EUROPEAN COMMISSION
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SET Plan Secretariat

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SET-Plan – Declaration of Intent on "Strategic Targets for bioenergy and renewable fuels needed for sustainable transport solutions in the context of an Initiative for Global Leadership in Bioenergy"

1. Purpose of this new document

This document[1] is intended to record the agreement reached between representatives of the European Commission services, representatives of the EU Member States, Iceland, Norway, Turkey and Switzerland, (i.e. the SET-Plan Steering Group) and representatives from the SET-Plan stakeholders on the implementation of the actions contained in the SET-Plan Communication[2], and specifically the strategic targets for the priority "Diversify and strengthen energy options for sustainable transport" for what concerns market take-up of renewable fuels and the actions concerned with the priority "Number one in renewable energy" for bioenergy.

This agreement follows consultations with stakeholders listed in Annex A as well as a public consultation via the SETIS website[3] on an issues paper prepared by the Task Force members[4]. It takes into consideration the corresponding input papers and public comments available on SETIS (https://setis.ec.europa.eu/towards-anintegrated-SET-Plan) and discussions in the SET-Plan Steering Group on 16 November 2016 with the participation of the relevant SET-Plan stakeholders.

The stakeholders agree to highly ambitious targets in an endeavour to strengthen market take-up of renewable fuels, to put forward their best efforts in a coordinated way between public and private sectors, and to jointly address all relevant issues in order to attain the agreed targets.

[1] This document has no legally binding character, and does not prejudge the process or final form of any future decisions by the European Commission.

[2] Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation" (C(2015)6317)

[3] Strategic Energy Technology Information System website https://setis.ec.europa.eu/system/files/action8_issues_paper.pdf

[4] Under the mandate of the SET Plan Steering Group members, a task force incorporating 6 MSs (FI, DE, FR, IE, IT and SE) and three Commission DGs (ENER, JRC & RTD) kicked-off on 30/08.

2. Introduction

Energy from biological resources is currently the most widely used renewable energy source worldwide. .According to the International Energy Agency (IEA), bioenergy accounts for roughly 10% of the global energy supply. Based on Eurostat records, it contributes to Europe's energy supply almost as much as the primary energy production of indigenous gas and more than that of indigenous oil. Furthermore, it represents two-thirds of Europe's renewable energy sources with an absolute growth in the last five years as important as the growth of all other renewable sources together.

Bioenergy is the only renewable energy source that is continuously available and versatile: on the product side; it can contribute to replace fossil fuels in all energy markets, heat, electricity with base load and flexible capabilities, allowing the integration of high renewables share (wind, solar) into electricity grid, as well as fuels for transport, including for aviation. On the supply side it may benefit from large availability and wide variety of potential feedstock such as energy crops and wooden biomass, but also residues from both agriculture and forestry, the organic fraction of municipal and industrial solid waste, as well as algae and aquatic biomasses. Feedstock flexibility is an important requirement for future plants as it is important for cost reduction.

On the path from resources to the final energy product there are many technologies used for feedstock preparation on one hand and for the conversion into the final product, being electricity, heat or transport fuel.

It is due to this versatility that an integrated approach is followed here to enhance the synergies and economies of scale, to achieve economic benefits in the value chain to ultimately reduce the production costs and to optimise the greenhouse-gas performance of all bioenergy-products through technology and feedstock upgrading. Although cost structure is heavily influenced by feedstock cost, this document focuses on R&I needs and targets solely for the conversion step.

In the longer-term, the very ambitious European climate targets of decarbonisation across all sectors beyond 2050 require a holistic look at the energy system, fully taking into account the interdependencies between various energy consuming sectors, and fully relying on low-carbon technologies. The use of renewable hydrogen and other renewable liquid and gaseous fuels derived therefrom (Biomass-to-liquid, Power-to-Gas including hydrogen and Power-to-Liquid) could play an important role not only in decarbonizing transport, but also in enabling the cross-sectorial integration of surplus renewable electricity and realizing a fully renewable energy supply linking the electricity, heating, transport and industrial sectors. These technologies could prove indispensable in the scenario where low-carbon renewable electricity needs to be stored either in large quantities or over very long-time (inter-seasonal storage). In addition, renewable hydrogen can also be used for upgrading biomass, allowing for additional synergies.

3. Policy Framework

The 2030 Climate and Energy Policy Framework for the period from 2020 to 2030 has set the objectives to reach a 40 % reduction in GHG emissions by 2030 compared to 1990, a binding target of at least 27 % for the share of renewable energy in 2030 and a 27% energy efficiency indicative target. The Energy Roadmap 2050[5] investigated possible pathways for a

[5] COM(2011) 885

transition towards a GHG emission reduction of 80% economy-wide. Bioenergy production for heating & cooling, electricity and transport is expected to play a major role in the decarbonisation in all scenarios of the Energy Roadmap 2050.

Within the current policy to achieve a RES share of 20% of final energy consumption by 2020, Member States committed in their National Renewable Energy Plans (NREAPs) to deploy bioenergy capable to deliver 140 Mtoe, which would correspond to about 57% of all RES, or in other terms, to about 12% of the entire final energy consumption. Moreover, a more ambitious 2020 target of 10% of the energy requirement for fuels for all forms of transport was set out in Directive 2009/28/EC, which included all renewable energy sources for transport, not just biofuels. To address sustainability of Biofuels for transport, 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 (e.g. cereal and other starch-rich crops, sugars and oil crops) and established an indicative target of 0.5 % for advanced renewable fuels in transport by 2020. These fuels should be based on non-food biomass feedstock, residues and wastes and of non-biological origin like renewable power to gas and power to liquid fuels (feedstock listed in Annex IX of Directive 2015/1513). However, there is still a need to extend the GHG savings methodology to the full range of renewable fuels and a for definition and scheme for guarantees of origin (GoO) for green hydrogen.

Regarding RE policy towards 2030, the EU considering a binding target of 27% by 2030 for renewable energy's share, and a decrease of Europe's final energy consumption to 950 Mtoe (2015: 1050 Mtoe), it is realistic to assume a contribution of 160 Mtoe (17%) by bioenergy, compared to 103 Mtoe achieved in 2014.

The final share however will depend on the cost and availability of sustainable biomass as a whole for all biomass origins and for uses including food, feed, and industrial uses of biomass.

4. Targeted Technologies

The scope of this declaration shall be to focus on bioenergy and renewable fuel solutions for sustainable transport, solutions for overcoming the barriers of feedstock availability and the economics of bioenergy production, in particular of larger CHP plants.

Renewable Fuels for Transport

The Renewable Energy Directive[6] established a 10% share of renewable sources for transport in 2020. However, the debate on sustainability of conventional biofuel production has led to more stringent sustainability criteria and for first generation biofuels, whilst 2nd generation biofuels still face multiple technical and economic barriers. Significant improvements are still required to achieve technical maturity and commercial availability of various conversion technologies for lignocellulosic biofuels production. In general for advanced biofuel production, the necessary technical maturity and efficiency can only be achieved through experiences with industrial scale-up and "first-of-a-kind" plants.

The share of biofuels, with 13.3 Mtoe in 2014, remained at 5.4%, and constitutes about 13% of all bioenergy. There is a need to increase this share by using replacement fuels from lignocellulosic biomass, residues, and power to gas/liquid that do not result in competition with food or land. In the absence of supporting policies and relatively low oil-prices, large-scale production of cost-competitive drop-in fuels will be very challenging. There are various

[6] Renewable Energy Directive (2009/28/EC)

options for the substitution of fossil-derived diesel for road transport, for example synthetic drop-in fuel made from lignocellulosic and low-ILUC[7] sustainable biomass which does not require any engine modification and therefore permits immediate introduction.

For aviation, liquid renewable fuels are seen as the only viable option for the mid-term to long-term (30-40 years). Today, only a limited quantity of aviation biofuels is available.

Other renewable Fuels of non-biological origin

There are other promising technologies under development to produce both liquid and gaseous renewable fuels. Renewable electricity can be used to produce renewable hydrogen (H_2) which can be used both for transport and non-transport purposes (zero-carbon emission fuel cell vehicles, injection into the natural gas grid), to be reacted with carbon dioxide captured from other processes to give either a liquid or gaseous transport fuel (power-to-gas, power to liquid). Although other pathways to use hydrogen as a fuel in transport are also feasible, e.g. via the use of synthetic methane in compressed natural gas (CNG) vehicles or through conversion to methanol, the use of pure hydrogen in fuel cell electric vehicles (FCEVs) should be prioritised on the basis of higher energy efficiencies.

Beyond direct use of renewable hydrogen in (FCEVs), renewable hydrogen could also be used as substitute of fossil hydrogen used in refineries in the production process of diesel and gasoline, hence reducing the GHG emissions of transport sector in the short term.

Bioenergy for power generation

With the increase of electricity production by solar and wind, the flexibility of power generation by biomass power plants has developed into a strategic asset for increasing further renewable electricity production for maintaining grid stability, and allowing higher stares of variable renewables (wind, solar). Bioelectricity generated from biogas has exhibited the largest growth rate, reaching more than 36% of bioelectricity production. Bioelectricity production across EU has increased significantly, and the current share (18.9%) of bioelectricity is already close to the 2020 expected, EU-wide share (19.3%)[8]. As an economically viable means to increase further grid penetration of solar and wind, power generation from biomass is expected to continue to increase significantly, both on a small and large scale.

Bioenergy for heating and cooling

The bioenergy contribution for heating and cooling has currently the largest share (88%) of all RES used for heat and cooling with 76 Mtoe, quite close to the 2020 Member States plan of 90 Mtoe. Towards 2030 a moderate increase can be anticipated due to increased CHP deployment, together with the integration requirements of renewable electricity satisfied by bioenergy produced electricity and further energy efficiency improvements of Europe's building stock.

5. Challenges to address

The availability and cost of sustainable **biomass feedstock** is a major barrier for large scale deployment of bioenergy technologies. There are significant uncertainties with regard to biomass potential for energy use due to difference in approaches, assumptions, aggregation levels that need to be addressed. It is also important to note that there is not only competition but there are also great synergies between these different uses.

[7] Annex IX of Directive (EU) 2015/1513 on the promotion of the use of energy from renewable sources

[8] As planned by the member states in their National Renewable Energy Plans (NREAP)

A main issue regarding the viability of bioenergy plants lies in the development of a reliable, integrated biomass supply chains from cultivation, harvesting, transport, storage to conversion and by-product use across Europe. Secure, long-term supply of sustainable feedstock – often by local supply chains -is essential to the economics of bioenergy plants.

Consequently and for overcoming the barriers of feedstock and economics of bioenergy production vis-à-vis higher capacity plants, it is necessary to improve the performance of the biomass **conversion** to intermediate bioenergy carriers analogous to coal, oil and gaseous fossil energy carriers and thus create the crude energy feedstock basis that could be further refined to final bioenergy products or directly used for heat and power generation. The conversion solutions can either be based on local feed stocks or in large scale and long transportation distances on low-cost bioenergy carriers.

The further **processing** of intermediate bioenergy carriers to advanced biofuels for transport purposes and the development of heat and power from biomass have additional particular challenges, related to performance concerning necessary technological development for improving the conversion and energy efficiency and reduce the production cost of the end product, but also to sustainability. These challenges are equally important for both thermochemical and biochemical/biological technological pathways, including the use of algae. On the other hand, sustainability in terms of environmental and social impacts is essential for increasing public acceptance of bioenergy production and enabling bioenergy deployment.

Sustainability both for bioenergy and biofuels is a concern as it can reduce public acceptance. It can improve when bioenergy is provided by waste or residual streams of biological materials. The use of residual biomass allows the valorisation of waste streams for energy recovery and it generally provides environmental benefits with environmental risks that can be minimized by proper management guidelines. These shall comprise land-use footprints, water resources and overall-lifecycle performance. Energy from biomass can also be an already existing part of a future circular economy and shall take advantage of the multiple product opportunities biomass can deliver.

The **economic competitiveness** of bioenergy can be improved in integrated systems such as biorefineries with co-production of high-value biochemicals in addition to biofuels, power and heat. Combined Heat and Power (CHP) could improve the economic performances of bioenergy plants, with some limitation due to local and seasonal heat demand and capital costs of the district heating/cooling network. Within a developed smart grid, such cogeneration district heating systems would have a large potential to compensate the lower generation of solar electricity during the heating season.

Although the GHG mitigation potential of hydrogen technologies is promising, important obstacles for widespread deployment need to be overcome. Most hydrogen technologies are still in the early stages of commercialisation and currently struggle to compete with alternative technologies, including other low-carbon options, due to high costs. Additional attention will be required before their potential can be fully realised.

The barriers are mainly related to cost efficient generation of low-carbon renewable hydrogen, including current high costs of the electrolyser technology. The other technical issues that must still be resolved include better adaptation to operation under variable load, making the technology more compact and durable as well as efficiency improvements.

Given the positive contribution to both energy security and climate mitigation goals, **advanced renewable fuels** can justify the short-term high economic cost, with the perspective that they can prove to become viable and cost effective in the longer-term through technological improvements. However, market analysis shows that both development and deployment is behind expectations. Therefore, the necessary technical maturity and efficiency can only be achieved through experiences with industrial scale-up and "first-of-a-kind" plants.

6. Targets

6.1 Renewable Fuels for Sustainable Transport

With regard to resource efficiency and costs, it is always necessary to consider all possible uses and products derived from the renewable sources, including for example renewable electricity and renewable chemicals and materials. There is growing interest in industrial products derived from renewable sources and, as a consequence, bioproducts within the emerging bioeconomy and the growing competition for available biomass and water can have an impact on biofuels production costs. In the same context, integrated biorefineries that convert biomass into advanced biofuels and other products such as biochemicals can improve the cost-competitiveness of the overall biomass conversion process and maximise resource efficiency. In any case, advanced biofuels should only be produced from environmentally sustainable biomass and must comply with sustainability criteria and constraints laid out in the RED and ILUC directives aiming at replacing fossil based fuels that continue to be incentivized today.

Renewable liquid and gaseous transport fuels of non-biological origin (e.g. power to gas and power to liquid), which in the future are expected to make a significant contribution to the total decarbonised transport fuels mix in the future and require targeted short term actions. Besides, they can also be integrated into biorefinery concepts to utilise available bio-CO2 (bio-Carbon Dioxide Capture and Utilisation, Bio-CCU). Furthermore, there are extensive potential opportunities for cost-effective integration of biofuel and renewable fuel production into other industries using renewable feedstocks. The high proportion of cost associated with sourcing of biomass needs to be addressed through further research on biomass production and supply chains.

Given the positive contribution to both energy security and climate mitigation goals, advanced renewable fuels can strongly justify the short-term high economic cost that their production implies, with the perspective that they can prove to become viable and cost effective in the longer-term through technological improvements. It is clear from stakeholder comments that many synergies exist between biofuels and other renewable fuels of non-biological origin and there are many opportunities for process integration to optimise resource efficiency. It is also clear that the contribution of many different types of renewable fuels (e.g. a diverse range of alcohols, hydrocarbons, H2, electricity, etc.) will be needed to achieve fossil fuel substitution across all transport modes (road, rail, waterways and aviation).

It is equally clear that each Member State must make its own sustainable transport fuel implementation plan based on its own strengths and resources. It is vital however that the EU ensures a supportive and stable policy framework for fossil fuel substitution to be achieved in a sustainable manner.

Agreed Strategic Targets in Renewable Fuels for Sustainable Transport

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[9]

1.2. *Other renewable liquid and gaseous fuels*

- By 2030, improve net process efficiency of various production pathways of advanced renewable liquid and gaseous fuels[10] of at least 30% compared to present levels
- By 2030, for renewable hydrogen production by electrolysis improve net process efficiency to reach 70% [11]

2. Improve GHG savings

Total GHG savings through use of advanced biofuels and renewable fuels will be at least that required in Directive (EU) 2015/1513 where Article 7b (amended) states that greenhouse gas emissions saving from the use of advanced renewable fuels shall be at least 60%. The greenhouse gas emission saving from the use of biofuels shall be calculated in accordance with Article 7d(1) of the same Directive and should be at least 60% of the 40% target in 2030.

3. Reduce Costs *(excluding taxes and feedstock cost)*

In conclusion, the target price in 2020 and 2030 for advanced biofuels and renewable fuels should be within a reasonable margin from parity with the fossil based fuels. Nevertheless, when policy incentives for CO_2 reduction are taken into account, they should aim to be in parity with fossil fuel prices in 2030. This will require in particular improvements in process efficiency and energy balance through the application of innovative practices[12].

3.1. Reduce 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 (<50 €/MWh)
- Renewable hydrogen: <7 €/kg.by 2020 <4 €/kg.by 2030 (electrolysis, reforming,..)

6.2 Bioenergy

Increasing the overall efficiency of the heat and power cogeneration and in particular the electrical efficiency is essential towards further reducing the cost of electricity and heat from biomass. A particular consideration shall be devoted to the development of smart integration concepts, such as the hybrid integration of biomass based cost-competitive polygeneration units, interacting with other RES in an integrated hybrid system mode and

[9]this corresponds to the non-binding target of 0.6% of the approximately 4100 TWh (350 Mtoe in 2014) total transport fuel consumption and to 3 GW installed production capacity.

[10]for example using renewable electricity to produce gaseous or liquid fuels, including the capture and reuse of CO2, as well as synthetic fuels made by other innovative processes

[11]50-47kWh/kg H2

[12]To determine the price margin, input from stakeholders and Member States will be needed for developing the Implementation Plan.

securing grid stability (e.g. heat, electricity, biofuels etc.). This includes taking into account regional feedstock availability, sustainability, storage, distribution and energy demand. The achievement of the overall bioenergy targets will depend not only on technological advances, but also on non-technological factors such as economies of scale (i.e. resulting from an increase in produced and installed capacity), risk-finance for first-of-a-kind manufacturing pilot lines and demonstration of small, commercial-scale bioenergy, biofuels and biomass co-fired CHP plants, as well as standardisation. Of equal importance will be the integration within the existing process industry for the main pathways.

Agreed Strategic Targets Bioenergy:

1. Reduce conversion system costs for high efficiency (>70% based on net calorific value of which >30% electrical) large scale biomass cogeneration of heat and power by 20% in 2020 and 50%

2. Improve performance and reduce GHG emissions by increasing efficiency: Obtain net efficiency[13] 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 intermediate bioenergy carrier products [14] resulting to a contribution to at least 4% reduction of the EU GHG emissions from the 1990 levels.

6.3 Intermediate Bioenergy carriers:

Increasing the efficiency of intermediate bioenergy carriers' production paves the way for reducing costs of the final bioenergy products and allows for new industrial and market opportunities. As costs of feedstock now account for around 50% of bioenergy costs, efforts need to be directed at reducing these costs via the use of intermediate bioenergy carriers and creating a commodity market for them. Cheaper and standardized intermediate bioenergy tradable commodities will allow for energy decentralized production with positive results to both rural development and cost reduction of final bioenergy products (biofuels, bio heat and bio power).

Agreed Strategic Intermediate Bioenergy Carriers[15]

Improve performance and reduce cost (excluding taxes and feedstock cost)[16] for intermediate bioenergy carriers (before further processing to final bioenergy products)

A. 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

B. Solid intermediate bioenergy carriers by thermochemical or biochemical processing (e.g., bio-char, torrefied biomass, lignin pellets): <10 €/MWh in 2020 and <5 €/MWh in 2030 compared to present levels.

[13]Net efficiency is the percentage of useful energy output compared with the net sum of energy inputs where the energy content is based on LHV (Lower Heating Value)

[14]For bioenergy products, other than biofuels and bioliquids for which GHG savings are not yet defined in directive 2009/28/EC, the Commission has indicated the targets set for biofuels and bioliquids should be used. Otherwise the reference will be the displaced fossil fuel use

[15] In the context of this document intermediate bioenergy carriers are formed when biomass is processed to energetically denser intermediary products analogous to coal, oil and gaseous fossil energy carriers that could be further refined to final bioenergy products or directly used for heat and power generation. The former European Industrial Bioenergy Initiative (https://setis.ec.europa.eu/system/files/Bioenergy%20EII%202013-2017%20IP.pdf), nowadays part of the ETIP on Bioenergy, provides examples of intermediate bioenergy carriers such as torrefied biomass and pyrolysis oils, microbial oils, algae oils, etc,

[16]The purpose of this target is to give a rating for different technologies concerning their cost competitiveness. Hence this includes production plus profit margin and relevant costs to point of sale to a customer where applicable, and excludes product related taxes applied (e.g. VAT) and feedstock cost

7. Next steps

The public and private stakeholders will:

- develop within 6 months a detailed implementation plan for the delivery of these R&I targets, in particular:
- determine joint and/or coordinated actions; to identify the ways in which the EU and national research and innovation programs could most usefully contribute;
- identify the contributions of the private sector, research organizations, and universities;
- identify all issues of a technological, socio-economic, regulatory or other nature that may be of relevance in achieving the targets;
- report regularly on the progress with the purpose to monitor the realisation of the targets and take rectifying action where and whenever necessary.

The stakeholders intend to use the new European Technology and Innovation Platforms for Bioenergy and for Fuel Cells and Hydrogen as the main vehicle for discussing and agreeing the implementation plan.

ANNEX A: List of stakeholders who have provided Input Papers

- European Producers Union of Renewable Ethanol (ePURE)
- European Platform of Universities in Energy Research & Education (EUA-EPUE)
- European Biomass Industry Association (EUBIA)
- European Technology Innovation Platform Bioenergy (ETIP Bioenergy)
- Fuel Cells and Hydrogen Joint Undertaking (FCH JU)
- RHC Platform (ETIP RHC)
- Energy Materials Industrial Research Initiative (EMIRI)
- COGEN Europe (The European Association for the Promotion of Cogeneration)
- European Power Plant Suppliers Association (EPPSA)
- New Research Grouping for Hydrogen and Fuels Cells (N.ERGHY)
- DHC+ Technology Platform
- New European Research Grouping on Hydrogen and Fuel Cells
- TUBITAK (TK)
- CDTI- Centre for the Development of Industrial Technology (ES)

Task Force for developing this Declaration of Intent

- Energy Department, Ministry for Energy and Environment (FI) *[Lead]*
- Fachagentur Nachwachsende Rohstoffe e.V.(DE)
- Ministry of Environment, Energy and the Sea, DG Energy & Climate (FR)
- Department of Communications, Climate Action and Environment (IE)
- University Perugia (IT)
- Research and Innovation Department. Swedish Energy Agency (SE)
- European Commission, DG Research and Innovation, Units G2 and G3
- European Commission, DG Energy, Unit C2
- European Commission, Joint Research Centre, Units C4 and C6