What is the role of bioenergy in a decarbonised Europe?

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With its proposed European Green Deal, the European Union aims at becoming the first carbon neutral continent by mid-century. This is a laudable and long-awaited commitment to tackle climate change and its impacts, promote sustainable policies and boost innovative and low carbon technologies. This will require deep transformations in the way we consume, move and produce. The energy sector must be subject to such a transformation, as it must become fossil-free and clean, based on sustainable renewable technologies.

This paper discusses the role of bioenergy in the context of a zero-emissions roadmap for the EU. It is based on the analysis of thirteen scenarios that look into pathways to achieve zero emissions by mid-century. Based on this analysis, T&E and Birdlife conclude that there are many uncertainties on the role that bioenergy can play in decarbonisation of the economy and that the potential for sustainable bioenergy will remain limited. This is mainly due to a lack of harmonisation among the scenarios regarding sustainability, making it difficult to have a clear overview of the availability of sustainable feedstocks for energy use. Instead, Europe should rely on clean and sustainable renewable energy sources such as wind and solar.

1. Bioenergy in Europe

The popularity of bioenergy as a source of energy has increased in the past years. Its use has been promoted in Europe in the Renewable Energy Directive (RED, adopted in 2009) which seeks to boost the use of renewable energy in all sectors of the EU economy by 2020. The recast of the RED (the REDII, adopted in 2018) sets some restrictions and criteria for the use of bioenergy, however these are contested. The new climate policy environment (triggered by the objective of Europe becoming a carbon neutral continent) is very likely to have consequences for the use of bioenergy.

Using biomass for energy has been criticized due to environmental and social concerns. The promotion and use of food and feed crops for biofuels leads to (direct and indirect) land use change due to the increased need of productive agricultural land to grow crops for energy purposes. The expansion of the agricultural frontier occurs at the expense of natural areas that are often rich in carbon stocks. Due to this, the life cycle emissions of biofuel feedstocks are, in some cases, much higher than those of fossil fuels[1].

The use of solid biomass for energy also has negative environmental and climate effects. Cutting trees for energy production reduces carbon sinks (needed in the short and long term to ensure the carbon neutrality of the EU), and poses a threat to biodiversity and ecosystems as it favours monoculture and increased logging pressure of natural forests[2].

1.1. The Renewable Energy Directive

The 2009 RED sought the promotion of biofuels in transport by setting a target for renewables in transport (10% of the total energy consumed in transport by 2020). There were no particular targets at EU level for bioenergy for heating and cooling in the 2009 RED, but its use has increased in the past decade by 12 % due largely to national subsidies and exemptions from energy or carbon taxes. Over this period biomass based electricity, despite being highly inefficient, has increased by 80 %[3] due to feed-in tariffs and accounting towards Member State renewable energy targets.

1.2. The Renewable Energy Directive II (REDII)

The REDII sets a target for renewables in Europe of 32% by 2030, up from the 2020 target of 20% renewables. Today, more than 50% of the renewable energy used in Europe comes from biomass (including energy in transport)[4]. In a 2030 scenario with an increased target, it is likely that the share of biomass will grow too, increasing the risks explained above.

In the case of transport, the REDII sets a system of targets and caps for the use of different energy sources for the transport sector[5]. It favours the use of advanced fuels (including advanced biofuels, renewable electricity and renewable hydrogen and synthetic fuels). The REDII still allows for food and feed crop biofuels to be used in transport, however subject to a limitation and progressively phasing out of palm oil based biofuels.

The supply of forest biomass is covered by five criteria which are intrinsically assumed to ensure sustainability of supply. In the first instance this should be assessed by national/sub-national legislation applicable in the area of harvest with related monitoring and enforcement systems. However, in the absence of such legislation, compliance can be demonstrated by forest management systems which inherently will not promote environmental safeguards at the expense of harvesting.

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[1] https://www.transportenvironment.org/publications/globiom-basis-biofuel-policy-post-2020

[2] https://onlinelibrary.wiley.com/doi/full/10.1111/gcbb.12643

[3] Banja, Manjola & Sikkema, Richard & Jégard, Martin & Motola, Vincenzo & Dallemand, Jean-François, 2019. "Biomass for energy in the EU – The support framework," Energy Policy, Elsevier, vol. 131(C), pages 215-228.

[4] https://ec.europa.eu/energy/data-analysis/energy-statistical-pocketbook_en?redir=1#country-datasheets

[5] https://www.transportenvironment.org/publications/how-member-states-can-deliver-sustainable-advanced-transport-fuels

The use of this biomass will only be required to meet efficiency standards if used in electricity-only power stations over 100MW, with a minimum efficiency of 36% required. Plants below 50 MW (big enough to power 50.000 homes) will not have to meet any efficiency criteria at all[6].

1.3. The EU Green Deal and the net-zero emissions goal

The EU presented its European Green Deal in December 2019. The EU Green Deal will instrumentalise the EU's goal to become carbon neutral by 2050. Over the course of the first half of 2020, the EU has presented several strategies on key policy areas that will deliver on this goal, including a European Climate Law, an Industrial Strategy and a Biodiversity Strategy, among others[7].

While this is a laudable commitment, an increase in the climate targets is likely to bring an upwards review of the renewable energy targets which can drive the use of unsustainable sources of energy, such as biomass. This is because bioenergy is considered carbon neutral under the main climate laws (the EU Emissions Trading Scheme and the EU Climate Action Regulation), and some countries rely on this type of energy to meet their climate commitments, even when discouraged by the REDII (e.g. in the case of crop biofuels). This is a loophole and this lack of harmonisation brings undesirable effects, such as increased deforestation, all in the name of climate action.

2. Analysis of decarbonisation scenarios

Transport & Environment and Birdlife Europe commissioned an analysis of studies that look into pathways to achieve the decarbonisation of the economy, mostly by 2050. It assesses how much these scenarios rely on bioenergy to achieve carbon-neutrality (or reduce emissions dramatically) and under what conditions, for example on sustainability or policy measures.

The analysis conducts a review of thirteen scenarios[8]. For all these studies, the analysis looks at the modelling approach, including the geographical and sectoral coverage, assumptions on biomass availability, including feedstocks considered and the sustainability considerations; and finally the role of bioenergy per sector, including the role of imports.

In general lines, the review concludes that all studies foresee an increase in the use of bioenergy by 2050. It also shows there is a lack of harmonisation with regards to the sustainability criteria for biomass for transport and energy. This inevitably results in a range of different projections as to how much bioenergy the EU can use to arrive at carbon neutrality by 2050. The differences in projected bioenergy

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6 https://www.iscc-system.org/wp-content/uploads/2017/02/1-Volpi_RED-II-EU-Sustainability-Criteria-for-Bioenergy.pdf

7 https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en#timeline

8 EU Commission "A Clean Planet For All"; IEA World Energy Review; IRENA Global Energy Transformation: A Roadmap to 2050; Öko-institut for the Greens/EFA Vision Scenario for the European Union; Net Zero 2050: from whether to how; ICF/Fraunhofer, Industrial Innovation: Pathways to deep decarbonisation of industry; IPCC Global Warming of 1,5ºC; Global Energy System Based on 100% Renewable Energy; Breaking new ground: wind energy and the Electrification of Europe's Energy System; Eurelectric decarbonisation pathways; Low Carbon Pathways 2050; Energy [r]evolution.

consumption are visible in the figure below, comparing the four EU focused scenarios: EU Commission, IEA, Öko Institut and net zero 2050 (done for the European Climate Foundation).

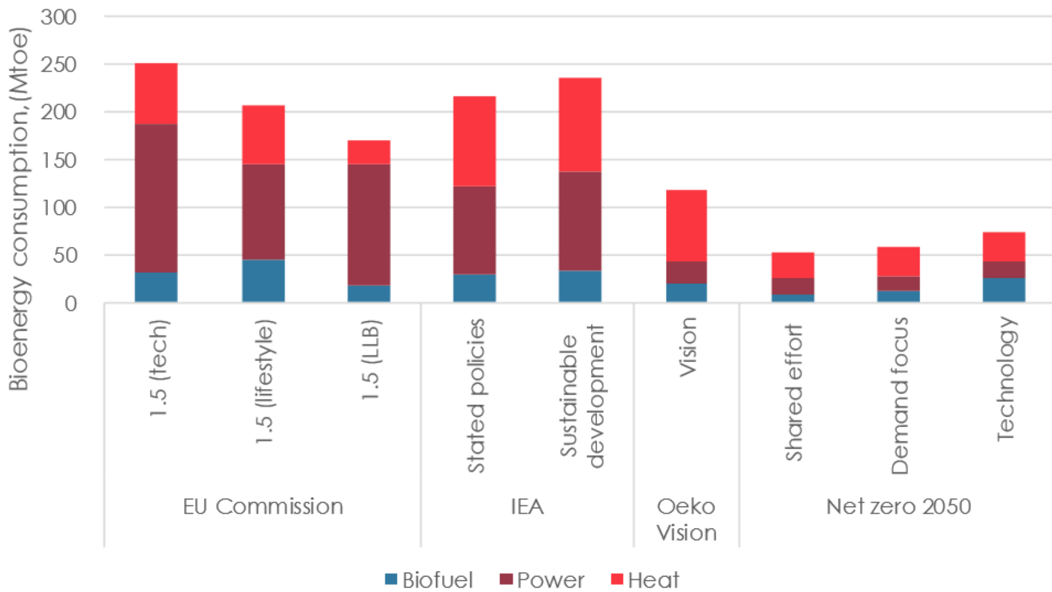

Figure 1: EU final bioenergy demand in 2050 in selected scenarios. Source: Cerulogy "We didn't start the fire", 2020.

2.1. How is the role of bioenergy determined?

How scenarios are built and the means of determining the contribution of each renewable energy source have an important bearing on the role of bioenergy. Studies that are based on integrated models of energy and land use such as the European Commission's "A Clean Planet for All", can incorporate minimum limits for biomass use reflecting existing policy measures, but generally choose technologies that minimise costs, often within GHG constraints or renewable energy targets. However, true environmental impacts and costs, such as biodiversity loss and health consequences from air pollution, are rarely incorporated which can be favourable to bioenergy over other renewable technologies.

Other studies rely on in-house expertise, policy outlooks in which bioenergy can feature prominently, or through feasibility assessments of different renewable energy technologies, which can see bioenergy as a ready to burn alternative in existing coal infrastructure. In the IPCC's Global warming of 1.5 °C, bioenergy use is influenced by classification of biomass as a CO2 reduction technology. If bioenergy is considered an emissions removal technology (excluding the land use emissions), the study will promote greater bioenergy use. These points demonstrate that assumptions on sustainability, carbon removals/zero emissions and existing alternative technologies can preferentially boost the use of bioenergy in decarbonisation scenarios and incorrectly in-grain it as a necessary part of a decarbonised energy system.

2.2. Lack of details on ‘sustainability’ assumptions

All reviewed models and scenarios assume that biomass is supplied ‘sustainably’ and that bioenergy is delivered in a way that minimises associated net CO2 emissions from land use change and from carbon stock reductions, without discussing how sustainability is defined and enforced. Bioenergy use is often justified only by the assumption that it will be sourced sustainably. However, this does not correlate to it necessarily being sourced sustainably in practice and the notion of sustainability is interpreted very differently between studies. Aside from carbon, notable biodiversity impacts that are likely to occur through the expansion of energy crops and afforestation are not specifically addressed in the studies.

The majority of studies show an increase in bioenergy in more sustainable scenarios, based on the assumption that bioenergy is zero emission. The IEA World Energy Outlook 2019 sustainable development scenario shows an increase in final consumption of biomass energy, with a shift from ‘traditional’ to ‘modern’ biomass[9] use for heating and increased power generation. The Öko-Institut for the Greens/EFA (Vision Scenario for the European Union 2017) is the only case where a more sustainable scenario decreases biomass use. The difference can be explained by the fact that the Öko-Institut scenario factors sustainability issues more effectively. It looks at the impact of biomass growth and harvest, rules out all crop-based biofuels, and includes more ambitious forecasts for the adoption of technologies such as electrification.

2.3. Biomass for transport

Not all the analysed scenarios look into the transport sector, but most do. However, there are big differences among them on the types of biofuels and sustainability safeguards for their use.

2.3.1. The role of food and feed based biofuels

Despite the EU attempts to move away from food and feed crop biofuels and onto more sustainable sources such as renewable electricity, all the scenarios in the review still foresee a role for these biofuels by 2050, except for the Öko-Institut for Greens/EFA and the Net Zero 2050 (which however considers energy crops). Regarding sustainability criteria, the “Clean Planet for All” relies on the REDII criteria as sufficient even though indirect impacts are not included in these criteria. For many of the other scenarios, no specific criteria are considered beyond a “food first” criteria (IEA; IRENA; IPCC; Net Zero 2050; Global Energy System Based on 100% Renewable Energy), and some (IEA, IRENA, IPCC) do not set restrictions on the types of feedstocks used (i.e. biofuels are one big category without distinction on crop-based or advanced).

2.3.2. The role of advanced biofuels

“Clean Planet for All”, IEA, the Öko-Institut for Greens/EFA, the net-zero 2050 and the Global Energy System based on 100% Renewables, the IPCC and the Energy [r]evolution studies specifically mention

[9] Traditional biomass use refers to the burning of wood in household fireplaces, while modern usage is the burning of biomass in industrial scale facilities with heat then dispersed through district heating or similar.

the role of advanced biofuels in 2050, although with different sustainability considerations. The mentioned scenarios include energy crops (the net-zero 2050 foresees a decreased role for those) and waste and residues. Even if these feedstocks are considered advanced (as they are part of the REDII Annex IX), energy crops, even if they are not food, do use land, which competes with food production. This can lead to expansion of the agricultural frontier at the expense of carbon stocks such as forests. Second, in the case of wastes and residues, they can play a role in decarbonising the transport sector, but none of the studies seem to consider the potential competing uses of wastes and residue feedstocks for biofuels. If all these materials are drawn to the energy sector, it would lead to displacement effects in other industries. This is particularly important in the context of the development and promotion of the EU bioeconomy which relies on the same feedstocks, leading to an increased competition for the same materials which can lead to displacement effects.

The "Clean Planet for All" notes potential sustainability problems linked to energy crops and land use. Beyond this, none of the scenarios seem to mention specific sustainability considerations for advanced biofuels (for example, sustainable forestry removal rates or consideration of competing uses) other than ensuring no competition with food.

2.3.3. Other alternative energies

The Öko-Institut for Greens/EFA, the IEA, the global energy system based on 100% renewables, the Breaking new ground and the Eurelectric scenarios (the last two reviewed in less detail) explicitly mention the role of electrification in the transport sector, stating that the penetration of this technology will contribute to the reduction or elimination of biofuels in transport - although limitations of electrification are highlighted, for instance in the aviation and shipping sectors. Based on T&E's analysis[10], while the shipping sector can count on other sources than biomass for energy (including electricity but also green hydrogen), aviation will still need liquid fuels. Here, both advanced biofuels and renewable fuels of non-biological origin (e-fuels, or PtX) will play a role. The latter needs to be based on additional renewable electricity, but the "Clean Planet for All" scenario foresees an increase in the use of biomass for PtX production, suggesting that biomass would still be used for transport through PtX production. This would be highly unsustainable due to the inefficiency of biomass burning for electricity and the process of PtX production[11].

2.4. Biomass for heat and power

Biomass for energy demand and consumption is generally broken down into heat, with studies varying in their differentiation of residential heating and the use of thermal heat energy for industry, and power.

[10] https://www.transportenvironment.org/publications/roadmap-decarbonising-european-shipping

[11] https://www.transportenvironment.org/press/e-fuels-too-inefficient-and-expensive-cars-and-trucks-may-be-part-aviations-climate-solution-%E2%80%93

2.4.1. Heat or Power

Most scenarios see heat (residential, industrial heat and space heating) as the largest part of final bioenergy consumption. Both the European Commission "A Clean Planet for All" and IEA's WEO 2019 sustainable development scenario have power as the highest form of energy demand/consumption. The analysis reasons that this is likely a result of combined heat and power generation which can include mechanical power, and in the EU case this category includes district heating. Yet despite electricity being a low efficiency use of biomass[12], and operational alternatives being available, criteria in REDII do little to restrict such power generation. In these studies, the share of biomass in final energy consumption can be greater than 10%. In contrast LUT University and the Energy Watch Group 100% renewable energy scenario, results in biomass providing only 6% of global primary energy in 2050 (about 4% in Europe), the majority of which is heat.

The analysis shows that the use of biomass for energy is widely foreseen to make up the majority of all bioenergy, and in particular play a role in industry and heating. The Öko-Institut study has biomass as the main renewable technology considered for industrial heat. A similar role of heat for buildings and industry is shown in the IRENA Global Energy Transformation study which notes hard to electrify industrial processes. However, the ICF/Fraunhofer Industrial Innovation modelling of industry found biomass energy was minimised in mixed energy source scenarios, suggesting it may not be cost competitive with many other industrial decarbonisation options, even with an assumption of carbon neutrality.

These differences between models suggest that rather than biomass for energy being necessary in decarbonisation scenarios, its role is significantly influenced by interpretation and assumptions of modelling and scenario building teams, which seemingly lead in to the policy recommendations that are drawn from these studies.

2.4.2. Source of biomass and impact to LULUCF

While most studies describe the types of feedstocks used as solid biomass for energy, a contribution to final supply is not incorporated. The European Commission work is the only study shown in the analysis with a breakdown of feedstocks, showing forest residues expected to increase to similar volumes as stemwood, while the use of wastes and energy crops are the feedstocks to most substantially increase. Different feedstocks can have considerably different impacts to climate and biodiversity, for example wastes and residues respecting the waste hierarchy and circular economy, compared to forest stemwood used for energy. The IPCC's Global warming of 1.5 °C report also highlights the impact of feedstocks, with Scenario 1 seeing an increase in forest area and corresponding use of forest biomass partly at the expense of other natural land, while Scenario 3 increases energy crops proportionally to the decrease in pasture land.

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[12] https://www.biomasscenter.org/policy-statements/FSE-Policy.pdf

EU-focused studies assume that imports of biomass are limited, although there are currently no policies restricting this, and sustainable based on the assumption that emissions are accounted elsewhere. Studies assume no emissions from the LULUCF sector, and often set wood availability to the regrowth rate to preserve forest carbon stocks but do not assess the foregone carbon sequestration. The landscape level at which this is calculated does not differentiate between monoculture plantations, managed natural forests and biodiversity rich/old growth forests, and there is no discussion of potential changes in carbon storage due to conversion of grassland or other natural land use types.

3. Conclusions

There are many concerns linked to the use of biomass for energy, due to the fact that trees and food crops are burnt for the production of energy. This is not a solution to tackle climate change and its role should be minimised in the short and long term. The studies reviewed do not seem to be based on robust sustainability criteria (except for the Energy [r]evolution but analysed in less detail), and only a few of them consider restrictions on unsustainable feedstocks (for instance, Öko-institut and Net-zero 2050). Europe is at a crucial political crossroad and certain climate incentives threaten to lock-in increases in bioenergy (instead of more sustainable sources of energy such as wind and solar) as more renewable energy is supported and deployed. The result of the analysis signals that the sustainability of such bioenergy is not well justified.

Based on the analysis, we recommend the following elements to be included in future modeling exercises and policy frameworks:

- End the zero-carbon rating of biomass in the EU Emissions Trading Scheme and the EU Climate Action Regulation.
- Phase out the policy support to food and feed based biofuels as soon as possible and avoid aviation and shipping to become new drivers for these unsustainable fuels.
- Improve the sustainability criteria for advanced biofuels, restrict the use of energy crops and more systematically take into account alternative uses of waste and residue feedstocks.
- Adopt measures for the transport sector to become zero emissions, to contribute to the net-zero emissions EU economy-wide goal, with a focus on renewable electricity-based solutions for all transport modes[13].
- Remove incentives which promote extraction of forest biomass for energy at both EU and national level, with current trends predicting the European forest carbon sink could halve by 2050[14].

[13] https://www.transportenvironment.org/publications/how-decarbonise-european-transport-2050

[14] https://ec.europa.eu/transport/sites/transport/files/media/publications/doc/trends-to-2050-update-2013.pdf; https://www.eea.europa.eu/soer/2015/europe/forests#note10

- Restrict the use of biomass for energy in order to minimise emissions from the land use sector and ensure climate change mitigation and biodiversity conservation; and maximise alternative sources of energy for heat (e.g. geothermal) and existing technologies (e.g. heat pumps) for heating/cooling.
- Invest in improved energy efficiency, with goals to achieve passive or near-passive housing.
- Invest in research and development towards finding/improving alternative solutions for industrial processes, such as cement and steel manufacturing, which avoid burning biomass as a replacement for fossil fuels.

Further information

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