intermediate bioenergy carriers of at least 75% by 2030 with GHG emissions reduction of 60% from use of all types of bioenergy intermediate carrier products resulting to a contribution to at least 4%reduction of the EU GHG emissions from the 1990 levels.

2. Reduce cost excluding taxes and feedstock cost for intermediate bioenergy carriers(before further processing to final bioenergy products)
    - Liquid and gaseous intermediate bioenergy carriers by thermochemical or biochemical processing: <20 €/MWh in 2020 and <10 €/MWh in 2030 for e.g. pyrolysis oil; <40 €/MWh in 2020 and <30 €/MWh in 2030 for higher quality, e.g.microbial oils
    - Solid intermediate bioenergy carriers by thermochemical or biochemical processing (e.g., bio-char, torrefied biomass, lignin pellets): <10 €/MWh in 2020 and <5 €/MWhin 2030)

3. Reduce conversion system costs for high efficiency (>90% based on net calorific value ofwhich >30% electrical) large scale biomass cogeneration of heat and power by 20% in2020 and 50% in 2030 compared to present levels

- It is recommended to clarify in goal 1 *"Improve performance in the production of bioenergy"* if the GHG emission target includes life cycle emissions and not only the conversion step (gate-to-gate). Furthermore, because the focus is on intermediate carrier products, it will be difficult to monitor whether the GHG reduction will be obtained (e.g. when is dependent on displaced fossil fuel).
- Goal 2 "*Reduce cost excluding taxes and feedstock cost for intermediate bioenergy carriers*" needs a higher level of ambition based on the current already high Technology Readiness Level (TRL) and macroeconomic market conditions.
- In goal 3 "*Reduce conversion system costs for high efficiency*",it is advisable to define what is included in the system and what the boundaries are. Conversion system costs can indeed be subject of interpretation.

Strategic targets in Renewable Fuels for Transport

- The paragraph starts by stating that "immediate action is needed to support development of technologies and their exploitation of *all* advanced renewable fuels". Although further research is needed for many of the options, it is already clear that some of them have a higher environmental footprint than conventional fuels. Advanced fuel does not mean per se that they are more sustainable than conventional ones.
- A key issue that the paper mentions is the need to extend the GHG saving methodology to the full range of renewable fuels and a definition and scheme for Guarantees of Origin (GoO) for low carbon hydrogen. This does not translate in the target, steps or actions named later in the

document.

- There are no specific targets for biofuels for the aviation sector. The current share of global CO_2 emissions ascribed to the aviation sector (both domestic and international) is 2%, but scenario analysis indicate that this may increase to 22% by 2050 if mitigation efforts fall behind those of other sectors. Clear targets and specific policies are urgently needed in order to decarbonise this sector.
- The issues paper states that the food crop-based biofuels can increase to a maximum of 7%. A source not yet considered for increasing the share of alternative fuels is represented by hydrogen, for which there are no major technical challenges for its combustion in the engines. The main challenges for directly using hydrogen in engines are related to the infrastructure for producing, transporting, storing, supply and generating costs of hydrogen.
- An important source of biofuel feedstock is from the biological waste streams of the food and materials sectors. One interesting example are the wastes from leather industry, which are currently 160 000 tones/year in Europe. Almost a third of the leather wastes can be directly used in a blend with diesel, after chemical pre-treatment, for combustion in engines. The LHV of the wastes from leather industry is about 40 MJ/kg, very close to that of diesel. The percentage of leather wastes in the blend can reach up to 10%. A third of the leather industry wastes is represented by protein wastes which can be used to produce biogas with a LHV of 20 MJ/m^3.
- The crops to contribute to biofuels production are: starch-rich crops (cereals, potatoes), sugar crops (sugar cane, sugar beet), oil crops (rape, sunflower, soya, etc), lignocellulosic crops (willow, poplar, miscanthus, arundodonnax, etc). Currently, only 2% of the global biomass production is used in the transportation sector. In 2015, the Council and Parliament (Directive 2015/1513 Article 3d) set a limit of 7% for the contribution of biofuels produced from food crops and established an indicative target of 0.5 % for advanced renewable fuels in transport by 2020. Biomass is considered a carbon-neutral source of energy at the point of use, where the carbon dioxide released during combustion is re-absorbed by crops when they re-grow and in this way contributes to maintaining the GHG emission level.
- Bioenergy is obtained from biomass through: direct combustion, pyrolysis with syngas generation, fermenting with biogas and bioethanol generation, chemical transformation of biomass in methyl esters (biodiesel) and glycerol, enzymatic degradation of biomass obtaining ethanol and biodiesel. The purified biodiesel can be combusted in diesel engines, and the vegetal oil in blends with diesel in variable (flexible) shares which can be combusted in conventional or modified diesel engines.
- Whilst the so-called carbon-neutrality of biomass for energy remains controversial, much work and new standards should be established in order to allow industry to demonstrate net carbon and GHG emissions in the supply and use of biofuels. Indirect impacts have been shown to be minimal in the major biofuel production supply chains.

1. Improve production performance

1.1. Advanced Biofuels

- By 2030, improve net process efficiency of conversion to end biofuels products of at least 30% compared to present levels, with simultaneously reducing the conversion process costs.
- By 2020, obtain total production of 25 TWh (2.15 Mtoe) advanced biofuels.

- The target for 2020 of 25 TWh advanced biofuels needs a higher level of ambition. This means that the target should duly take into account a wider integrated approach for decarbonisation as mentioned in the introduction of this issues paper. The "advanced biofuels" are not necessarily the desired outcome while decarbonisation of the transport sector is. The main barriers consist in oil and gas prices evolution, methanol toxicity, although other non-toxic, so-called 'drop-in' biofuels can be produced.
- Bio-ethanol, bio-butanol and dimethyl ether can be easily used in mixtures with diesel fuel. The main barriers imposed by these fuels consist of slow cost reduction and corrosion of supply systems. The evolution will depend on the development of materials resistant to this corrosion. Other novel fuel molecules are emerging (e.g. from US research) and this area is likely to evolve.
- Reaching the target on advanced biofuels is strongly correlated with continued investment in R&I and demonstration, and with the widespread diffusion of electric vehicles. Developing a focus area of using biofuels in the agriculture and food provision sectors could make the target more reachable, as e.g. agricultural equipment does not require sudden variations of torque compared to the road vehicles. Thus, the deposits of materials in the engines as corrosion phenomena are reduced.

1.2. Other renewable liquid and gaseous fuels

- By 2030, improve net process efficiency of various production pathways of advanced renewable liquid and gaseous fuels18 of at least 30% compared to present levels.
- By 2030, for renewable hydrogen production by electrolysis improve net process efficiency to reach 70%.

- The target for renewable hydrogen is made explicit for electrolysis. As the target is for 2030 and there are several R&D technologies in this area it would make sense to set the target for renewable hydrogen (e.g. in terms of energy per unit of H_2) and do not link it directly to only one technology.

- In a recently H2020 call[1], it was asked to demonstrate " an energy consumption consistent with 2020 expectations of 52 kWh/kg @ 1000+/kg for alkaline technology and 48 kWh/kg @ 1000+/kg for PEM technology at nominal power". As the values are equivalent to those in footnote 19 of the issues paper, it seems then that the SET target is low (as it could be achieved by 2020). In several biofuel production processes, CO_2 (bioethanol) as well as CO_2 and H_2 (e.g. butanol production via ABE fermentation) are produced in a very concentrated and easy to capture forms. Further, reuse of such sources should be implemented first (biorefinery concept) alongside continued R&I of looking to CO_2 sources which need large efforts (and costs) for capturing and purification before further use.
- Focusing on, for example, industry and food system wastes and by-products could help in reaching the target. One example, through this value generation approach in the leather industry alone, could provide about 1.5 TWh. In addition, more support is needed for lignocellulosic feedstock production, coupled to whole system, integrated agriculture and forestry, approaches to the sustainable provision of biomass.
- A strong regulatory framework at EU level is needed in order to achieve the target.

2. Improve GHG savings

- The proposed target covers the estimated GHG savings from using biofuels, and the European legislation[2] state that GHG savings from the use of biofuels shall be at least 60%. The capture and reuse of CO_2 is neutral with respect to GHG as the natural process of reuse is based on photosynthesis and transformation of CO_2 in biomass, and in the end, in this case, into biofuel. Thus, it is at least a semi-closed cycle. In addition, the last sentence of this section does not specify which % of the 40% should be targeted in 2030.
- Closing the carbon cycle, requires energy inputs to split the CO_2 molecule into C and O_2 (provided by solar radiation in photosynthesis), and afterwards re-emits the energy when C and O_2 are combined e.g. through combustion. But the CO_2 reduction needed to produce energy-rich molecules is made possible by combining the splitting with hydrogen production technologies using non-polluting energy sources (wind, solar, hydro), if GHG emissions are to be minimised. The hydrogen produced in this way appears to be a solution to reduce GHG emissions and also for the management of electricity peaking and grid storage. If H_2 fuel cell technology is improved to a level that it is viable for transport, for example, then use of CO_2 capture and reduction would not be as desirable.
- A proper design, implementation, monitoring and verification of the whole production chain is required. Whilst these assurance and certification systems are being pioneered in bioenergy supply chains, they will need to be applied to the biological food and materials sectors too.
- The increase in railway transportation is an important and increasing source of GHG emissions in transportation. The European Union can enhance the rate of electrification in railways,

[1] FCH-02-7-2016 "Demonstration of large-scale rapid response electrolysis to provide grid balancing services and to supply hydrogen markets"
[2] Renewable Energy Directive (Directive 2009/28/EC) and Fuel Quality Directive (Directive 2009/30/EC)

developing fast railway routes both for freight and people. However, a substantial share of energy dense, low GHG liquid fuels would still be required for marine, long-distance road and aviation (see IEA, World Energy Outlook, 2015).

3. Reduce Costs

3.1. Reduce cost (excluding taxes and feedstock cost) for end biofuel products

- Liquid or gaseous advanced biofuels by thermochemical or biochemical processing: <50 €/MWh in 2020 and <35 €/MWh in 2030 e.g. at least by 30% from 2020 levels
- Algae based advanced biofuels <70 €/MWh in 2020 and <35 €/MWh in 2030 e.g. at least by 50% from 2020 levels

3.2. Reduce cost for renewable liquid and gaseous fuels

- Other renewable liquid and gaseous fuels excluding renewable hydrogen: at least by 50% from 2020 levels
- Renewable hydrogen: by electrolysis <4 €/kg.

- "Smart biorefineries" need to contribute to the economics of biofuel production. Furthermore, incentives should be implemented in line with existing regulation.
- The target price should also be in line with potential carbon emissions savings. The more advanced the biofuel, the more valuable it is under such a scenario.
- In goal 3.2 "*Reduce cost for renewable liquid and gaseous fuels,* the target of at least 50% from 2020 levels should be better specified. It should also be clarified if this target is to be reached by 2030.

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