By 2050 biofuels provide 27% of total transport fuel, and avoid around 2.1 Gt CO₂ emissions per year when produced sustainably.

To meet this vision, the most cost and GHG efficient biofuels will be needed including considerable amounts of advanced biofuels.

Commercial deployment of advanced biofuels will require further substantial research, development and demonstration, as well as deployment investment.

Support policies should incentivise the most efficient biofuels in terms of overall green-house gas performance, and be backed by a strong policy framework which ensures that food-security and biodiversity are not compromised and that social impacts are positive.

This roadmap requires around 65 EJ of biofuel feedstock in 2050, occupying around 100 Mha. With a sound policy framework in place, it should be possible to source the required biomass from residues and wastes, along with sustainably grown energy crops.

Trade in biomass and biofuels will become increasingly important to supply biomass from biomass-rich regions to areas with high production and/or consumption levels and can help trigger investments in certain regions.

Increasing scale and efficiency improvements will reduce biofuel production costs. The competitive position of biofuels will depend on a number of factors. Most biofuels are competitive by 2030, except when their production costs are strongly coupled to oil prices. In the longer term, the marginal savings or costs of deploying biofuels are a very small percentage of overall fuel costs.
Global map of biofuel consumption

Key actions over the next 10 years

This roadmap suggests following key actions should be undertaken over the next few years:

- Create a stable, long-term policy framework for biofuels to increase investor confidence and allow for the sustainable expansion of biofuel production.
- Ensure sustained funding and support mechanisms for promising advanced biofuel technologies to reach commercial production within the next 10 years.
- Introduce mandatory sustainability requirements based on internationally aligned certification schemes in order to reduce land use change and ensure biofuels’ sustainability.
- Link financial support schemes to the sustainable performance of biofuels to ensure >50% lifecycle GHG emission savings for all biofuels.
- Incentivise use of residues and wastes as biofuel feedstock.
- Increase research efforts on feedstocks and land availability mapping to identify the most promising feedstock types and locations for future scale-up.
- Reduce and eventually abolish tariffs and other trade barriers to enhance sustainable biomass and biofuel trade.
- Support international collaboration on capacity building and technology transfer to promote the adoption of sustainable biofuel production globally.

Demand for biofuels (left) and resulting land demand (right)

To meet the feedstock demand required in this roadmap, around 100 Mha of land (mainly pasture and unused land) are needed. In addition, around 1 billion tons of residues and waste biomass is needed, mainly for advanced biofuel production.

Production costs (USD/litre gasoline equivalent)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2030</th>
<th>2050</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum gas</td>
<td>0.54</td>
<td>0.72</td>
<td>0.82</td>
<td>0.81</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Ethanol - conventional</td>
<td>0.70 - 0.75</td>
<td>0.70 - 0.80</td>
<td>0.65 - 0.85</td>
<td>0.65 - 0.85</td>
<td>0.65 - 0.85</td>
<td></td>
</tr>
<tr>
<td>Ethanol - cane</td>
<td>0.60 - 0.70</td>
<td>0.60 - 0.70</td>
<td>0.60 - 0.70</td>
<td>0.60 - 0.70</td>
<td>0.60 - 0.75</td>
<td></td>
</tr>
<tr>
<td>Ethanol - cellulose</td>
<td>1.05 - 1.15</td>
<td>0.90 - 1.05</td>
<td>0.80 - 0.95</td>
<td>0.80 - 0.90</td>
<td>0.75 - 0.90</td>
<td></td>
</tr>
<tr>
<td>Biodiesel - conventional</td>
<td>0.95 - 1.05</td>
<td>0.95 - 1.10</td>
<td>0.95 - 1.15</td>
<td>0.95 - 1.15</td>
<td>0.95 - 1.15</td>
<td></td>
</tr>
<tr>
<td>Biodiesel - advanced (BtL)</td>
<td>1.05 - 1.15</td>
<td>0.90 - 1.05</td>
<td>0.80 - 1.00</td>
<td>0.75 - 0.90</td>
<td>0.75 - 0.85</td>
<td></td>
</tr>
<tr>
<td>bio-synthetic gas</td>
<td>0.90 - 1.05</td>
<td>0.85 - 0.95</td>
<td>0.75 - 0.90</td>
<td>0.70 - 0.85</td>
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Note: Costs reflect global averages. Ranges result from the strength of correlation between oil price and feedstock costs and capital costs. Lower production costs result from a weak correlation, whereas higher costs result from a stronger impact of oil prices on feedstocks (20% impact) and capital costs.
Key actions over the next 10 years

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To meet the feedstock demand required in this roadmap, around 100 Mha of land (mainly pasture and unused land) are needed. In addition, around 1 billion tons of residues and waste biomass is needed, mainly for advanced biofuel production. If more residues were used, land demand could be reduced significantly.

- A sound policy framework is needed, including internationally aligned certification schemes, to promote the use of residues and wastes, along with sustainable production of energy crops and avoid competition for land and feedstocks with growing food demand and fibre production.
- Enhanced biomass and biofuel trade will play a crucial role to supply biomass and/or biofuels from biomass-rich regions to areas with high production and/or consumption levels.

Production costs (USD/litre gasoline equivalent)

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Biofuels for transport roadmap milestones

2010

Introduction of advanced biofuels
Support assessment of sustainable land and feedstock potential
Adopt medium term targets for biofuel uptake
Reduce tariffs and other barriers to enhance biofuel trade

2020

Incentive biofuels based on lifecycle greenhouse gas (GHG) performance
Support updating of biomass potential analysis and RD&D of new feedstock varieties
Monitoring of progress (deployment and sustainability) against targets
Further improve framework for international biomass and biofuel trade

2030

Adjust incentives to evolving market conditions
Further alignment of different certification schemes between sectors and regions
Review and refine GHG reduction targets for biofuels
Align biofuel sustainability policies with agricultural, forestry and rural development policies

2040

Continued reduction of capital costs and improved conversion efficiency
Establish internationally agreed sustainability indicators
Further improve framework for international biomass and biofuel trade
Further improve framework for international biomass and biofuel trade

2050

Biofuels for transport roadmap milestones

Stakeholders:
- Government
- Industry
- NGOs/IGOs

Biofuels for transport roadmap milestones

International Energy Agency www.iea.org/roadmaps

BIOFUELS FOR TRANSPORT ROADMAP

Biofuels contribution to emission reductions in the transport sector

2010

Biofuel use 3.0 EJ Share of total transport fuel 5.0 %

2020

Biofuel use 5.0 EJ Share of total transport fuel 10.0 %

2030

Biofuel use 10.0 EJ Share of total transport fuel 16.5 %

2040

Biofuel use 16.5 EJ Share of total transport fuel 27.2 %

2050

Baseline transport emissions 2.1 Gt Alternative fuels 31.5 EJ Vehicle efficiency 27.2 %

Key findings

- By 2050 biofuels provide 27% of total transport fuel, and avoid around 2.1 Gt CO₂ emissions per year when produced sustainably.
- To meet this vision, the most cost and GHG efficient biofuels will be needed including considerable amounts of advanced biofuels.
- Commercial deployment of advanced biofuels will require further substantial research, development and demonstration, as well as deployment investment.
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