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BioEnergy

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Contents

Editorial

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Improve incentives for high renewable impact at lower cost

Support through a number of policies has boosted the production of renewable electricity in Europe, but often at a high cost. As the share of renewables in energy production increases, it is important that future investments be demand-driven and market-based, so as to avoid negative prices and excess electricity production.

Take the example of Sweden. In the 1970s, the country was dependent on imported fossil fuels for 80 percent of its final energy supply. However, a targeted policy to become energy independent and increase the share of energy from domestic renewable sources resulted in renewables accounting for 51 percent of supply in 2012. Bioenergy accounts for the lion's share of this, at 33 percent. This swing to renewables has not been as expensive as one might expect, and it has been achieved in conjunction with economic growth and an improved balance of trade.

Penalising harmful emissions

An important instrument in achieving these goals has been the "Polluter Pays Principle," which penalises companies for their emissions. In Sweden, this takes the form of a carbon dioxide tax, along with NOx and sulphur charges. The carbon dioxide tax is differentiated by sector and households have always paid a higher rate than business, since industry has to be competitive on a global market. In particular, energy intensive industries had a very low or no carbon tax until entering the European Emission Trading Scheme. When enforcing the reduction target for carbon emissions in Europe, the share of the burden between the various sectors should be carefully considered.

Sweden's introduction of a carbon tax for heating in 1991, and the fact that district heating infrastructure was already in place, made it easy and profitable for power companies to convert large district heating plants from oil to wood chips, waste incineration or peat. In the 1980s wood chips were more expensive than oil but, with oil trading at over USD100 per barrel since 2008, the current price per energy unit for wood chips is less than half the world market price for crude oil. Wood pellets can be used in powder burners that replace oil at a price that is only 60 per cent of the current oil price per energy unit. The result is that fossil oil is being replaced for heating all over the world, even without the carbon tax. Bioenergy can also be competitive in electricity production but currently only when also using the waste heat in Combined Heat and Power.

Investing in infrastructure

A large part of the change to renewables is about infrastructure investments. In Europe about 50 per cent of final energy consumption is accounted for by heating and only 25 per cent by electricity. Using waste heat from power production in district heating is a perfect match, and infrastructure funds should be used to invest in district heating grids. Even though they are profitable, these investments have been difficult to raise due to a general lack of understanding and problems with planning restrictions. Nevertheless, they will be important step towards achieving the profitable supply of renewable electricity and heat.

Europe's potential to produce renewable energy and biomass is enormous if the demand exists: it is mainly a matter of cost, and bioenergy is not always expensive.

SET-Plan update Bioenergy

The European Strategic Energy Technology Plan (SET-Plan) aims to transform the way we produce and use energy in the EU with the goal of achieving EU leadership in the development of technological solutions capable of delivering 2020 and 2050 energy and climate targets.

Bioenergy is set to play a key role in ensuring the security and sustainability of the European energy system and achieving the ultimate goal of reducing Europe's dependency on fossil fuels. The following is a chronological overview of some of the actions taken to promote bioenergy across the EU, in addition to a more general look at recent actions in support of the SET-Plan.

- The **European Biomass Association (AEBIOM)** is set up in 1990 to act as the common voice of the European bioenergy sector. Bringing together 30 national associations and around 70 companies from all over Europe, the aim of the association is to develop a market for sustainable bioenergy and ensure favourable business conditions for its members.
- The **European Biomass Industry Association (EUBIA)** is established in 1996 with the objective of supporting the European biomass industry, promoting the use of biomass as an energy source, developing innovative bioenergy concepts and fostering international co-operation within the bioenergy field.
- The European Commission issues a Communication in November 1997 on **Energy for the Future: Renewable Sources of Energy – White Paper for a Community Strategy and Action Plan** [COM/97/0599 final]. The action plan contains a list of priority measures, including new initiatives regarding bioenergy for transport, heat and electricity and, in particular, specific measures to increase the market share of biofuels, promote the use of biogas and develop markets for solid biomass.
- The European Commission issues a Directive in 2001 on the **promotion of electricity from renewable energy sources in the internal electricity market [2001/77/EC].** This Directive concerns electricity produced from non-fossil, renewable energy sources including biomass, landfill gas, sewage treatment gas and biogas.
- May 2003 saw the publication of **Directive 2003/30/EC** of the European Parliament and of the Council **on the promotion of the use of biofuels or other renewable fuels for transport**. This Directive aims to promote the use of biofuels and other renewable fuels to replace diesel and petrol for transport purposes in each Member State, with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources.
- **ERA-NET Bioenergy**, a network of national government agencies and ministries responsible for coordinating and funding national research efforts into bioenergy, is set up in October 2004, with funding under the European Union's Sixth Framework Programme (FP6) and runs until the end of 2010. Eight countries decided to continue the network's work on bioenergy research without EC funding from 2011.
- In early 2005, the European Commission sets up the **Biofuels Research Advisory Council (BIOFRAC)**. The Council, which consists of a group of high-level experts representing different sectors of the biofuel chain, is charged with developing a vision for biofuels up to 2030 and beyond to increase biofuel deployment in the EU.
- In December 2005, the European Commission publishes its **Biomass Action Plan** [COM(2005) 628 final], which sets out a series of Community actions aimed in particular at increasing the demand for biomass, improving supply, overcoming technical barriers and developing research. This was followed in February, 2006 by **An EU Strategy for Biofuels** [COM(2006) 34 final], which examined the role that biofuels could play in helping Europe address its over-dependency on imported oil and gas.
- The **European Biofuels Technology Platform** is set up in 2006 following the dissolution of **BIOFRAC,** to bring together the knowledge and expertise of stakeholders from industry, biomass resources providers, research & technology development organisations and NGOs in a public-private partnership. The EBTP aims to contribute to the development of cost-competitive world-class biofuel value chains and to accelerate the sustainable deployment of biofuels in the European Union.
- In January, 2008 the EBTB publishes its **Strategic Research Agenda & Strategy Deployment Document,** which aims to highlight the research, development and demonstration (R&D&D) efforts required to achieve the vision for biofuels in Europe as set out in the Report of the Biofuels Research Advisory Council (BIOFRAC) '*Biofuels in the European Union - A vision for 2030 and beyond*'. The accompanying Strategy Deployment Document discusses the non-technical issues that should also be considered in developing the European biofuels market for road transport to its full potential.
- The European **Energy Research Alliance Joint Programme on Bioenergy** is launched at the end of 2010. The overall objective of this Joint Programme is to align pre-competitive research activities at EERA institutes to provide a technical-scientific basis to further develop the next generation biofuels and to explore the possibilities for joint technology development.

- Two **EC Communications** dealing with biofuels are issued in 2010: The Communication on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme [2010/C 160/01] and the Communication on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels [2010/C/ 160/02] in an effort to facilitate a consistent implementation of the sustainability criteria for biofuels and bioliquids across the EU.
- The **European Industrial Bioenergy Initiative** (EIBI) is officially launched in November 2010 to prioritise and facilitate 'first-of-a-kind' demonstration of innovative 'clean energy' technologies in Europe. The original EIBI Implementation Plan covers 2010-2012.
- The European Commission, Airbus and representatives from the aviation and biofuel industries launch the **European Advanced Biofuels Flightpath** in 2011. This action aims to achieve 2 million tons of sustainable biofuels used in the EU civil aviation sector by 2020. The actions covered by the Flightpath include facilitating the development of standards for drop-in biofuels and their certification for use in commercial aircraft.
- The European Commission adopted the strategy and action plan **Innovating for Sustainable Growth: a Bioeconomy for Europe** in February 2012. The plan focusses on three key aspects: developing new technologies and processes for the bioeconomy; developing markets and competitiveness in bioeconomy sectors; and pushing policymakers and stakeholders to work more closely together.
- Following an FP7 call in July 2012, an ERA-NET Plus activity was launched entitled **Bioenergy Sustaining the Future (BESTF)**. A first BESTF call is launched in January 2013. This activity aims to provide funding and support to collaborative bioenergy projects that demonstrate one or more innovative steps resulting in demonstration at a pre-commercial stage. A second BESTF2 call is launched in December 2013.
- In April 2014, the EC introduced new **guidelines on state aid for renewable energy**, including biofuels. These guidelines curtail state aid to food-based biofuels from 2014, but allow some limited operating support for food-based biofuels up to 2020. Support is allowed for 'sustainable biofuels' (as defined by the *Renewable Energy Directive, 2009/28, Article 17, Sustainability criteria for biofuels and bioliquids*), where supply or blending obligations are alone not deemed sufficient to facilitate market development.
- The fifth **AEBIOM Bioenergy Conference** is held in May 2014, co-organized by the European Biomass Association (AEBIOM), the European Pellet Council (EPC), the European Industrial Pellet Suppliers (EIPS) and the International Biomass Torrefaction Council (IBTC).

General SET-Plan news

- The development of the Integrated Roadmap has entered the final phase with the completion of the stakeholder consultation. The first consolidated draft of the stakeholders' inputs will be discussed at the next Steering Group meeting on June 26th.
- The inputs in the form of research and innovation action proposals address a set of energy system challenges, identified by the SET-Plan Steering Group, to meet the three overarching energy policy objectives: security of supply, competitiveness and sustainability. These are in line with the various scenarios for the evolution of the European energy system in the medium and long term as described in the EU Energy Roadmap 2050, and in national roadmaps.
- The Integrated Roadmap and the Action Plan are key actions of the European Commission's Communication on Energy Technologies and Innovation COM(2013)253. Under the guidance of the SET-Plan Steering Group, over 150 stakeholders participate in the stakeholder consultation. JRC/SETIS is leading the drafting process for both documents.
- The Integrated Roadmap and the Action Plan will be the main focus of the 7th SET-Plan conference that will take place in Rome on 10-11 December 2014.
- The **European Energy Research Alliance** held its Annual Congress in Brussels on April 9, 2014. At the Congress, **Dr Giovanni De Santi**, Director of the Institute for Energy and Transport at the Joint Research Centre, the European Commission's in-house science service, gave a presentation on the SET-Plan Integrated Roadmap – the State of Play and the Way Ahead.
- The Joint Research Centre published the **Smart Grids Projects Outlook 2014**. This publication is the update of a comprehensive inventory of smart grid and smart metering projects from the 28 European Union countries and beyond.
- The Joint Research Centre published its **2013 Technology Map** of the European Strategic Energy Technology Plan, providing up-to-date and impartial information about the current and anticipated future European energy technology portfolio.
- The European Commission adopted an **EU Energy Security Strategy** [COM(2014) 330 final] in May 2014. This strategy is based on an in-depth study of Member States' energy dependence and addresses medium and long-term security of supply challenges. It proposes actions in five key areas: increasing energy efficiency; increasing and diversifying energy production; completing the internal energy market; speaking with one voice in external energy policy; and strengthening emergency and solidarity mechanisms and protecting critical infrastructure.

SETIS TALKS TO:

Christian Rakos

European Pellet Council President

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What is the European Pellet Council and what is its role?

C.R.: “The European Pellet Council is an umbrella organisation representing the interests of the international pellet industry. We have 23 members, all of which are national pellet or biomass associations. Our objectives are to represent the pellet industry and its interests at the European institutions in Brussels, to stimulate cooperation between national pellet associations and to operate a certification scheme for pellet quality – the ENplus certification, which plays a key role for successful market development.”

How important is the contribution of solid biomass to the SET-Plan and attainment of Renewable Energy Directive targets, to 2020 and beyond?

C.R.: “In my view the role of solid biomass for space heating and low- and medium-temperature industrial heat has been neglected in the past by most national and European renewable energy policies. What puzzles me most is the fact that solid biomass use in heat markets is only getting attention now, even though it offers a commercially viable use of renewable energy. With limited financial efforts but well organized policies, major shifts in our heat markets could be realized, leading to net financial savings, greater energy security and a substantial reduction of greenhouse gas emissions.”

You have argued in the past[1] that solid biofuels and the heating sector offer greater potential to reduce greenhouse gas emissions than liquid biofuels and the transport sector, yet the latter receive more focus in policy. Could you expand on whether this is still the case?

C.R.: “For the time being we can see a dynamic market uptake of wood pellets for heating in just a few countries in Europe: Denmark, Sweden, Germany, Italy, Austria and France. In these countries dedicated policy measures have helped to kick-start the market, which is now on a sustainable growth curve. This year more than 10 million tonnes of pellets will be consumed in these heat markets. The average annual demand growth for pellets in the heat sector in the last four years was 15%. The main driver for market development is the fact that wood pellets are substantially cheaper than heating oil and national gas. Nevertheless, many countries have not realized this opportunity yet and have failed to kick-start market development by policy measures.”

Do we have enough wood in Europe to meet the EU demand for pellets? And for imports, say from North America, if transportation costs and fuel oil for shipping are factored in, are the GHG savings still economically interesting?

C.R.: “Obviously, Europe is a densely populated continent with limited biomass resources. Nevertheless, in many Member States,

use of wood resources is still way below the annual regrowth and could be significantly expanded. U.S. and Canadian imports add to supply security and the stability of pellet prices. In the U.S. the demand for pulpwood has declined by 100 million tonnes between 1995 and 2010. Consequently huge amounts of fibre are available at low prices. In terms of greenhouse gas savings, imported pellets from the U.S. can still achieve more than 80% GHG reduction, an excellent value compared to first generation liquid biofuels, which achieve around 30% GHG reduction.[2] With respect to costs, transport across the Atlantic in large vessels is fairly cheap and, given the lower fibre prices in the US, the imported pellets are cheaper at the port than European pellets.

Fast-growing forests for solid biofuels often have very low biodiversity, while continuous harvesting can exhaust the soil. How sustainable is the wood pellet industry, for example, in the long term?

C.R.: “In Europe, raw material used for pellet production mainly comes from saw-mill residues and to a lesser degree, also from low value pulp-wood. Indeed, in the U.S. a large part of pellet production is based on fast growing pine tree plantations that have been established to supply the pulp industry with fibre. Trees, in contrast to annual crops, require significantly lower levels of nutrients. Due to the permanent cover, no soil degradation takes place. Also, herbicides are usually not applied except once in 20 years, just after planting. So, tree plantations are much more sustainable from an ecological point of view than annual crops.

Is the future market for the pellet industry in Europe in the domestic heating sector, in pellet boilers and stoves for example, or in the power industry? Or both? Where is the most growth expected?

C.R.: “Currently wood pellet consumption in Europe for power production is around 9 million tonnes, and for heat generation, about 10 million tonnes. In my view, both markets complement each other and support each other’s development. The ability of power producers to sign long-term advance agreements to purchase pellets (off-take agreements) has enabled major investments into pellet production facilities that are now also starting to supply heat markets. On the other hand, demand in heat markets is growing in a more predictable way than in the power sector as it is not dependent on day-by-day political decisions.

The role of pellet use in power markets is entirely dependent on adequate political framework conditions, as pellets are significantly more expensive than coal. On the other hand, with the conversion of coal-fired power plants to wood pellets, it is possible to realize large greenhouse gas savings within a very short period of time and at comparatively low costs, compared to other renewable electricity generation technologies. At the moment it seems that certain Member States’ policies aimed at reducing electricity costs have an adverse effect on renewable energy technologies. Recently, the use of wood pellets for power production was stopped in Belgium and in the Netherlands, for regulatory reasons. In Poland the market for power generation collapsed last year for similar re-

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asons. In the UK, the Department of Energy and Climate Change is constantly altering its policies and creating very significant risks for generators. This makes it very hard to predict future growth in the power market.

Pellet use in heat markets will continue to grow in those countries where it has entered into steep growth curves. The question is whether we will also see more widespread use of pellets for heating in currently dormant markets. I believe this will happen and continued rapid growth of the market can be expected.

What are some of the main challenges and opportunities facing the solid biofuel industry in the next decade or so?

A major challenge we face at the moment is posed by policies that attempt to establish emission limits that are extremely difficult to meet. This could lead to massive cost increases due to the necessary attachment of filters. At present a modern pellet boiler reduces particulate matter emissions, compared to an old logwood boiler, by about 95%. From our point of view it would make much more sense to promote the use of pellets and reduce the use of old logwood stove and boilers than to require even lower emissions of already clean burning appliances. Another challenge I see is the huge communication effort needed to introduce a new fuel in the market. Our industry is mainly based on small and medium sized enterprises that do not have the means for communication and promotion on the large scale necessary. This is one of the main things we need policy support for. Apart from that, the opportunities are great. Fuel availability with on-going internationalisation is almost unlimited. The price of our fuel is fully competitive. Technologies are fully developed and used by millions of European households and the only question is how can we expand this technology from the developing markets to dormant markets in other Member States..

What potential is there for synergy with other renewable energies, such as solar, for example?

C.R.: “The synergies between pellet heating and solar thermal collectors are considerable and increasingly both systems are combined. A buffer tank, needed to run the solar thermal collectors is very useful for stabilizing heat demand from the pellet boiler. The downside is that the cost of heat provided from the pellet boiler is very low, so the economical benefit from the solar system is not so significant. We can also observe synergies between air source heat pumps, which operate very inefficiently at cold outside temperatures, and pellet stoves that can top up heating capacity and reduce electricity demand during cold weather conditions.

1 Conference of the Association for the Study of Peak Oil and Gas (ASPO) in 2012
2 Editor's note: GHG reductions can vary, depending on how different variables such as transport are factored in. In a recent article in Environmental Research Letters, estimates of 50% to 68% GHG reductions were found for pellets imported into the UK from USA. See: Puneet Dwivedi et al (2014) Environ. Res. Lett. 9 024007 doi:10.1088/1748-9326/9/2/024007.

Christian Rakos

With a degree in physics, Christian Rakos has been executive director of the Austrian Pellet Industry Association 'proPellets Austria' since 2005 and president of the European Pellet Council since 2010. He has held posts at the Institute for Technology Assessment of the Austrian Academy of Sciences, the Austrian Energy Agency and the Irish Renewable Energy Information Office.

BIOCORE

- mixing up the feedstock

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Much of the discussion about biomass and biofuels centres around their use for residential heating or as a replacement for fossil fuels in the transport sector. It should not be forgotten, however, that Europe's dependence on fossil fuels is not restricted to these uses. Fossil fuels are also a key raw material in the chemical industry, and are used extensively in the production of polymers and plastics.

The aim of the EU-financed BIOCORE project, which ran from March 2010 to February 2014, was to conceive and analyse the industrial feasibility of a biorefinery concept that would allow the conversion of feedstock into a wide spectrum of products, including second generation biofuels, chemical intermediates, polymers and materials. By developing a range of polymer building blocks, BIOCORE aimed to show that 70% of polymers currently in use could be derived from biomass.

The first challenge that the project addressed was to demonstrate that a biorefinery could operate on mixed biomass feedstock. Several scenarios were generated that took into account harvest seasonality, transport and storage of biomass for biorefineries located in different regions of Europe and Asia. These scenarios were then used to analyse how a biorefinery could be stably supplied with a mixture of cereal crop by-products, forestry residues and Short Rotation Coppice (SRC) wood.[1]

The BIOCORE project intensively studied and optimised a pilot plant run by France-based project partner Compagnie Industrielle de la Matiere Vegetale (CIMV) S.A., which operates on organosolv technology, based on the use of a formic/acetic acid solvent. The organsolv process was tested for its capacity to use a feedstock mix comprising rice straw, hardwood and SRC wood. The studies revealed that, with some process modifications, the organosolv process can be adapted to use this feedstock mix, thereby meeting a key criterion of the BIOCORE concept.

BIOCORE developed valorisation pathways for three types of lignocellulose feedstock: wheat and rice straws; deciduous forestry residues; and SRC. Regarding the latter, a recent IEA report has estimated that in 2050 up to 1000 exajoules of SRC could be produced annually, which represents approximately 66 gigatonnes of biomass. The IEA also expects that energy crops, particularly SRC and miscanthus, will continue to show yield increases as new varieties are developed and commercialized.[2] According to the IEA report, this biomass will be produced on surplus or marginal lands and will therefore not compete with land use for food. Moreover, SRC woody crops have the added advantage that they can be grown on polluted land that is unfit for food production, which means that biomass production can be coupled with bioremediation land reclamation programmes.

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A key feature of BIOCORE is its ambition to produce several types of polymer. This is because forecasts indicate that polymers will constitute one of the most dynamic future markets for bio-based products. Furthermore, it is clear that society is highly dependent upon bulk thermoplastic polymers, such as polyolefins PVC and polyurethanes. This means that, if biorefineries are to respond to market needs, it is vital that they develop the capacity to produce bio-based polymers that meet current standards.

An overarching priority for BIOCORE was to investigate the sustainability of the BIOCORE biorefinery concept from an environmental, economic and social viewpoint, in order to identify the most sustainable biorefinery options. A study of the environmental impacts of BIOCORE products revealed that biorefineries based on the BIOCORE concept could have various potential impacts, ranging from significant environmental benefits to distinctly harmful outcomes. The drivers behind these impacts include factors such as the choice of product portfolio, the mode of implementation and external influences. In many cases the impact analysis revealed significant opportunities to optimize the biorefinery's environmental performance. However, to correctly identify these the specific interdependencies of local factors will have to be taken into consideration, which will only be possible during the planning of an actual industrial biorefinery. Overall, in terms of environmental sustainability, BIOCORE has shown that its biorefinery concept has the potential to deliver environmental benefits and that these could, in specific circumstances, be greater than those offered by current biomass-based energy processes.

The project's economic assessment of the bioerfinery concept was complicated by the current immaturity of the biorefinery sector, by market factors such as green premiums and by the fact that BIOCORE biorefineries are expected to co-manufacture several products aimed at markets with very different volumes and revenue structures. Nevertheless, clear indications were received that a biorefinery producing chemicals will be more profitable than an ethanol biorefinery and that certain products could benefit from significant green premiums. Finally, the economic analysis provided compelling arguments in favour of a new subsidy policy for bio-based products, which would provide subsidies for bio-based chemicals.

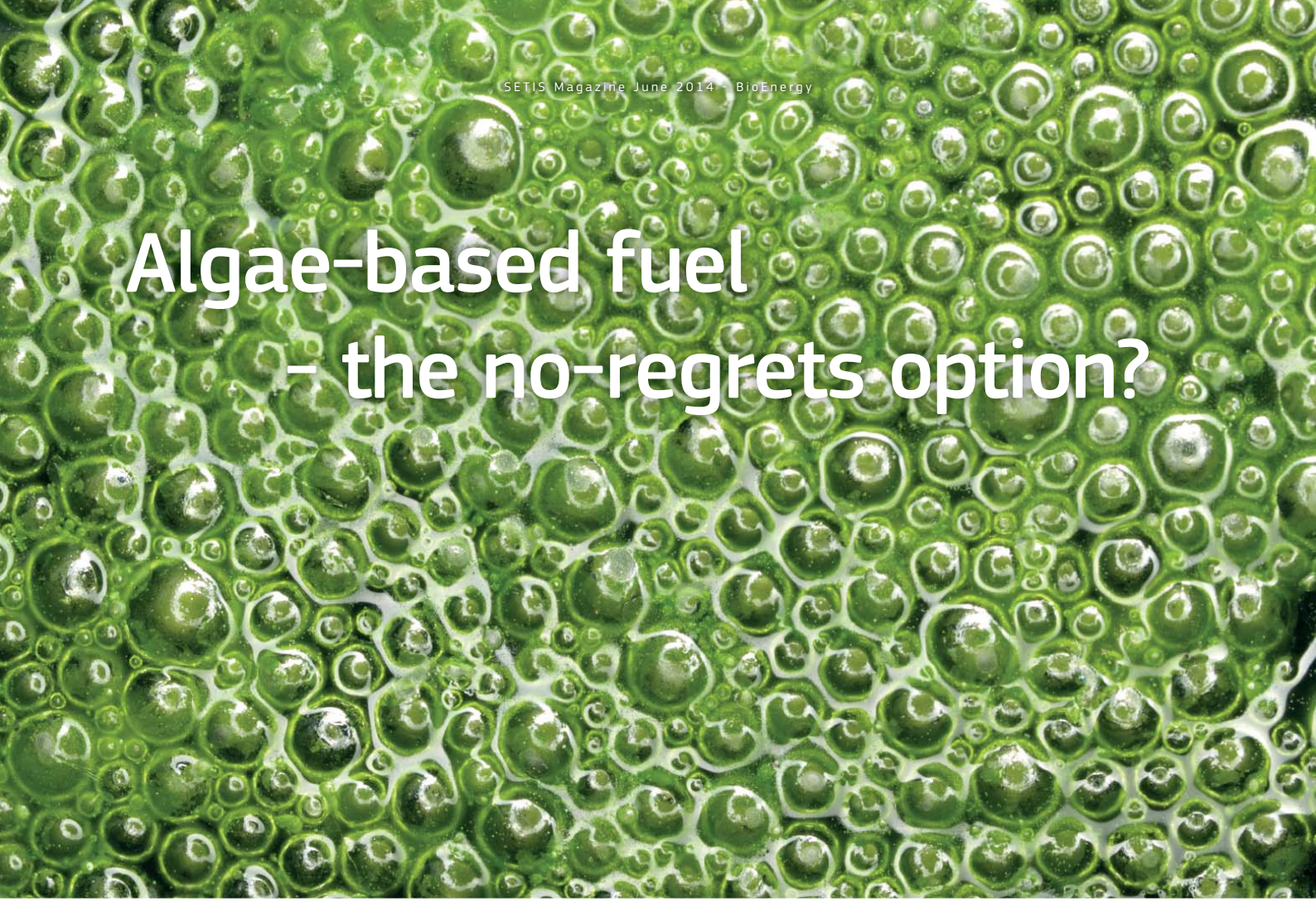
The researchers developed and tested several methods to study the social impacts of biorefining, making it possible to investigate a large number of social issues. Overall, these methods revealed that BIOCORE biorefineries could create new jobs and generate rural development. Competition for biomass was identified as a potential threat, which might be partly mitigated through close collaboration with local stakeholders, in particular farmers/forest owners. The project's final report notes in particular the importance of conducting a thorough social impact assessment for any planned biorefinery based on the BIOCORE concept, which should take into account potential impacts along the entire value chain.

There are a number of pilot lignocellulose biorefineries currently operating – for example, in Denmark, Italy, Spain and Sweden. However, these are mainly focussed on fuel ethanol production and significant work is required to fully integrate the use of all biomass fractions in the manufacture of additional products. Consequently, there is clearly a need for industrial demonstration of new technologies that use lignocellulose as a raw material for the manufacture of both fuels and chemicals. By providing this, BIOCORE has made a significant contribution to the advancement of this technology and increased the potential for the use of bio-based products in the chemical industry in Europe.

For more information:
http://www.biocore-europe.org/

1 Species selected for adaptability to various climate and soil conditions, relative insusceptibility to pests and diseases, ease of propagation and speed of vegetative growth.
2 http://www.iea.org/media/pams/uk/PAMs_UKBiomassTaskForce2005.pdf

Algae-based fuel – the no-regrets option?



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With food and biomass competing for land use, and with first generation biofuels receiving widespread criticism for undermining food security, algae is viewed by some as an alternative that will allow the biofuels industry to sidestep some of the more controversial issues that it has encountered.

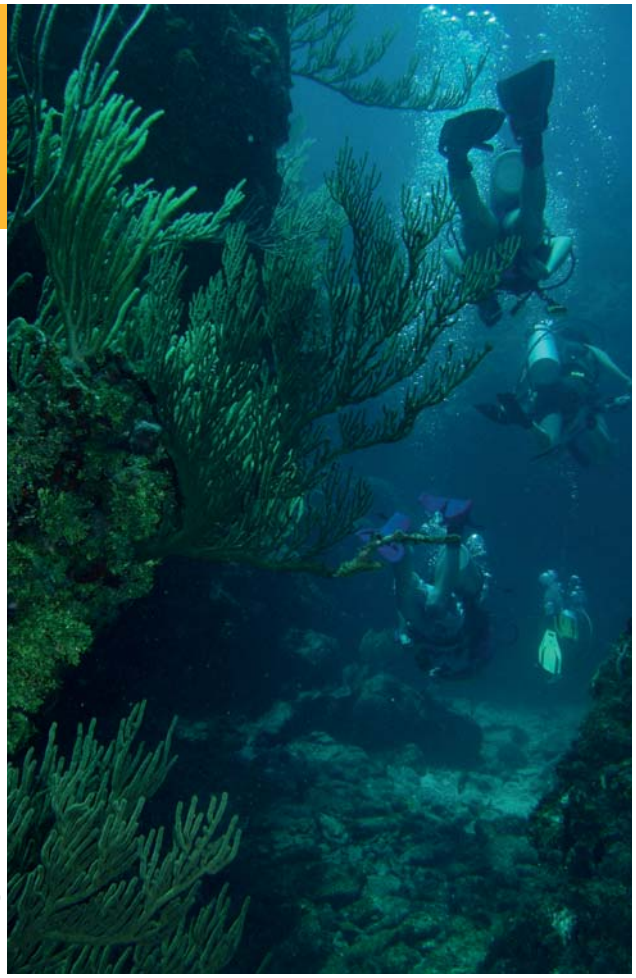
On the face of it, it is true that algae-based fuels offer a wide range of advantages. Research into the technology has been underway for many years, which means that it is currently at an advanced stage of development. Many species of microalgae have high lipid contents that can readily be extracted and converted to biodiesel. Similarly, their high fermentable sugar content makes them suitable for bioethanol production.[1] As a result, microalgae can be used to generate a wide range of bioenergy products with good environmental credentials.

Moreover, algal fuel is carbon neutral – it absorbs carbon dioxide as it grows and both CO_2 and waste water can be used as nutrients for its cultivation. The energy yield per acre is higher than for other biofuels, and algae can be produced on land that is unsuitable for other types of agriculture – in tanks in deserts, for example. Algal cells reproduce much faster than crop plants and can be grown using both saline and wastewater, which means they have a minimal impact on fresh water resources. To this impressive array of benefits we can also add the fact the fuels produced from algae are completely biodegradable and relatively harmless to the environment if spilled.

However, as with any emerging technology, there are still some issues to be dealt with. Gerhard Knothe, a research chemist with the US Department of Agriculture's Agricultural Research Service, has identified some problems with the cold flow properties of algal biofuels (their ability to flow well at low temperatures).[2] Algal fuels have also been found to degrade more easily than other biofuels, due to the fact that many of the oils from which the biofuels are derived contain relatively high amounts of saturated and polyunsaturated fatty acids. There are also some questions about the cost per litre of the fuel, which is currently too high.

Several EU-funded projects have been set up to address these issues and to advance the technology for energy production from algae. The Biowalk4Biofuels Project aims to develop an innovative system for biowaste energy recovery in order to produce biofuels using macroalgae (seaweed) as a catalyser. In so doing, the project aims to achieve the cost-efficient production of biogas without using cereal crops. Moreover, with a view to further reducing the land impact of the technology, the project aims to optimise the biogas yield from the amount of biowaste and CO_2 used and expand the range of biowastes that can be utilised for biogas production.

To achieve these objectives, the project's research will focus on selecting macroalgae species that provide significant yields of biomass with high carbohydrate content, which it will do by choosing algae species according to growth rate and high-energy content.



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The researchers will then isolate and regenerate protopoplasts from the selected species in order to optimize cell growth rate and achieve the maximum biomass yield from the selected species.

Another work package will focus on the selection of biowaste and exhaust gases to be used for algae growth and studying and implementing a piping system for recovering and transporting CO_2 to the project's algae ponds. These ponds will also be used to evaluate a closed macroalgae cultivation system and the results of this evaluation will be used to optimize macroalgae cultivation parameters with a view to ultimately increasing biomass yield.

Finally, a two-phase anaerobic digestion biogas production plant and a gas cleaning and upgrading process is required to achieve compressed biomethane, which will be used to fuel motor vehicles. The ultimate goal is to produce a cost-efficient, low energy-intensive, purified biogas, and to reduce biowaste and negative environmental impacts from industry.

Another EU-funded project also believes that the answer to the food-fuel conundrum lies with aquatic organisms. The nine-partner team behind the DirectFuel project ('Direct biological conversion of solar energy to volatile hydrocarbon fuels by engineered cyanobacteria') aims to develop photobiological systems for the production of volatile hydrocarbon fuels such as propane using only CO_2, water and sunlight as the principal substrates. Biological energy-conversion processes are well-suited for the production of hydrocarbon fuel molecules. However, as the natural potential for this conversion is limited, DirectFuel's aims to construct new metabolic pathways with this capability.

The project has chosen propane as a key-target as it is volatile at room temperature, yet easily liquefied at moderate pressure. This allows the fuel product to be harvested without disturbing the biological production process, while at the same time allowing the fuel to be directly and easily used under high energy-density storage conditions. Propane has already been utilized as vehicle fuel for over half a century and many EU countries already have infrastructure for distributing liquefied propane in the form of LPG. This compatibility with existing distribution and end-use infrastructures increases the market uptake potential of the technology.

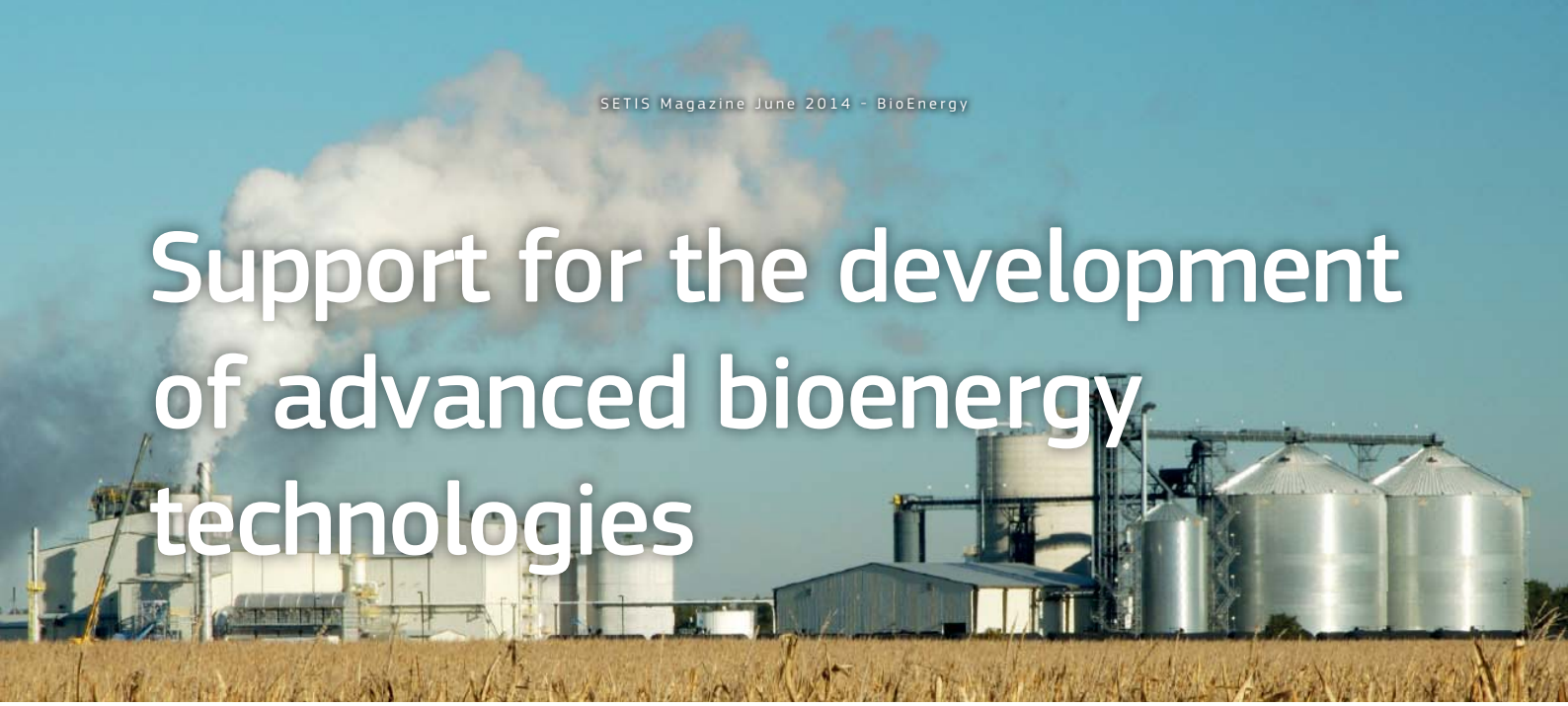
Cultivation of the essential cyanobacteria can be carried out on land unsuitable for agriculture, and in enclosed containers that require no soil, thus eliminating any competition between land use for food and fuel production. It will take some time before the technology developed within DIRECTFUEL is available on the market, but the research has already attracted interest from petroleum gas associations and the project's eventual impact on the production of carbon-based fuels and chemicals is likely to be considerable.

A recent report from the Institute for European Environmental Policy[3] has concluded that there is limited 'spare' land in Europe for the cultivation of energy crops. In light of this, and given the good land-use credentials of algae, we are likely to see growing market demand for systems that allow the production of high quality fuels from algal biomass. With projects like Biowalk4Biofuels and DirectFuel successfully meeting this demand, we can expect algae farming to become a major player in the fuel industry in the coming years.

For more information:
http://www.biowalk4biofuels.eu/
http://www.directfuel.eu/index.html

1 http://www.enalgae.eu/the-case-for-algal-biotechnology.htm
2 http://www.scidev.net/global/biofuels/news/biofuels-from-algae-plagued-with-problems-says-review-1.html
3 http://www.ieep.eu/assets/1392/IEEP_2014_Space_for_Energy_Crops.pdf

Support for the development of advanced bioenergy technologies



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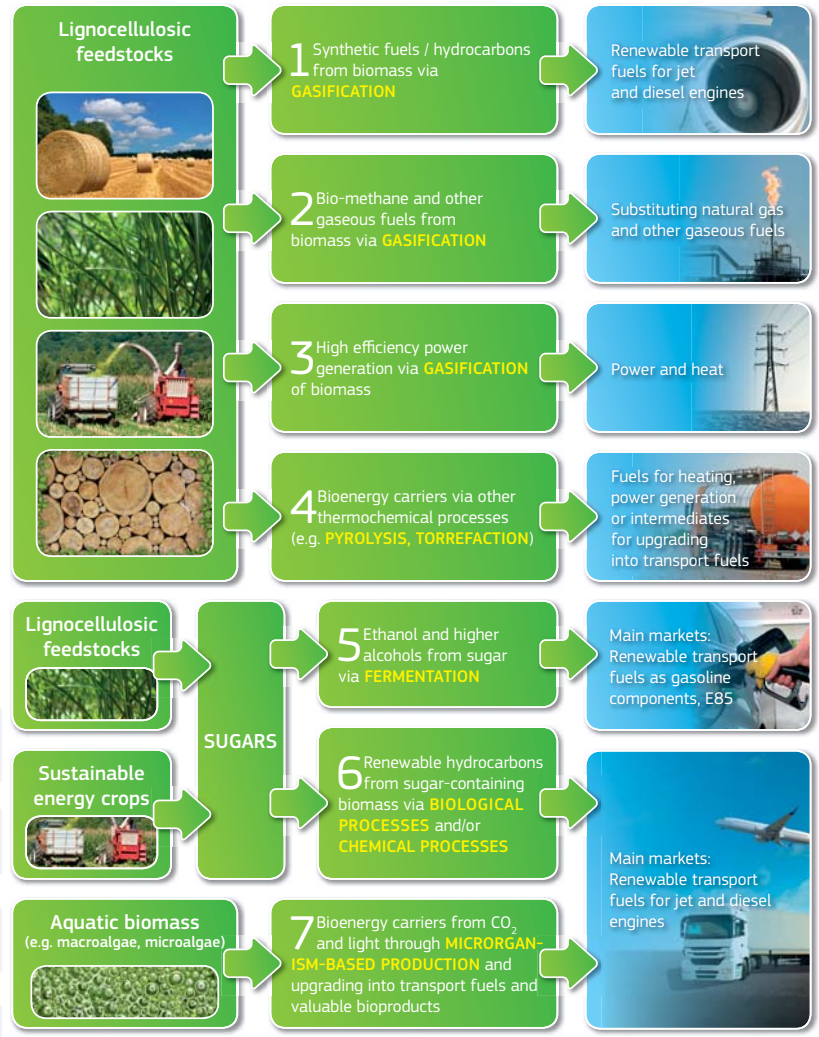
Bioenergy has for decades been the dominant contributor to the renewable energy mix in the EU. While its share in percentage terms is decreasing as wind and solar energy in particularly experience rapid growth, bioenergy is destined to grow considerably in the coming years. Most of the expected growth will depend on the development of new technologies for both bioenergy and biofuels production. In terms of bioenergy, this includes both small- and large-scale systems for high efficiency biomass conversion. For biofuels, this means mainly large-scale systems for conversion of non-food biomass to liquid or gaseous fuels for the transport sector. A very wide range of biofuels could possibly be produced, however the most interesting biofuels for the current transport fleet are those that can directly substitute for fossil fuels without adaptation to engines or delivery systems (so-called drop-in fuels like bio-gasoline and bio-kerosene). Nevertheless, a great deal of attention is directed to alcohol-type fuels that can be blended, within certain limits, with existing fossil fuels. The new technologies for bioenergy and biofuels can be both expensive to develop and to scale up to commercial size and involve significant risk. Various schemes have been implemented to provide support to new technology development.

Within the Strategic Energy Technologies Plan (SET-Plan), the European Commission launched a number of European Industrial Initiatives (EIIs) to provide coordination and structural support to strategic energy sectors. The European Bioenergy Industrial Initiative (EIBI) was launched in 2010 to support demonstration of a range of promising bioenergy and biofuel technologies within 7 well-defined Value Chains. The key objective of the EIBI is to provide support to those technologies that have a high potential to achieve satisfactory operating performance under normal commercial market conditions. In principle, the target is to achieve successful "first of a kind" commercially viable projects by 2020. Progress of the various bioenergy projects included in the EIBI is monitored in part using Key Performance Indicators (KPIs) established by the JRC in collaboration with the European Biofuels Technology Platform. The KPIs are derived in large part from market information and projections on the economic side and from environmental sustainability requirements defined in the European Renewables Directive (2009/28/EC). The progress of technology development is monitored through the now well-known "Technology Maps" (JRC Science and Technology Report, 2013).

Within the frame of the EIBI, a consortium of six Member States (Denmark, Germany, Netherlands, Spain, Sweden and the United Kingdom) and Switzerland, is implementing an ERANET Plus activity called "Bioenergy Sustaining the Future" (BESTF). BESTF has already made 2 calls for projects and approved projects from the first call in 2013. The BESTF projects are all subject to EIBI project selection criteria and are targeted to achieve EIBI KPIs. Substantial funding has been approved for a further 8 large-scale bioenergy demonstration projects (in the first call for projects) using funds from the European Emissions Trading System (ETS). Under this scheme, 300 million allowances from the ETS "new entrants reserve" (NER300) are used for the funding. The first of the bioenergy projects, making cellulosic ethanol, was launched in June 2013 and further projects are scheduled to start in the period to 2016. A second NER300 call for additional projects was closed in 2014. Most of the Value Chains defined in the EIBI implementation plan are covered by the NER300 projects.

All bioenergy and biofuels projects aiming for commercial viability must invariably minimise waste and maximise utilisation of residues to produce value-added products. In terms of economic performance, maximum output of high value products such as chemicals and biomaterials will be needed to enable competitive biofuel production. This situation is the same for bioenergy projects. Hence, most bioenergy and fuels projects are better described as biorefineries. While there are many biorefinery definitions, the IEA Bioenergy definition is the most comprehensive; "Biorefining is the



sustainable processing of biomass into a spectrum of bio-based products (food, feed, chemicals, and/or materials) and bioenergy (biofuels, power and/or heat). Both energy-driven biorefineries and product-driven biorefineries can be distinguished. In energy-driven biorefineries the biomass is primarily used for the production of secondary energy carriers (biofuels, power and/or heat); process residues are sold as feed (current situation), or even better are upgraded to added-value bio-based products, to optimise economics and environmental benefits of the full biomass supply chain. In product-driven biorefineries the biomass is fractionised into a portfolio of bio-based products with maximal added-value and overall environmental benefits, after which the process residues are used for power and/or heat production, for both internal use and selling of the surplus to national grids." (IEA Bioenergy, 2014).

The environmental performance of biomass conversion technologies for bioenergy and biofuels is a key topic of the JRC's contribution to monitoring of implementation of the renewables directive (2009/28/EC). The economic performance of all technologies covered by the SET-Plan is a key component of the JRC's modelling of the EU's energy systems.

Biorefining is a key component of the emerging bioeconomy in which Europe will address the complex inter-connected challenges of biomass utilisation, while at the same time achieving sustainable economic growth. The Bio-based Industries Consortium (BIC) was established in 2013 to provide an additional impulse to industrial participation in sustainable biomass utilisation. The Commission launched the Bioeconomy Observatory in 2013 with the aim of providing data on the growth of the bioeconomy and its constituent sectors. In addition, the observatory should track economic and employment indicators, innovation indicators, and measures of productivity, social wellbeing and environmental quality. It will also provide a "technology watch" and "policy watch", to follow the development of science and technology as well of policies related to the bioeconomy.

David Baxter

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David has a PhD in high temperature materials.

SETIS TALKS TO:

Juan Carrasco

EERA Bioenergy Joint Programme Coordinator

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How important a contribution will bioenergy make to meeting Europe's 2020 targets?

J.C.: "According to the expectations contained in the National Plans for Renewable Energies, the target is for bioenergy to contribute about 11% of the primary energy consumed in the EU in 2020, or more than 50% of the total primary energy from renewable sources. Furthermore, the share of biofuels by that year should amount to 10%, half of which will come from second generation (2G) biofuels. Additionally, a large part of the expectations to reduce GHG emissions in the EU in the short and long term rely on bioenergy.

In 2012, bioenergy's contribution was about 8% of the total primary energy consumed in EU countries, which is in line with the planned target. Moreover, in the same year first generation biofuels supplied 4.7% of the transport sector's needs, representing more than 95% of the target for 2020 for these fuels. However, achieving the goal of biofuels for transport with next generation biofuels is uncertain, since they have not yet reached the commercial stage.

Bioenergy therefore plays a crucial role in meeting Europe´s 2020 targets and in complying with SET-Plan objectives and this will possibly continue to be the case in the coming decades, if the appropriate frameworks and alternatives to exploit its full potential in a sustainable way are adopted."

One of the most controversial aspects of bioenergy has been the competition between land use for energy and for food. How can we ensure sustainability of agriculture for biofuels?

J.C.: "This is quite a tricky subject, in the first place because supplying the world's population with food depends upon many factors, most of which have a large degree of uncertainty in their definition and projections for the future.

Concerning the potential land available for alternative crops, according to a recent report from the United Nations' Food and Agriculture Organisation (FAO), more than 2700 million hectares of land not utilised for agriculture are suitable for potential crop production worldwide; and vast areas, including EU agricultural land, are strongly affected by monocultural practises. In the EU, a recent study by the European Environment Agency[1] estimates that in 2020 the land surface available for the environmentally sustainable introduction of energy crops, based on resource efficiency criteria, is about 7 Mha, where an annual biomass crop equivalent to 2.3 EJ can be produced. This figure reduces by about 45% the potential for energy crops in a previous study from 2006[2], but still leaves the energy crop's potential well above the aggregate waste (including agricultural residues) and forest potentials.

On the other hand, it is worth mentioning that the production of food for the whole world´s population under sustainable conditions up to 2050 does not necessarily imply significant changes in the present agricultural land surface requirements. In fact, there is currently a trend towards the so call 'doubly green' revolution, consisting of increasing crop yields worldwide together with reducing the environmental footprint of agriculture.

Other factors, like the effects of agricultural policies, the actual evolution of the world´s population, the development of the international food and biofuels market or the effects of climate change on agricultural production, will also have a strong influence on the land surface needed for food production in the next decades.

In the above context, and although the results of different studies are controversial, it can be estimated that there is room for the sustainable introduction of energy and, in general, non-food crops into agricultural land, including in the EU. Non-food crops should therefore be seen as an opportunity to create new markets to assure and/or increase farmers' incomes. A consequence of this is that they contribute to improving the security of food supply, while also encouraging various positive trends, like the diversification of crops and the establishment of new crop rotations in the present monocultural systems, along with the development of low-carbon energy techno-

logies and a reduction in agriculture's carbon footprint. According to different studies, perennial energy crops may also have additional environmental advantages compared to traditional annual crops, like a reduction in the crop inputs and an increase in soil protection, as well as positive effects on biodiversity, if they are introduced in appropriate conditions.

In any case, the implementation of the new crop systems should be made with prudence and taking into account the local conditions, in order to avoid any significant negative impact. A possible option to effect such a secure introduction is to adopt an integrated view of the new crops in the existing agricultural systems, fixing short term objectives for non-food crops at national or regional levels and making a careful follow up of the integrated systems from the food security, socioeconomic and environmental points of view. Some countries, like the UK, are already adopting this approach and in the US the Environmental Protection Agency fixes annual quotas for biofuels production.

Monitoring the results of the above agrosystems should produce learning curves on its behaviour, thus making it possible to define sustainable conditions, also in economic terms, for their eventual implementation and optimisation.

The development of aquatic crops and waste streams for biofuels production, as land neutral alternatives, as well as of multifuel conversion technologies and of the international biofuels market, are challenges that can contribute to alleviating the competition between food and non-food crops for land use. ”

Some researchers have concluded that the energy that goes into crop production for fuel far exceeds the energy that the fuel is capable of generating. How sustainable is the use of biomass to produce liquid fuel in reality?

J.C.: “ The net energy gains from energy crops and liquid biofuels have been widely debated and are highly variable depending on value chains, local context or the methodological assumptions in the calculations, in particular regarding the handling of co-products.

For feedstock production, however, there exists a wide consensus that the production of raw materials from energy crops used for biofuels production, including agricultural raw materials, present a positive energy balance under the more typical conditions in which those crops are developed. This balance is much more positive for lignocellulosic energy crops, which present energy yield values (specific ratio between the energy contained in the biomass compared to the energy used in the crop production) in the range of 8-15 for average biomass yields under the most common growing conditions.

Considering the entire energy chain, including the energy costs of logistics and the conversion process, the production of first generation biofuels may present a negative energy balance in some particular circumstances (for instance, if grains from low productive areas are used). However, most reviews of these data conclude that current (first generation) biofuels produced in Europe and the USA consume 20% to 70% less fossil energy than their petroleum-based equivalents for a similar distance travelled. These values are even higher for bioethanol produced from sugar cane from high productive areas and with the integration of bagasse for co-generation. Next-generation biofuels are expected to yield even larger savings (70-90%). ”

One of the focuses of the EERA programme is next generation biofuels. What are the most promising avenues of research in this area?

J.C.: “ The generically-titled biomass thermal fuels produced via gasification of biomass, and the bioethanol obtained from the enzymatic hydrolysis and subsequent fermentation of lignocellulosic biomass represent the more advanced routes for the production of 2G biofuels (part of the next generation biofuels), utilising lignocellulosic biomasses. However, important improvements still need to be achieved in order to increase the viability of both pathways, which is the subject of an important research effort. For the gasification-based routes, the 'flexibilisation' of biomass fuel requirements, the optimisation of process and gasifier operating conditions and, in particular, the development of viable alternatives for syngas cleaning and syngas upgrading for 2G biofuel production are important research issues.

Regarding the biological pathway, the development of strategies to make the cellulose and hemicellulose more accessible to the action of the hydrolytic enzymes, the genetic improvement of the microbial ability and efficiency to perform the conversion of cellulose and hemicellulose into ethanol, the improvement of the performance and reduction of the costs of hydrolytic enzymes, together with the development of more integrated processes to effect lignocellulose hydrolysis and fermentation are some of most important current R&D activities aimed at making this conversion route more efficient and viable.

Another promising R&D field in bioenergy is the production of synthetic hydrocarbons via thermochemical, biological and/or chemical processes for jet and diesel engine fuel applications, as well as higher alcohols, like buthanol, by biological pathways to improve the performance of the ethanol in fuel mixtures with gasoline.

Hydrothermal gasification and hydropyrolysis are also examples of promising and innovative processes being researched to improve efficiency and reduce the costs of biofuels, as well as the production and use of algae for biofuels (3G) and bioproducts.

In the long term, the EU policy depicts a framework for energy production in 2050 characterized by no public aid, as well as for high efficiency in the use of resources and the implementation of low-carbon and low-environmental-impact technologies. Under the above perspective, it is imperative to find appropriate combinations of raw materials, logistic systems, conversion processes and end fuel uses that comply with the environmental and efficiency policy requirements whilst being economically competitive. The biogas obtained from a mix of different biomass flows, to be used as transport fuel with the integrated production of additional high-value products, is an example of these future processes that needs further research.

For next generation biofuels production, due to the relatively low efficiencies of the conversion processes (50-65%) and with a view to increasing their economic viability, some strategies, including maximising the use of forest and agricultural waste streams involving low-cost and GHG neutral materials and, in particular, the development of the so called biorefineries, are the subject of an intense research and demonstration effort. Biofuels production as part of a biorefinery concept involves the integration of production together with other types of energy and/or other high-value products in order to achieve an efficient utilization of all biomass fractions from an economic point of view. In biorefineries, combinations of raw materials are generally utilised in order to achieve high environmental, economic and efficiency values for the whole process.

In the future context for bioenergy production described, it may occur that the thermal use of biomass and decentralised biomass cogeneration technologies, including micro-cogeneration, could account for a progressively larger share of bioenergy's contribution at the expense of the generally less efficient technologies for the production of transport biofuels, including next generation biofuels. This means that a considerable research effort will also be required in those areas.

In the above context, the development of ultra-low particle and NOx emission biomass combustion installations adapted to the low heat release and comfort requirements of the houses of the future, and including micro-cogeneration technologies, is a promising area of research. Another promising area to satisfy future heating, cooling and electricity demand in residential, municipal and industrial facilities is the development of intelligent biomass-based small to medium combined heat and power technologies in order to achieve high process efficiency and minimize the carbon footprint.

In addition to developments in conversion technologies, securing biomass supply based on the requirements of conversion plants (and taking into consideration future demand in other emerging markets for biomaterials) is a major issue for the viability of bioenergy and the bioeconomy. The provision of alternatives to maximise the availability of biomass for energy use under sustainable conditions is a priority research avenue which, although it is the subject of a major effort, still requires much more work. There is a limited amount of residue and waste material resources available from biomass, and there are limitations on using the full potential of these resources. As a result, research into sustainable conditions for the production of dedicated non-food crops in EU agricultural and forest land should be a key issue, especially in light of the possible socioeconomic and environmental advantages associated with these crops.

Finally, given the disperse production and low-energy density of in-field biomass, an avenue of major importance in bioenergy RD&D is the development of logistic chains to supply biomass to conversion plants and of model tools to optimise the supply of sustainable biomass to final use sites, taking local conditions into account.

All of the R&D avenues described are being very actively considered in the EERA-Bioenergy Joint Research Program, which is currently a powerful tool for development of bioenergy in the EU. ”

What is being done to improve the competitiveness of next generation biofuels, and what do you consider to be a realistic time-frame for the commercial use of these fuels?

J.C.: “ Some of the most significant research work being done to increase the competitiveness and sustainability of the next generation biofuels has been described in the previous point. This work is the basis for the considerable effort being currently undertaken by the industry, particularly in the USA and in some countries of the EU, to scale up the production of 2G biofuels from different technologies and biomass streams in big pilot and demonstration plants. Forest and agro-industrial waste are most commonly utilized in the pilot and demo projects, but frequently other biomasses, including forest and agricultural residues, energy crops and municipal solid waste (MSW), as well as algae biomass are also being considered in integrated schemes. Many of these projects envisage the production of new fuels with other non-food higher value bioproducts (chemicals, bioplastics, fertilizers...) in biorefineries. As mentioned before, the development of the biorefinery concept is a key issue to increase the competitiveness and sustainability of the next generation biofuels and of the bioeconomy.

In my opinion no full commercial development of next generation biofuels and, in particular, of 2G biofuels, can be expected by the end of this decade. The results obtained in the current demonstration projects will deliver the information required to identify the more competitive alternatives and the real market size and opportunities for the new fuels in the next decade. ”

The link between transport and fossil fuels seems to be engrained in the public consciousness. What can be done to encourage a societal shift from gasoline to biofuels and how to you evaluate the potential for market uptake?

J.C.: “I think in the last decade public opinion has been very much in favour of a transition from petroleum to agricultural biofuels. But there is an image problem with biofuels, at least in the EU, due to the changing message with regard to the benefits of first generation biofuels. As the results of the various studies in this field become known, there is a loss of credibility for these fuels. The economic crisis has also had a negative impact on public interest in this alternative in many EU countries, given the higher prices of renewable fuels in comparison to fossil fuels.

Clear and consistent messages about the benefits of secure and proven alternatives, the security of use of new products, as well as about the reasonable prices of these alternatives, are key factors to regain public interest in transport biofuels and in low-carbon technologies in general.

The potential market uptake of biofuels is difficult to predict and I think it will rely to a large extent on the policies implemented. The adoption of objectives for liquid biofuel use at the EU level seems to me to be crucial for the development of the market in the short to middle term, but this must be based on a detailed and objective analysis of the real possibilities and alternatives to supply a sustainable future market for these products.”

How important has the SET-Plan been in providing a policy framework for the bioenergy sector? What other policy support is needed to ensure that bioenergy achieves its full potential?

J.C.: “The SET-Plan has revealed itself as a crucial initiative in providing an adequate framework for the development of the bioenergy sector. Firstly, by identifying bioenergy as one of the main key areas to support SET-Plan objectives, and then by promoting initiatives to bring together and support complementary R&D programmes (EERA-Bioenergy) and companies (EIBI) in this field. This has strongly contributed to the development of common views in the research and industrial sectors about the needs and priorities for bioenergy, also in view of the global EU situation. Moreover, the implementation of the research Joint Programme in EERA-Bioenergy offers a wide range of possibilities for scientists to exchange knowledge and results, and to share scientific tools and infrastructures in most of the bioenergy research areas, all of which is essential for an efficient use of resources, to increase the scope and quality of the individual results and ultimately to accelerate the development of the bioenergy sector.

The SET-Plan, as well as NER300, Horizon 2020 and ERA Net are also crucial for public Research, Technological Development and Demonstration (RTDD) funding and risk-sharing in the development of advanced bioenergy technologies, flagship projects and innovative industrial implementations in this area.

A stable and predictable framework with appropriate support measures capable of generating private investment, also including the users sector, is a prerequisite for the full development of any new market, and bioenergy is no different. In this context, in the present situation, subjects like ILUC and further sustainability requirements are causing uncertainty over the development potential of the resource. These questions should therefore be clarified and a stable framework for biomass and biofuels production and use should be established in the short term.”

Juan E. Carrasco

A Doctor of Biology, Juan Carrasco is the Head of the Biomass Unit at the CIEMAT Center for Development of Renewable Energies (Spain). He has 30 years’ experience in R&D activity dealing with biomass, particularly in the areas of sustainable biomass production and biomass and biofuels characterization.
He has co-ordinated about forty projects on biomass production and conversion, including the Spanish National Strategic Project for Development and Commercial Demonstration of Energy Crops under Sustainable Conditions, a project developed in 2005 to 2012 with a total budget of EUR 62 million, involving farmers and industry.
He is the coordinator of the European Energy Research Alliance (EERA) Joint Program on Bioenergy, which includes 34 R&D organisations representing 16 European countries.

1 http://www.eea.europa.eu/publications/eu-bioenergy-potential
2 http://www.eea.europa.eu/publications/eea_report_2006_7

SafePellets

- securing the pellet supply chain

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The rapid expansion of the market for biomass pellets has brought an increasing focus on safety issues along the entire pellet supply chain, from production to storage and final use. At the first International Workshop on Pellet Safety, in Fügen, Austria, in March 2013, the two most intensely debated topics were safety issues related to pellet storage and pellet production, followed by human health and safety, safety in transport and handling of second-generation pellets. There is good reason for this concern. Pellets are highly combustible and estimated to be 100 times easier to ignite than coal. A pellet fire at a power station in Essex, in the United Kingdom in 2012 knocked parts of the plant offline for six months.

In 2000, the European Commission issued a mandate to the European Committee for Standardization (CEN) to prepare standards for solid biofuels. In total 38 standards for solid biofuels were published,[1] covering terminology, fuel specification and classes, quality assurance, sampling and sample preparation, and analysis of the physical, mechanical and chemical properties of solid biofuels. A number of organizations and EU-financed projects are working to develop guidelines that will form the basis for European standards related to pellet quality assurance and safety. The European Pellet Council (EPC), one of the co-organizers of the Fügen workshop, coordinates the ENplus quality certification system, for which a dedicated organisation - PellCert – was set up and funded under the Intelligent Energy Europe programme. The EPC believes that sustainability requirements are key to securing large scale-investments in the biomass sector, and that the ENplus certification scheme could include such sustainability criteria.

This work is being augmented by other EU-funded projects. The FP7-financed SafePellets project (Safety and quality assurance measures along the pellets supply chain) aims to support international standardization work by developing a set of guidelines for the safe production, handling, and storage of pellets from different sources. The project aims at providing solutions to ensure consumer protection by developing preventive measures to avoid off-gassing of toxic substances during storage and by providing technical solutions to safely remove off-gasses on demand. Furthermore, SafePellets deals with the problems of self-heating and spontaneous ignition of stored pellets. The project is developing preventive measures to avoid fires in storage and provide guidelines to improve fire safety. Moreover, Sweden's Firefly AB, which is a member of the project's consortium of 15 SME-industry partners and research institutes, plans to develop new sensor solutions to detect fires and off-gases in pellet storage facilities.

A SafePellets project report has outlined some of the inherent risks involved in working with wood pellets, specifically those related to the storage, production, transport and handling issues highlighted in Fügen. With respect to storage, most research was carried out for small scale users. Generally, domestic pellet storage is subject to the same risks as those experienced by producers and whole-

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salers. However, large pellet storage facilities are usually equipped with temperature and CO detectors to locate self-heating processes and fires as quickly as possible. Furthermore, employers are generally well trained and aware of possible risks. In contrast, knowledge about possible risks and appropriate handling of these risks is less common among small scale users, which can result in fatal accidents.

Fresh pellets (within the first three months after pelletizing from fresh wood) seem, under certain circumstances, to bear a higher risk for off-gassing and self-heating, and the risk of fire tends to be greater in large warehouses. The larger the storage capacity is, the higher the risk of spontaneous ignition of the fuel because the ratio of surface area to volume decreases. In the event of incipient smouldering the temperature rises quickly and may cause the pellets to ignite. The auto-ignition temperature is dependent on the quality of the pellets and is influenced by the same factors that cause off-gassing. Spontaneous combustion reactions are therefore more frequent immediately after pellet production than in pellets that have been stored for a long time.

The project report outlines the current standards and guidelines governing pellet safety and, perhaps more importantly, it identifies problem areas that are not covered by existing standards. It appears that so far adequate solutions have been found only for high-quality pellets. The report stresses that increased focus should be given to the fact that pellets are a fuel and should be handled with the same care as oil or gas. In particular, inexperienced users need to be informed about the potential health risks from gas emissions.

Given that that freshly produced pellets seem to have a higher emission potential than pellets stored for a certain period, the project recommends that a minimum storage period be put in place for pellet producers, in order to reduce the risk to users further down the line. Furthermore, the report recommends setting a fixed value for the temperature to which fresh pellets should be cooled before being stored. Only the ENplus certification system currently contains the requirement that the temperature of pellets should not exceed 40°C before delivery to the end-consumer – there is no comparable regulation for pellet fabrication sites.

The participants in the Pellet Safety Workshop in Fügen identified limited knowledge of the underlying reasons for some safety risks as one of the main problems facing the pellet industry. By aiming to address this knowledge gap, SafePellets will increase the safety of pellet supply and storage, thereby increasing consumer confidence and strengthening the feasibility of European supply chains for biomass, which was one of the challenges set forth in the Biomass Action Plan. Ultimately, by helping create a sustainable European pellet market, SafePellets is contributing to the overarching goals of increasing Europe's energy security and diversifying its energy supply.

For more information:

http://biomassmagazine.com/articles/8820/safety-on-top-of-the-agenda

http://www.safepellets.eu/about-project/

[1] http://www.pelletcouncil.eu/cms/wp-content/uploads/2011/12/Alakangas_Towards-international-pellet-standards.pdf

NER300

- a barometer for bioenergy

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Of the 23 projects awarded funding under the EU's New Entrants' Reserve (NER)300 first call, eight were bioenergy projects[1], underscoring the relative importance of the sector for Europe's renewable energy ambitions. Five of these projects are still underway, but three have stalled. An examination of the reasons behind this may allow us to see what lessons can be learned and what implications, if any, there are for future bioenergy projects in Europe.

The first NER300 bioenergy project to be mothballed was Pyroglot, a project by Sweden's BillerudKorsnäs that investigated conditions for pyrolysis oil production from forestry residue. The company announced the project's withdrawal from the NER300 programme in December 2013, citing concerns about the current commercial environment and short- to mid-term market development forecasts. BillerudKorsnäs CEO Per Lindberg said at the time that the company was unhappy about having to discontinue a project that it believed in, but that it would continue to monitor developments and be ready to act if and when conditions change.[2]

Similarly, the board of directors of Finland's Vapo Oy decided in February 2014 to freeze project planning for the Ajos BTL biodiesel plant. This project had been jointly launched with the company Metsäliitto in 2007 but, after its partner withdrew in 2012, Vapo Oy was forced to go it alone. In the summer of 2012, the project received a commitment for support of EUR 88 million from the EU if the EUR 700-million project were realised.

According to Vapo's Managing Director Tomi Yli-Kyyny, the project raised a great deal of international interest but it proved impossible to obtain a binding long-term partner agreement due to increased uncertainty in the operating environment and concern over renewable fuel legislation under preparation in the European Union. Another Finnish company, UPM, has also put its Stracel BTL biomass-to-liquid plant in France on hold, also citing proposed changes in the regulatory regime for the bioenergy sector. The company had been awarded EUR 170 million under the NER300 scheme in 2012 and the project was expected to become operational at the end of 2015. However, UPM Vice-President Marko Janhunen said that the company had mothballed the project until some clarity is received on the post-2020 regime for biofuels.[3]

From these three projects it seems clear that regulatory certainty for the post-2020 bioenergy sector is a 'sine qua non' for investor confidence. That said, the five other bioenergy projects awarded funding under NER300 are continuing to operate in the current environment. So, what is the secret of their success?

Germany's VERBIO received EUR 22 million of NER300 funding for demonstration projects for the production of biomethane entirely from straw in December 2012. The project has now officially been launched and the biomethane is set to be fed-in at the VERBIO plant in Schwedt in the second half of 2014. The company underlined the important role that European Commission funding plays

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in the continuing development of biomethane in Germany and said that the decision to grant funding to the project underscored its intention to provide greater funding for sustainable types of biofuel in the future.[4]

Another NER300 bioenergy project to be successfully launched is the Crescentino biorefinery in Italy, being implemented by Beta Renewables. This integrated biofuels plant will use giant cane and wheat straw to produce ethanol, and will have an annual production capacity of 51 million litres per year. "Policy makers now need to send clear signals to encourage the necessary investments in advanced biofuels," said Peder Holk Nielsen, CEO of project partner Novozymes.[5]

Sweden's Goteborg Energi is implementing its GoBiGas (***Gothenburg Biomass Gasification***) plant to produce biogas via the gasification of biofuel and forestry waste, in two phases. Phase one of the plant was commissioned in March 2014, and the second phase is planned for completion in 2016. "The conditions for implementing GoBiGas 2 is, just as for any other plant for renewable energy production, a market demand for the product and an acceptable level on the forecasted market's ability to pay, so that the plant can generate profits that provide acceptable return on investment over time," Göteborg Energi Chairman Kia Andreasson said, adding that this would require the provision of "clear instruments or other measures."[6]

The remaining two bioenergy projects to receive NER300 funding are the CEG Plant in Goswinowice, Poland, which will demonstrate the production of second generation bioethanol from agricultural residues on a large commercial scale, and the Woodspirit refinery in the Netherlands. Information on the current status of the CEG plant is scant. However, a statement on the NER300 website suggests that the spectre of uncertainty may be casting its shadow on Woodspirit also. NER300 consultant Greg Arrowsmith notes that the regulatory outlook for the advanced biofuel sector means a review may be needed on whether the remaining projects awarded NER300 cash can come to fruition, or need to be withdrawn so their funding can be redistributed in the second round. NER300 estimates that from EUR 250 million to EUR 450 million of funding could go unclaimed, "if Woodspirit goes the way of Stracel and Ajos BTL".

While some of the decisions to mothball or to forge ahead with bioenergy projects have been taken for purely strategic business reasons, or based on the level of investment already carried out, one thing that all NER300 bioenergy projects, both stalled and ongoing, have in common is that they all view policy support as crucial for their future success. In response to the energy security crisis that has developed in the meantime as a result of the conflict between Russia and Ukraine, the Commission has adopted an Energy Security Strategy[7] in which it stipulates that Member States should consider favorable taxation for alternative fuels, in particular for renewable fuels. This and other policy signals may be sufficient to underpin investor confidence and keep Europe's bioenergy and biofuel projects on track.

For more information:
http://www.ner300.com/

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2 http://www.billerud.se/en/Media/Press-releases/2013/BillerudKorsnas-discontinues-pre-study-on-production-of-green-oil-further-focuses-on-smarter-packaging-solutions/
3 http://www.endseurope.com/34973/policy-fears-see-another-green-energy-project-falter?referrer=search
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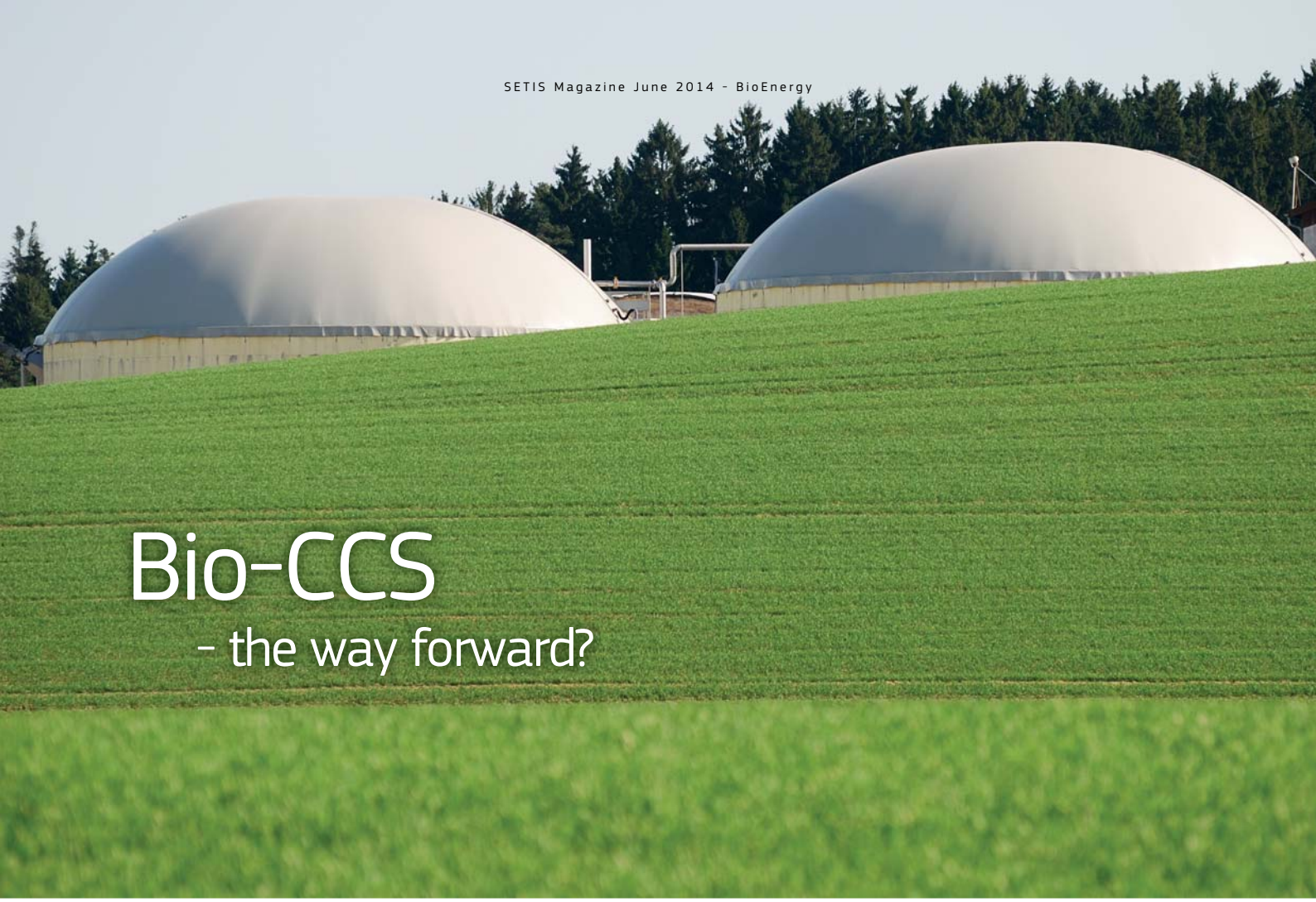

Bio-CCS
- the way forward?

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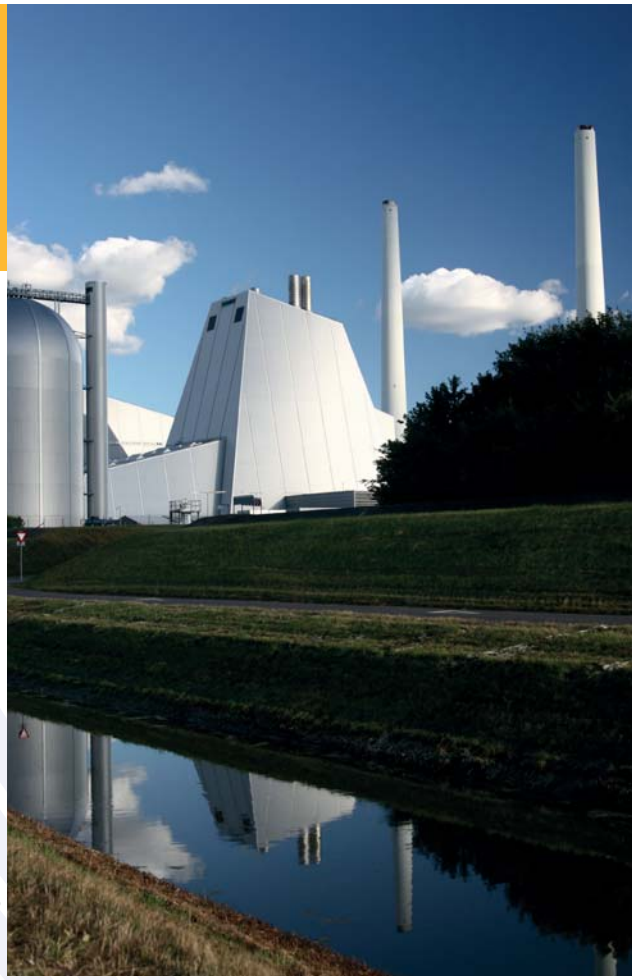
The concept of Bioenergy with Carbon Capture and Storage (Bio-CCS) has been put forward as a way of producing carbon negative power by removing carbon dioxide from the atmosphere using biomass conversion technologies and underground storage. Biomass absorbs carbon from the atmosphere as it grows but when this biomass is converted into energy the carbon is released again as CO_2. However, if this CO_2 is captured and transported to a permanent underground storage site, this results in the net removal of CO_2 from the atmosphere.

The Fifth Assessment Report produced by the Intergovernmental Panel on Climate Change[1] notes that carbon dioxide concentrations in the atmosphere have increased by 40% since pre-industrial times, primarily from fossil fuel emissions, of which about 30% has been absorbed by the ocean, causing acidification. The report stresses that continued emissions of greenhouse gases will cause further warming and other changes in all components of the climate system. Bio-CCS has the capacity to contribute to the substantial and sustained reductions of greenhouse gas emissions required to mitigate these climatic impacts. The potential role CCS can play in tackling climate change has been recognized by the European Parliament, which passed a resolution earlier this year in support of CCS in Europe by a resounding 524 to 141 votes.[2]

According to the report 'Biomass with CO_2 Capture and Storage – The Way Forward for Europe,' produced jointly by the European Biofuels Technology Platform (EBTP) and the Zero Emissions Platform (ZEP), Bio-CCS is the only large-scale technology capable of removing CO_2 from the atmosphere. Several technological pathways exist to convert biomass into final energy products or bio-chemicals in combination with CSS, and these can be divided into three groups: biochemical production of biofuels, thermo-chemical production of biofuels and biomass combustion for the production of heat and electricity. These technology routes differ in that a significant share of the carbon contained in the feedstock generally ends up in the biofuels or bio-chemicals produced, resulting in smaller CO_2 streams compared to electricity generation.

A report from the International Energy Agency[3] suggests that Bio-CCS could remove 10 billion tonnes of CO_2 from the atmosphere every year by 2050 using available sustainable biomass. In most regions in the EU, this technical potential for Bio-CCS is mainly limited by the available supply of sustainable biomass, as there is likely to be sufficient CO_2 storage capacity. In the biofuels routes, a relatively small fraction of the CO_2 is captured, so a correspondingly small storage capacity is required. The EBTP-ZEP report notes that in the 100% biomass-fired routes for power generation, less storage capacity is required compared to co-firing routes in order to realize the full carbon-negative impact. In Europe alone, Bio-CCS could remove 800 million tonnes of CO_2 from the atmosphere every year by 2050 using available sustainable biomass – which is the equivalent of more than half of all current EU energy-related emissions. Bio-CCS technologies can also be deployed in energy-intensive industries or in industrial clusters where CCS infrastruc-



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ture can be shared. This has the potential to deliver industrial sectors with overall emissions of below zero, which can then offset emissions from other sectors where reductions are more difficult to achieve.

Although there are no current fully-integrated, commercial-scale CCS power projects in operation, the technologies that underpin the process have been around for a long time: CO_2 capture is already practiced on a small scale based on technology that has been used in the chemical and refining industries; transportation of CO_2 is well understood and storage projects have been successfully operating for over a decade. While these individual components in the chain have already proven themselves, further R&D into next-generation technologies is required to enable widespread deployment.

The costs of large-scale deployment of Bio-CCS have not been comprehensively assessed; nevertheless, the EBTP-ZEP report makes a number of observations regarding the economics of the technology. Several biofuel production routes have an almost pure CO_2 stream, allowing for CCS deployment options at a very low additional cost once units reach a certain scale. Studies into the costs of CO_2 capture, transport and storage show that the current suite of technologies will be cost competitive. As regards the levelised cost of electricity (LCOE), Bio-CCS is generally more expensive than fossil CCS due to the relatively higher cost of biomass. Given that the price of feedstock will only increase as demand grows, novel feedstock sources will have to be up-scaled to meet this demand and keep prices stable.

To ensure that this happens, the report stresses the need for urgent policy action at EU and Member State level to support CCS demonstration projects, as market forces alone will not be sufficient. These actions include establishing economic incentives to enable the large-scale deployment of Bio-CCS, specifically by rewarding negative emissions under the EU Emission Trading Scheme and establishing non-ETS measures to enable CCS demonstration projects to take final investment decisions (FID) and provide security for long-term investment. It will also be necessary to identify and incentivise the clustering of small-scale biogenic emission sources with other emission sources in order to achieve economies of scale for CO_2 transport and storage, and to undertake R&D to determine the costs of various Bio-CCS routes. Furthermore, dedicated funding is required to finance research and development and to fund pilot projects, in order to further develop and prove advanced technologies.

The IEA sees CCS as having enormous deployment potential, spanning manufacturing, power generation and hydrocarbon extraction worldwide – creating the single biggest lever for reducing CO_2 emissions and providing almost 20% of the global cuts required by 2050. This potential is recognised by the European Commission also. In its Energy Roadmap 2050[4], the Commission calls for CCS to be used in the decarbonisation of the power sector from 2030 onwards and recognises that, combined with biomass, CCS could deliver "carbon-negative values." This recognition, coupled with the technology's incontrovertible carbon mitigation credentials, will guarantee its role in post-2020 EU energy and climate action.

For more information:
http://www.biofuelstp.eu/bio-ccs.html

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Biofuels in aviation

- greening the skies

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The aviation industry accounts for 2% of all anthropogenic CO_2 emissions and 12% of emissions from the transport sector, with flights generating 628,000,000 tonnes of CO_2 every year. The world's commercial aircraft fleet is expected to double in size over the next 20 years to accommodate a forecast annual increase in demand of 4-5%.[1] As a result, the aviation industry is faced with the dual challenge of meeting the growing demand for air travel, while at the same time reducing the industry's carbon footprint. As around 80% of aviation CO_2 emissions are generated by flights of over 1,500 km, for which there is no practical alternative mode of transport,[2] the only way to meet this challenge is to increase the efficiency of aircraft and the environmental performance of the fuels they use.

Alternative fuels, particularly sustainable biofuels, have been identified as excellent candidates to help achieve aviation industry sustainability targets. Biofuels derived from biomass such as algae, jatropha and camelina have been shown to reduce the carbon footprint of aviation fuel by up to 80%. If commercial aviation were to get 6% of its fuel supply from biofuel by 2020, this would reduce its overall carbon footprint by 5%. According to the Air Transport Action Group, a non-for-profit association representing all sectors of the air transport industry, net carbon emissions from aviation will be capped from 2020 through carbon neutral growth, and by 2050 net carbon emissions from aviation will be half of what they were in 2005.[3]

With a view to achieving annual production of 2 million tonnes of fuel derived from renewable sources by 2020, the European Commission, in cooperation with leading European airlines and biofuel producers, launched the Biofuel Flightpath Initiative within the framework of the Strategic Energy Technology Plan (SET-Plan), at the 49th International Paris Air Show in Le Bourget in 2011. The initiative sets forth a range of activities for policymakers, bio-kerosene

producers and the aviation industry to achieve this common goal. On a policy level, the initiative stresses the need for support policies, including stable sustainability criteria, and the availability of a mix of financial support mechanisms for research, demonstration and commercial application for second generation biofuels.

The 2011 Flightpath Initiative was predated by several EU initiatives and projects with the overarching goal of improving the environmental performance of the aviation industry. The Clean Sky Joint Technology Initiative (JTI)[4] was initiated in 2008 as a unique Public-Private Partnership between the European Commission and the industry. This ambitious aeronautical research programme aimed to develop breakthrough technologies to significantly increase the environmental performances of airplanes and air transport, resulting in less noisy and more fuel efficient aircraft, thereby making a key contribution to achieving the environmental objectives of the Single European Sky initiative.

In December 2012, the EC launched the ITAKA project under its Seventh Framework Programme (FP7), to look at removing barriers to the use of sustainable biofuels in aviation and contribute to the Flightpath Initiative's annual production target of two million tonnes by 2020. The project aims to produce sustainable renewable aviation fuel and to test its use in existing logistic systems and in normal flight operations in Europe. Another similar project, ALFA-BIRD[5] (Alternative Fuels and Biofuels for Aircraft Development) was already up and running before the launch of the Flightpath initiate. This project, which was also co-funded under FP7, aimed to identify and evaluate possible alternatives to petroleum kerosene with a view to setting the path towards industrial use of the best alternative fuels.

Another FP7 project launched at the same time as the Biofuel Flightpath Initiative was SOLAR-JET[6], which aimed to demonstrate an economically-viable, carbon-neutral path for producing aviation fuel, compatible with current infrastructure. SOLAR-JET aimed to demonstrate a process that combines concentrated sunlight with CO_2 captured from air and H_2O to produce kerosene. The project has resulted in the production of the world's first "solar" jet fuel from water and carbon dioxide, with the first successful demonstration of the entire production chain for renewable kerosene, using concentrated light as a high-temperature energy source. The project is still at the experimental stage, with a glassful of jet fuel produced in laboratory conditions, using simulated sunlight. However, the results give hope that in future any liquid hydrocarbon fuels could be produced from sunlight, CO_2 and water. The process demonstrated in SOLAR-JET eliminates logistical requirements associated with the biomass processing chain and results in much cleaner kerosene and represents a significant step forward in the production of renewable aviation fuels. The outcomes of SOLAR-JET have the potential to propel Europe to the forefront in efforts to produce renewable, aviation fuels with a first-ever demonstration of kerosene produced directly from concentrated solar energy.

Commenting on this development, European Commissioner for Research, Innovation and Science Máire Geoghegan-Quinn said: "This technology means we might one day produce cleaner and plentiful fuel for planes, cars and other forms of transport. This could greatly increase energy security and turn one of the main greenhouse gases responsible for global warming into a useful resource."[7]

Although producing syngas through concentrated solar radiation is still at an early stage of development, the processing of syngas to kerosene is already being deployed by companies on a global scale. Combining the two approaches has the potential to provide secure, sustainable and scalable supplies of aviation fuel as well as diesel and gasoline, or even plastics. In the next phase of the project, the partners plan to optimise the solar reactor and assess whether the technology will work on a larger scale and at competitive cost.

The search for new, sustainable sources of energy continues to be a priority under Horizon 2020. The Competitive Low-Carbon Energy call published on December 11 last year, which has earmarked EUR 732 million in funding for this area over the next two years, includes a topic on the development of next-generation technologies for biofuels. This support, coupled with the promising results already being achieved by EU-funded projects and the need for improved environmental performance being placed on the industry by buoyant growth, guarantees an increasing role for aviation biofuels in the years to come.

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4 http://www.cleansky.eu/content/news/clean-sky-2-taking
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