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Bellona Europa response to the consultation on a sustainable bioenergy policy for the period after 2020

May 2016

The Bellona Foundation is an independent non-profit organisation that aims to meet and fight the climate challenges, through identifying and implementing sustainable environmental solutions. We work towards reaching a greater ecological understanding, protection of nature, the environment and health. Bellona is engaged in a broad spectre of current national and international environmental questions and issues around the world.

Pollution knows no borders, thus Bellona works with and against anyone and everyone relevant to our work, both nationally and internationally. Bellona has a solution-oriented approach to the environmental challenges and has since 1998 had extensive cooperation with a number of companies in different industries and businesses. Our approach is that to achieve results one must jointly work out the best social and environmental solutions, and make these financially profitable and viable. Bellona has always been and remains an independent watch dog that investigates, scrutinises and reports any environmental crime we uncover.

The Bellona Foundation was founded in 1986. We are currently 65 employees, working at the main office in Oslo and our three international offices in Brussels (Belgium / EU) Murmansk (Russia) and St. Petersburg (Russia). Bellona has been established with an office in Brussels since 1994.

Introduction

EU Member States have agreed on a new policy framework for climate and energy, including EU-wide targets for the period between 2020 and 2030. The targets include reducing the Union's greenhouse gas (GHG) emissions by 40 % relative to emissions in 2005 and ensuring that at least 27 % of the EU's energy comes from renewable sources. They should help to make the EU's energy system more competitive, secure and sustainable, and help it meet its long-term (2050) GHG reductions target.

In January 2014, in its Communication on A policy framework for climate and energy in the period from 2020 to 2030, the Commission stated that '[a]n improved biomass policy will also be necessary to maximise the resource-efficient use of biomass in order to deliver robust and verifiable greenhouse gas savings and to allow for fair competition between the various uses of biomass resources in the construction sector, paper and pulp industries and biochemical and energy production. This should also encompass the sustainable use of land, the sustainable management of forests in line with the EU's forest strategy and address indirect land-use effects as with biofuels'.

In 2015, in its Energy Union strategy, the Commission announced that it would come forward with an updated bioenergy sustainability policy, as part of a renewable energy package for the period after 2020.

Bioenergy is the form of renewable energy used most in the EU and it is expected to continue to make up a significant part of the overall energy mix in the future. On the other hand, concerns have been raised about the sustainability impacts and competition for resources stemming from the increasing reliance on bioenergy production and use.

Currently, the Renewable Energy Directive and the Fuel Quality Directive provide an EU-level sustainability framework for biofuels and bioliquids. This includes harmonised sustainability criteria for biofuels and provisions aimed at limiting indirect land-use change, which were introduced in 2015.

In 2010, the Commission issued a Recommendation that included non-binding sustainability criteria for solid and gaseous biomass used for electricity, heating and cooling (applicable to installations with a capacity of over 1 MW). Sustainability schemes have also been developed in a number of Member States.

The Commission is now reviewing the sustainability of all bioenergy sources and final uses for the period after 2020. Identified sustainability risks under examination include lifecycle greenhouse gas emissions from bioenergy production and use; impacts on the carbon stock of forests and other ecosystems; impacts on biodiversity, soil and water, and emissions to the air; indirect land use change impacts; as well as impacts on the competition for the use of biomass between different sectors (energy, industrial uses, food). The Commission has carried out a number of studies to examine these issues more in detail.

The development of bioenergy also needs to be seen in the wider context of a number of priorities for the Energy Union, including the ambition for the Union to become the world leader in renewable energy, to lead the fight against global warming, to ensure security of supply and integrated and efficient energy markets, as well as broader EU objectives such as reinforcing Europe's industrial base, stimulating research and innovation and promoting competitiveness and job creation, including in rural areas. The Commission also stated in its 2015 Communication on the circular economy that it will 'promote synergies with the circular economy when examining the sustainability of bioenergy under the Energy Union'. Finally, the EU and its Member States have committed themselves to meeting the 2030 Sustainable Development Goals.

II. Perceptions of bioenergy

2.1. Role of bioenergy in the achievement of EU 2030 climate and energy objectives

Please indicate which of the statements below best corresponds to your perception of the role of bioenergy in the renewable energy mix, in particular in view of the EU's 2030 climate and energy objectives:

- ☐ Bioenergy should continue to play a dominant role in the renewable energy mix.
- ✓ Bioenergy should continue to play an important role in the renewable energy mix, but the share of other renewable energy sources (such as solar, wind, hydro and geothermal) should increase significantly.
- ☐ Bioenergy should not play an important role in the renewable energy mix: other renewable energy sources should become dominant.

2.2. Perception of different types of bioenergy

Please indicate, for each type of bioenergy described below, which statement best corresponds to your perception of the need for public (EU, national, regional) policy intervention:

	Should be further promoted	Should be further promoted, but within limits	Should be neither promoted nor discouraged	Should be discouraged	No opinion
Biofuels from food crops				X	
Biofuels from energy crops (grass, short rotation coppice, etc.)				X	
Biofuels from waste (municipal solid waste, wood waste)		X			
Biofuels from agricultural and forest residues		X			
Biofuels from algae		X			
Biogas from manure		X			
Biogas from food crops (e.g. maize)				X	
Biogas from waste, sewage sludge, etc.		X			
Heat and power from forest biomass (except forest residues)				X	
Heat and power from forest residues (tree tops, branches, etc.)			X		
Heat and power from agricultural biomass (energy crops, short rotation coppice)				X	

Heat and power from industrial residues (such as sawdust or black liquor)		X			
Heat and power from waste		X			
Large-scale electricity generation (50 MW or more) from solid biomass				X	
Commercial heat generation from solid biomass			X		
Large-scale combined heat and power generation from solid biomass			X		
Small-scale combined heat and power generation from solid biomass			X		
Heat generation from biomass in domestic (household) installations			X		
Bioenergy based on locally sourced feedstocks			X		
Bioenergy based on feedstocks sourced in the EU			X		
Bioenergy based on feedstocks imported from non-EU countries				X	
Other: Bioenergy for heat and	X				

power and biofuels from macro algae (seaweed)					

III. Benefits and opportunities from bioenergy

3.1. Benefits and opportunities from bioenergy

Bioenergy (biofuel for transport, biomass and biogas for heat and power) is currently promoted as it is considered to be contributing to the EU's renewable energy and climate objectives, and also having other potential benefits to the EU economy and society.

Please rate the contribution of bioenergy, as you see it, to the benefits listed below:

	Of critical importance	Important	Neutral	Negative	No opinion
Europe's energy security: safe, secure and affordable energy for European citizens			X		
Grid balancing including through storage of biomass (in an electricity system with a high proportion of electricity from intermittent renewables)			X		
Reduction of GHG emissions		X			
Environmental benefits (including biodiversity)				X	
Resource efficiency and waste			X		

management					
Boosting research and innovation in bio-based industries			X		
Competitiveness of European industry			X		
Growth and jobs, including in rural areas			X		
Sustainable development in developing countries				X	
Other: Shedding light on difficulties in attaining emission reduction targets and carbon removal without sustainable bioenergy	X				

3.2. Any additional views on the benefits and opportunities from bioenergy? Please explain.

The IPCC has made it clear that bioenergy is central to attaining a 2 or 1.5 degree world, particularly for its role in enabling carbon negative pathways through Bio-CCS (BECCS). Yet it remains highly uncertain to which extent this role can be sustainably fulfilled as biomass plays many important roles in balancing our climate apart from energy.

It is therefore of paramount importance that any bioenergy is developed in a well-thought trough, incorporated manner, alongside co-benefits rather than solely for energy use. An example of this is developing an advanced biorefining industry that makes best possible use of the intrinsic value of each component of the biomass while maximising yields.

Such thinking must be at the foundation as the remit of bioenergy is shifted from land-based to marine sources, including both micro and macro algae (seaweed). While it has become increasingly clear what should not be used for fuel, it remains difficult to find sensible

alternatives. Yet the options for land-based transport like electrification are not feasible for aviation, therefore making biofuels a necessary pathway to further develop and to be prioritised in these uses.

While micro algae have benefited from more attention and research, the biofuel potential of seaweed is not yet as well understood, but may be significant. With their high water content of 85-90% seaweeds are particularly suitable for established wet fuel conversion methods such as anaerobic digestion (AD) and fermentation. (Hydrothermal) gasification and/or a mix of pathways, may further improve yields. The high carbohydrate content renders seaweeds highly suitable for bioethanol and biobutanol production, where the sugars are fermented. Meanwhile, the low lignin content eliminates many of the challenges currently faced by wood-based bioethanol producers.

Marine bioenergy could harbour the potential to circumvent many of the sustainability challenges that render land-based biofuels' sustainability profile questionable. A future EU bioenergy sustainability policy should prioritise better understanding this potential.

IV. Risks from bioenergy production and use

4.1. Identification of risks

A number of risks have been identified (e.g. by certain scientists, stakeholders and studies) in relation to bioenergy production and use. These may concern specific biomass resources (agriculture, forest, waste), their origin (sourced in the EU or imported) or their end-uses (heat, electricity, transport).

Please rate the relevance of each of these risks as you see it:

	Critical	Significant	Not very significant	Non-existent	No opinion
Change in carbon stock due to deforestation and other direct land-use change in the EU		X			
Change in carbon stock due to	X				

deforestation and other direct land-use change in non-EU countries					
Indirect land-use change impacts	X				
GHG emissions from the supply chain (e.g. cultivation, processing and transport)		X			
GHG emissions from combustion of biomass ('biogenic emissions')		X			
Impacts on air quality		X			
Impacts on water and soil		X			
Impacts on biodiversity		X			
Varying degrees of efficiency of biomass conversion to energy	X				
Competition between different uses of biomass (energy, food, industrial uses) due to limited availability of land and feedstocks and/or subsidies for specific uses	X				
Internal market impact of divergent national sustainability schemes		X			

Other: Wasteful use of biomass resources contrary to ideas of the circular economy, synergies and cascading use principle		X			

4.2. Any additional views on the risks from bioenergy production and use? Please explain

Regarding marine biomass and seaweed in particular, the environmental risks of an industrial scale production are not yet well enough understood and require targeted research. This goes for the entire value-chain, including:

- Understanding the local environmental impacts of industrial seaweed production, including nutrients, wastes and biodiversity impacts
- Life cycle assessment of biofuels from seaweed, production, maintenance and harvesting of the seaweed culture in the open sea, where reliance on fossil ships etc. persists
- The potential of Integrated Multi-Trophic Aquaculture, where seaweed can mitigate the impacts of e.g. fish farming and help mitigate impacts of excess resource use in order to increase production of other species.
- Through bio-refining and local/regional value chains, the potential of using seaweed for both energy and feedstock can reduce the need for land-based resources and long-haul transport
- The potential of combining seaweed farming with other offshore infrastructure, such as fish farms or wind parks, to reduce life cycle emissions and reduce costs of investment and operation
- High electricity consumption resulting from any storage or pre-treatment requirements of the seaweed, depending on the desired end-product
- The high variability of the chemical composition of seaweeds which may translate to variable methane yield of any harvest, impacting on overall energy and GHG emissions

In general, a more complete understanding is needed of the role of biomass in combating climate change: as carbon sinks, as energy sources with varying degrees of carbon intensity, and for their carbon removal potential via Bio-CCS.

Further general key risks which EU bioenergy policies need to address and mitigate are:

- Exceeding the limits of sustainably available biomass due to the increasing, policy driven demand for biomass energy that comes on top of other, existing demands

- Failing to reduce carbon emissions sufficiently due to the flawed zero rating of carbon emissions from bioenergy
- Inefficient and wasteful use of biomass resources that is not in line with the cascading use principle or the circular economy
- Negative environmental and social impacts, e.g. impacts on air quality, land use, biodiversity, land right conflict, food security and land grabs
- High risks of carbon emissions from bioenergy due to changes in nature's carbon stocks from deforestation, direct land use change and time delay in (assumed) recapture by growth.

V. Effectiveness of existing EU sustainability scheme for biofuels and bioliquids

5.1. Effectiveness in addressing sustainability risks of biofuels and bioliquids

In your view, how effective has the existing EU sustainability scheme for biofuels and bioliquids been in addressing the risks listed below?

	Effective	Partly effective	Neutral	Counter-productive	No opinion
GHG emissions from cultivation, processing and transport		X			
GHG emissions from direct land-use change		X			
Indirect land-use change				X	
Impacts on biodiversity				X	
Impact on soil, air and water				X	

Any additional comments?

The biofuels sustainability scheme in place from 2009 to 2015 ignored ILUC emissions and therefore did not prevent the deployment of those biofuels with potentially higher GHG emissions than fossil fuels that they were meant to replace. Revision of the sustainability scheme in 2015 with the introduction of the 7% cap on first generation/food based biofuels is expected

to partly address ILUC impacts, but is still not effective enough because a) it does not include ILUC factors, b) it doesn't cover all land-based crops, c) it is not extended to the Fuel Quality Directive and d) it still allows for an increase in food-based biofuel use until 2020 as the 7% cap is higher than current consumption levels.

The revised 2015 scheme's sub-target and multiple counting for advanced biofuels does not go far enough to encourage a swift enough shift from first and second to third generation bioenergy (*see further comment on sub-targets in answer to 5.2*). Furthermore, it fails to send a clear enough signal regarding *which* advanced biofuels will play a sustainable and significant role in a low-carbon economy. For marine biomass producers for instance, such signals are clearly lacking, leaving them to continue focusing on higher-value products in food, feed and pharmaceuticals, while the much-needed energy value is left un-pursued.

Existing sustainability criteria have been partly effective in preventing direct land use change and other negative impacts, however compliance of the sector with existing criteria cannot be claimed since these are enforced through verification systems that are often not sufficiently robust.

5.2. Effectiveness in promoting advanced biofuels

In your view, how effective has the sustainability framework for biofuels, including its provisions on indirect land-use change, been in driving the development of 'advanced' biofuels, in particular biofuels produced from ligno-cellulosic material (e.g. grass or straw) or from waste material (e.g. waste vegetable oils)?

- ☐ very effective
- ☐ effective
- ✓ neutral
- ☐ counter-productive
- ☐ no opinion

What additional measures could be taken to further improve the effectiveness in promoting advanced biofuels?

The 7% cap on conventional biofuels agreed in the ILUC decision of 2015 should be maintained after 2020 and these biofuels phased out. Advanced, marine biofuels should play a role in the phase out of conventional biofuels, and should be prioritised in sectors which face no or few other (e.g. efficiency and electrification) decarbonisation options, such as aviation.

Regarding sub-targets, the use of any volume/percentage targets for advanced (or any other) biofuels can be problematic as this leads to a quantitative approach when what is most important is quality and impacts of biofuels.
The pervading weaknesses of advanced bioenergy take-up are uncertain yields and high costs. These must be addressed by encouraging a wider number of industrial actors through clear, long-term policy and clearer scientific understanding of the role of sustainable bioenergy in combating climate change. A European-level approach to bioenergy must be continued and furthered to ensure this, particularly regarding investments into R&D.

For marine biofuels, there are some clear barriers to industrial production which R&D can help break, including better understanding of:

- Local environmental impacts of industrial seaweed production, including nutrients, wastes and biodiversity impacts
- Ideal harvesting times, storage options, best processing methods, screening for suitable marine bacteria and enzymes for digestion and fermentation, optimal digester designs and conversion pathways with highest yields and lowest energy penalties
- Pre-treatment methods (mechanical and chemical) which take the sought end-product – in this case biofuel – into account.
- A method of assessing cascading/prioritized use of seaweed which best preserves the feedstock's intrinsic value in an advanced biorefining industry
- Translating land-based biofuel research and industry to the marine sector: Especially on measures improving performance of anaerobic digestion and fermentation processes, or the potential of a combination of biochemical and thermochemical conversions so as to optimize yields.

5.3. Effectiveness in minimising the administrative burden on operators

In your view, how effective has the EU biofuel sustainability policy been in reducing the administrative burden on operators placing biofuels on the internal market by harmonising sustainability requirements in the Member States (as compared with a situation where these matter would be regulated by national schemes for biofuel sustainability)?

- ☐ very effective
- ✓ effective
- ☐ not effective
- ☐ no opinion

What are the lessons to be learned from implementation of the EU sustainability criteria for biofuels? What additional measures could be taken to reduce the administrative burden further?

Concerns on negative societal, climate and environmental impacts of policies, raised by the scientific community and civil society should be addressed in a precautionary manner when the policy is first introduced to avoid flawed or constantly changing policy incentives.

A robust, coherent and binding EU level policy for all forms of bioenergy (biofuels, solid and gaseous bioenergy) is needed to give a harmonized basis for sustainability and clear direction for public incentives.

Sustainability policies need to go beyond regulating land and forest management practices. They need to also address natural resource use and our ecological footprint, resource efficiency, full carbon emission impacts, social issues and overall volume of demand created.

Furthermore, with a shift to marine bioenergy sources, lessons learned from land-based management must be translated. Countries with an established offshore industry, be it renewable energy, petroleum or aquaculture, will also have valuable experience in ocean-area management and licencing processes. Future licencing of offshore areas for seaweed production should for instance be encouraged to take place in synergy with other offshore installations.

More transparent requirements for the approval of different verification schemes for the sustainability policy are needed and should be introduced by the Commission.

5.4. Deployment of innovative technologies

In your view, what is needed to facilitate faster development and deployment of innovative technologies in the area of bioenergy? What are the lessons to be learned from the existing support mechanisms for innovative low-carbon technologies relating to bioenergy?

Targets and mandates for bigger volumes of biofuel or bioenergy encourage quantities without more effective, innovative or environmentally beneficial use of bioenergy. Policy needs to give a clear preference for the kinds of bioenergy (biomass source, conversion technologies etc.) that deliver societal and environmental benefits and exclude bioenergy with negative impacts, so that development of more innovative uses and forms of bioenergy is incentivized.

Economies of scale and industrialized production are drivers for technology development and implementation. Volume therefore remains one of the key barriers for e.g. large-scale use of marine biomass for energy purposes today. Today its use is far more economical in e.g. pharmaceutical (EUR10-1000/kg) or feed (EUR1-2/kg) industries than for energy (EUR0.5/kg). Therefore, additional programs for technology development that enable commercialization, with a focus on preferred biomass sources and conversion technologies, is needed to enable faster deployment of innovative technologies.

VI. Effectiveness of existing EU policies in addressing solid and gaseous biomass sustainability issues

6.1. In addition to the non-binding criteria proposed by the Commission in 2010, a number of other EU policies can contribute to the sustainability of solid and gaseous bioenergy in the EU. These include measures in the areas of energy, climate, environment and agriculture.

In your view, how effective are current EU policies in addressing the following risks of negative environmental impacts associated with solid and gaseous biomass used for heat and power?

	Effective	Partly effective	Neutral	Counter-productive	No opinion
Change in carbon stock due to deforestation, forest degradation and other direct land-use change in the EU				X	
Change in carbon stock due to deforestation, forest degradation and other direct land-use change in non-EU countries				X	

Indirect land-use change impacts				X	
GHG emissions from supply chain, e.g. cultivation, processing and transport				X	
GHG emissions from combustion of biomass ('biogenic emissions')				X	
Air quality				X	
Water and soil quality				X	
Biodiversity impacts				X	
Varying degrees of efficiency of biomass conversion to energy				X	
Competition between different uses of biomass (energy, food, industrial uses) due to limited availability of land and feedstocks				X	
Other: Social impacts, human rights, land rights and food security				X	

6.2. Any additional views on the effectiveness of existing EU policies on solid and gaseous biomass? Please explain

Use of biomass for energy is driven by the EU ETS that erroneously assumes all bioenergy emissions to be zero, without any requirements to prove that emission savings actually take place (*see appendix*). To avoid misguiding policies, such EU climate and energy policies should

also be aligned with the requirements of the bioenergy sustainability policy. Furthermore, there is a need to positively incentivise capture and sequestration of all biogenic CO_2 regardless of whether their source is sustainably replacing fossil fuels or not.

Existing policies in the field agriculture, like the Common Agricultural Policy (CAP) or rural development policy, or in the field of forestry, such as national legislation on sustainable forest management, or waste management have not been effective in ensuring the use of biomass for energy is done in a sustainable way. In some cases, the contrary is true. Therefore clear sustainability requirements need to be placed on energy producers.

Measures to report for emissions in the Land Use, Land Use Change and Forestry (LULUCF) sector or account for under the Kyoto Protocol have not been effective in capturing the emissions of increased bioenergy use, in excluding high-carbon bioenergy sources or thereby ensuring effective carbon emission savings.

There's particularly a gap in policies at EU and national levels ensuring that bioenergy use delivers true GHG savings, for instance by ensuring that biomass is used in a resource efficient way in line with the cascading use principle. Sustainability requirements on agriculture or forestry have not yet been enough to ensure these gaps in policy are addressed.

VII. Policy objectives for a post-2020 bioenergy sustainability policy

7.1. In your view, what should be the key objectives of an improved EU bioenergy sustainability policy post-2020? Please rank the following objectives in order of importance: most important first; least important 9th/10th

1. Contribute to climate change objectives
2. *Other*: Enable carbon removal/negative emissions pathways and technologies
3. Avoid environmental impacts (biodiversity, air and water quality)
4. Promote efficient use of the biomass resource, including efficient energy conversion
5. Mitigate the impacts of indirect land-use change
6. Ensure long-term legal certainty for operators
7. Promote EU industrial competitiveness, growth and jobs
8. Promote energy security
9. Promote free trade and competition in the EU among all end-users of the biomass resource
10. Minimise administrative burden for operators

7.2. Any other views? Please specify

We rely on bioenergy to tackle climate change, studies have shown that the EU is already starting to reach the limits of wood and land resources available for the various growing needs of different sectors, including the policy driven energy demand. The EU should therefore evaluate the sustainable potential of land-based domestic biomass supply for energy use, taking into consideration competing uses in other sectors and environmental protection, and cap the use of land-based biomass for energy accordingly.

Parallel to this, the EU should shift its focus to better understanding and developing the vast untapped potential of marine bioenergy. In 2050 we will need 70% more food than today. Meanwhile the World Resource Institute says meeting 20% of the world's energy demand in 2050 with land-based bioenergy would require an amount of biomass that equals all biomass harvested today for food, feed, energy and materials.

Seaweed is an abundant yet underutilised biomass source. The sea covers 70% of the world, accounts for 50% of biomass production, yet only 2% of our energy from food comes directly from the sea the form of aquaculture and fisheries. Compared to Asia, industrial seaweed cultivation is in the developmental phase in Europe and comprises only a few species. There is therefore a golden opportunity to design a high-potential industry effectively from scratch.

Bioenergy use needs to contribute to climate change mitigation, the circular economy and resource efficiency without negative impacts on the environmental or on land-use and human rights. In all these areas concerns are already raised and evidence of negative impacts exists. Neglecting any of these policy objectives can easily lead to discrediting of the future sustainability policy. Therefore it must be noted that the above 'forced' ranking of these aspects poorly communicates the importance of their interconnected nature.

VIII. EU action on sustainability of bioenergy

8.1. In your view, is there a need for additional EU policy on bioenergy sustainability?

- ☐ No: the current policy framework (including the sustainability scheme for biofuels and bioliquids, and other EU and national policies covering solid and gaseous biomass) is sufficient.
- ☐ Yes: additional policy is needed for solid and gaseous biomass, but for biofuels and bioliquids the existing scheme is sufficient.
- ☐ Yes: additional policy is needed on biofuels and bioliquids, but for solid and gaseous biomass existing EU and national policies are sufficient.

- ✓ Yes: a new policy is needed covering all types of bioenergy.

8.2. In your view, and given your answers to the previous questions, what should the EU policy framework on the sustainability of bioenergy include? Please be specific

In line with other environmental NGOs, Bellona recommends that the EU should introduce four main safeguards for bioenergy use as part of the EU's 2030 climate and energy policies:

- A cap to limit the use of land-based biomass for energy production to levels that can be sustainably supplied;
- An efficient and optimal use of all biomass resources, in line with the principle of cascading use;
- Verifiable greenhouse gas savings and correct carbon accounting for biomass;
- A comprehensive binding sustainability criteria to mitigate other negative social and environmental impacts

More concretely, the policy should result in exclusion of the kinds of biomass sources that have the highest risk of negative climate and environmental impacts (such as biodiesel) and support only the use of lower-risk sources such as waste and residue based biomass, while still respecting the principle of waste hierarchy, and higher-potential sources such as seaweed.

IX. Additional contribution

Do you have other specific views that could not be expressed in the context of your replies to the above questions?

It must be noted that practically all biomass conversion entails CO_2 emissions, regardless of the biomass source. CO_2 has the same effect on the atmosphere regardless of where it comes from, fossil or biogenic. Hence anywhere biomass is utilised at scale, the EU ought to strive to capture and store that CO_2.

Several biofuel production routes, notably bioethanol and Biomass to Liquids (BtL), constitute the lowest hanging fruits for CO_2 capture costs due to high-purity CO_2 emission streams and CO_2 from such sources, including in Europe, often being captured already but sold on to e.g. fizzy drinks producers rather than being stored. The ADM Decatur project in Illinois, USA is an example of an operating Bio-CCS facility at large scale. Although it produces first generation bioethanol (corn), it proves capture and storage of CO_2 in underground geological formations.

Appendices

1) *BellonaBrief: The carbon negative solution – incentivising Bio-CCS in Europe* (July 2015). Available at: http://bellona.org/publication/bellonabrief-the-carbon-negative-solution-incentivising-bio-ccs-in-europe

2) *Bellona response to the consultation on the preparation of a new renewable energy directive for the period after 2020* (February 2016). Available at: http://bellona.org/publication/bellona-response-to-the-consultation-on-the-preparation-of-a-new-renewable-energy-directive-for-the-period-after-2020

3) *BellonaBrief: IPCC 5th Climate Assessment Report: An unequivocal call for action on (Bio-)CCS* (December 2015). Available at: http://bellona.org/publication/bellonabrief-ipcc-5th-climate-assessment-report-an-unequivocal-call-for-action-on-bio-ccs