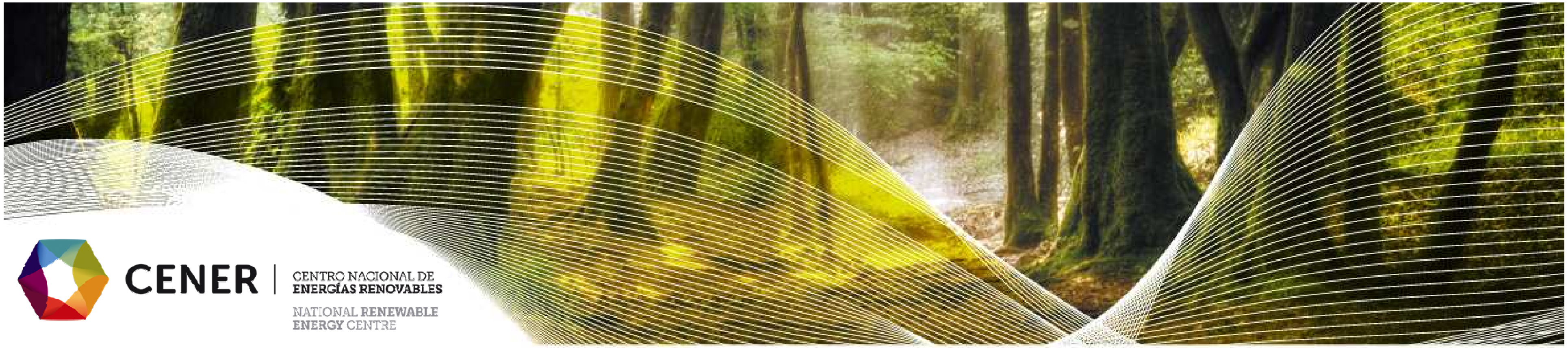

Advanced Biofuels for Transport

ENERMASS Bioenergy School

January 21st

enermass.org

Table of Contents

- CENER & Biomass Department
- Advanced Biofuels
  - Introduction
  - Technologies
  - Specifications & Performance
  - Sustainability Requirements
  - Conclusions
- The Second Generation Biofuels Center (CB2G)

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NATIONAL RENEWABLE ENERGY CENTRE

CENER & Biomass Department

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Introduction: CENER

Activities	Applied research, technology transfer….
	Assessment, approval, accreditation and certification services.
Areas	Wind
	Biomass
	Solar Photovoltaic
	Solar Thermal
	Energy Grid Integration
	Energy in Building

Introduction: CENER

Headquarters
Sarriguren

Wind Test Laboratory
Sangüesa

Biofuels plant
Aoiz

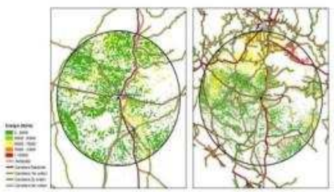
Experimental Wind Farm
Alaiz

Microgrid, Sangüesa

Offices:
Sevilla

Introduction CENER: Biomass Department Main Activities

Activities & Strategic research lines



Biomass Resources Assessment, Production and Sustainable Management:

Biomass resources assessment. Supply & logistics studies, GHG & Energy balances, Sustainability studies

Biofuels:

Solid Biofuels: Densification & Energetic characterisation

Liquid Biofuels: Bioethanol: & Biodiesel : Process Development; Production Technologies Assessment,

Lignocellulosic ethanol pretreatment,

Microalgae extraction & valorisation.

Thermal chemical processes:

Solid Bioenergy carriers by means of Torrefaction

Gasification and gas-cleaning technologies.

Development of second-generation biofuels via thermo chemical process.

Advanced Biofuels

Introduction

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Introduction

- Transport fuel supply today is dominated by oil which has proven reserves that are expected to last around 40 years [1,2].
- The combustion of mineral oil derived fuels gives rise to CO2 emissions and they have increased by 24% from 1990 to 2008, representing 19.5% of total European Union (EU) greenhouse gas emissions [3].
- Decarbonising transport is a core theme of the EU 2020 strategy and of the common transport policy. The long-term perspective for transport in Europe has been laid out in the Commission Communication on the Future of Transport of 2009 . The long-term objective of the European Union on CO2 emissions is an overall reduction of 80-95% by 2050 with respect to the 1990 level [4,5,6].
    - **Decarbonisation of transport** and the **substitution of oil as transport fuel** therefore have both the same time horizon of 2050.
    - **Improvement of transport efficiency** and **management of transport volumes** are necessary to support the reduction of CO2 emissions while fossil fuels still dominate, and to enable finite renewable resources to meet the full energy demand from transport in the long term

[1] European Commission, EU Energy and Transport in Figures, 2010 http://ec.europa.eu/transport/publications/statistics/statistics_en.htm

[2] BP Statistical Review of World Energy, June 2010

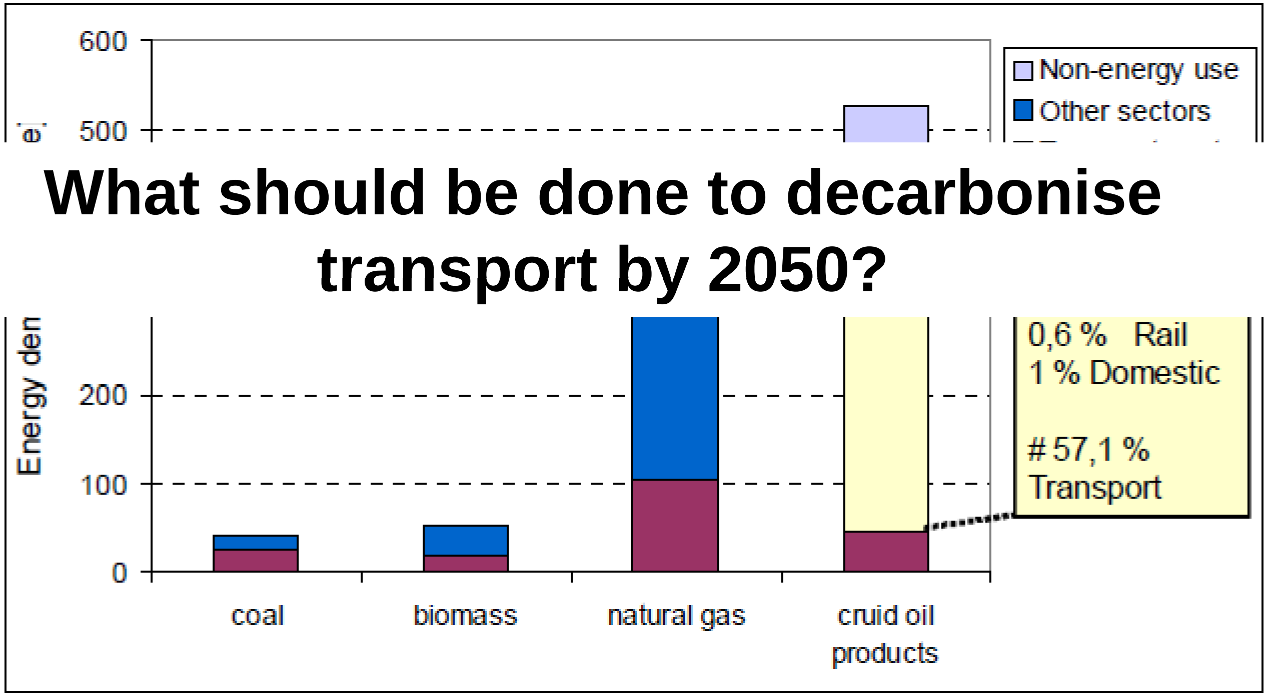
[3] Future Transport Fuels. Report of the European Expert Group on Future Transport Fuels. January 2011

[4] Conclusions of Council, October 2009

[5] Communication from the Commission: Europe 2020. A strategy for smart, sustainable and inclusive growth. COM (2010)2020, Brussels, 3.3.2010

[6] Communication from the Commission: A sustainable future for transport: Towards an integrated, technology-led and user friendly system, COM (2009)279, Brussels, 17.6.2009

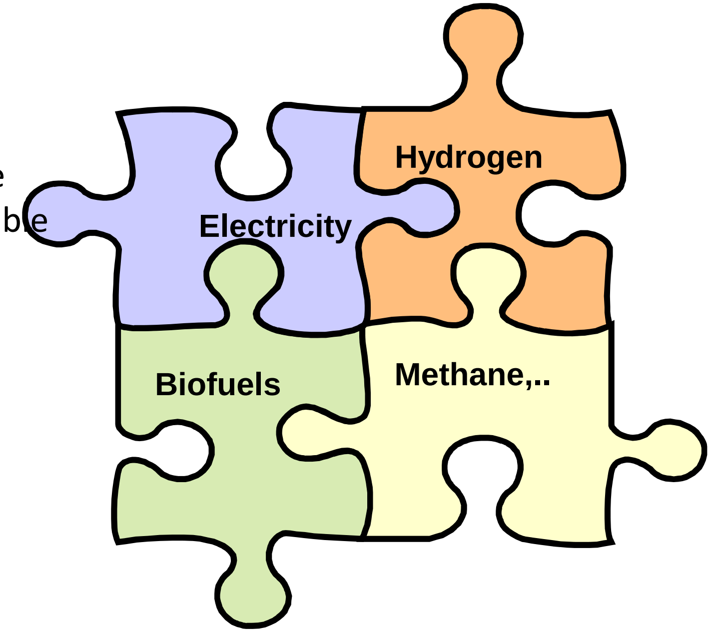
Oil dependency of transport sector in the EU



What should be done to decarbonise transport by 2050?

Share of transport in energy demand (Source: Report of the European Expert Group on Future Transport Fuels, 2011, built out of figures provided by IEA website (http://www.iea.org/). EU27, 2007)

- **Alternative fuels** (electricity, hydrogen, **biofuels**, synthetic fuels, methane or LPG) will gradually become a much more significant part of the energy mix.
  - **No single substitution candidate** →Fuel demand and greenhouse gas challenges will most likely require the use of a great variety of primary energies. All sustainable fuels will be needed to resolve the expected supply-demand tensions.
  - Any new fuels should **demonstrate their availability, affordability and reliability** .
  - **Compatibility with existing fuels and vehicle technologies** would facilitate a smooth market transition and optimize the total system cost and customer acceptance.
  - **Political and regulatory support** will be decisive in the first phase to support the development and market entry of alternative fuels able to respond to the decarbonisation objectives.



- Among the alternative fuel options for substituting oil as energy source for propulsion in transport, **liquid biofuels** are one of the most promising ones.
- According to the IEA, the biofuels can play an important role in **reducing CO2** emissions in the transport sector, and **enhancing energy security[7]**.

What else?

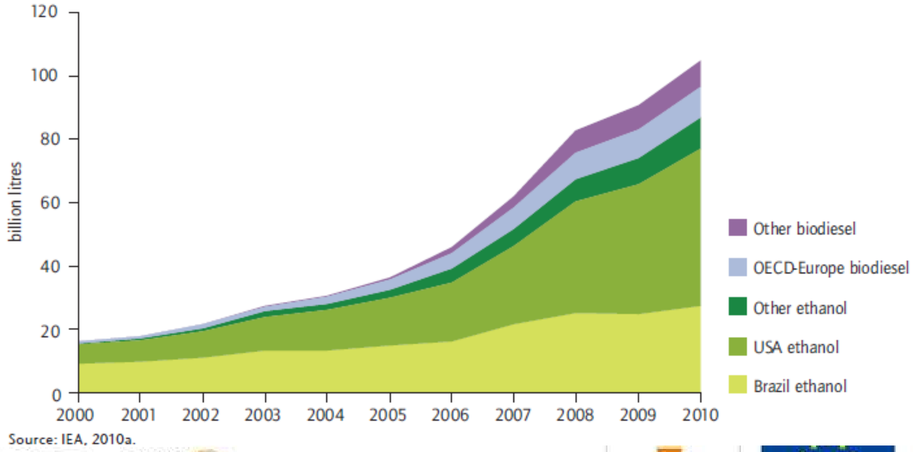
- They can be produced from a **wide variety of biomass feedstocks**
- They can **support economic development** by creating **new sources of income** in rural areas.
- They have a **high energy density**, especially in the case of synthetic / paraffinic fuels (HVO, BTL)
- They can be **technically used for propulsion in all transport modes** and can be used with **existing power train technologies**, for certain biofuels with minor technical modifications
- They are also **compatible with existing distribution and re-fuelling infrastructures** in various blending ratios depending on biofuel types.

[7] OECD/IEA, 2011. Technology Roadmap. Biofuels for transport.

Dominant commercial biofuels are the following ones:

- **Bioethanol** as a blending component in petrol (E5, E10) and in the form of ETBE (Ethyl *tert-butyl ether),* made from sugar-producing plants, such as sugar cane and sugar beets, or starch-producing plants like wheat and corn, and used in gasoline engines.
- **Biodiesel (esters, FAME)** as a blending component in diesel (B7), made from vegetable or animal oils in the chemical form of fatty acid methyl esters and used in diesel engines
- Also non-esterified **pure vegetable oil** has been in use to a limited extent, especially based on rapeseed oil. Contrary to biodiesel due to specific physical and biochemical properties, the use of pure vegetable oil requires some adaptations of the diesel engines.

Global biofuel production 2000-10
Source: IEA, 2010ª. Medium Term Oil and Gas Markets 2010, OECD/IEA, Paris.



Biofuels classification

Before→ Biofuels were comonly divided into 1st generation (1G) and 2nd generation (2G) biofuels. The distinction between these generations was based on the type of feedstocks used:

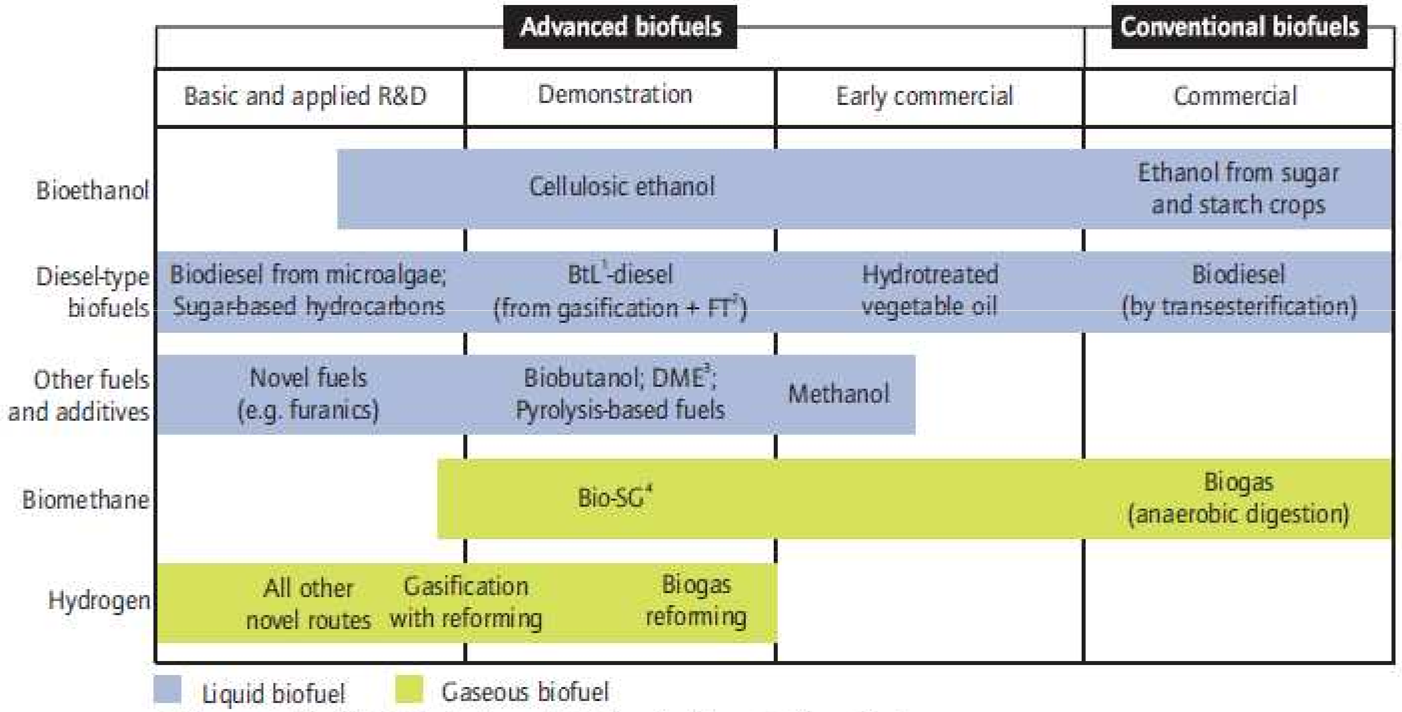
- 1G fuels are produced from **conventional crops** or **waste oils** and **fats**
- 2G fuels are produced from **waste streams** such as **municipal solid waste** (MSW) and **manure, residues** (straw, husks, shells, bagasse, forest residues), **lignocellulosic** (wood and grass), **energy crops**, **microbial oils** and **microalgae**

Now→ Biofuels are classified based on the maturity of the technology and other issues (sustainability and end-use)

Biofuels classification *(IEA/OCDE, 2011)*

- **Conventional biofuel technologies** include well-established processes that are already producing biofuels on a commercial scale. These biofuels, commonly referred to as first-generation, include sugar- and starch-based ethanol, oil-crop based biodiesel and straight vegetable oil, as well as biogas derived through anaerobic digestion. Typical feedstocks used in these processes include sugarcane and sugar beet, starch-bearing grains like corn and wheat, oil crops like rape (canola), soybean and oil palm, and in some cases animal fats and used cooking oils.
- **Advanced biofuel technologies** are conversion technologies which are still in the research and development (R&D), pilot or demonstration phase, commonly referred to as second- or third-generation. This category includes hydrotreated vegetable oil (HVO), which is based on animal fat and plant oil, as well as biofuels based on lignocellulosic biomass, such as cellulosic-ethanol, biomass-to-liquids (BtL)-diesel and bio-synthetic gas (bio-SG). The category also includes novel technologies that are mainly in the R&D and pilot stage, such as algae-based biofuels and the conversion of sugar into diesel-type biofuels using biological or chemical catalysts.

Commersialisation status of main biofuels technologies *(IEA/OCDE, 2011)*



1. Biomass-to-liquids; 2. Fischer-Tropsch; 3. Dimethylether; 4. Bio-synthetic gas.

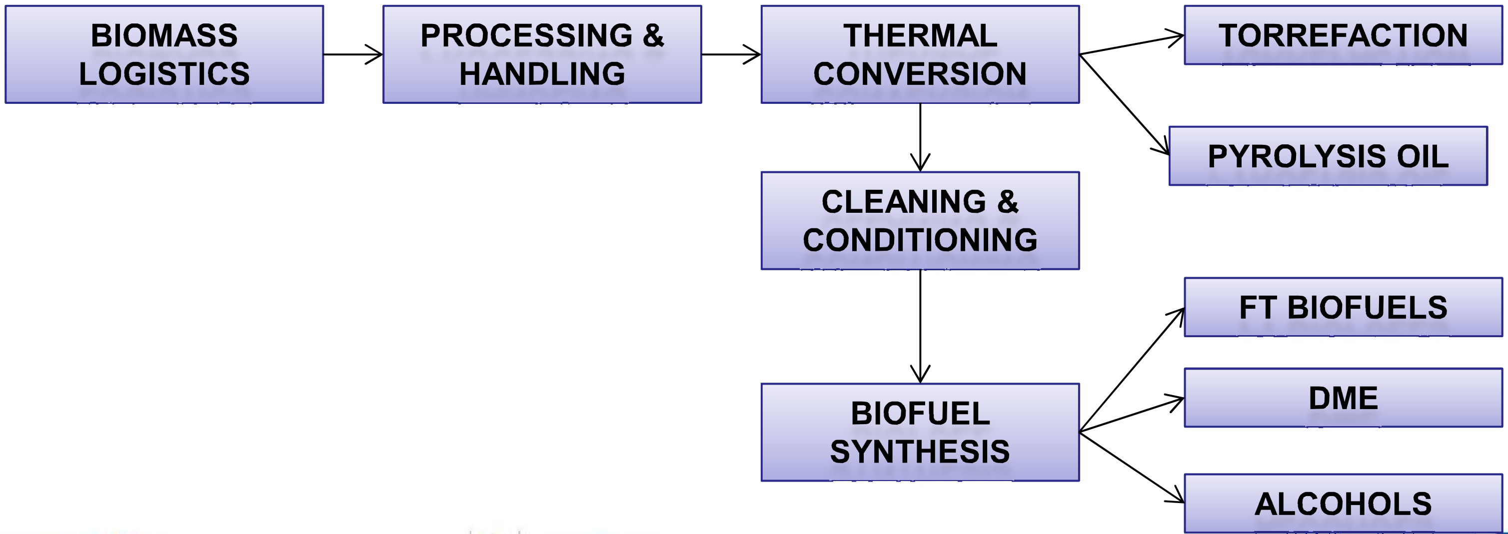
Feedstocks for advanced biofuels in Europe

- Advanced biofuels are produced from cellulosic materials (lignocellulosic feedstocks): eg. agricultural and forestry residues or wastes, or energy crops.
  - Energy crops: production of more fuel per unit of land used and require less chemical and energy input for production and harvesting → higher yield in terms of net GJ energy produced per hectare land used.
  - Grown on marginal land that does not compete directly with (or displace) land used for food crops.
- Sustainability issues:
  - Increasing demand for food in developing economies is also creating competition for land all over the world
  - Many availability assessments have been carried out covering a range of biomass feedstocks in Europe. It is clear that to meet the competing demands from different sectors, the efficiency of biomass supply chains in Europe needs to be maximised.
  - A wider range of biomass feedstocks need to be made available. At the same time, feedstock costs need to remain competitive, and sustainability criteria need to be met.

Advanced Biofuels technologies

Advanced conversion technologies based on <u>thermo-chemical processes</u>

In the thermo-chemical route, ligno-cellulosic biomass and solid waste go through a series of common steps including preliminary processing and handling, thermal conversion (gasification, torrefaction, pyrolysis) and purification to give synthesis gas (a mixture of hydrogen and carbon monoxide) or pyrolysis oil. The synthesis gas is then processed using different catalyst systems to give ethanol, higher alcohols, methanol, hydrocarbons/middle distillates, methane, ammonia or hydrogen.

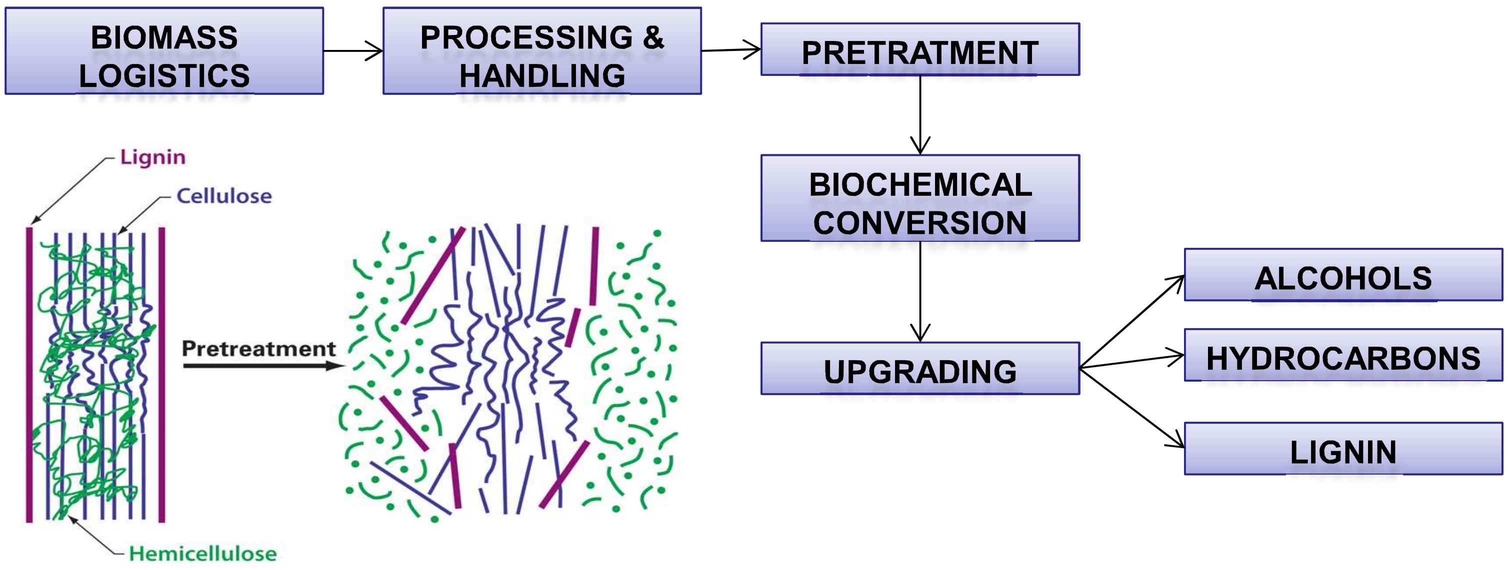


Advanced conversion technologies based on thermo-chemical processes

- Bioethanol and higher alcohols from biomass via gasification.
- Hydrotreated vegetable and animal oils (HVO) produced by oil refining type catalysts and processes that can be stand alone units or co-processing of bio and fossil feed in an oil refinery. Paraffinic diesel fuels and minor amounts of bio-gasoline are commercial HVO products. Aviation jet fuel (HRJ) and bio-LPG can be produced, too.
- Synthetic fuels / hydrocarbons from biomass via gasification (BTL, main markets: renewable transportation fuels for diesel and aviation engines).
- Bio-methane and other gaseous fuels from biomass via gasification (substituting natural gas and other gaseous fuels), which could also be liquefied.
- Bio-energy carriers from biomass via other thermo-chemical processes like pyrolysis, torrefaction etc. (main markets: fuels for heating, power generation or intermediate for further upgrading into transportation fuels.)

Advanced conversion technologies based on biological and chemical processes

- In the biochemical route, ethanol or higher alcohols (e.g. butanol) or hydrocarbons are produced by hydrolysis of cellulose and hemi-cellulose followed by fermentation of resulting sugars and upgrading.



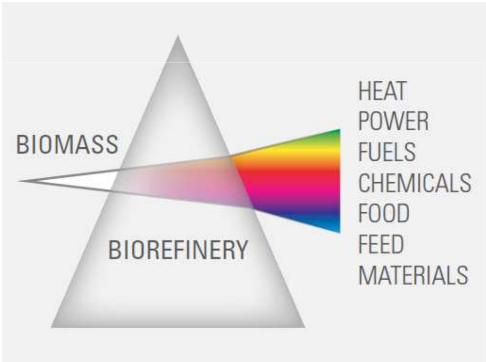
Advanced conversion technologies based on biological and chemical processes

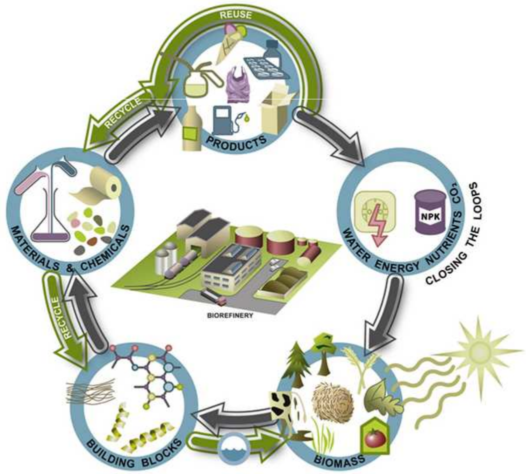
- Ethanol and higher alcohols from ligno-cellulosic biomass (main market: fuels as gasoline substitutes)
- Renewable hydrocarbons from sugars containing biomass via biological and/or chemical process (main markets: fuels for jet and diesel engines)
- Bio-energy carriers from CO_2 & sunlight through micro-organism based production (algae, bacteria etc.) and further upgrading to transportation fuels and valuable bio-products (main market: fuels for jet and diesel engines)

Biorefinery Concept

- The biorefinery concept is analogous to the basic concept of conventional oil refineries: to produce a variety of fuels and other products from a certain feedstock

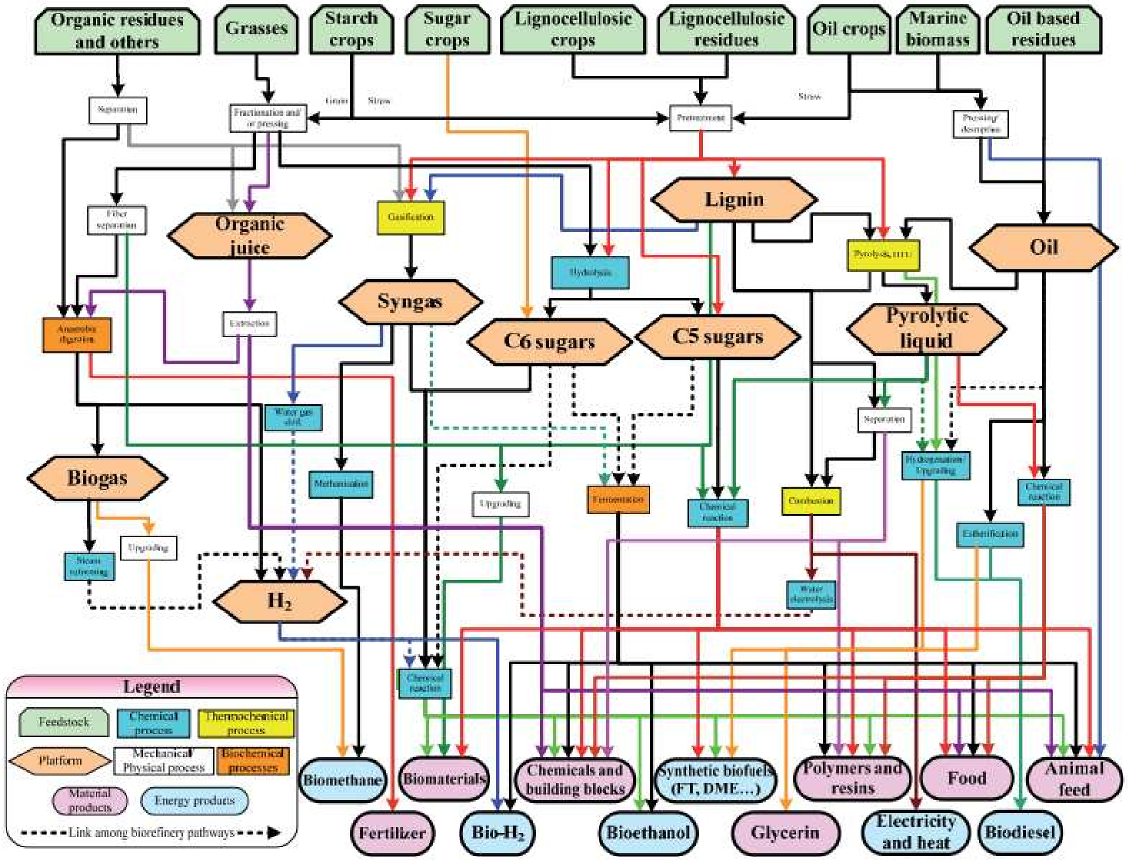
According to IEA Bioenergy Task 42, a biorefinery can be defined as 'the sustainable processing of biomass into a spectrum of marketable products and energy'. Therefore, this definition includes several systems that may exist as a whole concept, as for example a facility, a process, a plant, or even a cluster of facilities.





Biorefinery concept scheme
Fuente; JTI BRIDGE. Vision
http://bridge2020.eu/our-vision

An overview of biorefinery processes



Biorefineries: adding value to the sustainable utilisation of biomass. 2009 IEA Task 42.

Advanced Biofuels Projects in EU

Company	Headquarters	Plant Location(s)	Fuel type	Feedstock(s)
Abengoa	Spain	Salamanca	Ethanol	MSW
Beta Renewables	Italy	Crescentino, Italy	Ethanol	Wheat straw
Borregaard	Norway	Sarpsborg, Norway	Ethanol	Woody biomass
Clariant	Germany	Munich, Germany; Straubing, Germany	Ethanol	Agricultural residue
Shell (Raízen project)	The Netherlands	Sao Paulo State, Brazil	Ethanol	Sugarcane
Eni	Italy	Venice. Italy	green diesel/biodiesel	waste oils, possibly MSW and algae
Green Biologics	United Kingdom		Biobutanol	Lignocellulosic biomass
Inbicon/DONG	Denmark	Kalundborg, Denmark	Ethanol	Wheat straw
Naturally Scientific	United Kingdom	Nottingham, UK	Renewable oils	Sugars
Neste Oil	Finland	Singapore; Netherlands; Finland	Renewable diesel; jet fuel	Vegetable oils, waste residues
Statoil	Norway	Mestilla, Lithuania	Biodiesel	Rapeseed, cereals, sugar cane, algae (R&D)

Advanced Biofuel Market Report 2013- Capacity through 2016. Solecki et al. 2013.

Advanced Biofuels Projects in EU

Ethanol from MSW (Abengoa, Spain).

Ethanol from wheat straw (Chemtex , Italy).

Ethanol from wheat straw (Inibicon, Denmark)

Site for the Woodspirit Plant

Innitiatives to support commercialisation of advanced biofuels technology in Europe

- Numerous **FP7 projects** have made a significant contribution to the development of advanced biofuels technology in Europe.
- New funding programmes: HORIZON 2020, ERANET+ BEST, JTI OF BIO-INDUSTRIES, etc.
- The **European Industrial Bioenergy Initiative** (one of the industrial initiatives under the SET-Plan) aims to have the first commercial plants in operation by 2020 with a focus on advanced biofuels, which could meet 4% of EU transport energy needs, while strengthening EU technology leadership.
- The EIBI covers industrial bioenergy projects of European relevance, with the potential of large scale deployment along seven value chains (covering both biochemical and thermochemical technologies,). There are two main types of unit:
    - **Demonstration Units**, which prove the performance of an innovative advanced bioenergy technology and pave the way for
    - **Flagship Plants**, the first commercial-scale unit

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Advanced Biofuels

Specifications & Performance

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Advanced Biofuels → Alcohols & Ethers

- Ethanol, methanol
  - Liquid fuels (easy re-fuelling and storage)
  - High octane numbers enable blending with gasoline and usage in spark-ignition engines.
  - Even neat alcohols can be used in modified engines (FFV)
  - Ignition properties of alcohols are not suitable for diesel engines, but they can be used if engine or fuel is modified.
  - Phase separation problems with blends
  - Several fuel properties cause end-use problems (low energy content, high heat of vaporization, vapour pressure).
  - Methanol burns with an invisible flame, ethanol with a slightly luminous flame.

- Other alcohol-based options
  - Conversion of alcohols to ethers (e.g. MTBE,ETBE) improves end-use properties of alcohols.
  - Some heavier alcohols, such as **butanol**, provide better end-use performance than ethanol or methanol as gasoline components.

Advanced Biofuels →Diesel type

Hydrated oils-HVO

- New refinery-based technologies: hydrotreatment of oils and fats.
- Traditional feedstock, vegetable oils and animal fats converted into high-quality Biodiesel
- End-use properties resemble FT diesel.

Fischer-Tropsch diesel, BTL:

- Synthetic fuels: gasification or steam reforming to synthesis gas (H2, CO), and Fischer-Tropsch liquefaction
- From from biomass BTL (Bio-to-Liquid).
- The first commercial BTL plant is built in Germany

Properties of paraffinic fuels:

- Clean, high-quality fuels. Can be used as neat or blends with diesel.
- Very high cetane number, high hydrogen to carbon ratio, no aromatics or sulfur, no oxygen, low density

Advanced biofuels use

- **Traditionally use as blending components→ (Non drop-in) fuels**
- ➢ Gasoline vehicles→ Ethanol: E5, E10, ETBE
- Alcohols (ethanol) can be used either for blending into gasoline and, with some preconditions, as a fuel itself. Alcohol is characterized by:
  - high octane rating
  - oxygen contained in the alcohol enhances combustion to some extent
  - heat value 45.60% of that of gasoline
  - high latent heat of evaporation
  - poor lubricity
  - increases gasoline vapor pressure when used for low-level blending
  - polar compound, may cause corrosion
  - modified engines can run on neat or almost neat alcohol.
  - Ethanol is widely used for blending into gasoline. With ethanol concentrations up to some 10% normally **no vehicle modifications are needed**

Advanced biofuels use

- **Traditionally use as blending components→ (Non drop-in) fuels**

➢ Diesel vehicles→ FAME: B7
  - Using neat biodiesel may cause some problems, especially in cold conditions and might require some modifications to the engine, mainly changes in gaskets, hoses, and elastomers.
  - FAME is a strong solvent, and can dissolve deposits in the fuel systems of old vehicles, causing clogging of fuel filters.
  - Incompatibility with vehicles equipped with particle filters. In light-duty applications, the manufacturers periodically use late injection to increase exhaust temperature and facilitate particle filter regeneration.

- Special vehicles→ FFV: E0 to E85
  - True Flexible Fuel Vehicles (FFVs) can operate on any fuel from gasoline up to 85% alcohol.
  - The FFV system is requires a fuel detection system based on either a physical or virtual fuel sensor to determine fuel alcohol concentration.
  - The alcohol fuel also has to be taken into consideration in choosing materials for the fuel system.

Advanced biofuels use

- **Future: Drop-in fuels?**
  - According to DOE it refers to a blendstock that does not require substantialchanges in refining or distribution infrastructure. This means hydrocarbons (gasoline, diesel, and jet fuel blendstocks)
  - The key to being drop-in is that the overall final blended fuel product meets specifications
  - Drop-in diesel is the most interesting option because of the EU long-term heavy reliance on diesel fuel and its dependency on diesel imports, though the picture is different in the US where ethanol and other gasoline engine compatible fuels are the main option.

Synthetic fuels performance (FT Diesel)

- High quality fuels attractive for use in diesel engines.
- The FT diesel fuel has no sulfur, almost no aromatics, and a high cetane number. Provides excellent emission performance with reduced NOx and PM emissions.
- From an end-use point of view synthetic fuels are a convenient option as **no engine modifications are needed.**
- FT fuels can be used as a blending component or even as is (drop-in).
- In the latter case lubricity additives may be needed. Running on pure FT diesel engine power output can be reduced somewhat (5%) due to low fuel density. An engine can be run on 100% synthetic diesel with standard settings, and this will reduce NOx and PM emissions. Alternatively, at least in theory, the engine manufacturer could recalibrate the engine to give improved fuel efficiency at a given emission level.
- Vegetable oils and animal fats can be converted into a product resembling FT diesel using hydrogenation. Tailored synthetic fuels might be the only option to meet the fuel requirements of future advanced combustion systems
- Fischer-Tropsch can also render gasoline components

- **Advanced biofuels Roadmap to the EU to 2030**

Table 1: Summary of different components of the roadmap

Roadmap ingredients	Description
B7	• B7 remains the blend wall for FAME • FAME supply in EU27 grows within the B7 blend wall
E10	• E10 supply in EU27 grows with a coordinated effort as the E10 fleet justifies introduction in different countries • E10 becomes the protection grade when E20 is introduced in 2025, once sufficient tolerant vehicles are present in the market place
E20 or equivalent oxygenate level fuel (Butanol, ETBE blends)	• E20 homologated vehicles introduced from 2018; initial E20 tolerant vehicles as early as 2011 with all new vehicles E20 tolerant by 2016 • E5 fuel phased out as protection grade from 2025, when E20 fuel is introduced • E5 available at limited number of forecourts as specialist fuel for oldtimers • E10 becomes the protection grade in 2025 when E5 is phased out • Biocomponent could be supplied by ethanol, butanol or ETBE
Lignocellulosic drop-in gasoline	• The focus in EU for drop-in fuel will be on diesel drop-ins. Some drop-in gasoline products may be produced but preference will be given to diesel and jet fuel
Lignocellulosic drop-in diesel	• Lignocellulosic drop-in diesel production future focus for biofuel production in Europe
HVO/CHVO	• Existing drop-in fuel, limited by vegetable oil availability to 2030, but feedstock base could be extended by microbial and microalgal oils

E4Tech, 2013. A harmonised Auto-Fuel biofuel roadmap for theEU to 2030

Analysis of characteristics of biofuels components

Pathway ingredient	Fuel widely available today in Europe	No vehicle modification needed	Mass blend option	Refuelling infrastructure available now	Significant potential contribution to EU 2020 GHG targets	Significant potential to reduce EU 2030 GHG emissions
	G: Sold and widely available Y: Sold but not widely available R: Fuel not commercially available	G: None Y: Yes but not likely to be significant R: Significant	G: Yes Y: Starting to expand beyond niche areas R: Limited to niche areas	G: Infrastructure already exists Y: Some modification needed R: Significant modification needed	G: Yes R: Limited contribution based on ramp-up potential	G: Yes R: Limited contribution based on ramp-up potential
E10 or equivalent oxygenate blend wall	Y	G	G	G	G	G
E20 or equivalent oxygenate blend wall	R	Y	G	Y	R	G
E25/E30 or equivalent oxygenate blend wall	R	R	G	R	R	R
E85	Y	R	R	R	R	R
LC* gasoline drop-in	R	G	G	G	R	G
B7	G	G	G	G	G	G
B10-30	Y	R	R	R	R	R
ED95 in modified diesel HDVs	Y	R	R	R	R	R
LC* diesel drop-in	R	G	G	G	R	G
Hydrotreated/co-processed oils and fats	Y	G	G	G	G	G
Biogas	Y	R	Y	R	G	G

*lignocellulosic

E4Tech, 2013. A harmonised Auto-Fuel biofuel roadmap for theEU to 2030

European Standards (European Comitee for Standarization)

- EN 15376: 2011. Automotive fuels - Ethanol as a blending component for petrol - Requirements and test methods
- EN 14214:2012+ A1:2014. Liquid petroleum products - Fatty acid methyl esters (FAME) for use in diesel engines and heating applications - Requirements and test methods

Technical Specifications

- CEN/TS 15940:2012. Automotive fuels - Paraffinic diesel fuel from synthesis or hydrotreatment - Requirements and test methods
- CEN/TS 15923:2011. Automotive fuels - Ethanol (E85) automotive fuel - Requirements and test methods

Technical Reports

- CEN/TR 16569:2013. Automotive fuels - Assessing the effects of E10 petrol on vehicle emissions and performance
- CEN/TR 16514:2013. Automotive fuels - Unleaded petrol containing more than 3,7 % (m/m) oxygen - Roadmap, test methods, and requirements for E10+ petrol
- CEN/TR 16557:2013. Automotive fuels - High FAME diesel fuel blends (B11 - B30) - Background to the parameters required and their respective limits and determination
- CEN/TR 16435:2012. Liquid petroleum products - Oxygenates blending in line with actual EN 228 requirements

Advanced Biofuels

Sustainability Requirements

Sustainability

- Biofuels sustainability in the EU is stipulated in the **Renewable Energy Directive (RED)**, which originally stated that use of biofuels must result in an overall GHG saving of 35%, in order to qualify towards the 10% biofuels target in the EU27 by 2020. This was set to rise to 50% from 2017 for existing production, and 60% for new installations from 2017. For plants already operating in January 2008, the GHG requirement was set to start in April 2013.
- All biofuels that are used in the EU to fulfil its climate and energy targets need to comply with the sustainability criteria as laid down in Directives 28/2009/EC (RED) and 30/2009/EC (FQD).
- The production of first and second generation biofuels from both traditional crops and ligno-cellulosic crops requires efficient land use, and compliance with strict sustainability criteria is important.
- Research into liquid and gaseous biofuels is still needed to reduce the carbon footprint and increase the efficiency of land use.
- Non-food feedstock (such as algae, jatropha,) and waste biomass (MSW) are alternatives.
- Furthermore, the problem of high production costs of advanced biofuels needs to be tackled

- In October 2012 the EC published a proposal to minimise the climate impact of biofuels, by amending the current legislation on biofuels through the Renewable Energy and the Fuel Quality Directives. In particular, the proposals suggest:
  - To increase the minimum greenhouse gas saving threshold for new installations to 60% in order to improve the efficiency of biofuel production processes as well as discouraging further investments in installations with low greenhouse gas performance.
  - To include indirect land use change (ILUC) factors in the reporting by fuel suppliers and Member States of greenhouse gas savings of biofuels and bioliquids;
  - To limit the amount of food crop-based biofuels and bioliquids that can be counted towards the EU's 10% target for renewable energy in the transport sector by 2020, to the current consumption level, 5% up to 2020, while keeping the overall renewable energy and carbon intensity reduction targets;
  - To provide market incentives for biofuels with no or low indirect land use change emissions, and in particular the 2nd and 3rd generation biofuels produced from feedstock that do not create an additional demand for land, including algae, straw, and various types of waste, as they will contribute more towards the 10% renewable energy in transport target of the Renewable Energy Directive.
- In addition a new standard (prEN 16214), has been developed by CEN/TC 383 on Sustainably produced biomass for energy applications.

Are the feedstocks for advanced biofuels sustainable?

- An energy balance can be calculated for each advanced biofuel taking into account the type of feedstock, the energy used in fuel production and in transporting the end product. Generally this shows that advanced biofuels offer a great reduction in Greenhouse Gas (GHG) than conventional biofuels. However, there remains competition for land and feedstock between liquid biofuels and the rapidly expanding use for heat and power generation through combustion.
- The sustainability of biofuels is covered by the Biofuels Certification Scheme, while projects such as BioGrace and Global-Bio-Pact aim to harmonise the way sustainability of bioenergy and biofuels is calculated and certified.
- Important→ the same rules need to be applied to all use of biomass for food and other products. There is limited value in creating sustainable biofuels if unregulated and unsustainable biomass production is allowed for other uses.

Conclusions

Conclusions

- Biofuels could technically substitute oil in all transport modes, with existing power train technologies and existing re-fuelling infrastructures. Use of biomass resources can also decarbonise synthetic fuels, methane and LPG.
- First generation biofuels are based on traditional crops, animal fats, used cooking oils. They include FAME biodiesel, bioethanol, and biomethane. Advanced and second generation biofuels are produced from ligno-cellulosic feedstock and wastes. They include bioethanol, HVO, higher alcohols, DME, BTL and biomethane.
- The production of biofuels from both food and energy crops (1st Gen) is limited by the availability of land, water, energy and co-product yields, and sustainability considerations, such as the life-time accountancy of CO2 emissions. Second generation biofuels from wastes and residues are also limited by the availability of these materials.
- The development of feedstock potential and of optimised production processes is of the highest priority.
- A supportive policy framework at the EU level and harmonised standards for biofuels across the EU are key elements for the future uptake of sustainable biofuels.

In Summary: What requirements should Advanced Biofuels comply?

From a feedstock and process point of view advanced biofuels should fulfill at least the following criteria, with a focus on sustainability:

- Feedstock production should not compete with food production
- Feedstock production should not harm the environment (e.g. cause deforestation, ground water pollution etc.)
- Feedstock production and fuel processing should be efficient from a GHG point of view.

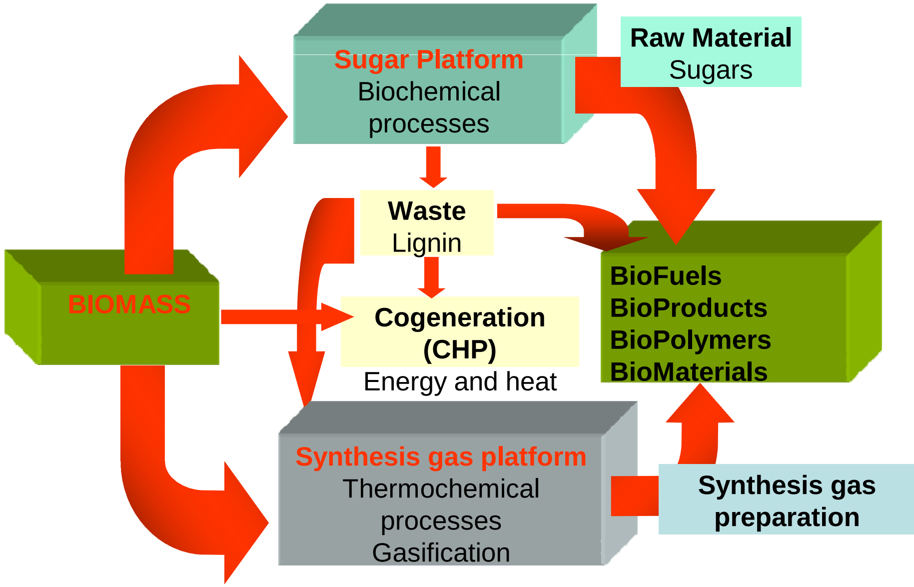
The criteria from an end-use point of view could be:

- At least equivalent end-use quality compared with traditional mineral oil based fuels
- Compatibility with existing refueling infrastructure
- Compatibility with existing vehicles
- Fuel components that do not only provide heating value but also a possibility for reduced harmful exhaust emissions.

The Second Generation Biofuels Centre (CB2G)

enermass.org

The **Second generation Biofuel Centre** is a **Process Development Units (PDUs) to produce 2nd generation biofuels on a pilot scale level** as an intermediate step towards the industrial scale-up of these technologies and as a biorefinery test platform. The CB2G constitutes an integrated trial and demonstration platform designed to develop process, equipment and specific components, new biofuels and to apply bio-refinery concepts to biofuels production processes.



The CB2G is a R&D infrastructure managed by CENER with the collaboration of CIEMAT in the definition, design and scientific and technological management.

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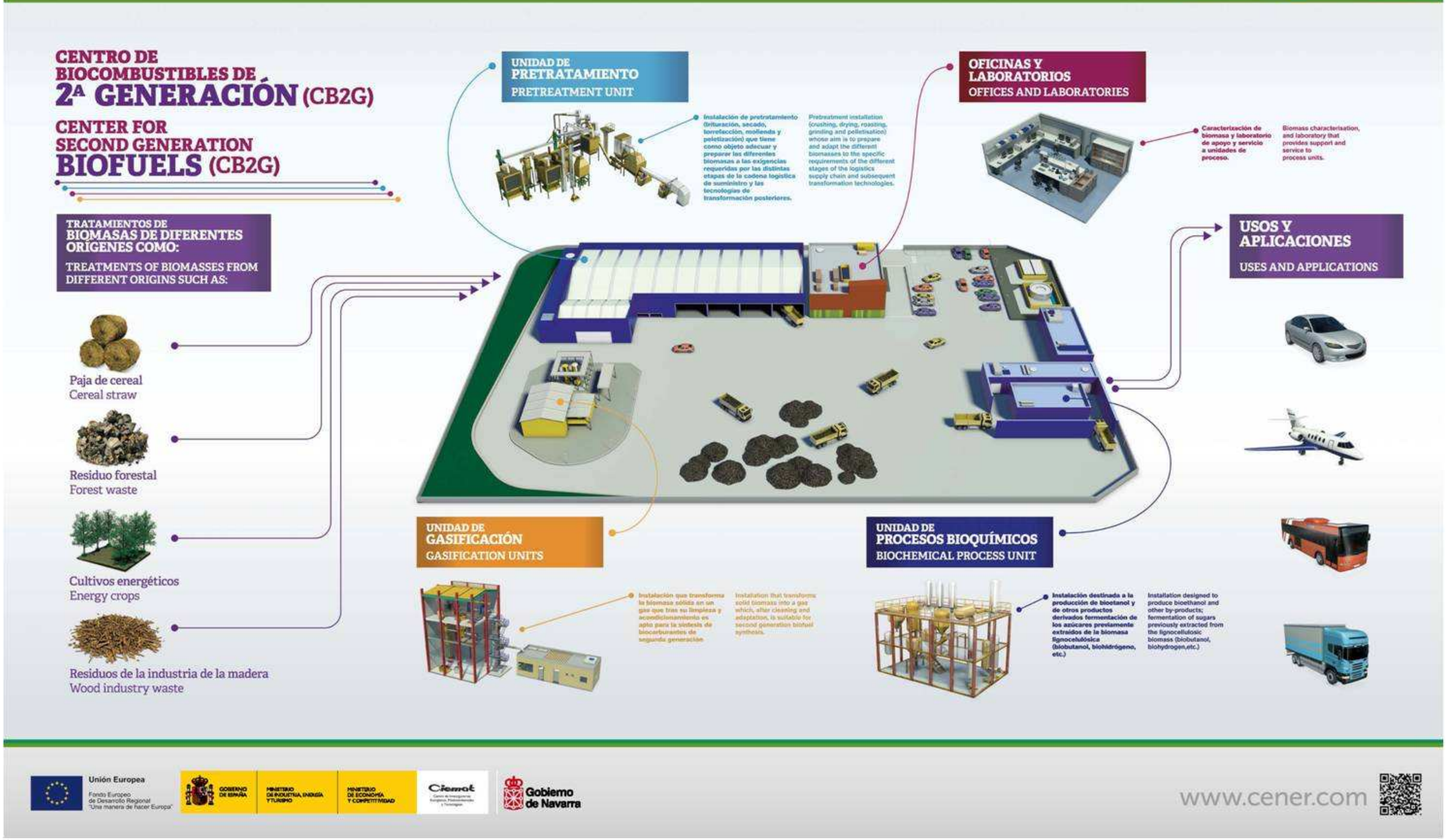
CB2G – Process Units: General overview

2. Resources & Facilities



2. Resources & Facilities

- **Pretreatment Unit**: Capacity**: 2MWt** - **500 Kg Biomass/h**
  - Chipping for woody biomass.
  - Chopping for herbaceous biomass
  - Drying
  - Torrefaction
  - Milling.
  - Pelletizing
  - → In operation from 2008
- **Thermo-Chemical Unit:** Gasification unit: Capacity **2 MWt-500 Kg Biomass/h**
  - Gasification Island
  - Thermal Oxidizer and Flue gases treatment
  - → In operation from Q4 2012
- **Biochemical Process Unit:** Capacity: Up to **1.500 kg biomass / week**
  - Pretreatment.
  - Solid / Liquid Fractionation
  - Biological Processes (Enzymatic Hydrolysis & fermentation).

  → In operation from Q1 2013

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CB2G – Pretreatment Unit

2. Resources & Facilities

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Chipper & Chopper	Drying Unit	Milling Units
		
Pelleting Unit	Pelletizing unit	Torrefaction reactor

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Any question?

Thank you very much!
Merci beaucoup!
¡Muchas gracias!
O brigada!

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