BE
sustainable
The magazine of bioenergy and the bioeconomy
July 2020

BIOECONOMY IN FRANCE

Bioeconomy and the CAP | Bioenergy towards 2050
Precision forestry | Advanced Biofuels | Marine Biofuels

BIOMASS FOR THE GREEN TRANSITION, THE IMPORTANCE OF SCIENCE AND OTHER LESSONS LEARNT DURING THE LOCKDOWN

Like every year, the digital issue of BE Sustainable is launched together with the start of the European Biomass Conference and Exhibition, which was originally planned for last April and then postponed to July due to the lockdown. Many of the articles you will find in this issue were written either before or during the lockdown, so before publishing we asked ourselves if they were still up-to-date.

The answer is yes definitely. As Europe is planning its recovery, it is clear that the green transition and the pathway towards the decarbonization of our economy will remain as cornerstones of this strategy. Quite likely the EU climate and energy targets will be increased in the next years. Several of the industrial players which had announced investments in renewable fuels and advanced biofuels before the lockdown have confirmed their long-term commitments, including some in large-emitting sectors such as the refining industry, aviation and maritime transports.

The Next Generation EU programme and the new EU multiannual framework 2021-2017, will be key opportunities to boost the bioeconomy sector and to prove the pivotal role of biomass for the decarbonization of our economy, job creation and growth. An article in this issue explains how the new CAP will support the bioeconomy.

I think the pandemic reminded us the importance of taking political decisions based on acknowledged science- and fact-based information.

It also made us realize why we need to have long-term continuous investments in research and innovation to find solutions for today's problems. Lastly, global challenges require global responses and climate change is one of those.

These are also the principles and the criteria that inspire both this magazine and the European Biomass Conference and Exhibition, organized this year in an entirely virtual platform for the first time in its history. In the last months we all became more aware than before of how much we can already achieve by using digital tools to connect to our peers and to put our minds at work in a collaborative way. This is a trend that will certainly stay in the future, let' use our creativity and take advantage of these tools for the benefits of a sustainable biomass sector, while waiting for better times to meet again in person, freely and safely at the next EUBCE.

Enjoy reading.

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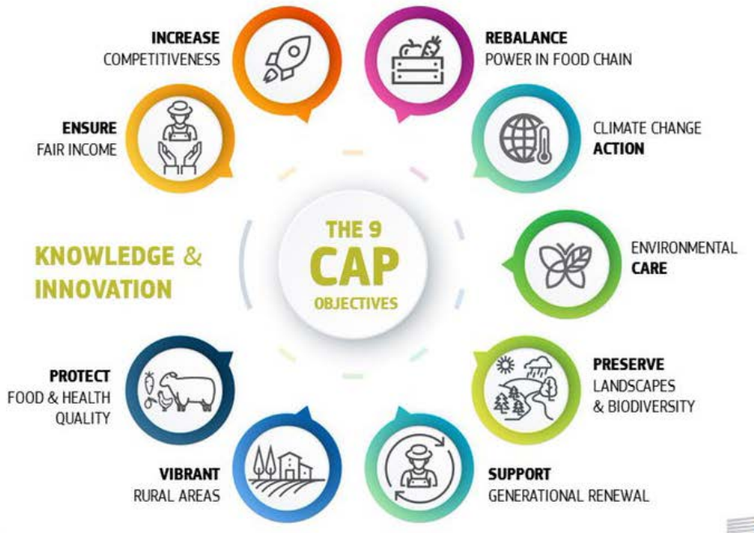


#EUBudget #FutureofCAP

European Commission

BIOMASS AND THE BIOECONOMY IN THE NEXT CAP

Nicola Di Virgilio, European Commission DG Agriculture

Supporting the decarbonisation in the EU in a system-wide approach by developing the bioeconomy through the post-2020 Common Agricultural Policy.

The bioeconomy offers important opportunities for the decarbonisation of the European economy. Its role is clearly recognised in the Communication adopted by the EU Commission in November 2018 "A Clean Planet for all"[1], in which the Commission set out its vision for a climate-neutral EU. The document explores several pathways for EU sectors and their contribution to reach carbon neutrality by 2050, concluding that the development of the bioeconomy for the substitution of fossil-based materials is key to achieve that. This will imply sourcing biomass from waste, crops and forest residues, further promoting circular solutions in the supply chains of biogas and advanced biofuels, with a further development of non-food crops on agriculture land.

The modelling exercise envisages that depending on the analysed scenarios, the domestic production of feedstock to fulfil the EU demand for bioenergy, would range from 214 Mtoe to more than 320 Mtoe by 2050, of which 38 Mtoe to 108 Mtoe are provided by fast growing energy crops, such as lignocellulosic grasses and short rotation coppices.

The analysed scenarios with the highest energy crop requirements see about 29 Mha of land being used for new energy crops, representing a **diversification in agricultural land use equivalent to 10%.**

The contribution of energy crops is fundamental in order to avoid unsustainable use of forests, to maintain the natural carbon sink while preserving ecosystems, therefore an increase of land cultivated with energy crops is expected in all tested scenarios. For the same reason, adaptation measures to climate change are also needed in order to ensure a sustainable production of biomass. Although biomass can be considered as a diffused resource, Member States in EU have different situations in terms of land availability, farming system, socio-economic conditions, which affect their biomass potentials, thus calling for different strategies.

BIOECONOMY, ENVIRONMENTAL AND CLIMATE AMBITION IN THE NEW COMMON AGRICULTURAL POLICY

Bioeconomy is seen as a good opportunity for rural areas, which will spur innovation and creation of new jobs in primary production and processing, increase and diversify rural income.

The Commission's legislative proposals of the CAP for the period 2021-2027[2] recognises these opportunities including specific elements which will support the bioeconomy in its role for the decarbonisation of the European society.

For the first time indeed, **the bioeconomy is clearly mentioned among the EU common specific objectives of the future CAP**, highlighting its potential to improve both the environment and the climate, while providing new business opportunities for farmers and rural areas.

Actions under the new CAP are expected to contribute up to 40% of the overall financial envelop to climate objectives, with **at least 30% of the total European Agricultural Fund for Rural Development (EAFRD) contribution that shall be reserved for interventions addressing the specific environmental and climate-related objectives**.

Specific indicators on the bioeconomy are also part of what is called the new common monitoring and evaluation framework of the future CAP. A policy impact indicator on the production of renewable energy from agriculture and forestry, two policy results indicators on investments in renewable energy production and the number of bioeconomy-related business developed, will be used as a reference for preparing and assessing the CAP strategic plans of Member States.

HOW THE NEW CAP WILL SUPPORT THE BIOECONOMY

The current CAP already provides several instruments supporting farmers and forest owners participating in the bioeconomy. The switch to de-coupled payments in the last reforms gave the possibility to farmers to adapt to market demands of biomass.

Furthermore, within the Rural Development Plans, several examples can be found on investments for renewable energy production, anaerobic digestion, local operational groups involving farmers in innovation projects on bioeconomy, on cooperation and knowledge transfer[3].

In the proposed new CAP, **three** new main elements can help to further improve the participation of primary producers into the value chains created by the bioeconomy.

Firstly, the new CAP delivery model is based on a rebalanced responsibility between the Commission and Member States with more subsidiarity for Member States, which will apply to both direct payments and EAFRD. This will allow the definition of **local-specific strategies**, based on a SWOT analysis for each of the new CAP objectives, **including the bioeconomy**.

This would normally start with the identification of the biomass potentials. Member States would then propose specific combinations of the main types of interventions in order to answer to their specific needs linked to the bioeconomy, (such as decoupled direct support, basic income support for sustainability, coupled support, eco-schemes for the climate and the environment, management commitments, investments, cooperation, knowledge exchange and innovation).

Secondly, the bioeconomy can be specifically supported with the **eco-scheme intervention**, a new way of spending Pillar I funding (i.e. without Member States co-financing) on environment and climate objectives. Under certain conditions the production of biomass can provide different ecosystem services, such as soil and animal protection, increase soil organic carbon and improve water filtration. The **eco-scheme is a land-based payment additional to basic payments**, for genuine farmers, voluntary for them and compulsory for Member States to target specific needs or areas. They can be used for example to support a **change of crop rotation schemes**, including the coverage of soil with novel crops for anaerobic digestion (e.g. intermediate crops) in sensitive periods; **to enlarge filtering strips along river courses** beyond what required in the basic conditionality and allowing harvest of biomass without compromising the filtering function; **to support paludiculture for wetlands** (i.e. the cultivation under wet conditions, of lignocellulosic grasses and trees able to grow in wet conditions). The basic conditionality – linking area- and animal-based CAP payments to a range of obligations – goes beyond the current requirements, focusing, on the **protection of soil organic carbon**, which ensures a basic level of sustainability when dealing with the production of biomass or the removal of crop residues.

Rural development plans can complement for example by

providing support for investments such as machinery for harvesting biomass in wet conditions, biogas plants and distribution systems, energy efficient systems, solar or wind farms. They can also provide support to encourage the development of cooperation partnership among farmers and or with other rural stakeholders, in order to reach economy of scale.
Finally they can also support knowledge exchange and information, training and advisory services, for example starting with raising awareness of the primary producers,or supporting them in developing the right skills.

Thirdly, The proposal of the new CAP has also introduced **voluntary coupled support for crops used for products that have the potential to substitute fossil-based materials**.

BIOECONOMY STRATEGY, RESEARCH AND INNOVATION

The proposed new CAP is in synergy with the EU Bioeconomy strategy. Following its review, an updating exercise has taken place in 2018[4]. In the revised strategy, agriculture and rural development are prominent, including inter alia, dedicated activities or explicit references to small-scale biorefineries, inclusive business models, "living labs", agro-biodiversity, or support to national authorities for the integration of Bioeconomy in future CAP plans.
Research and innovation will always remain an important bridge between bioeconomy and agriculture. Broadly half of Societal Challenge 2 in Horizon 2020, focuses on those aspects of the bioeconomy that are most relevant for the farming and forestry sectors: sustainable biomass production and logistics, making the bioeconomy contribute to rural development.
Next efforts concentrate also on building a **more circular bioeconomy**, facilitate the **recovery and reuse of nutrients** and by-products from different waste streams, sharing good practices.
The CAP will continue to support EIP-Agri5 innovation project typologies with direct involvement of farmers.
Bioeconomy projects are eligible also today in the current CAP, but with the proposal of Commission for the new CAP there is the possibility to move from individual projects and ideas to a more systemic approach for making farmers and foresters active actors of the supply chain, use the potential to improve their living conditions, and at the same time contribute to environmental care and climate targets.

Tall wheatgrass plantations in Spain. Source CIEMAT

CONCLUSION

Bioeconomy will have an important role in mitigating EU emissions and reaching net carbon neutrality in 2050. The proposal of the EU Commission for the post-2020 Common Agricultural policy, in recognising the opportunity for the rural areas, provides tools that will help ensuring the contribution of primary producers in producing biomass, with more subsidiarity for Member States to adapt to local specificities, eco-schemes, voluntary coupled support, and an increased budget for environment and climatic objectives.
Bioeconomy also has a potential to improve the living conditions of primary producers by creating additional outlets and higher value added for their products, improving the resource efficiency of their activities and spurring innovation in the primary sector.
However, in order to reap this potential, primary producers should play a more active/central role into the value creation of the bioeconomy supply chain, by increasing their awareness, and by developing new business and cooperation models at small, medium and large scale that most effectively integrate the primary producers.

1 In-Depth Analysis In Support Of The Commission Communication Com(2018) 773. A Clean Planet for all A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0773
2 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A392%3AFIN
3 https://enrd.ec.europa.eu/projects-practice_en; https://ec.europa.eu/eip/agriculture/en
4 SWD(2017)374, Review of the 2012 European Bioeconomy Strategy, 13.11.2017
5 https://ec.europa.eu/eip/agriculture/en

INCREASING EFFICIENCY AND ECONOMIC GAINS IN SUSTAINABLE FORESTRY AND HARVESTING OPERATIONS

Philippa Webb-Muegge - RTDS Association, Austria

SILVISMART is a digital portal to promote precision forestry developed by the TECH4EFFECT BBI project.

Finding new innovative products to replace fossil-intensive materials is an important step in moving away from petrochemicals towards a more sustainable future. A major societal challenge lies in being able to meet the expected, increasing demand for biomass, such as wood, to supply bio-economies, while ensuring sustainable land management practices.

Precision forestry is a knowledge-based management concept, where digital tools and technology aid data collection and analysis for improved site-specific management aimed at increasing both production and environmental performance. Such approaches will bring the next breakthrough in efficiency gains in speed and revenue, while ensuring sustainable practices. Better and faster access to information, including benchmarking tools, should have a major impact on planning and decision-making to speed up supply for biomass-based value chains. Examples of such chains are prime saw logs and engineered wood for construction, bark for ropes, sap to bind paint and cellular pulp for clothes.

SILVISMART PART OF TECH4EFFECT

The TECH4EFFECT project engaged in multiple topics and initiatives to research, design and implement methods and tools, create better business models, and provide digital solutions, such as SILVISMART, to help the forestry sector become more efficient. The fundamental solution for the digital portal SILVISMART is now operational, and TECH4EFFECT is focusing on getting users from across Europe to join the platform.

TECH4EFFECT Project Leader, and Head of Research of the Norwegian Institute of Bioeconomy Research (NIBIO), Rasmus Astrup, said that automatically collecting data from forest operations, and converting that data into business intelligence, could make significant gains in terms of biomass provision,

Onboard computers in harvester cabs make it easier to submit data for precision forestry. Source: Ponsse

Ponsse eight-wheel forwarder, designed to reduce ground compression, carries logs roadside. Source: Ponsse.

efficiency of operations and environment performance.
"In the TECH4EFFECT project, we are actively engaged in developing business and digital tools to increase supply of forest biomass for the emerging European bio-economy. At the same time, we need to ensure that forests are sustainably managed, and that a wide range of desired ecosystem services are provided," he said.
SILVISMART is a key step towards this, offering potential ways for all actors in the harvesting chain to benefit.

COLLECTING AND TRANSFORMING DATA INTO USEFUL INFORMATION WITH SILVISMART

In a perfect world, data from forest operations would be automatically collected, in real-time, from all forests, big and small, across all types of harvesting techniques. This would give rise to an enormous amount of data that can be transformed into business intelligence and decision support. The data could benefit machine owners and operators, as well as the forest owner and forest manager.

Collected data then has to be systemised, and fed into a database such as SILVISMART, where it is transformed into valuable information which is easily accessible. For the information to have meaning, it is analysed, presented in a visual form, which is easy to understand, and customized to the needs of the different user groups, such as contractors, operators, forest owners and managers.

The data automatically collected from forest machinery consists of several types of data. For example, information about the forest, such as tree species, tree positions, assortments and tree sizes, which can be used to improve future forest management. Environmental data, such mapping apps, illustrate the driving patterns of forest machines during operations. This can be used to document and demonstrate sustainable management, which is required for forest certification schemes. Importantly, data about the performance of the contractor and operator, such as harvesting productivity, measured in cubic metres/hectare, as well as fuel consumption, can be used for continuous improvement within the operation.

There are multiple ways in which this data could be used, benefits such as improved digital dataflow between the different actors in the value chain can be achieved, reducing the need for manual paperwork related to both production reporting and sustainability documentation. Personal benchmarking for operators or contractors to allow for continuous improvement and learning would be an additional major step towards efficiency. All of these aspects of data flow would provide detailed and precise forest information that can be used for implementing precision forestry management.
"If you look at the European landscape, there is a lot of untapped potential for the uptake of technological solutions and data sharing which will, in the end, help manage and harvest Europe's valuable timber resources in an efficient and sustainable manner," Astrup explained.
However, this perfect world scenario depends on many real-life situations, industry norms and methods of forest management, which potentially could affect data flow. Digitalisation, in general, is not only about the technology, but also about the people who use the technology, and about adapting the work processes in order to take advantage of the technological possibilities.

EUROPEAN HARVESTING METHODS

According to a Bloomberg report (2019), global Cut-to-Length (CTL) technology in timber harvesting is expected to make up the largest market share of precision forestry and will be worth $6.1bn by 2024. The data harvested from CTL technology is already, to a large degree, standardised and ready to be used as part of the overall digitalisation of the forestry sector. In northern Europe, CTL technology is predominant and, according to Bloomberg, more than "90 per cent of logging in Sweden and Finland is carried out by CTL harvester forwarder systems".
When taking this Nordic perspective into consideration, it is useful to remember that not every forest is equal, and the overall predominance of CTL systems of the conifer-dominated boreal forests of Scandinavia cannot directly be transferred to the broadleaf forests of central Europe.
Most of Scandinavia has highly commercialized operations, mainly using CTL harvesters and forwarders. In contrast, mainland Europe mostly has much more variety in harvesting operations ranging from fully mechanized, as in Scandinavia, to more manual operations with chain saws and skidders, tractor-mounted winches and tractor-trailer combinations, or cable yarders.
Automatic data collection from these types of more manual operations are much less developed than for CTL operations, making it a harder case for rapid digitalisation. However, large steps are currently being taken by chain saw manufacturers, for example, to make it possible to also automatically collect data from these manual means. TECH4EFFECT is adding to the potential for data collection for these types of operations through the Bucking App, aimed at chain saw operators, and the Mapping App that can collect information about the driving patterns of skidders and tractors (www.tech4effect.eu).
Astrup pointed out that increased mechanization and the associated, digital benefits that came with such developments were not only attributed to terrain and forests types, but also by the way the forestry tradition had evolved country-to-country.
"It's all about the speed at which industry has been able to embrace technology and use digital solutions. It has a lot to do with the way people view technological change and how they see the benefit. The predominance of CTL operations in the Nordics makes it an easier case for rapid digitalization but, on the other hand, there may be even greater potential gains through digitalisation in other parts of Europe," he said.

DATA SHARING ATTITUDES

Willingness to share data and information is a key aspect of a more efficient and digital future. Attitudes towards data collection and sharing varies throughout the European forest sector. It is often more open in the Nordic countries, which is sometimes not the case with its mainland counterparts, who are generally more hesitant to share. At times, it could come down to a trade-off as to the perceived benefits of information sharing, versus competitive edge.

A key component in facilitating data sharing and automatic data flow is that independent, reliable systems are in place where the data is safe; where the data collector has full control over what data is being shared; and with whom. Accordingly, the SILVISMART developers are adamant that access to sharing between different parties is tightly controlled by the individual data provider.

ROAD TO DIGITAL FOREST

Project partners of TECH4EFFECT are currently making adjustments to SILVISMART and, most importantly, interacting with the existing users of the system, hoping to create the perfect world scenario in building a digital efficiency portal for the forest sector. Transforming this machine-captured data into business intelligence, and decision support for continuous improvement purposes could be a game changer. If you wish to join the SILVISMART portal the developers can be contacted at www.silvismart.eu.

ABOUT TECH4EFFECT PROJECT

The project "Knowledge and Technologies for Effective Wood Procurement" (TECH4EFFECT) started on 1 October, 2016 and will run for a duration of five years. With a budget of € 5.2 million it receives €5m in public funding from the Bio-Based Industries Joint Undertaking (BBI-JU), under grant agreement No. 720757. project website
http://www.tech4effect.eu/
https://www.silvismart.eu/
Check out our video
https://youtu.be/aTrv9aiF-Y8

TECH4EFFECT Project leader and NIBIO Head of Research, Rasmus Astrup, helping digitise forestry to increase biomass supply. Source: Astrup

BIOMASS AND ITS VALORISATION: A PROMINENT CHALLENGE OF THE ECOLOGICAL AND ENERGY TRANSITION

Bruno Gagnepain, ADEME France

Biomass production, from agriculture, forestry, aquaculture, biowaste and the valorisation channels is a major area of the ecological and energy transition.

New production models and relationships with consumers are emerging. Many agglomerations are involved in the food system of their territory. There are many actions to take dealing with a wide panel of topics. They develop on various scales, notably territories and sectors.
The prospective scenarios carried out at national and international levels highlight the major and inescapable role of all actors of the «living world» to meet the environmental challenges of our societies.

Harvesting of lavender fields in Provence, an example of the bioeconomy in France.

In the beginning of 2017 France adopted a national bioeconomy strategy. In order to strengthen the contribution of the bioeconomy sectors as a whole to ecological and energy transition of the society and to the development of circular economy, and in line with the national strategy, ADEME defined its own strategy on sustainable bioeconomy over the period 2017-2022.

CONTOURS AND TARGETS OF ADEME STRATEGY ON SUSTAINABLE BIOECONOMY

The strategy covers all activities in the fields of bioresources production, transformation, delivery and management, as well as biological treatment of organic wastes. These activities share the use of resources and primary and secondary materials coming from « living world », all issued from plant photosynthesis and multiple biological process.

Non-renewable and limited resources, soils constitute the basis of plant and animal productions and equilibrium of ecosystems. The sustainable management of soils enables to preserve them in order to maintain their productivity and services.
They provide the whole part of biomass used for food, feed, materials, biobased products and bioenergy.
The scope covered requires various methodologies and areas of expertise such as agronomy, biology, chemistry and also the social and economic sciences.

ADEME has defined its own strategy by prioritising its actions according to the added value it could bring among all concerned organisms and enterprises and its know-how.
The orientations of ADEME strategy on sustainable bioeconomy are consistent with the national bioeconomy strategy piloted by Ministry of Agriculture. ADEME intends to focus its actions at two main scales: territories and sectors, decisive levels for ecological and energy transition.

THE KEY ISSUES

The main challenges faced by the agricultural, forestry sectors and their associated fields are:

- contributing to the global food challenge while reducing environmental impacts and dependency to non-renewable resources
- developing the potential of substitution of fossil energy by renewable energies coming from biomass while preserving natural lands, water quality, soil fertility and quality, and taking account of the linkage between uses and effects of climate change (intensity, variability).
- Optimising the other ecosystem services contributing to environmental challenges of our society.

The agricultural and forestry sectors are looking for equilibrium between the services provided by ecosystems (food and feed, development of biobased products, biomass production, carbon storage, regulation and water flow and quality, conservation of soil fertility and their resilience, genetic reserve, social and cultural function), and the impacts generated by the different associated activities (GHG emissions, air and natural land pollution.

Thus, the ecological and energy transition of those sectors requires a global and multicriteria approach.

PRIORITY AREAS OF THE STRATEGY

The strategy is structured around three topics covering the productions of primary materials and their conversion up to their delivery to users.

Soil lies at the heart of the bioeconomy: back to the soil of fertilising matter is essential, as well as the quality of organic matter in order to maintain the fertility. The management of soil, organic matter and resources must be done in a circular economy approach.

The three prior topics of the strategy are interdependent and would lead ADEME to analyse them in their globality (by including synergies, complementarities and risks of use competition).
Some approaches, and methodologies in particular (life cycle analysis), are common to the three topics.

The first one is the **sustainable management of land**, agricultural and forestry systems:
The aim is to promote and to help the development of agricultural production and forestry system management consistent with environmental challenges.
The major issues consist in:

- optimizing the production systems along with the climate change and air pollution,
- managing land in a sustainable way,
- developing anaerobic digestion and composting especially through on-site sorting of organic wastes,
- mobilising biomass while preserving resources and equilibrium of forestry ecosystems,
- developing renewable energies.

The second one is the development of **sustainable food systems**
Through this topic ADEME is involved on sustainable food, a recent subject which constitutes a major issue of the ecological transition.
The general goal consists in promoting eating habits that aim to feed people in sufficient quantity and quality today and tomorrow in the respect of environment. It

is to support the evolution of food in order to include environmental requirements with connection to health, economic and social requirements.

The third topic is support of **sustainable biobased sectors**
This topic concerns especially biobased products. One of the challenges consists in putting more focus on the services brought by biobased products and to analyse the conditions enabling to optimize their environmental benefits.

The priorities are the following:
- supporting the processes that will enable to develop sustainable biobased sectors,
- improving yhe knowledge on environmental impacts
- following the development of chains (markets, jobs, available resources),
- supporting innovation for the development of new competitive biobased products,
- raising consumers awareness concerning the conditions of correct use of these products.

ACTION MODES

In order to reach all these objectives and to implement two major energy and ecological transition policies on behalf of the French State, ADEME manages **two major funds** to support the production and distribution of renewable heat (**Heat Fund**) and to support waste prevention and management (**Waste Fund**).
These two funds allow to bring support to collective pilot operations, communication, training actions towards stakeholders, as well as support actions to public policies.

The Heat Fund managed by ADEME is the **main tool for the ramping up of renewable heat** towards the different actors outside of domestic sector. Since it has been set up in 2009, it allowed to speed up the development of renewable heat plants. Since 2009, 4813 plants have been financed with 2.16 billion euro for a total investment of 6.7 billion euros.

The new planning of investments for energy linked to energy transition law includes an increase of the Heat Fund up to 350 million euros in 2020 (compared to 294 million euros in 2019).
As explained above, ADEME supports Innovation mainly by financing and animation of R&D programs (TRL 4-7), financing of PhD (TRL 3) and by financing innovation among enterprises through to the Future Investment schemes (TRL 7-9).

Since 2016, a specific R&D call for projects brings together the different themes of the bioeconomy. This scheme aims to support projects dealing with production, management and conversion of renewable biologic resources, including organic wastes, in order to meet food needs, develop activities of their industrial conversion (in food, energy as heat, electricity, biofuels, biobased chemical products or materials) and contribute to environment preservation.
With the first calls in 2016 and 2017, 50 projects have been financed, with a total subsidy of around 13 million euros. A 3rd call has been launched in autumn 2019 in a 2-step process, with a final selection of projects at the end of summer 2020.
The different sectors of bioeconomy are also examined in the frame of the annual ADEME call for PhD candidates since 2017. 32 PhD have been financed upon these 3 years.
Among the ways of actions developed above, ADEME handles calls for projects and support schemes aiming at the demonstration and validation of new processes or products and equipment. There are two kinds of schemes:
- The « **innovation contest** », i-Nov, dedicated to SME and startup, for projects conducted by only one partner, with total budget from 600k euro to 5 million euro. Its goal is to help to boost the appearance of leader firms on their fields.
- The call for project «**démonstrateurs et territoires d'innovation de grande ambition**», concerning projects with one or several partners, with a total budget mandatory higher than 2 million euros. These calls for project aim to finance and accelerate the placing on the market of innovative solutions. Since 2011 several calls for projects have succeeded. A call is running since 2019 dedicated to bioeconomy and environment protection.

10 new projects have been financed in 2019 with a rise of projects in the field of **biocontrol** and **biostimulation**. Since 2011, concerning biobased products and materials and biofuels, 14 projects have been financed with a funding of around 59 million euros. About agriculture and forestry, 30 projects have been financed with a funding of 37 million euros.
Supported projects concern the following sectors:
- Building and transport (polymeric materials, insulating materials, fuels for road and aviation,…)
- Chemical industry (intermediate molecules,
- Packaging
- Agriculture, winery, sawmill (equipment, software, products for biocontrol or biostimulation).

In conclusion, the bioeconomy brings a set of very useful solutions to contribute to the French ecological transition. It is not a new activity but corresponds more to a willingness to approach this sector as a whole.
The bioeconomy lies indeed at crossroads of many challenges in terms of food, energy, climate and biodiversity that needs a systemic approach and the systematic search of equilibrium between all these dimensions.
The development of bioeconomy also raises economic and social acceptability questions that must necessarily be understood.
New economic models allowing a better convergence of environmental performance with economic performance should be built. This evolution implies an involvement of all economic actors up to the final consumer.
It also raises the question of the distribution of value on the chain and the emergence of collective organisation making it possible to associate producers with this societal evolution.

Resource document

Stratégie ADEME pour une bioéconomie durable (2017-2022) – validated in July 2018 – complete document and synthesis available online on ADEME website, French version only, https://www.ademe.fr/strategie-lademe-bioeconomie-durable-2017-2022.

Sustainable management of soils, agricultural and forestry systems	Development of sustainable food systems	Support to sustainable biobased products	Development of bioenergies
Territorial knowledge of biomass (MOFOB), soils (GIS Sol), good practices for the preservation of environments (forest)	PNA – National program for food PAT – Territorial food projects	See above (R&D, innovation, call for projects…)	Heat fund
Climate Change: - Tools and approaches for territories: ClimAgri, Aldo - Approaches to adapting agriculture: Oracle, … - Approache for forest GHG report	Eco-design approaches for agrifood chains: Green Go program - Session 2019: 19 laureates	Ecodesign of chains and comparative environmental evaluation (LCA)	Awareness of the challenges of domestic heating (modernization of appliances, good practices): ADEME positioning
Anaerobic digestion: Number of cogeneration plants: 78 more in 2019 (cumulated figures: 528) Collective pilot projects: Dynamic bois	Agribalyse – launch of version 3.0 (2500 agricultural and food products) of a software for evaluation of environmental impact of agricultural products	Support for a responsible and informed consumption: - ADEME positioning about environmental impact of fruit and vegetable packaging bags - Guide for public and private buyers	Support for pilot projects

Some examples of flagship actions

source: Air France

SUSTAINABLE AVIATION FUEL 2020 IS TAKE-OFF YEAR IN FRANCE

Philippe Marchand, Biofuel expert, France

Sustainable Aviation Fuel are a necessity for the future acceptability of Air Transport.

When one quarter of man-made Green House Gas (GHG) emissions comes from transport, 2% from air transport alone, reducing the carbon footprint becomes a cornerstone in the fight against Climate Change and, possibly, an absolute necessity for responsible transport to stay in business in the future: United Nations' International Civil Aviation Authority (ICAO) and the International Airlines Transport Association (IATA) have both committed to a challenging global GHG emission reduction of 50 % in 2050 vs 2005, starting with an objective of Carbon Neutral Growth as from 2020. In the context of a robust growth that could double the number of passengers in the next twenty years, progress in technology alone, e.g. more fuel-efficient engines, lighter airframes or more straightforward routing between airports, will not be enough to meet this Climate Goal: alternative aviation fuels, with a lower net carbon emissions score than fossil-based fuels, are needed, as from now, as the other fuels that could be considered, such as hydrogen and natural or bio-gas, will not materialize at scale until the second half of this century. Liquid fuels are there to stay for many decades, but their sustainability has to improve.

Sustainable Aviation Fuel (SAF), the air transport version of biofuels, has been available for more than ten years, and nearly ten alternative pathways have been so far certified for the production and use of these alternative aviation fuels on a world-wide basis. And many more are under certification as we speak, at various levels of Research and Development. The most mature pathway, a.k.a. Hydrotreated Esters and Fatty Acids (HEFA), a well-known lipids hydrogenation process, has been, up to now, the main contributor to the early use of SAF in air transport, in many demonstration programs around the world, mostly in Europe and the USA: but on a very modest scale, reaching 0.06 % of total flights in 2019.

Why? Air Transport is a global activity, extremely competitive. Pending a level-playing field mandating, on a world-wide basis, the use of SAF or a progressive reduction in the carbon intensity, mirroring regulations in place in road transport at national or regional levels, airlines will be reluctant to use SAF unless close to price parity with fossil-based aviation fuel is attained: alas, supply of sustainable raw materials, such as biomass, and SAF production technology performances, today, lead to costs of production for SAF that are, at best, twice more expensive than market prices for fossil-based aviation fuel. Initial consequence: achieving Air Transport Carbon Neutral Growth as from 2020, as required by the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), will have to come from carbon compensation programs, such as reforestation, which GHG emission reduction cost is much lower.

But there is a silver lining in the bleak situation faced by SAF: the limit in volumes available from robust and credible carbon compensation programs. Coupled with the sustained growth in Air Transport, mainly led by the rise of an Asian middle class eager to travel, SAF will eventually become a necessity at a significant, thus industrial, scale, possibly as early as 2030. Fueling a support for a robust Research and Innovation (R&I) effort to improve the price competitivity of SAF, both to identify cheaper raw materials resources and to improve the efficiency of transformation technologies: R&I has been very active in the USA, where military, federal and state supports allow today some SAF pathways to be competitive, but also in Europe, via R&I support programs such as Horizon 2020 and its sequel Horizon Europe.

FRANCE AT THE FOREFRONT OF SAF DEVELOPMENT IN EUROPE

France has many leaders in the aviation sector: Airbus and Safran are world-leaders in technology, Air France is a legacy airline, Total is a major supplier of aviation fuel. No surprise then that a public-private association for the development of SAF, led by the French Civil Aviation Authority (DGAC), including the above-mentioned industry leaders, joined by large-scale Research and Development centers such as IFPEN and ONERA, has been active since 2009.

Several demonstration programs have taken place in the last decade as a result of the efforts by this association to help develop the use of SAF in France, e.g. weekly commercial flights with SAF between Toulouse and Paris in 2015, or between Paris and Nice during the Cannes French Film Festival in 2016:

More recently, a Green Deal, in French "Initiative pour la Croissance Verte", grouping Airbus, Air France, Safran, Suez and Total, under the leadership of the Ministries in charge of transport, ecology and energy, has conducted a feasibility study, aiming at the identification of key success factors and barriers in the deployment of SAF, to help shaping future regulations for sustainable air transport. Focus has been put on the supply of sustainable raw materials, a durable economic viability for all the actors of the value chain, the easiness to incorporate SAF in existing airport fuel supply chains, and the necessary diversification of production pathways, both for resources and transformation technologies. On the latter point, the investigation was able to draw from a recent exhaustive study, conducted by the French Alliance to Coordinate Research on Energy (ANCRE), a public-private partnership between leading industries and research entities, to identify the key SAF production pathways, both from the point of view of resources and transformation technologies, to be targeted for Research and Development with a 2050 horizon.

Publication of the feasibility study report has taken place in January 2020, leading to the publication of the French Roadmap to develop the use of SAF, undersigned by the Ministries of Ecological and Inclusive Transition, Finance and Agriculture, calling for the incorporation of 2% of SAF in 2025, 5% in 2030.

Five fundamental principles have been identified to allow this roadmap to succeed and relevant regulations to be defined in due course:

1. Safety first and foremost: only internationally certified SAF can be deployed.
2. Sustainability: strong environmental criteria must be applied to SAF to ensure true, verifiable and traceable GHG emission reductions take place; within these requirements, focus on the origin of the raw materials, their environmental and social-economical sustainability.
3. Economic viability: profitability is today the main barrier to the deployment of SAF; any at-scale deployment must allow each actor of the supply chain to be profitable, while limiting the cost impact on the aviation fuel and avoiding "tankering" (supply of aviation fuel outside of France).
4. Efficient logistics: supply of SAF has to be simple, efficient and limiting GHG emissions, taking into account present airport supply chains diversity.
5. France is not alone: consistency is necessary between the French initiative to deploy SAF and similar developments in Europe and in the world.

As part of the French Roadmap, a Call for Interest has been issued to define the adequate support mechanisms to develop SAF in France and identify the industrial actors with innovative projects.

REACHING CARBON NEUTRALITY BY 2050

René Venendaal – CEO BTG Biomass Technology Group, The Netherlands

A bioenergy industry perspective towards carbon neutrality and how to address the refining sector.

With the Green Deal, the European Commission has set as target to be climate neutral by 2050, in line with the commitment to the Paris agreement. As the Green Deal is presented as a 'New Growth Strategy', it also offers plenty of opportunities for the European bioenergy industry.
Total greenhouse gas emissions in the EU are in the order of magnitude of 4 billion ton annually[1]. This includes international aviation and maritime, indirect emissions and excludes LULUCF (Land Use, Land Use Change and Forestry).
Parties under the EU-ETS scheme (the 11,000 bigger emitting parties in the power sector, industrial plants and airlines) emit about 45% of the total greenhouse gas emissions in terms of CO_2-equivalents annually[2].
An interesting sector is the oil refining sector, responsible for a significant part of the greenhouse gas emissions.

The European demand for oil products in 2018 was almost 640 million tons and the refinery throughput was about the same[3]. Ten years earlier the demand was about 100 million ton higher[4]. If this trend would be continued, the demand for oil products in 2050 would be about 300 million tons annually. Tens of scenarios show a range from 200 to 400 million ton by 2050[5].

What are the opportunities for the bioenergy industry in reducing greenhouse gas emissions? And how can the refining industry be challenged?

CRITERIA FOR SECURING A STEADY INVESTMENT CLIMATE FOR THE NEXT DECADES

First of all, biomass used for energy generation should be sustainable. So, no clear cuts of forests for the generation of bioenergy or harmful practices in the agriculture conflicting with sustainable food production. This is governed by the RED-II and other directives and may need updates in the future based on new experiences and insights.

To have impact, innovative bioenergy technologies should contribute to a reliable, flexible and cost-effective energy system as the energy transition will require multifold adaptations during the coming decennia.

As the energy sector is a strongly regulated sector, policies are of the utmost importance. The bioenergy industry can prepare itself for the future by anticipating on developing policies and by providing input to the development of new policies. Stimulating policies should secure a steady investment climate for the next decades. A stimulating policy covers a set of measures like increasing ETS-prices or/ and limiting emission allowances, CO_2-taxes, innovation and other stimulating (innovation) subsidies, obligations, etc. while at the same time safe-guarding competitiveness and cost-effectiveness. Clear objectives with penalties for non-conforming parties should be in place.
As an example, figure 1 shows the interaction between policies, oil prices, innovation and implementation for the markets of advanced biofuels[6]. The positions of the blue dots show the changes due to the economic crises in 2008 and the economic crisis as a result of Covid-19. The big difference now compared with the situation in 2008 is that there are very stimulating policies (obligations) for advanced biofuels (at least for 2030) in place. With strong targets set for 2050, innovation will continue and investments will be secured.

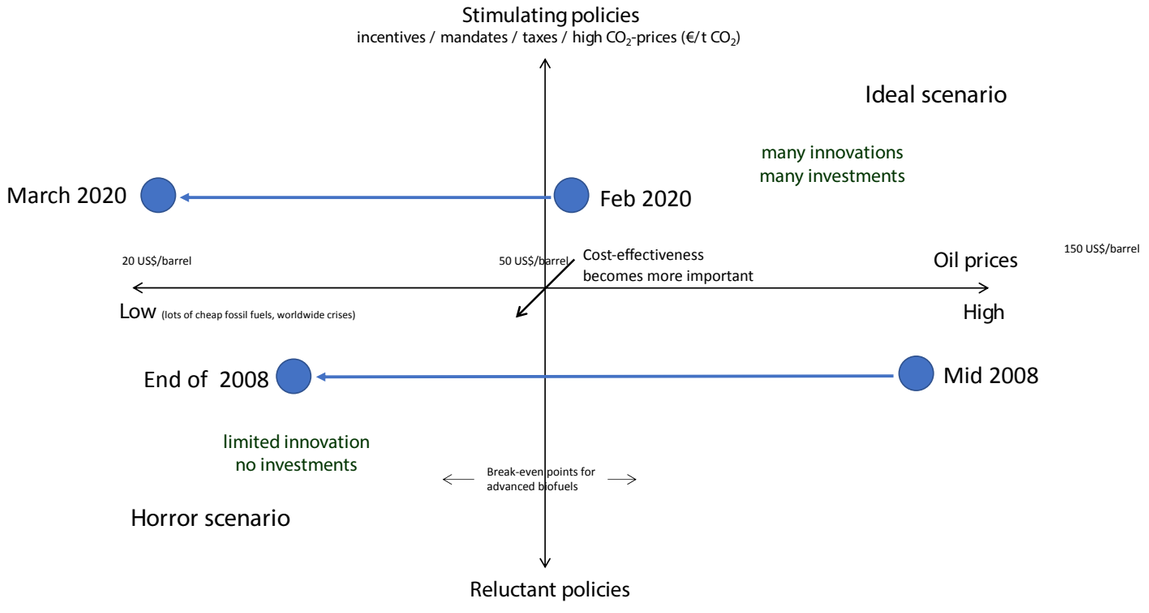


Figure 1 - Scenarios (energy prices + policies) – strong policies needed if energy prices are low

HOW TO ADDRESS THE REFINERY INDUSTRY AS BIG EMITTER?

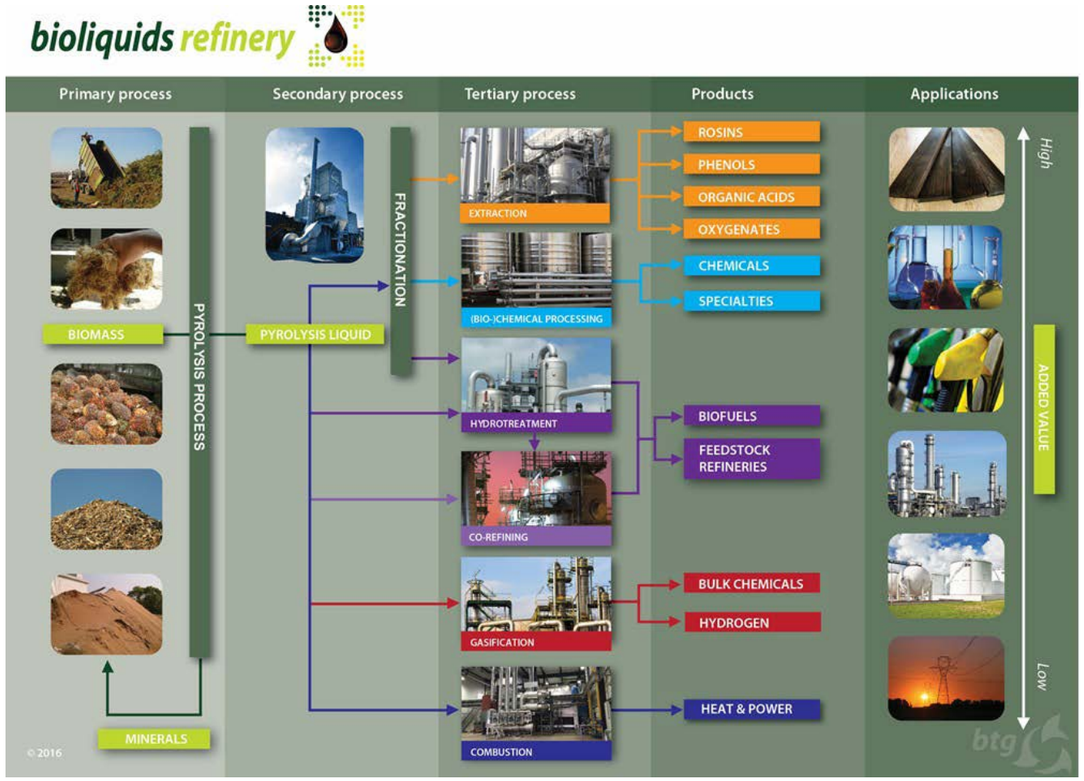
Options for the refinery sector include a shift from crude oil to natural gas, carbon capture & sequestration, forestation, advanced biofuels, hydrogen, etc.
Recently, various oil companies[7] have announced to strive towards becoming net zero carbon neutral by 2050.
A battle might occur: which oil company will become net carbon neutral towards 2050 without losing market share and keeping profits and dividends at the desired level?
Interesting concepts are the retrofitting of energy and industrial plants including the co-processing of sustainable biomass in existing refineries[8]. The latter option avoiding high additional capital costs for the refinery owners and facilitating a step-by-step approach, herewith mitigating risks.
This could also be integrated with the production and use of renewable hydrogen from renewable energy from wind, creating a win-win situation.

A SCENARIO FOR 2050

Let's assume the following scenario: 45 out of the around 90 refineries existing nowadays in Europe still remain in 2050, but only a limited amount of fossil fuels is used (in a ratio of less oil and more gas). CO_2-emissions are compensated by CCS and large scale afforestation.
This half of the former existing refineries is not necessary anymore, as 2/3 of the personal cars are electrically driven, which makes part of the refineries abundant. The electricity needed for all these personal cars is obtained from renewable sources, mainly hydro, wind and solar. But from biomass and some nuclear power as well, as Europe can't rely on hydro, wind and solar only.
The remaining 1/3 of the passenger cars are hybrid, of which the high energy density liquid fuels are based on advanced biofuels. There is a number of hydrogen powered cars, but very limited, as the refinery sector has replaced its fossil based hydrogen completely by green hydrogen, and thus contributing to the direct greening of the refinery sector (greening of the transport fuels indirectly).
In the remaining refineries, fuels for transport are still being produced, but mostly for the heavy-duty road transports, the maritime and the aviation sectors[9].
The liquid fuels are not fossil based any longer, but are advanced biofuels from sustainable biomass residues. The renewable hydrogen available on the market, is mainly produced by wind power.

Part of depreciated refineries has been retrofitted into 100% biomass-fed refineries, another part of the still existing refineries is co-refining biomass intermediates to a significant amount, and the newly constructed refineries are 100% stand-alone biorefineries.

In the above scenario, hundreds of million tons of sustainable biomass would be needed for a sufficient production of advanced biofuels[10]. The production will take place in biomass-rich areas around the world, including Europe, that would have increased its capacity due to large scale forestation.
The products of the forest are used firstly for construction purposes in the biobased economy, herewith storing CO_2 for a long term and replacing energy-intensive materials like concrete. Only biomass residues are used for advanced biofuels production in a responsible manner.



Co-processing 2050	70 billion €	Flexible
22 Mtoe/yr	40.000 jobs	Scaleable
Advanced Biofuels (flexible mix of diesel and kerosene)	80 mio t CO_2/yr	Using existing infrastructure

Figure 2 - Pyrolysis as platform technology (BioLiquids Refinery)

An example of what co-processing could offer in this 2050 scenario with just one platform technology (fast pyrolysis) is presented in figure 2. By using this flexible and scalable technology in the existing infrastructures a potential of 22 Mtoe/yr of advanced biofuels could be achieved, saving 80 million tons of CO_2 emissions every year and generating up to 40,000 jobs.

A PORTFOLIO MANAGEMENT APPROACH TO TRACK TECHNOLOGICAL DEVELOPMENT

It may be clear that innovation will be key for the coming decennia, as a complete renewal of the industry has to be established and new technologies will have to be integrated with existing infrastructure wherever possible.

For both the industry as the European Commission it will be important to keep track of technological developments and to have insights in the critical issues relevant for the innovation routes. One way to track is the concept of Portfolio Management.
This could be done as part of the Integrated Strategic Energy and Technology Plan (SET-Plan) of the European Commission[11].
For bioenergy and advanced biofuels this is taken care of by the European Technology and Innovation Platform[12].
With portfolio management a number of innovations are being monitored and policies will be modified if needed. This approach offers many advantages because:

1. it is a proven method for successful project development and an economic principle used by many project developers, private equity parties as well as multinationals
2. it is very useful in case many projects are listed and critical success and fail factors are difficult to recognize
3. it allows for bundling of projects
4. it can facilitates risk mitigation
5. it avoids the re-inventing of the wheel over and over
6. it can facilitate the reduction of costs and the acceleration of successful innovations
7. it offers a way to learn from failed innovation routes
8. it helps to achieve the targets in a well-managed manner

The first action is to list all projects and technology developments ongoing, expected and completed. New projects are placed left in the pipeline (low TRL), almost completed projects (high TRL) to the right.
Dropped out and failed projects are listed as out of the pipeline. Successfully completed projects have left the pipeline at the right. A successful innovation starts left with low TRL-projects and leaves the pipeline right as it is commercially adopted by the market.

Critical success- and fail factors are determined by observing the developments of the innovation routes.
Examples: technological developments can be too expensive, no market, no incentives in place, not matching the market demand, not matching biomass supply and energy demand, too complex, no adequate legislation in place, weak organization, not scalable, no business case, or whatsoever. Figure 3 shows a simplified example of Portfolio Management.

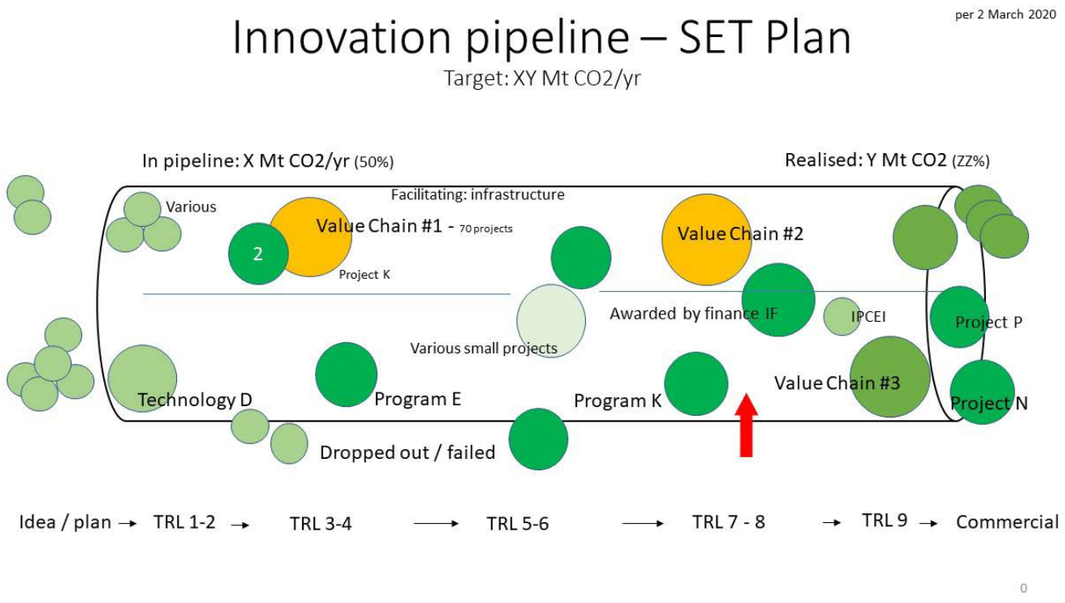


Figure 3 - Portfolio Management (also as tool for managing the portfolio of SET Plans)

Conclusions

There is no silver bullet for replacing crude oil in 30 years, while the sector has been practicing current operations for almost 150 years. Europe will need multiple options and the most cost-effective and appropriate ones will emerge in due time.

Investment security for the industry is of utmost importance and long-term policies need to be in place. Especially in economic crises, like the present one as a consequence of the Corona (Covid-19) virus, it is important to enforce investments in innovation and sustainability, herewith enabling a competitive edge for Europe as well.

Energy storage and renewable energy carriers will become of key importance. Biomass intermediates can play an important role in this.

Keeping track of the technological developments and accelerating the best developing ones through portfolio management may help to achieve the targets cost-effectively.

1 Eurostat, Statistics explained – Greenhouse Gas Emission Statistics, Table 1, 15th April 2020, data from June 2019. See the link: https://ec.europa.eu/eurostat/statistics-explained/index.php/Greenhouse_gas_emission_statistics

2 https://ec.europa.eu/clima/policies/ets_en

3 European Petroleum Refiners Association - FuelsEurope Statistical Report 2019, Figure 5, page 11. Link: https://www.fuelseurope.eu/wp-content/uploads/FuelsEurope-Statistical-Report-2019-2.pdf

4 European Petroleum Refiners Association - FuelsEurope Statistical Report 2019, Figure 7, page 13. Link: https://www.fuelseurope.eu/wp-content/uploads/FuelsEurope-Statistical-Report-2019-2.pdf

5 David Chiaramonti, Alternative and Renewable Liquid & Gaseous (ART) Fuels Forum, 2nd Plenary Meeting, Brussels, sheet 7-9, 10-11 February 2020. Figures have been rounded by the author. See also: http://artfuelsforum.eu

6 These scenarios have been developed by the author during the economic crisis after 2008 and were updated recently by the author due to the Corona crisis

7 Among others companies like Total, BP, Shell. See for example https://www.worldoil.com/news/2020/5/5/total-pledges-to-be-carbon-neutral-by-2050)

8 See for example https://www.biofit-h2020.eu

9 Tens of scenario studies have been carried out during last years. Compare for example with the key findings of so-called 'Ricardo Study': https://www.fuelseurope.eu/wp-content/uploads/Key-findings-Ricardo-Study.pdf

10 Listed amounts of advanced biofuels for the various scenarios varying from 13 – 134 million tons oil equivalents. See: David Chiaramonti, Alternative and Renewable Liquid & Gaseous (ART) Fuels Forum, 2nd Plenary Meeting, Brussels, sheet 7-9, 10-11 February 2020. See also: http://artfuelsforum.eu

11 See for example: https://ec.europa.eu/energy/topics/technology-and-innovation/strategic-energy-technology-plan_en and https://www.setplan2019.fi/content/uploads/2019/11/SET-Plan_2019-Outcome.pdf

12 ETIP BioEnergy, see https://www.etipbioenergy.eu

THE STATUS OF ADVANCED BIOFUELS PLANTS IN EUROPE

ETIP Bioenergy has recently compiled a comprehensive list of advanced biofuels demonstration and first commercial plants available in Europe.

Dina Bacovsky, BEST Austria and ETIP Bioenergy Working Group 2 - Conversion Processes. Edited

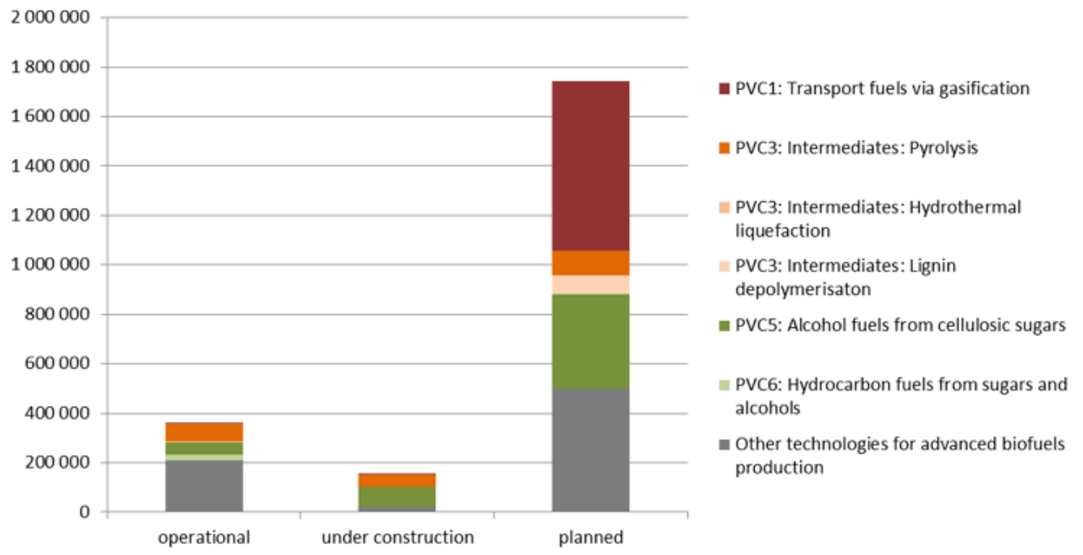
A report prepared by Working Group 2 – conversion processes of the European Technology and Innovation Platform Bioenergy and published last March has analysed the current and planned capacity of advanced biofuels plants available in Europe. Based on the available public information, the report has found that the currently operational advanced biofuel plants all together provide a capacity 358,828 tons per year.

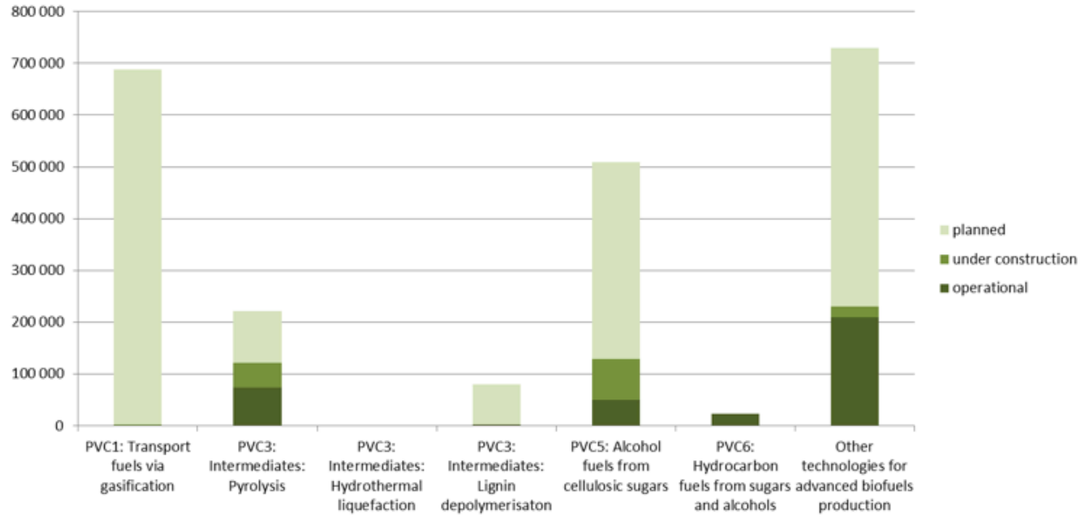
Additional capacity for 151,900 tons per year is currently under construction and plans for another 1,742,760 t/y have been announced. The technologies considered in the report include the priority value chains (PVC) as defined by

Fig. 1 - Priority Value Chains (PVC) as defined by ETIP Bioenergy

ETIP Bioenergy and in addition to these, other important facilities for advanced biofuels via other technologies.
Most of the current operational capacity stems from pyrolysis oil production (74,000 t/y), followed by production of alcohols from cellulosic sugars (49,420 t/y).
Additional planned capacity relies mostly on a variety of pathways based on gasification (685,760 t/y in total), followed by alcohols from cellulosic sugars (380,000 t/y).
The large contribution of other technologies to the planned capacity is due to the planned production of 500 000 t/y of tall oil diesel.
The most important fuel products are ethanol, followed by pyrolysis oil and methanol. Upgrading of pyrolysis oil in refineries and the integration of advanced biofuel production into pulp mills become increasingly attractive.

The full report is available here https://bit.ly/2Y9QAY3





European production capacity of advanced biofuels (t/y)

ETIP Bioenergy
European Technology and Innovation Platform

THE ROLE OF ETIP BIOENERGY IN PROMOTING ADVANCED BIOENERGY RESEARCH, INNOVATION AND MARKET DEPLOYMENT IN THE EU

P. Klintbom, RISE Sweden, T. Fellenberg, S. Gonzalez, FNR Germany

The EU aims to be climate-neutral by 2050 – that means creating an economy with net-zero greenhouse gas emissions.
This objective is at the heart of the European Green Deal, and also in line with the EU's commitment to global climate change actions under the Paris Agreement.
ETIP Bioenergy believes that sustainable bioenergy has a key role to play in reducing GHG emissions in the EU energy mix, as well as in decreasing dependence on fossil fuels.
The promotion of bioenergy in the EU should be based on sound sustainability criteria, including a high performance in regard to reducing GHG emissions. As for the use of biofuels in transport, it is important to remember the importance of high quality biofuels, so that they can be successfully introduced and subsequently, obtain high market shares.

Bioenergy is a key element in terms of reaching renewable energy goals by 2030 and beyond. According to the mitigation scenario of the European Commission, the gross inland bioenergy consumption by 2050 will amount to 170 to 252 Mtoe (European Commission's Knowledge Centre for Bioeconomy, 2019).
Opportunities to increase the utilisation of bioenergy are seen e.g. in the field using agricultural residues, by-products and waste. Bioenergy can also play a significant role as a flexible energy carrier to balance the power systems and thus allowing for higher shares of renewable energy sources as wind and solar power. To reach the deployment of advanced biofuels and other renewable fuels, an integrated approach of strong policy measures, research, innovation and improved financing solutions is necessary.

Renewable fuels and especially biofuels can contribute in the short-term to reduce the carbon footprint in transport segments that will continue to rely on internal combustion engines, and are complementary to new mobility modes that are expected to make a significant impact in the market. Biofuels play a very important role alongside other measures, and in order to have substantial amounts of biofuels in the future, the playing field has to be levelled through

the development of innovative technologies and policies that unlock the full potential of bioenergy.

SUSTAINABLE BIOMASS POTENTIAL IN THE EU

Resource efficient biomass feedstock supply is essential to facilitate market development for advanced bioenergy and biofuels. Bioenergy applications have already established concrete sustainability criteria with strict principles.
Europe offers a diverse portfolio of feedstocks that are produced as primary or secondary products from agriculture, forestry and waste sectors.
Every year in the EU, about 1.2 billion tonnes of biomass are supplied and used up whereas about 1 billion tonnes are procured from primary sources (agriculture, forestry, pastures, fisheries and aquaculture), while 0.2 billion tonnes are derived from secondary sources (recovered paper, wood and other bio-waste).

Currently, there is still a large untapped potential of sustainable biomass from forestry, particularly in Germany, Sweden, France and Finland. In addition, especially in Southern and Western Europe, forest utilisation rates have been reported as low. In half of the countries in the EU, less than two thirds of sustainable biomass has been harvested.
This potential could be further extended by developing technologies to access difficult terrains. Such terrains include steep slopes (especially in Central and Southern Europe) and peatlands (especially in Northern Europe).
Digitalisation and big data (including big data and automation for optimal harvesting, storage, etc.) can provide opportunities for radical innovations in biomass supply and logistics.
Marginal land is another significant and underutilised resource that has gained significant attention in the renewable energy sector as of late.

Marginal lands make up for around 30% of the European agricultural land space, and the most common reasons for their marginality are limitations to plant rooting, adverse climate and excessive soil moisture.
A large goal of the sector is to implement ways in which to recover those lands and bring them back to productivity. Growing energy crops on marginal land can reduce competition for land with food production, while helping to increase biodiversity and at the same time creating diverse landscape structural elements.
Long-term experiments of growing perennial lignocellulosic crops such as giant reed or miscanthus on marginal land in different regions of Europe indicate that this is absolutely a feasible option.

ABOUT ETIP BIOENERGY

The European Technology and Innovation Platform Bioenergy is an industry-led stakeholder platform that brings together relevant actors from academia, industry and civil society, engaged in the development of sustainable bioenergy and competitive biofuel technologies.
The platform, which started as European Biofuels Technology Platform (EBTP) in 2006, has been running for 14years, with several changes of scope and main themes having occurred throughout this period. The overall goal of the European Technology and Innovation Platform Bioenergy is stated right in its name- to promote and advance bioenergy research, innovation and market deployment, within the European Union collectively.

The ETIP Bioenergy website serves as a basis for these determinations, and allows professionals in the field to make their knowledge and expertise available to the general public.
Knowledge availability and sharing is the name of the game for ETIP Bioenergy, and there are a number of ways the website goes about accomplishing this mission.

STAKEHOLDER PLENARY MEETINGS

Last November in Brussels, Belgium, the **9th Stakeholder Plenary Meeting** of ETIP Bioenergy took place in which numerous sectoral professionals were in attendance.
During the most recent SPM, the latest sector trends in advanced bioenergy technologies were presented to disseminate and facilitate as many results as possible aming at a sustainable European energy system. This included very exciting news provided by BTG CEO René Venendaal, in which he announced the implementation of a new high-end technology that possesses the ability to convert crude pyrolysis oil into diesel fuel, suitable for the shipping sector. It will be the first refinery in the world that produces advanced marine biofuels retrieved from pyrolysis oil.
In addition to these exciting advancements in technology, many stakeholders and participants presented a very positive outlook regarding the existing biomass value chains as well as value chain actors. "*We have an ambition to become CO_2 neutral in 2045 and we are working to reduce emission along all the steps of the value chain, whereas it is important to remember that complexities in regard to value chains offer many opportunities for refiners, not just challenges*", stated **Olov Öhrman** from **Preem AB**.

These developments and positive mind-sets are necessary in consideration of the clean energy transition in Europe, as the road towards clean energy is paved with many challenges.
These positive implications were received well and excited the event's participants however; it is important to include that the events organised by the ETIP Bioenergy are not held solely for the purpose of disseminating only good news.
A key element of the SPMs is to provide a space in which professionals can determine as well as tackle issues, challenges and barriers still standing in the way of deploying sectoral goals fully in the market. For this purpose, **ETIP Bioenergy Working Group Breakout** Sessions were held during the first day of the two-day SPM event.

HOW ETIP BIOENERGY'S WORKING GROUPS TACKLE SECTORAL CHALLENGES

The Working Groups of the ETIP Bioenergy are composed of experienced biofuel and bioenergy stakeholders with specific technical competence, individual commitment and recognised contributions concerning the development of advanced bioenergy.
WGs also contribute to advance the **ETIP Bioenergy Strategic Research and Innovation Agenda** in Europe, a critical task in the renewable energy field. The WGs bring together experts from across Europe, and are organised into four groups:

1. **biomass availability;**
2. **conversion technology;**
3. **markets and end use; and**
4. **policy and sustainability**.

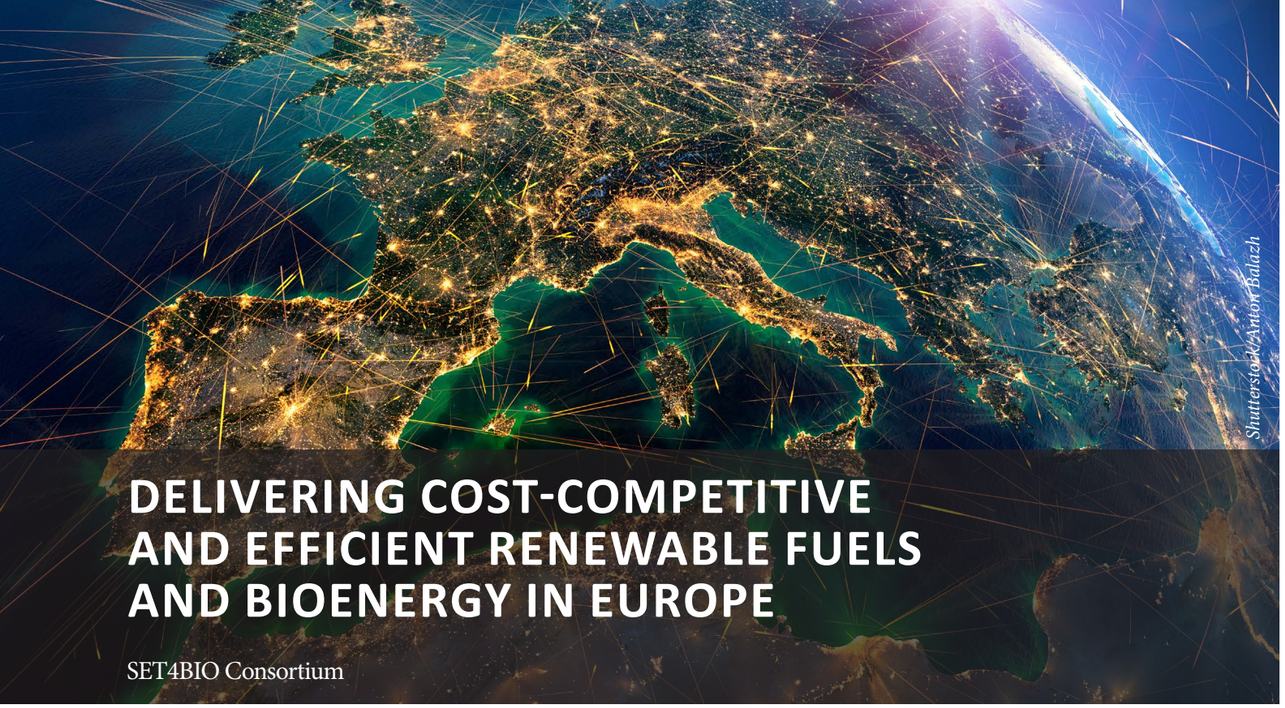
In order to broaden the scope of expertise regarding these elements of the renewable energy mix, the Working Group Breakout Sessions were open to the entire event, not just to already established group members.
Herein, event participants were able to learn and or provide their opinions on a myriad of sectoral challenges.

Within **Working Group 1**, it was determined that as farmers are producing a broad range of raw materials and not only food, new options to increase income opportunities would also strengthen rural areas while empowering farmers to exploit new sources of income.

Concurrent to these determinations being made, participants of the **Working Group 2** session focused on the new value chain concepts approved by ETIP Bioenergy in August 2019, a direct link to the **SET-Plan Action 8**, which included recent bioenergy market developments and suggestions regarding how to improve stakeholder engagement.
Working Group 3 participants discussed potential synergies regarding the combination of various fuel technologies and the feedstocks they employ (hybrid value chains), a classic example being the use of alcohols in diesel engines to get around the issue of biodiesel acceptable raw materials availability.
Working Group 4 activities consisted of addressing the implications and opportunities of the (new) **European Directive REDII**, determining the main issues of the directive lie within the current unclear status of the policy landscape, as this directly effects each individual actors of the bioenergy value chain.
The results of Breakout Sessions therefore surpassed what was foreseen during the organisation of the event. This then led the ETIP Bioenergy Secretariat to seriously consider ways in which these types of dynamic conversations can continue in the future.
As a result, consecutive **Working Group Webinars** were made available on the ETIP Bioenergy website whereas challenges that were identified at the SPM, are continuously addressed until they are no longer determined as a barrier to sectoral goals. Working Groups Webinars will be scheduled and held dependent on arising needs, topics or issues consistent with the specific subject matter of each of the four Working Groups. Direct links to the webinars are available on the ETIP Bioenergy website.

THE INNOVATION FUND

Although the Stakeholder Plenary Meetings are a major cornerstone of ETIP Bioenergy's supporting actions to the renewable energy sector, the ETIP Bioenergy has also organised many other events/conferences/functions that adhere to this mission in more tailored ways. One key support mechanism carried out by the Platform is its direct involvement in the **Innovation Fund**, one of the world's largest funding programmes for the demonstration of innovative low-carbon technologies.
The Innovation Fund receives funding from the **EU Emissions Trading System** (**EU ETS**), which is currently the world's largest carbon pricing system. The system provides funding for the Innovation Fund by auctioning off 450 million allowances starting in 2020 until 2030, as well as any unspent funds from the **NER300 programme**, the direct predecessor of the Innovation Fund.
The grants will be disbursed in a flexible way based on project needs, taking into account the milestones achieved during the project lifetime. Project proponents can apply by submitting their projects when there is an open call for proposals, the first one being scheduled for this summer.
Please visit the ETIP Bioenergy website to find ways in which to help lead the fight against climate change (http://etipbioenergy.eu/)!



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DELIVERING COST-COMPETITIVE AND EFFICIENT RENEWABLE FUELS AND BIOENERGY IN EUROPE

SET4BIO Consortium

Last March the Horizon 2020 project SET4BIO was launched with the aim to support the Implementation Plan of Action 8 (IP8)- Bioenergy and Renewable Fuels for Sustainable Transport of the EU Strategic Energy Technology Plan.

The Implementation Plan was approved in June 2018 by the Temporary Working Group 8 of the SET Plan, following the initial Declaration of Intent (DoI) of 2016, which defined the challenges and clear targets for Action 8. In line with the DoI, the plan details the European Research and Innovation activities required by 2030 to reach the strategic targets for this sector. These can be resumed by improving the performance (yield and efficiency) and the GHG saving of bioenergy technologies by 2030, whilst reducing their costs at the same time.

The Implementation Plan is challenging both in terms of reaching the targets and in mobilizing the financial volumes required for this. 13 actions are identified by the Plan to reach this ambitious target and the volume of investments required for this goal is estimated at 107 billion €: 2.29 billion € for development measures and 104.31 billion € for demonstration and scale-up activities.

The financing instruments for this target shall be mobilized by activating and coordinating a wide number of actors, including private and public stakeholders, in addition to Member States and the EU, putting together their resources in a concerted effort towards the same goal.

SET4BIO will support the realisation of the 13 research and innovation actions included in the plan by pursue the direct involvement of both industry stakeholders and the Member States representatives.

This will be done also via a direct support of SET4BIO to the Implementation Working Group for Action 8 (IWG 8) by engaging with and coordinating its members and all the stakeholders (entrepreneurs, experts and citizens).

It will develop a roadmap for funding and financing of the bioenergy projects and infrastructures included in the plan, innovation challenges to stimulate and encourage new business models, and an array of activities to bridge the gap between R&I results and industry application in SET Plan countries and globally.

The three-year project is carried out by a consortium of six partners, coordinated by RISE Research Institutes of Sweden. To deliver its results, SET4BIO will work in an aligned way with the **Integrated SET Plan Steering Group**, the European Technology and Innovation Platforms (ETIPs), in particular **ETIP Bioenergy**, the **European Energy Research Alliance** (**EERA**), the **SET Plan Information System** (**SETIS**) as well as with members from industry, academia, SET Plan countries and citizens.

www.set4bio.eu

The SET4BIO project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 884524

HYDROTHERMAL LIQUEFACTION FOR SEWAGE SLUDGE VALORIZATION

Alex Gorodetsky, Ling Li, Steeper Energy Canada Ltd

Steeper Energy's proprietary HTL process can transform urban sourced bio-organic wastes into advanced biofuels

Europe is facing major challenges in balancing its future energy needs and reaching the targets of 10% renewables in transport fuels by 2020, and a total of 27% penetration across energy sectors by 2030.

At the same time, increasing residual mass flows from society are challenging Europe's ability to design sustainable and circular approaches for valorization of organic as well as inorganic components.

Increasing the use of bio-based products in the European economy is a strong focus, and an important aspect is the conversion of biomass into 'advanced biofuels' that significantly contribute to reducing the greenhouse gases (GHG) by more than 60% as required by the RED II.

The transportation sector is especially challenged in the European Energy Roadmap 2050, by an 80% reduction of GHG emissions compared to 1990, but with the

The continuous bech scale Hydrothermal Liquefaction Plant at Aalborg University (DK)

Biocrude oil obtained from Steeper Energy's proprietary HTL process. Source: Steeper Energy.

contribution of first-generation biofuels currently capped at 7% and with a possible reduction to 3.8%.
The EU Strategy for Low-Emission Mobility calls for the speed-up of deployment of alternative energy vectors for transport, with a specific focus on biofuels.
The NextGenRoadFuels partnership will provide significant technological advancements within the entire value chain from various, low-value biogenic wastes through efficient and sustainable processing to drop-in quality synthetic gasoline and diesel fuels, in order to facilitate strategic decision making for, and implementation of, a future European energy infrastructure. This is a multi-disciplinary, pan-European effort reflected in the NextGenRoadFuels consortium, joining academia and research, industry and SMEs in a common effort.

HYDROFACTION®: HARNESSING THE UNIQUE CHEMISTRY OF SUPERCRITICAL WATER

The core technology behind this initiative is Hydrofaction® - Steeper Energy's proprietary hydrothermal liquefaction (HTL) process, which can efficiently transform urban sourced bio-organic wastes into advanced biofuels with the added environmental and social benefits of destroying micro-plastics, pharmaceuticals, and endocrine disruptors as well as isolating heavy metals, phosphorous and nitrogen, making them available for other higher-value uses.
Hydrofaction® harnesses the unique chemistry of supercritical water and delivers low-oxygenated bio-crude oil at high biomass-to-oil yields, and ultimately into drop-in biofuels. Unlike traditional HTL process conditions, Hydrofaction® is a conversion pathway under supercritical water conditions. In this condition, water becomes a solvent to oil as well as simultaneously producing alkali and acidic conditions, among other properties.
Thus, it allows for the efficient de-oxygenation of bio-organic molecules and production with higher yields when compared to other HTL technologies.

SEWAGE SLUDGE FROM WASTE TO FEEDSTOCK

The overall market focus of NextgenRoadfuels Project includes sewage sludge and municipally aggregated biowaste. The amount of both sewage sludge and municipal organic waste is considerable, while the later one has a higher volume. However, the disposal cost of sewage sludge is significantly higher than municipal waste.
Therefore, considering the ability of HTL to efficiently process wet materials, an initial focus on sewage sludge has been chosen for market entry.
Currently, sewage sludge disposal methods include incineration, land spreading (for agriculture use), compost, and landfill. The jurisdictions that focus on landfill or land spreading of sewage sludge may be a more accessible initial entry point for HTL as significant capital has not yet been deployed on sludge incineration or composting infrastructure.
As shown in Fig. 1, many countries in the EU fit this description. Additionally, it has been determined that smaller urban centres may be preferable, rather than larger centres with longer planning horizons.

DEVELOPING A GO-TO-MARKET STRATEGY FOR HTL IN THE WASTE MANAGEMENT SECTOR

A series of interviews with waste industry executives and operators have been conducted to advance the understanding of the Go-to-Market strategy for HTL entering the waste management industry.
Industry feedback indicates that the urban waste market is extremely conservative and bringing a new technology into the market can be challenging and time consuming. Projects within the sector are governed by the EU tendering process and necessitate the need for EPC (Engineering, Procurement and Construction company) participation in providing completion and performance guarantees to which municipalities are accustomed.
Land spreading of sewage sludge conforms with the Sewage Sludge Directive. This directive is old legislation that regulates the use of sewage sludge in agriculture and sets limits for concentrations of heavy metals in soil (EIONET). Significant disagreement exists on whether land spreading should continue, and therefore the directive is unlikely to be altered.
It is the view of one industry association that all routes of sewage sludge disposal must remain open. However, a trend is emerging in decreased usage of land-spreading. Germany has taken the lead, and Sweden, Norway, and Finland are following suit by not allowing land-spreading.
This trend provides an opportunity for HTL penetration into the wastewater treatment market.

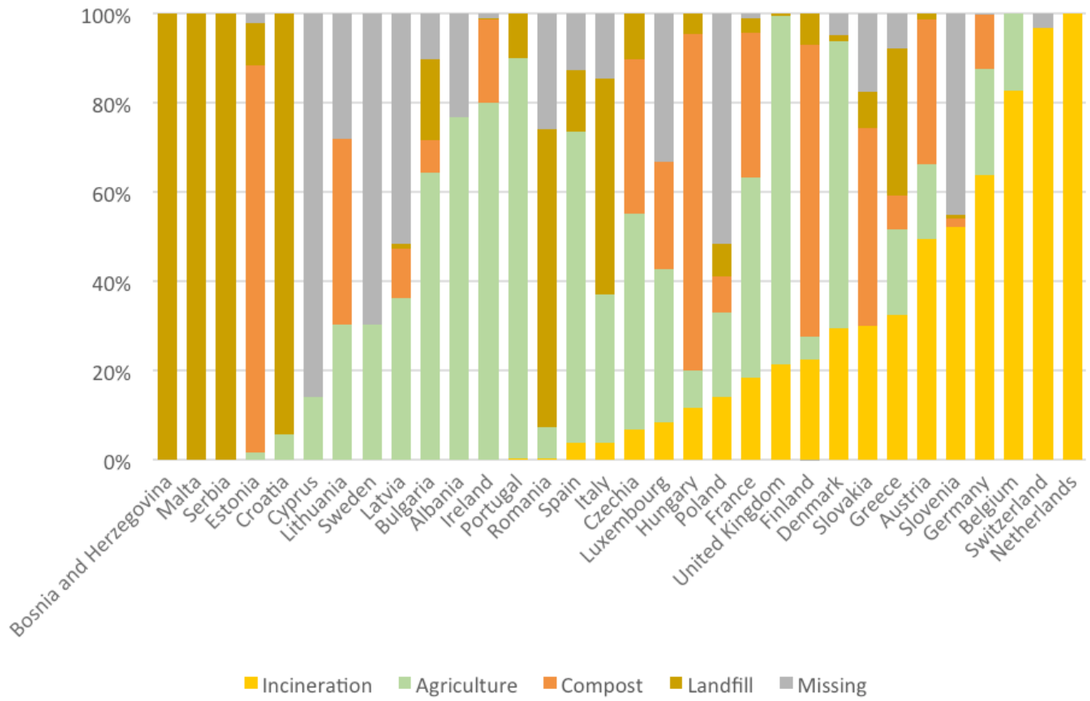


Figure 1 - Sewage Sludge Disposal by Country (Eurostat, 2017)

The following market drivers were identified through our research:

- 60% of global sludge disposal is either incinerated or landfilled costing € 11.2 B per year in EU and € 142 B globally for wastewater treatment plants (UN-HABITAT, 2008)
- The global sewage treatment plants market is forecast to grow at a positive CAGR (Compound Annual Growth Rate) of 9% during 2016 - 2021 to reach € 154 B by 2021, due to increasing population and emerging stringent regulations (Azoth Analytics , 2016)
- Changing trends and new government legislations regarding resource usage, the European sewage sludge market will move towards mono-incineration
- If traditional sewage sludge disposal solutions in EU are replaced by incineration, the additional cost would approximately € 650 million per year [source: interviewee feedback].

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 818413

THE ROLE OF RENEWABLE MARINE FUELS

Rianne de Vries, GoodFuels The Netherlands

The GHG strategy communicated by the International Maritime Organization in April 2018 to reduce 50% of the CO_2-emissions by shipping in 2050 compared to 2008, functioned as a wakeup call for many stakeholders in the shipping industry. The IMO's GHG targets made clear that 2020 is just the beginning of a very challenging pathway towards a low – and ultimately zero – carbon era for the industry.

At GoodFuels, we accelerate this transition by developing and commercializing sustainable alternatives to fossil fuels.
Having been a true pioneer and market leader ever since 2015, we have supplied the marine industry with innovative and sustainable fuels such as Hydrotreated Vegetable Oil and more recently our ground breaking Bio-Fuel Oil, a 100% replacement of the polluting heavy fuel oil.
With these products, we have truly triggered and accelerated the transition towards fossil-free shipping.

DECARBONIZING THE SHIPPING SECTOR

In transportation different modalities have different options for decarbonization. At GoodFuels, our aim is to focus on those segments that do not have many alternatives (yet). For now, this is very much the case for deep sea shipping. This segment is still almost fully reliant on fossil fuels.
When expressed in CO_2-emissions per ton-mile, the results are in general better compared to aviation or road transport, however the industry is heavily dependent on fossil fuel oil, the cheapest and also arguably the dirtiest fossil fuel in the world. Since the introduction of the 0.5% Sulphur cap at the start of 2020, *Very Low Sulphur Fuel Oil*, also known as VLSFO, is the new standard for ships without scrubbers. This fuel contains significantly less sulphur than Heavy Fuel Oil, but still emits the same CO_2 emissions.

Other segments we actively focus on are short sea shipping, offshore and dredging. Especially the offshore and dredging companies often work for governmental tender projects. In these tenders, the government can give a fictive discount when low emissions fuels are used. This incentive proved in the past to be a trigger for the use of the slightly more expensive sustainable low carbon fuels because this could increase the chance of winning a tender.

GoodFuels is also active in inland shipping. Next to noise effects, CO_2, SO_x, NO_x, PM are emissions that play a key role in this segment, especially because of EU legislation. An advantage of inland shipping is that it shows a high potential to decarbonize as the ships are relatively small and have the opportunity to tank and recharge frequently. This gives them the opportunity to use less energy dense fuels without the need for a lot of onboard energy storage space. For these reasons some experts think inland shipping is able to be near emission free before 2030. GoodFuels is of the opinion that sustainable drop-in biofuels play a vital role in the transition towards zero-emission inland shipping.

THE SILVER BULLET

The IMO's target of a 50% reduction in shipping's carbon emissions by 2050 is ambitious and, some would argue, unattainable. The options for the maritime sector to significantly decarbonize are limited.
A lot of focus is put on reducing fuel consumption, due to energy efficient measures such as redesigning hulls and propellers, air lubrication and installing performance-management software. The main argument for vessel owners to adopt such measurements, is that reduced fuel consumption goes hand-in-hand with cost reduction.

Energy efficiency measures however do not lead to full decarbonization of the industry. The 'silver bullet' to fully decarbonize the shipping sector has not been found yet, and we argue that it's probably the case that there is no such ultimate solution. To decarbonize, the shipping sector needs to adopt several technologies to ultimately be able to substitute fossil fuels and reach their target.
One thing is certain, alternatives to the use of fossil fuels such as biofuels and other non-fossil fuel options could make a significant impact on decreasing emissions of shipping now and in the future.
Popular options often discussed here are methanol, ammonia, LNG, hydrogen or electricity. However, the low technical readiness in combination with the required new infrastructure and modifications onboard raises doubts about their role in the near future.
Drop-in biofuels though meet the technical and operational criteria and are in some case already price competitive. On top of that, the current (e.g. national) targets and ambitions to lower emissions lead to a current growing demand for drop-in biofuels.

AVAILABLE BIOFUELS

Biofuels are available as 1) biofuels for which (small) engine or infrastructure modifications are necessary and 2) drop-in biofuels.

Fuels based on alcohols, ethers and esters are considered a biofuel. These fuels are by definition not drop-in, as small (engine/infrastructure) modifications are necessary. This includes fuels like, ethanol, DME and FAME. FAME, Fatty Methyl Esters, blended in low percentages with HFO could however be considered a drop-in fuel, however, further testing is required whether FAME could also be blended in higher percentages.

True drop-in biofuels are defined as liquid hydrocarbons that are functionally equivalent to petroleum fuels and are fully compatible with existing petroleum infrastructure.
The main advantage of drop-in biofuels is the ability to go directly to high blend ratios and even pure forms without the need of establishing a new fuel infrastructure, including the replacement of existing engines and fuel infrastructure, in order to roll out a more sustainable fuel.
This saves both time and infrastructure investments and repurposes already existing hydrocarbon infrastructure. In addition, ships using drop-in biofuels can freely switch between biofuel and fossil fuels. From an operational point of view this is important since sustainable drop-in biofuels are currently only available in a limited number of ports.

Synthetic Paraffinic fuels *are* considered drop-in biofuels. HVO, Hydrotreated Vegetable Oil, is a good example of a Synthetic Paraffinic drop-in fuel already used to replace marine gas oil. HVO perfectly fits the technical requirements of marine engine and, depending on the feedstock used, can also result in a significant CO_2 reduction. HVO can be bunkered as a blend or as a 100% fuel. GoodFuels currently delivers both blends as well as HVO as 100% replacement to marine customers.

Another drop-in biofuel available is GoodFuels Bio Fuel Oil, a fuel specifically aimed at deep sea ships. Bio Fuel Oil is considered by GoodFuels as a suitable replacement for fossil based heavy fuel oil and low sulphur fuel oil, directly making a positive impact on lower CO_2 emissions from shipping. Currently GoodFuels has only a certain

amount of supply of this fuel, but as demand is rising GoodFuels is working hard to increase scale through both existing technologies and advanced technologies.

INNOVATION

GoodFuels sees truly sustainable (drop-in) biofuels as one of the solutions to decarbonize the shipping sector. We have already launched a world's first Bio Fuel Oil and we don't stop pioneering here. We have performed a world's first pilot bio bunkering with blockchain technology and plan to scale this up with the aim to further ensure transparency and sustainability of a biofuel.

Moreover, together with our partner BTG Biomass Technology Group BV, also based in The Netherlands, we announced the plan to build the world's first dedicated bio-refinery based on pyrolysis technology, to support shipping's low carbon fuel demands. In this case the pyrolysis oil is made from biomass-based residues such as sawdust and is a sustainable alternative for replacing fossil fuels.

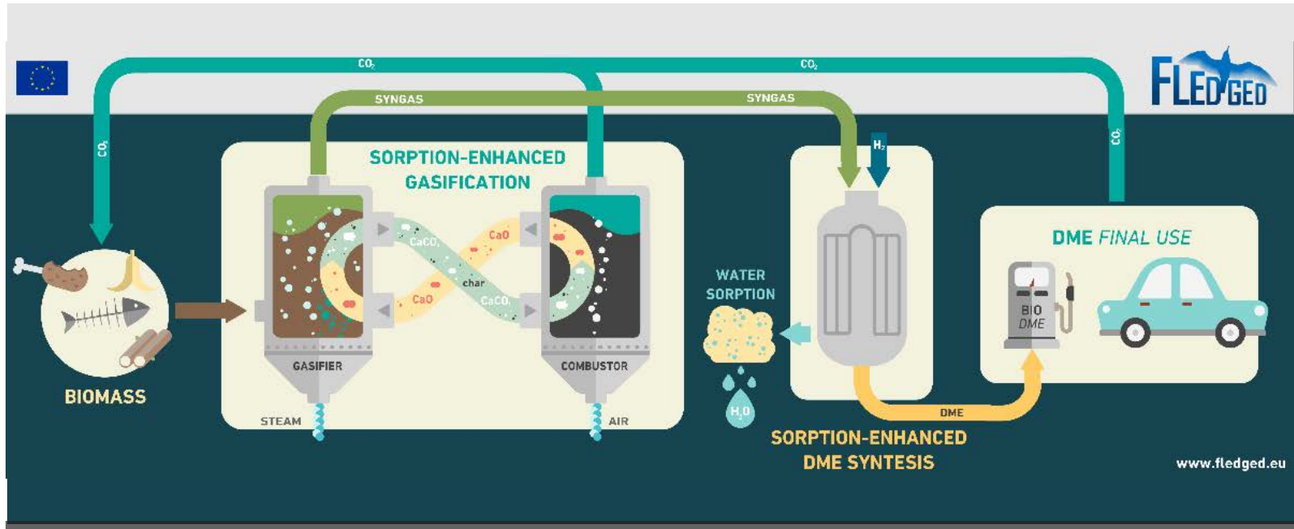
In general upgraded pyrolysis bio-oil or upgraded HTL bio-oil are very interesting technologies which the GoodFuels Innovation team is working on throughout the fuel supply chain, from sustainable feedstock sourcing to commercializing a fuel.

To stay on top of most recent developments of sustainable advanced biofuels and ensuring their market potential a key priority is participation in Innovative R&D projects for example Horizon 2020 and Dutch granted projects. We do this together with all types of for profit and not for profit organisations. A good example is the project NextGenRoadFuels, granted by the European Commission, bringing together experts from all over Europe to develop a biofuel for the road and maritime sector based on HTL technology with municipal waste and sewage sludge as a feedstock.

During the developments of these innovative biofuels it is considered very important that the biofuels are made out of pure sustainable residual flows. This means, no competition with the food chain, or result in the deforestation of rainforests and no harmful social or cultural consequences. To ensure this statement, GoodFuels is under the supervision of an independent sustainability board consisting of leading NGOs and academics.

At GoodFuels we know we cannot move this entire industry by ourselves. We aim to build long term relationships with feedstock suppliers, technology developers, OEMS, knowledge institutes and end-user to drive developments forward and achieve our ultimate goal: a fossil-free transport sector.

Source: GoodFuels



SORPTION-ENHANCED PROCESSES FOR BIO-DME SYNTHESIS

Giulio Guandalini, Matteo C. Romano, Department of Energy, Politecnico di Milano, Italy

DME production from biomass gasification: Results from the FLEDGED project and the way forward.

The ***FLEDGED Horizon 2020 European Project*** (FLExible Dimethyl ether production from biomass Gasification with sorption enhancED processes, www.fledged.eu) addresses the integration of flexible Sorption-Enhanced processes for the conversion of second generation biomass (forestry biomass, agricultural residues, waste derived fuel, etc…) to Dimethyl Ether (DME). This fuel is a promising substitute of oil-derived Diesel fuel for cars and heavy-duty vehicles, requiring minor changes of the engines and allowing energy efficient propulsion with a soot-free combustion. The production of second-generation biofuels from biomass or waste is one of the most promising solutions to meet the CO_2 emissions targets in the EU transport sector.

The FLEDGED project will end in October 2020, after 4 years of hard work. The project consortium is developing technologies leading to **process intensification** and potential cost reduction of the biomass-to-DME conversion process. Another primary focus of the project was the development of a **flexible process** with respect to:(i) **feedstock flexibility** (ii) **operational flexibility**, to allow the integration with electrolysis system for **power & biomass to DME** process and (iii) **retrofitability into a Bio-CCS process** resulting in a **negative CO_2 emissions** system.

SORPTION-ENHANCED BIOMASS GASIFICATION (SEG)

In the Sorption-Enhanced gasification process, a calcium-based sorbent is used to separate carbon in the gasifier and so adjust the syngas composition fulfilled for the downstream DME synthesis. The FLEDGED activities related with SEG biomass gasification have been recently concluded and involved tests in the 30 kW_{th} bubbling

FLEDGED project concept: from biomass to biofuels through flexible and integrated sorption-enhanced processes.

fluidized bed (BFB) facility at ICB-CSIC and in the 200 kW_{th} dual fluidized bed facility at University of Stuttgart. Experiments using different gasification temperatures, sorbent-to-biomass and steam-to-carbon ratios have been conducted in these experimental facilities.

ICB-CSIC has evaluated SEG performance for six different biomass feedstocks. Special attention has been paid to study the influence of each operating variable in the syngas yield and syngas composition as well as in solids conversion. Syngas yield and light hydrocarbons (C_2-C_4) content have been found to be mainly linked with the gasification temperature, due to the impact of such variable on primary pyrolysis, cracking and reforming reactions. Char conversion reached in the reactor was noticeably influenced by the temperature, the solid residence time and the type of biomass. The optimum value of the M-module $(H_2\text{-}CO_2)/(CO+CO_2)$ for DME production (M=2) has been reached for most of the biomass tested. The biogenic waste material from the Econward plant resulted to be among the most reactive feedstocks tested, resulting in the largest gas yields (i.e. up to 1.6 Nm^3/kg_{waf} biomass).

In a parallel set of activities, the University of Stuttgart performed tests in their 200 kW_{th} dual fluidized bed facility. Experiments involving sorption-enhanced gasification of wood pellets were conducted at several operating conditions, obtaining a M-module in a range between 12 and 1, showing the flexibility of the process.

The experimental experience showed that the process can be operated stably in the pilot scale facility at gasification temperatures between 600 °C and 775 °C. Experiments with biogenic waste material from the Econward plant have been also successfully conducted in the pilot plant.

Both in the BFB and in the pilot, no significant effect of the steam-to-carbon ratio has been found in the syngas composition, while it is mainly driven by the gasification temperature and the sorbent-to-biomass ratio by means of the CO_2 separated from the gas phase.

Lappeenranta University developed a 3D model for steady state semi-empirical simulation of CFB reactors. The in-house model combines modelling of all major heterogeneous and homogenous reactions, fluid dynamics of gas and solids, and heat transfer. The advanced coupling scheme allows to connect multiple CFB reactors with various solid and gas stream connections, which provides an option to study different SEG process configurations.

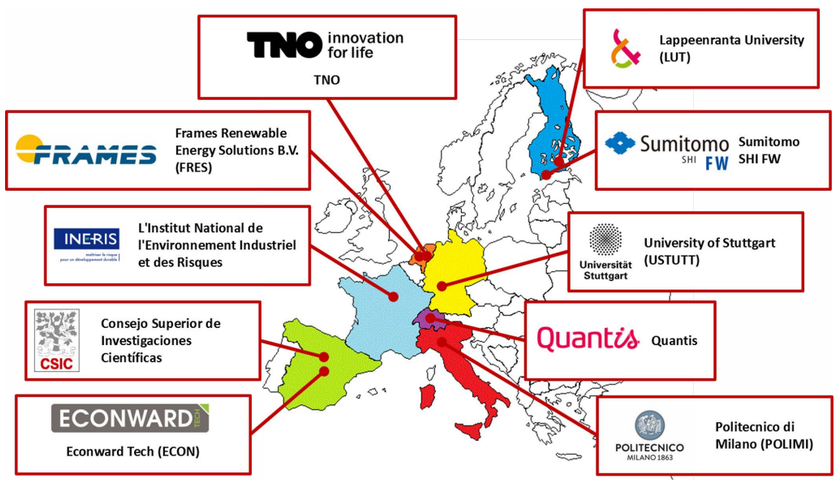
SORPTION-ENHANCED DME SYNTHESIS (SEDMES)

Steam separation enhancement is shown to be a promising process intensification technology especially for CO_2 utilisation, as from over 120 literature references.

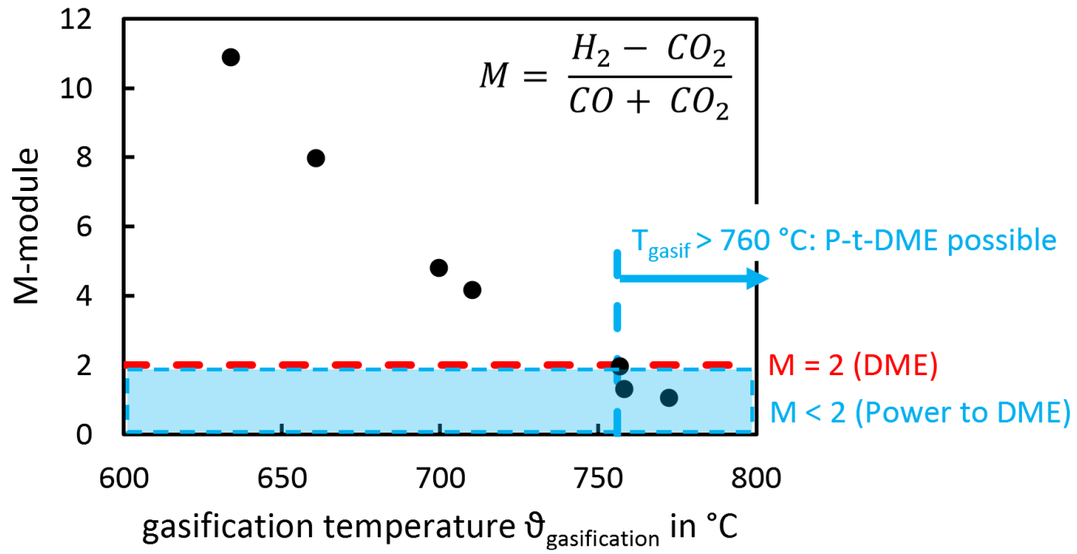
The feasibility of reactive steam adsorption processes, such as sorption-enhanced DME synthesis (SEDMES) requires high working capacity at elevated reaction conditions and heat management as has been addressed in the FLEDGED project.

In the SEDMES process, catalyst and sorbent for in-situ water removal are admixed, overcoming the thermodynamic limit of the DME production reaction and leading to high single-pass DME yield with no need of unconverted gas recirculation.

The complexity of the problem arises the necessity of combining process simulation (POLIMI, TNO), catalysts development (ICP-CSIC) and experimental validation and accelerated scale-up (TNO).



FLEDGED project consortium: 10 leading companies and institution from 7 European countries.



Performance of SEG as a function of temperature, as measured in the pilot scale facility at University of Stuttgart. Operational limits for DME synthesis evidenced

The ICP-CSIC developed a set of catalyst for the methanol synthesis from bio-syngas and for DME synthesis from methanol dehydration. The physicochemical properties of the synthesized materials were thoroughly analyzed, considering also commercial options, and the optimal reaction conditions were identified to obtain the direct synthesis of DME.

The performance in terms of DME yield and DME productivity, as a function of operating parameters, has been identified through extensive testing in lab scale facilities at TNO (>300 SEDMES runs). The potential operating window has been defined and a suitable combination of catalyst for direct DME synthesis and zeolite water adsorbent have been selected. All SMART targets for the small-scale testing were successfully met, such as CO_x content halved compared to steady-state/equilibrium, fully flexible operation with respect to CO-CO_2 ratio in the feed and single pass CO_2 production below 5%. Experiments under industrially relevant conditions have been performed at the bench-scale (TRL4) setup, using a single reactor column of 2 m.

The promising results of this accelerated scale-up of the SEDMES technology show already an order of magnitude increase in the DME productivity, without further optimization. Further process validation on TRL5 is currently ongoing on existing facilities, while a dedicated DME pilot reactor is being built in the follow-up EU Interreg project E2C.

Combining theory and experiments, modelling efforts have continued both at TNO, where the cyclic operation of the reactor has been modelled successfully, allowing cycle design and optimization as input for the overall process integration and economics, and at POLIMI, where detailed intra-particle mass transfer phenomena are coupled with 2D simulation of the whole reactor to increase design accuracy and predictive capabilities. The developed tools allowed for an extensive parametric analysis aimed at identifying the best operating conditions and to design the reactor geometry in order to maximize the DME productivity and controlling the temperature hot-spot.

The analysis also includes a detailed study of the possible different configurations (hybrid, mechanical mixture, core@shell) of the two catalysts present in the DME direct synthesis process (methanol synthesis and methanol dehydration catalyst).

PROCESS INTEGRATION, RISK AND SUSTAINABILITY ANALYSIS, EXPLOITATION OF PROJECT RESULTS

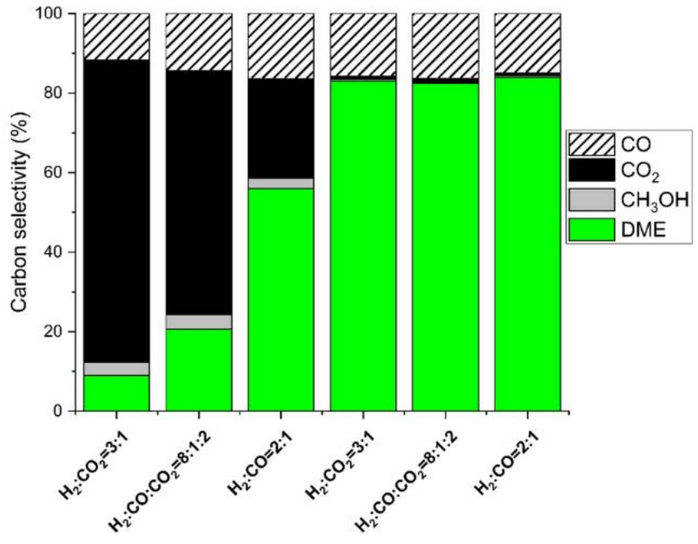
The complete process and economic model developed by POLIMI allowed identifying process integration solutions and strategies for flexible operations, to design an overall economically competitive process. The design of the heat recovery cycle and heat exchanger network has been optimized through advanced Mixed Integer NonLinear

Programming (MINLP) algorithms to optimize the economic objective function. The adopted methodology allowed to simultaneously consider many possible configurations of thermodynamic cycles, thanks to the development of a general superstructure, and to account for different expected operating modes (i.e., with or without H_2 input).

A multi-criteria impact assessment of the FLEDGED value chains is ongoing which includes the following indicators namely the environmental LCA, risk assessment and socio-economic impacts. A stepwise methodology has been implemented to study the risks related to process steps and materials all along the value chain, making use of Inherently Safer Design (ISD).

The risk assessment identified the main accident scenarios whereas the hazard profiles of feedstocks and key materials were experimentally studied.

Finally, recommendations for risk management by proposing technical and organizational safety barriers will be provided. QUANTIS is also performing the Life Cycle Assessment of the FLEDGED system assessing the environmental burden of the process in terms of climate change impact, energy use, water use, impacts on human health and impacts on ecosystems. Results will be then compared to the impact of conventional fuels and other promising biofuels. The Socio-Economic Analysis aims at identifying advantages and disadvantages of the FLEDGED technology, providing monetary estimates of induced environmental and health impacts assessed in LCA. It also models air quality and health impacts in the EU28 of DME use scenarios, compare benefits to costs between a business as usual and a FLEDGED scenario.



Example of results from SEDMES experimental campaigns as single-pass selectivity to final product for different compositions of syngas

Two exploitation business models of FLEDGED technology, producing DME from different types of biomass, have been selected and are being analyzed by SHI-FW, Frames and Econward. The first option proposes the use of lignin and wood biomass as raw materials. The feedstock selected in second model adopts biomass produced from Municipal Solid Waste by ECONWARD technology as feedstock. This solution is an example of circular economy approach aligned with the European directives, since the Econward technology is a solution for biomass pretreatment and the DME is a fuel suitable for garbage trucks.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 727600.

References

The project has been financed by the Horizon 2020 programme of the European Union, with a budget of about 5 300 000 €.
More details about the project results are freely available on the website. In particular, deliverables on characterization of raw materials (D2.1), catalytic performance of novel mixtures (D2.6) and final experimental results on SEG process at TRL5 (D3.4) are available for consultation in the website dedicated section. The scientific outcomes are also collected in peer-reviewed papers available on FLEDGED Zenodo repository:
J. van Kampen et al., "Sorption enhanced dimethyl ether synthesis for high efficiency carbon conversion: Modelling and cycle design", Journal of CO_2 utilization, 2020
I. Martinez et al., "Experimental investigation on sorption enhanced gasification (SEG) of biomass in a fluidized bed reactor for producing a tailored syngas", Fuel, 2020
J. van Kampen et al., "Steam separation enhanced reactions: Review and outlook", Chemical Engineering Journal, 2019
J. Boon et al., "Reversible deactivation of γ-alumina by steam in the gas-phase dehydration of methanol to dimethyl ether", Catalysis Communications, 2019

BIOBRIDGES: A WAY TO MARKET

Matteo Sabini, Serena Cheren APRE Italy

Numbers demonstrate that bioeconomy is one of the European core activities: 18 million people employed are producing a turnover of 2.3 trillion euros with an added value of 621 billion euros.

Unsurprisingly, bioeconomy was recently addressed with a renewed strategy by the European Commission, pledged to invest public funding and to trigger also private resources with the overall objective to create 1 million new jobs by 2030[1]. In light of this, the above-mentioned numbers and policies are drawing a future scenario where bioeconomy is becoming more and more central and where bio-based products – manufactured from natural and re-used resources – are intended to replace the fossil-based ones.

Despite such preconditions, several challenges still need to be addressed. Market acceptance, higher prices, performances, feedstock availability are just some of the factors that are slowing down this process, affecting all actors in the value chain. Indeed, without a relevant change in consumers' habits – depending on their willingness for more sustainable market choices or "forced" by changes in regulation – the market demand by itself will not be able to drive a widespread take-up of these products by brands.

Moreover, in this context, innovative solutions developed by researchers or by industries face difficulties in the scaling-up process, falling in the "valley of death" between the research phase and the commercialization stage.

Funded by the Bio-Based Industries Joint Undertaking (BBI JU), under the Horizon 2020 programme, Biobridges project mission (https://www.biobridges-project.eu/) is exactly this: to tackle the key challenges hampering the marketability of bio-based products through the improvement of a closer cooperation and partnerships among three identified key actors of the value chain: consumers, brand ownersand bio-based industries.

In this context, Biobridges is implementing a wide range of different and tailored actions to stimulate and support the dialogue and collaboration among the three identified key actors, but also to engage the other stakeholders in the debate falling in the so-called supporting environment (policy

makers, clusters, NGOs, researchers, local communities, etc). Starting from a thorough desk analysis, validated by a group of experts belonging to different stakeholders' categories, Biobridges is now organizing co-creation workshops aiming to:

- jointly identify solutions to overcome existing challenges;
- stimulate new collaborations among stakeholders;
- support the definition of a policy paper on how to improve the public acceptance of bio-based products;
- contribute to the identification of the most mature sectors for the adoption of bio-based products;
- get insights for drawing an action plan to raise consumers' awareness.

CHALLENGES & GOOD PRACTICES

As a first and outstanding result – emerged from the analysis of the results deriving from EU funded projects and of more than 60 interviews conducted with key stakeholders in 15 European countries – the project drew the Biobridges value chain collaboration challenges model (figure 1), challenges faced by consumers, brand owners and bio-based industries along the whole value chain, from feedstock to market. The figure shows the complexity of the challenges that should be addressed to enhance the market adoption of bio-based products, classifying them into two main distinct categories (highlighting stakeholders involved):

- challenges that can be approached thanks to the collaboration of various stakeholder in the bioeconomy value chain (*vertical pillars*)
- challenges that can be addressed through cross-cutting actions implemented by policy makers and researches (*horizontal pillars – supportive environments*).

At the same time, Biobridges conducted an analysis of 18 regional and national bioeconomy or bioeconomy-related clusters to track their incentives/best practices for supporting bio-based businesses and facilitating multi-stakeholder and cross-sector cooperation for the development of bio-based products aligned with consumer's needs. Aiming to identify successful examples to replicate in other regions, the analysis found good practice tools for engaging stakeholders. However, examples of cross–sectoral collaboration are rare and the analysis highlighted that the main obstacle is the lack of public support. The obtained results were further assessed and validated by 20 experts in a Focus Group meeting held in Brussels, in June 2019. Thanks to their multidisciplinary knowledge, the experts highlighted the importance to also focus the project activities on *supporting environment* for the stakeholders. Moreover, they identified three application sectors most promising for bio-based products uptake: food packaging (in particular disposable products for catering and events); personal care and cosmetics; sports accessories and toys.

Figure 1 - Biobridges value chain collaboration challenges model

CO- CREATION WORKSHOPS AND BRANDS-TAILORED EVENTS

The two mentioned analysis paved the way to 18 co-creation workshops already organized (and others are in the pipeline) around Europe and with a regional, national or European relevance. So far, around 600 participants representing various stakeholders were actively engaged in the discussions for identifying solutions to overcome existing challenges, covering different value chains (wood, textile, construction, agriculture, etc.) and at different stages. The main ideas collected through the events will feed a *policy paper* aimed to provide policy makers with good practices, practical actions and recommendations on how to improve the public acceptance of bio-based products, and suggest further measures to reduce potential conflicts among different stakeholders.

Moreover, the events create a supportive environment for establishing new partnerships among actors that were not already cooperating in the bioeconomy sector. Indeed, thanks to the participation in the co-creation workshops and the active intermediation of Biobridges consortium, 2 new cross-sector interconnections were already established – and more are expected before the end of the project. These were the case of a Croatian and a Dutch companies that joint forces for the algae production for nutraceuticals products; and two Italian research centres that established a cooperation for valorising wool residues for new bio-based products.

Despite the promising results achieved so far, scarce availability of brand owners in participating in the co-creation workshops was registered: indeed, these events were perceived as "too generic" for them and therefore emerged the need for organizing more tailored ones. Hence, a new concept and format of co-creation events were elaborated by Biobridges, consisting of 5 steps: Inspire, activating a direct line with the brand, for raising their awareness on the importance of switching from fossil to bio-based products;

1. *Inform*, providing mentoring opportunities stemming from the bioeconomy;
2. *Assess*, identifying with the brand the most-urgent challenges to be solved;
3. *Connect*, creating a bridge between the brands and potential bio-based solution providers;
4. *Co-create*, identifying new bio-based solutions to be implemented by the brand.

Such personalised mentoring approach is currently in a testing phase with **P&G** (and in particular with its brands **Oral-B** and **Braun**) and with another big company. Thanks to the collaboration with Biobridges, brand owners identified their specific sustainability challenges in beauty care, personal hygiene, and automotive sectors: based on that, a call for solutions is open to companies, innovators and researchers that, after a selection process, will be invited to pitch their ideas to the brands during a dedicated event[2]. As a result, it is expected that the Brands' awareness and interest in Bio-based products will be raised, new interconnections will be created and that the approach will accelerate the adoption of new bio-based solutions in the market.

RAISING CONSUMERS' AWARENESS: THE EUROPEAN SURVEY AND THE #BIOHEROES CAMPAIGN

Biobridges pledges to deliver an action plan for raising awareness of consumers on bio-based products, and, in addition to insights coming from events organized, it will use the results that will be collected through a survey recently launched, that assess the knowledge that consumers have and their purchase habits on bio-based products. **Available in 9 languages** (https://www.biobridges-project.eu/survey-for-consumers-/), the questionnaire will be open until Autumn 2020 and it is targeted mainly to people not already engaged in the bioeconomy community, thanks also a dedicated social media campaign. On this point, Biobridges already used Twitter, Facebook, Linkedin and Instagram accounts for the #BioHeroes campaign, to people on sustainability topics. Ensuring broader visibility under the label of "BioHeroes", people were requested to promote the benefits of the bioeconomy, share the use of bio-based products on the every-day life and encourage consumers to change their habits towards switching to bio-based products. Thanks to this, 24 BioHeroes were recruited and posts had more than 68.000 impressions, encouraging people to have a more sustainable lifestyle. The same approach was followed by a successful video published by Biobridges (https://www.youtube.com/watch?v=6f7Ej2_BLso&t=56s), where the main starring is an example of BioHero, showing us how a "bio-based day" can be. Cosmetics with functional ingredients from fruit waste, neutraceuticals from spirulina algae and blueberries, clothes from milk waste or coffee grounds, biofuel for the car from castor oil, are just a few of the bio-based products used in the video by a young modern woman during the whole day. The "moral" is that we are already surrounded by a wide spectrum of bio-based products, alternative to the fossil-based ones, and therefore, a more sustainable lifestyle is really possible!

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1 Numbers presented are extracted from the Updated Strategy on Bioeconomy "A sustainable Bioeconomy for Europe: Strengthening the connection between economy, society and the environment" Brussels, 11.10.2018.

2 The collaboration with P&G was still on-going during the preparation of this article: indeed, a call for solutions was launched in May and concluded on the 5th of July, when around 30 companies presented ideas for addressing the identified challenges. A short number of them will be selected to present their solutions to P&G during a dedicated workshop on 24th of June.

Upcoming bioenergy events

SEPTEMBER 2020		
02 - 03	6th European Biogas Conference 2020	Brussels, Belgium
09 - 10	Biomass Trade Summit Europe 2020	Amsterdam , the Netherlands
10	Svebio Fuel Market Day 2020	Stockholm, Sweden
15 - 17	Advanced Biofuels Conference 2020	Stockholm, Sweden
23 - 24	The Wood Energy Congress	Würzburg, Germany
OCTOBER 2020		
05 - 06	EFIB 2020	Frankfurt, Germany
14 - 16	2nd International Sustainable Energy Conference – ISEC 2020	Graz, Austria
15 - 16	7th International Conference on Renewable Energy Gas Technology, REGATEC 2020	Weimar, Germany
NOVEMBER 2020		
03 - 05	World Ethanol and Biofuels Conference	Brussels, Belgium
03 - 06	Ecomondo - The Green Technology Expo	Rimini, Italy
04 - 06	11th Biomass Pellets Trade and Power	Tokyo, Japan
11-12	Future of Biogas Europe 2020	Berlin, Germany
16 - 19	8th International Symposium on Energy from Biomass and Waste	Venice, Italy
17 - 19	European Bioenergy Future 2020	Venice, Italy
JANUARY 2020		
18-19	Fuels of the Future 2021	Berlin, Germany
18-20	World Future Energy Summit	Abu Dhabi, UAE
27-29	Powergen India	New Delhi, India