Briefing
June 2017

European Parliament

Advanced biofuels
Technologies and EU policy

SUMMARY

Road transport remains significantly more dependent on fossil fuels than other sectors. In the early 2000s, biofuels appeared as a way to reduce this dependency and to cut greenhouse gas emissions. However, when greenhouse gas emission reductions through using conventional biofuels were called into question because of the indirect effects involved, advanced biofuels emerged as an alternative.

Although the advanced biofuels sector has been facing technological challenges and economic difficulties, global advanced biofuels production has been forecast to double between 2013 and 2020, with the largest (planned and in operation) production capacity located in Europe. In 2016, most advanced biofuels production routes were at prototype or demonstration stage, with two being considered ready for commercialisation.

Advanced biofuels may offer a series of opportunities, in particular as regards greenhouse gas emission savings and energy security, but also pose a series of challenges, in particular as regards sustainability.

EU policy support for biofuels started in 2003, but has since been shifting away from conventional biofuels. Since 2015, it has explicitly supported advanced biofuels. A legislative proposal on the regulatory framework beyond 2020, put forward by the European Commission in 2016, seeks to strengthen this support. In addition, funding opportunities are being provided through various programmes.

In this briefing:

EPRS | European Parliamentary Research Service
Author: Didier Bourguignon, with Thijs Vandenbussche
Members' Research Service
PE 603.972

Glossary

Advanced biofuels (also referred to as second- and third-generation biofuels): biofuels that do not compete directly with food and feed crops. Second-generation biofuels may be derived from waste and agricultural residues (such as wheat straw and municipal waste) or non-food crops (such as miscanthus and short-rotation coppice). Third-generation biofuels generally refer to biofuel production routes which are further away from commercialisation (for instance biofuels from algae or hydrogen from biomass).

Biofuels: liquid fuels derived from biomass, used mainly in transport; the most common biofuels are bioethanol (a substitute for petrol) and biodiesel (a substitute for diesel).

Conventional biofuels (also called first-generation biofuels): biofuels derived from crops, which can also be used for food and feed (such as sugar, starch and vegetable oils).

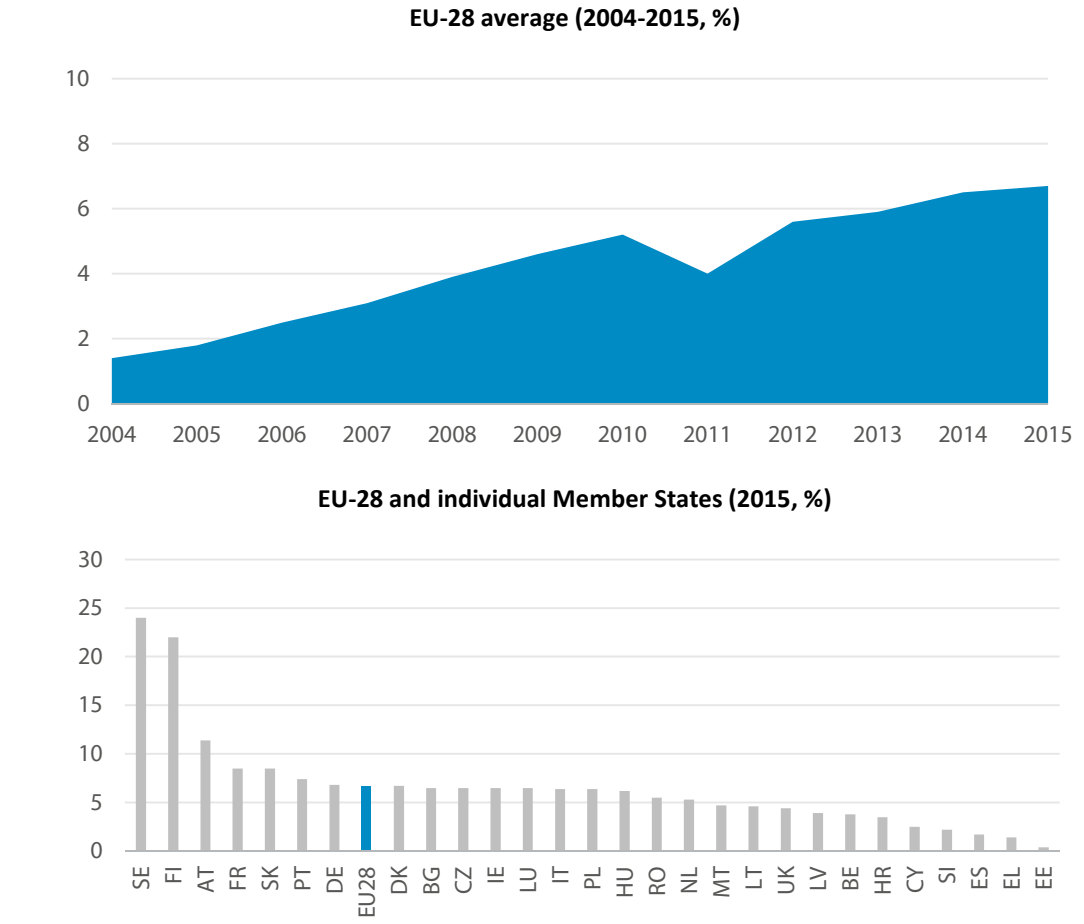
Feedstock: (plant) material used to produce biofuels through various conversion processes.

Indirect land use change (ILUC): the displacement of agricultural production (food, feed) or forest production (fibre, timber) to previously uncultivated areas, such as peatland, grasslands or forested lands, induced by the cultivation of biomass feedstocks.

Background

Although the share of renewable energy in the EU's transport sector has grown in recent decades, 93 % of energy used by this sector in 2015 came from non-renewable sources (fossil fuels), with large variations among Member States (see second graph in Figure 1).

Figure 1 – Share of renewable energy in transport in the European Union



Data source: Eurostat, 2017.

In the early 2000s, **biofuels** emerged as a way to reduce dependency on fossil fuels and to cut greenhouse gas emissions without requiring substantial new investments in infrastructure. Current combustion engines can burn fuels containing a low share of biofuels mixed with conventional fossil fuels. A 2013 study for the European Commission indicates that by 2020, 95 % of passenger cars and vans would be compatible with E10, a fuel with about 10 % biofuel content. However, greenhouse gas savings from the use of conventional biofuels have been called into question because of the indirect land use change (ILUC) such biofuels may cause.[1] Advanced biofuels have subsequently emerged as an alternative to conventional ones for the purpose of mixing with fossil fuels.

Other alternatives for decarbonising road transport include hydrogen and electric vehicles capable of producing a lower environmental impact (including greenhouse gas emissions) than internal combustion-engine vehicles over their whole lifecycle. However, switching to hydrogen or electricity requires fleet replacement and the roll-out of new infrastructure.[2]

Market and technologies

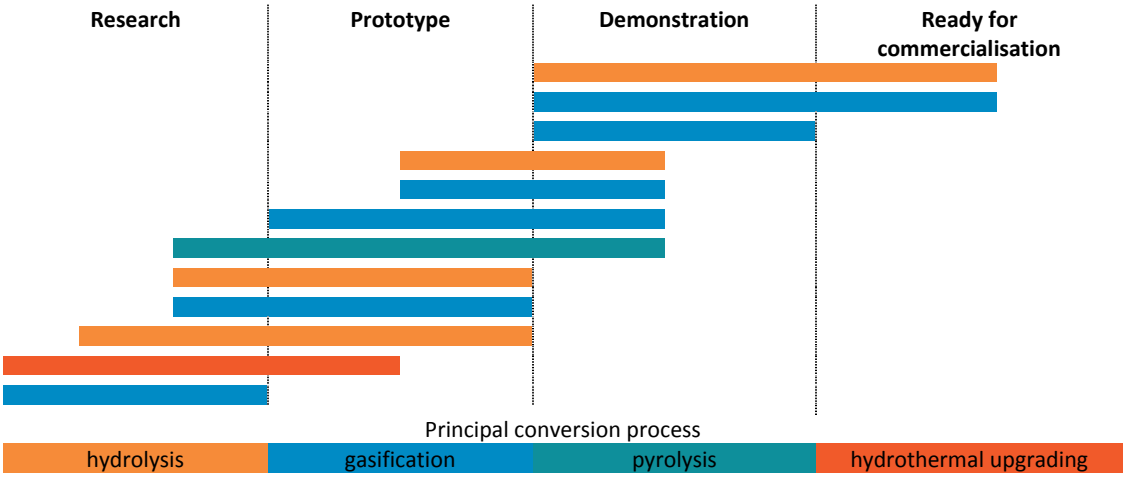
The **advanced biofuels sector** has been facing technological and economic challenges that are also confronting the conventional biofuels industry. These challenges have been caused, among other things, by a difficult economic environment, falling oil prices and investment uncertainty due to changing policies. However, a 2014 report by the International Energy Agency indicates that global advanced biofuels operating capacity is set to double from 2 billion litres in 2013 to 4 billion litres in 2020, while global biofuels production would grow from 115 to 139 billion litres over the same period. A 2016 report by Lux Research, a US consultancy, considers that advanced biofuels are starting to push first-generation ones aside, given that advanced biofuels now account for over half of all newly installed biofuel production capacity. The International Renewable Energy Agency (IRENA) notes in a 2016 report that while Europe has fewer advanced biofuels plants than North America,[3] it has the largest (planned and in operation) production capacity worldwide in terms of volume, although many European projects have been delayed as a result of policy uncertainty.

Policy and market support

Government policy can promote advanced biofuels in a number of ways, including through the provision of a blending mandate and support for research and development. A 2015 report by the International Energy Agency suggests that to be competitive, advanced biofuels may require an oil price of USD 100/barrel. A 2016 report by the Centre for European Policy Studies estimates that advanced biofuels could be competitive if the full life-cycle of fuels is taken into account.

Advanced biofuels can be produced from a number of **feedstocks**, including agricultural and forest residues (such as straw and sawdust), residues from industrial processes (such as crude glycerine or palm oil mill effluent), non-food energy crops (such as rapidly growing grasses like switchgrass and miscanthus, or short rotation tree species like poplar and eucalyptus), and algae. These feedstocks can be converted through different **technologies** (hydrolysis, pyrolysis, gasification and hydrothermal upgrading) to produce various biofuels, such as biodiesel, bioethanol, methanol or butanol.[4] In 2016, most advanced biofuel production routes were at prototype or demonstration stage, with two – ethanol from dry plant matter and methanol produced through gasification – being considered ready for commercialisation (see Figure 2).

Figure 2 – Commercialisation status of selected advanced biofuels production routes



Data source: IRENA, 2016.

Opportunities and challenges

Advanced biofuels may offer a series of **opportunities**, in particular as regards greenhouse gas emission savings and energy security. Unlike their conventional predecessors, advanced biofuels do not directly influence food and feed prices, and therefore pose a significantly lower risk of indirect emissions caused by land conversion. A study published in 2014 by environmental NGOs and advanced biofuels companies suggests that all the wastes and residues that are sustainably available in the EU have the technical potential to supply 16 % of road transport fuel in 2030, thereby generating greenhouse gas savings of more than 60 %. The study argues that if this resource is used to its full potential, up to €15 billion of additional revenue could flow into the rural economy annually, and up to 300 000 additional jobs could be created by 2030. Beyond road transport, advanced biofuels could also contribute to decarbonising aviation and waterborne transport.

However, advanced biofuels may also pose a series of **challenges**, in particular as regards sustainability. Large-scale use of residues (such as wood chips) for biofuel production could create competition with other uses, such as bioplastics manufacturing. The removal of agricultural and forest residues (typically straw and branches, stumps or roots left after felling) can have negative impacts on soil properties, with consequences on biodiversity and ecosystems. As a result, it is important to consider the full impact of advanced biofuels, in particular the complete lifecycle of greenhouse gas emissions, as well as the indirect environmental, social and economic impacts.[5]

EU policy on biofuels

In 2003, the EU introduced a blending target in its Biofuels Directive, involving the achievement of a 5.75 % share of biofuels in the EU's transport sector by 2010. In 2009, as part of the 2020 climate and energy strategy, the Renewable Energy Directive introduced a 10 % renewable energy target (essentially biofuels) in the transport sector, to be reached by 2020. At the same time, an amendment to the Fuel Quality Directive introduced a mandatory target, involving a 6 % reduction, by 2020, in the greenhouse-gas intensity of fuels used in road transport and non-road mobile machinery.

Following an intense debate on indirect land use change, Directive 2015/1513 amended the Renewable Energy Directive and the Fuel Quality Directive to introduce new incentives for advanced biofuels. In particular, the 2015 directive limits to 7 % the

contribution of conventional biofuels[6] to the overall target of a 10 % share of renewable energy in transport by 2020. It also sets a non-binding target of 0.5 % for advanced biofuels,[7] the contribution of which towards the 10 % target should be counted as twice their energy content.

In recent years, the European Commission has repeatedly indicated that public support for food-based biofuels should be phased out, and that transport decarbonisation should rather be based on electric vehicles and advanced biofuels.[8] In November 2016, the Commission put forward a legislative proposal modifying the Renewable Energy Directive and establishing a post-2020 policy with a view, among other things, to creating regulatory certainty conducive to private investments. The proposal requires Member States to progressively reduce the share of conventional biofuels in the energy mix used in road and rail transport, from 7 % in 2021 to 3.8 % in 2030. It also requires Member States to meet targets for advanced biofuels derived from specific feedstocks[9] (0.5 % of transport fuels in 2021, increasing annually to at least 3.6 % by 2030) and targets for advanced biofuels, renewable electricity and other sources[10] (1.5 % of transport fuels in 2021, annually increasing to at least 6.8 % by 2030). The use of advanced biofuels in the aviation and maritime sectors would be further supported, with their contribution counting for 20 % more than their actual energy content.

EU funding for advanced biofuels

The **Horizon 2020** framework programme for research provides some funding for advanced biofuels. The programme's 'societal challenge 3' on 'Secure, clean and efficient energy', which has a budget of €5.93 billion for the 2014-2020 period, funds several calls related to advanced biofuels. Horizon 2020's 'societal challenge 2' on 'Food security, sustainable agriculture and forestry, marine, maritime and inland water research and the bioeconomy', which has a budget of €3.85 billion for the 2014-2020 period, funds in particular the Bio-based industries (BBI) public-private partnership (€1 billion, topped up by €2.7 billion in private investment). This project is aimed at developing bio-refining technologies to turn waste and residues into bio-based products, materials and fuels. **Other support** includes the European industrial bioenergy initiative (EIBI) (2010-2017), funded from EU and Member-State research programmes, which aims to build and operate demonstration or flagship plants for innovative bioenergy value chains. Besides, the 2013-2020 New Entrants' Reserve innovation fund (NER300), fed from the sale of greenhouse gas-emission allowances under the EU Emissions Trading System and worth €2.1 billion, has provided financial support to several advanced biofuels projects.

Stakeholders' views

A coalition of trade associations, including Copa-Cogeca (representing European farmers and agri-cooperatives), the European Biodiesel Board, ePure (representing bioethanol producers), the European Oilseed Alliance and Fediol (representing vegetable oil producers), has warned against lowering the target for first-generation biofuels below 7 %, as this would have negative consequences in particular on agricultural markets, jobs in rural areas, energy security and the environment.

Leaders of Sustainable Biofuels, a business association promoting advanced biofuels, supports separate binding targets for advanced biofuels as a way to create a stable and predictable business environment, providing stronger incentives for investing in advanced biofuels production capacity.

Transport and Environment, an environmental NGO, has criticised the European Commission's lack of ambition in phasing out first-generation biofuels, noting that the 3.8 % target barely reduces the current 4.9 % market share of conventional biofuels at EU level.

Main references

Bourguignon, D., EU biofuels policy: Dealing with indirect land use change, EPRS, European Parliament, 2015.

International Renewable Energy Agency, Innovation Outlook, Advanced Liquid Biofuels, 2016.

Marelli, L. et al., The impact of biofuels on transport and the environment, and their connection with agricultural development in Europe, Policy Department B, European Parliament, 2015.

Wilson, A., Promoting renewable energy sources in the EU after 2020, EPRS, European Parliament, 2017.

Endnotes

1 For more details, see L. Marelli et al., The impact of biofuels on transport and the environment, and their connection with agricultural development in Europe, Policy Department B, European Parliament, 2015, p.33.

2 The EU supports the deployment of alternative fuels infrastructure through Directive 2014/94/EU.

3 The report indicates that nine commercial plants and seven demonstration plants are planned or in operation in Europe, while 12 commercial and 11 demonstration plants are planned or in operation in North America.

4 For an overview of advanced biofuels production routes, see IRENA, Innovation Outlook, Advanced Liquid Biofuels, pp.19-22.

5 A 2016 report by the Institute for European Environmental Policy proposes sustainability criteria for biofuels derived from 'land and non-land based feedstocks'.

6 More specifically 'biofuels produced from cereal and other starch-rich crops, sugars and oil crops and from crops grown as main crops primarily for energy purposes on agricultural land'.

7 Derived from the following feedstocks: algae if cultivated on land; biomass fraction of municipal or industrial waste (under conditions); bio-waste from households (if separately collected); straw; animal manure and sewage sludge; palm oil mill effluent and empty palm fruit bunches; tall oil pitch; crude glycerine; bagasse; grape marcs and wine lees; nut shells; husks; cobs cleaned of kernels of corn; biomass fraction of wastes and residues from forestry and forest-based industries; other non-food cellulosic material; other ligno-cellulosic material except saw logs and veneer logs; substances of non-biological origin; carbon capture and bacteria (provided energy sources are renewable); used cooking oil; animal fats.

8 See for instance the 2014 communication on the climate and energy framework for 2020-2030 and the strategy for low-emission mobility from July 2016.

9 Derived from the following feedstocks: algae if cultivated on land; biomass fraction of municipal or industrial waste (under conditions); bio-waste from households (if separately collected); straw; animal manure and sewage sludge; palm oil mill effluent and empty palm fruit bunches; tall oil and tall oil pitch; crude glycerine; bagasse; grape marcs and wine lees; nut shells; husks; cobs cleaned of kernels of corn; biomass fraction of wastes and residues from forestry and forest-based industries; other non-food cellulosic material; other ligno-cellulosic material except saw logs and veneer logs.

10 Other sources include biofuels derived from used cooking oil, animal fats and molasses; renewable fuels of non-biological origin; and waste-based fossil fuels.

Disclaimer and Copyright

eprs@ep.europa.eu
http://www.eprs.ep.parl.union.eu (intranet)
http://www.europarl.europa.eu/thinktank (internet)
http://epthinktank.eu (blog)