SCIENCE AND TECHNOLOGY OPTIONS ASSESSMENT
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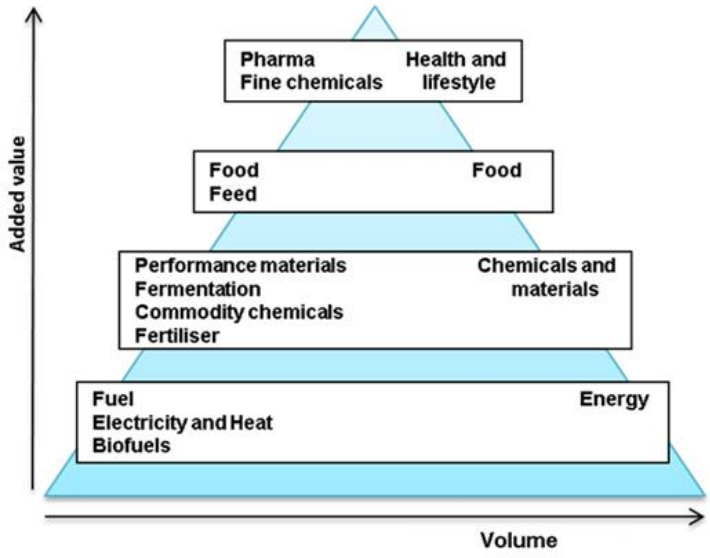
Recycling agricultural, forestry & food wastes and residues for sustainable bioenergy and biomaterials

The use of biomass resources in a wide range of industrial sectors is not new. Biomass has a very long history of use as an energy source, both for process and space heating as well as being fed to animals to provide transport and traction power. Non-energy or 'material' uses of biomass also have a long tradition. Examples are provided by the construction and furniture sectors as well as for pulp, paper and textiles. The more recent and growing policy discussion of the 'bioeconomy' therefore builds on a strong foundation of well-established uses of biomass both inside and outside the food and feed sector. The renewed focus on biomass as a resource goes in hand with emerging technology options that offer new bio-based products in a range of sectors.

This study by IEEP has reviewed biorefinery technology options that exist to convert biomass in the form of agricultural crop and forestry residues and food waste into biomaterials and bioenergy. There is considerable potential for such processes and they are worth being further developed especially as Europe is already seen as having a lead in relevant technologies. To give a flavour of the size of the potential: the evidence reviewed suggests that the development of the food wastes and the crop and forestry residue streams considered in this report together could account for between three and 12 per cent of total EU final energy consumption (1.55 EJ[1] to 5.56 EJ out of a total 46.19 EJ in 2011). These figures are offered as the crudest of indicators of orders of magnitude for potential *energy* generation. The full report explains the great uncertainties about mobilising and utilising such magnitudes of bio-resources. Also, it must be noted that it may well be that producing energy from such resources is not the most efficient way of utilising them. There might be far greater value realisable by decomposing the resources into a cascade of more valuable intermediate chemicals and products. There might be far greater value realisable by decomposing the resources into a cascade of uses, with lower volume but more valuable chemicals and other products at the top of the hierarchy and high volume, low value uses such as energy at the bottom (as illustrated in the biomass value triangle, Figure 1), making use of residual biomass sources that have gone through recycling loops, where technically feasible.

Figure 1: The biomass value triangle



Source: Adapted after Eickhout (2012), based on http://www.biobasedeconomy.nl/themas/bioraffinage_v2

[1] Exajoules (equal to 10^18 joules).

At present, there are also considerable uncertainties for investors and indeed all market participants and thus a major task is to ensure good transparency and better information concerning the availabilities of the waste and residue streams, the opportunities for processing, the environmental risks and benefits involved and the benefits to consumers. *The conclusion is thus encouragement should be given to this sector, but with enhanced transparency of all aspects of its development, and with equally strong sustainability safeguards, as set out in the following 'options'.*

1. Options for successfully mobilising waste and residue feedstocks

Make best use of available support and advice measures available for land and forest managers

Instruments in Member States' Rural Development Programmes could play a role in helping to overcome technical and economic barriers when sourcing ***agricultural crop and forestry residues***. These can be used *inter alia* to advise farmers in assessing sustainable residue extraction levels on fields; to support the increased management of currently undermanaged forests; and to support supply chain functioning through cooperative arrangements of farmers organised in producer groups or associations.

Improve food waste separation and collection and revisit legislation on its use for anaerobic digestion

A harmonised definition of food waste across Europe would be a first step to enable the compilation of better statistical data of food waste volumes. This would support policy and investor decision making on the use of food waste for energy recovery. Enhanced efforts in Member States to source separate and collect food waste are needed to increase available volumes and therefore improve waste management. Legislative requirements in Member States would usefully be revisited with regard to their impacts on using food waste as a co-substrate with manure and slurry in anaerobic digestion.

Follow a regional approach to biomass development

This is recommended to take into account regionally or locally relevant sustainable limits of residue availability and link these to the siting of bioenergy or biorefinery plants.

2. Options for moving from demonstration to commercialisation – the role of public policy

Sufficient financing for setting up large scale demonstration or first-of-its-kind plants

There is a warranted role for *some* public money to provide finance and other assistance for setting up large scale demonstration plants, for example as part of public-private partnerships, such as the 'Biobased PPP'. This would help new industries compete with established fossil-based ones, and at the same time to realise the provision of public goods in the form of reduced greenhouse gas (GHG) emissions and other pollution. Given high capital costs for biorefinery plants, there may be to focus (research) grants on developments that promise to be more cost-effective and possible to operate at smaller scales.

Facilitate market-driven demand for bio-based products

Several mandates exist to develop standards for bio-based products. These are worth pursuing further and could form the basis for a future public procurement programme for bio-based products. Another powerful tool could be the introduction of a (EU wide) label for bio-based products, endorsed by high-level politicians to increase its visibility among consumers.

Ensure a supportive and stable policy framework

This includes rectifying a situation where bioenergy enjoys solid public support through renewable

energy targets while other bio-based products do not benefit from a similar level of support. Instead of introducing new targets, fixing this situation should be by phasing out support for volume targets in the transport sector for biofuels in particular. There needs to be an urgent discussion about the role of biofuels and bioenergy as part of renewable energy policy post-2020. In this context, there could be a case made to legislate biofuels and all forms of bioenergy outside of the renewable energy policy framework and to consider working towards a *Bio-resources Directive*, which would provide a more integrated set of objectives and principles for the efficient use of Europe's bio-resources for food, energy and material use.

A further practical measure that could be implemented within the framework of sustainability criteria in the Renewable Energy Directive would be incentives to use end-of-life biomass for energy purposes, for example through enhanced support for those biomass resources that have gone through cascading uses.

Creating a level playing field between fossil and biomass resources would be a helpful step forward and one with multiple benefits when implemented through the removal of environmentally harmful subsidies for fossil resources or through appropriately taxing the use of non-renewable and polluting resources such as fossil fuels.

3. Options for ensuring environmental sustainability

The following points concern the necessity for environmental safeguards to minimise the risk of over-utilising wastes and residues with resulting long-term damage, particular to soil fertility.

Ensure policy coherence in the energy recovery of food waste

Respecting the waste hierarchy as set out in the Waste Framework Directive is essential to avoid working against efforts to reduce waste when increasing the value of food waste used for energy recovery.

Avoid depleting soil carbon and other nutrients when mobilising agricultural crop residues

- Consider requiring biorefinery operators to conduct humus balance assessments in the relevant region prior to installing plants and to ensure that their sourcing of agricultural residues does not impact negatively on soil carbon and other soil nutrients through continued monitoring.
- Strengthen environmental requirements in relation to soil organic matter as part of the cross compliance provisions of the Common Agricultural Policy to safeguard against unsustainable residue sourcing. This would be accompanied by advice and support measures for farmers to assess sustainable residue extraction levels under the CAP's Rural Development Policy.
- Extend the Renewable Energy Directive's (RED) GHG accounting framework to include soil carbon stock changes. Given the RED's sustainability criteria only apply to biofuels currently, their extension to other forms of bioenergy and bio-based products would be a logical step to protect soil carbon.

Ensure sustainable extraction rates for forestry residues

These are best ensured as part of clear and comprehensive measures put in place in Member States for the sustainable management of forests and woodlands. In addition, the need for sustainability criteria that go beyond the biofuel sector and are comprehensive in considering carbon stock changes in soil and the overall forest carbon stock is valid also for forest residues. There is a range of existing uses for forest residues, such paper, pulp, fibre boards, composting and soil mulch processing. A valid safeguard would be to require biorefinery operators to investigate the sustainable sourcing of residues and also explicitly to consider the likely displacement effects on other industries and their GHG implications.

In conclusion

Any policy recommendations targeted at the development of biorefinery pathways must be underpinned by clear evidence that the relevant bio-based pathways contribute towards meeting climate change mitigation targets by delivering GHG benefits or other defined environmental benefits compared to the traditional products they replace. This includes a monitoring of the displacement effects where the waste and residues used as raw material in biorefineries have existing uses. The Bioeconomy Observatory could perform a most important role in co-ordinating and providing the necessary evidence in all these respects.

All this should be seen as a chance to reduce uncertainty about necessary environmental performance. This greater predictability of the environmental ground rules should be beneficial for attracting investment and ensuring the long-term viability of the sector. Indeed, given the experience with first generation biofuels, the lack of well-based and understood sustainability criteria have been a barrier to the sector's development. There is a chance to overcome this barrier now and to avoid it arising in the case of the wider biorefinery sector.

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