The Role of Biomass, Bioenergy and Biorefining in a Circular Economy

Harriëtte Bos, Bert Annevelink & Rene van Ree
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Task 42 - www.iea-bioenergy.task42-biorefineries.com
Circular Economy (CE)

A Circular Economy is an industrial system that is restorative or regenerative by design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.

Nine circular strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Reference: PBL (2016)</th>
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</thead>
<tbody>
<tr>
<td>R1 – Refuse</td>
<td>Smarter use &amp; production</td>
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<tr>
<td>R2 – Rethink</td>
<td>Prolong life time of products &amp; parts</td>
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<tr>
<td>R3 – Reduce</td>
<td>Prolong life time of products &amp; parts</td>
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<td>R4 – Re-use</td>
<td>Use useful application of materials</td>
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<td>R5 – Refurbish</td>
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<td>R6 – Remanufacture</td>
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<td>R7 – Repurpose</td>
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<td>R8 – Recycle</td>
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<td>R9 - Recover</td>
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Five EU priority areas for CE

• food waste
• biomass and bio-based products
• plastics
• critical raw materials
• construction and demolition waste

Food Waste

- Agriculture
- Industry
- Distribution
- Retail
- Consumer

1/3
Of all the food in the world is wasted

This means:
A waste of resources
In Europe, the harvest of 28,940 km² of agricultural land can be saved each year through the reduction of food waste.

It also means:
Food waste negatively affects the availability of food for others.

And it is:
A waste of money

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Five EU priority areas for CE

- food waste
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- plastics
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What is Bioeconomy

- The bioeconomy encompasses the **production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy** via innovative and efficient technologies.

- Feedstock comes from agriculture, forestry and side streams from food production, landscape conservation.
Role of bioeconomy in CE

- bioeconomy is circular by nature
- bioeconomy regenerates CO₂ and uses renewable raw materials to make greener everyday products
- bio-based products and materials have the benefit of achieving a more balanced carbon cycle in comparison to fossil alternatives
- circular economy is complementary to the renewable character of the bioeconomy and must facilitate the recycling of carbon after efficient uses

Reference: BIC (2015);
How can the bioeconomy contribute to the circular economy?

- supplier of renewable energy (primary sources + side streams)
- supplier of materials that can be well cascaded (wood, fibres)
- supplier of feedstock for plastics, which means also supplier of feedstock for the technical cycle!
Biorefining

Definition Biorefining (IEA Task 42):
Sustainable processing of biomass into a portfolio of marketable biobased products (food and feed ingredients, chemicals, materials, fuels, energy, minerals, CO₂) and bioenergy (fuels, power, heat)
Building materials

Insulation

Modified wood

Biofuel

Recent developments

Bioplastics

Compostable packaging

Natural fibre composites

Green plasticisers

Building materials

Paints, glues, coatings, inks, dyes

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How can bio-cascading and biorefining prevent the production of residues or wastes

- more efficient use of biomass through biorefinery, which avoids competition for space and gives better resource use efficiency
- biocascading ensures that materials can be kept in the economy for longer, and the final step can deliver renewable energy
- biorefining can upgrade side streams into usable molecules that can form the basis for the plastics circle
Example: Plastics

• in 2050 use 100% renewable (recycled or biobased) plastics wherever technically possible

• design for end-of-life options (e.g. end-of-life due to quality loss)

• use plastics as efficiently as possible to avoid “leakages”

• large scale use of recycled feedstock and biobased feedstock.

• biodegradability when it has an additional value for the circular economy (end-of-life, marine litter)
Can we make all plastics from biomass?

Green building blocks for biobased plastics

Paulien F. H. Harmsen, Martijn M. Hackmann and Harriëtte L. Bos, Wageningen UR-FBR, the Netherlands

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Biofuels Bioprod Bioref (2014)

Demand versus supply

- World consumption of (fossil) plastics: 350 Mtonne/year, expected to grow

- World consumption bioplastics: 1.7 Mtonne/year, expected to grow

- Global Biomass supply: 11.4 Gtonne/year dry matter

- At an efficiency of 50% (2 kg dry matter biomass for 1 kg plastic), plastic feedstock demand is 6% of supply, if all fossil plastics were replaced
Reasons for a shift towards biobased plastics

1. Responding to increasing material demand and price volatility

2. All plastics age and become increasingly less usable over time
   • this implies that “refilling the system”, always ought to be done from a renewable source (not biodegradable!), this could be biomass or direct CO₂ conversion to chemicals
   • biobased ≠ biodegradable! Biodegradable materials should only be used when they have clear advantages

Reference: Ellen MacArthur (2014); Annevelink & Bos
What are the barriers for a CE?

- current levels of resource pricing; no level-playing field for the bioeconomy
- lack of sufficient incentives due to the insufficient internalization of externalities
- insufficient waste separation at source
- too complicated products with too many materials make recycling more difficult
- insufficient investment in recycling and recovery infrastructure, innovation and technologies
Role IEA Bioenergy Tasks (1)

- Analyse and disseminate scientifically sound knowledge on global sustainable biomass availability and sourcing options
- Advising on the need for a level-playing policy field for sustainable biomass production and use in a CE
- Develop and promote use of internalization of externalities ($\text{CO}_2$-price)
- Promote industrial symbiosis for full sustainable biomass use
- Promote biocascading and biorefining as methodologies for optimal sustainable biomass use
Role IEA Bioenergy Tasks (2)

• Promote advanced biofuels and bioenergy as integral links in sustainable biomass valorisation strategies
• Promote the use of the words biomass residues/co-products rather than wastes to emphasise their role as raw materials
• Contribute to monitoring progress towards a CE (incl. BE, BbE)
• To check the distribution of biomass over consumption (food, energy, etc.), products/materials that have an end-of-life (wear/break-down) and products that can be re-used in existing or new form
Thank you for your attention

www.iea-bioenergy.task42-biorefineries.com

Contact Details

Harriette.bos@wur.nl
Bert.annevelink@wur.nl
Rene.vanree@wur.nl