IEA Bioenergy Task 42 – Co-production of fuels, chemicals, power and materials from biomass

IEA Bioenergy Task 42
Country report 2012

Edited by Henning Jørgensen and Merete Madslund
University of Copenhagen
Denmark

Participating countries

Australia	Gil Garnier
Austria	Gerfried Jungmeier
Denmark	Henning Jørgensen
France	Jean Christophe Pouet
Germany	Thomas Willke
The Netherlands	René van Ree
Italy	Isabella de Bari
Turkey	Ozlem Atac
United Kingdom	Adrian Higson
USA	Melissa Klembara

Table of content

Introduction

The world is in a transition towards a bio-based society. This is driven by growing awareness of depletion of fossil resources and the wish to mitigate climate changes by increasing the use of renewable and carbon neutral resources. The most obvious example is currently the growing use of biomass for bioenergy, not only the traditional use for heat and power but more importantly the production of liquid biofuels (bioethanol and biodiesel). Several countries are politically endorsing this as a mean to ensure national security, rural development, future fuel supplies and reduce the carbon dioxide emission from the transport sector. However, increasing attention is also on exploiting biomass for replacing fossil resources for production of a variety of materials and chemicals.

Increasing exploitation of biomass by means of various routes of thermochemical and biochemical conversion is part of the development of biorefineries. There is increasing awareness that biomass is after all also a limited resource, and the efficient utilisation is key to future growth and economic viability of bio-based processes. A biorefinery is an integrated process that optimises and integrates the production of food & feed ingredients, chemicals, materials, fuels, power and heat from biomass.

The definition of biorefining developed in IEA Bioenergy Task 42 is:

"Biorefining is the sustainable processing of biomass into a spectrum of marketable products and energy"

Many traditional biomass converting technologies/industries, such as sugar, starch and pulp and paper industries operate in similar manner to biorefineries. However, IEA Bioenergy Task 42 sees a true biorefinery as a facility that has multiple energy and non-energy products.

IEA Bioenergy Task 42 is one of 12 tasks operating under the IEA Bioenergy umbrella, and was established in 2007. The aim of Task 42 is to initiate and actively promote knowledge and information exchange on biorefining, e.g. a report on the potential for bio-based chemicals produced from biorefineries has recently been published[1]. Part of this work is also mapping of biorefinery status in the participating countries.

Aim and concept of the report

In 2009 the first country report on the Biorefinery status was published covering the 7 participating countries in the IEA Bioenergy Task 42 in the period 2007-2009. The aim of this report is to give an updated overview of the biorefinery situation, the developments since the last report, and expand the report to include the new countries participating in IEA Bioenergy Task 42 in the period 2010-2012. The countries that are included in the report are: Australia, Austria, Denmark, France, Germany, Netherlands, Italy, Turkey and UK. Both Canada and Ireland were not able to provide the necessary data because gathering of these data would require too much effort (Can) and no real biorefinery activities were available yet (Ire). This report should provide a mapping of the activities and the potentials, and help national governments and stakeholders to define their biorefinery goals.

[1] Jong, E., Higson, A., Walsh, P., Wellisch, M. (2012). Bio-Based Chemicals – Value Added Products from Biorefineries

Unlike the previous country report, this report is based on individual country reports, which are also published separately, including a section summarising the trends and data across the countries. Each National Task Leader (excepted Can and Ire) has provided data from the respective countries based on a common template for data collection. The individual country reports have partly been edited to ensure consistent use of units and representation of data. However, it should be pointed out that statistical data, the data collection and grouping of data varies across countries, and data might therefore not be directly comparable. It has also been a challenge to get good and reliable data in some countries or data were simply not available. The listing of pilot and demo plants, as well as RTD activities, might not be exhaustive, especially for the bigger countries with many biorefinery activities. Noticeable for this area is also that it is an area in development, and therefore there is a lot of dynamics and continuous changes. For further and more updated information, the respective country representatives should be contacted (a full list of National Task Leaders and their contact details are given at the end of this report).

For each country, the report will contain generic data about population, total area and agricultural and forest land. The following chapter is on the current use and production of energy and bioenergy followed by a chapter on use of biomass for non-energy purposes. The next two chapters describe the political framework and legislation as well as the support and funding for research, development and deployment of bioenergy and biorefineries. Each country report is ended with tables listing current biorefinery facilities (commercial, pilot and demo), major RTD activities, and a list of stakeholders in the country.

Trends and developments in the IEA Bioenergy Task 42 countries

The production and use of bioenergy

Bioenergy production and usage relative to fossil energy varies substantially across the member countries (Figure 1). Ireland, the Netherlands and UK have the lowest share of bioenergy in their energy system (around 2%), whereas Austria and Denmark are the two countries with the highest share of energy being supplied by biomass (11-14%). The average share of bioenergy among the member countries in IEA Bioenergy Task 42 was in 2009 close to 6%. For Germany and Denmark there was a great increase in the bioenergy share from 2005 to 2009. This increase could be ascribed to increased use of biomass for heat and power, expansion of the biogas production, and use of liquid biofuels.

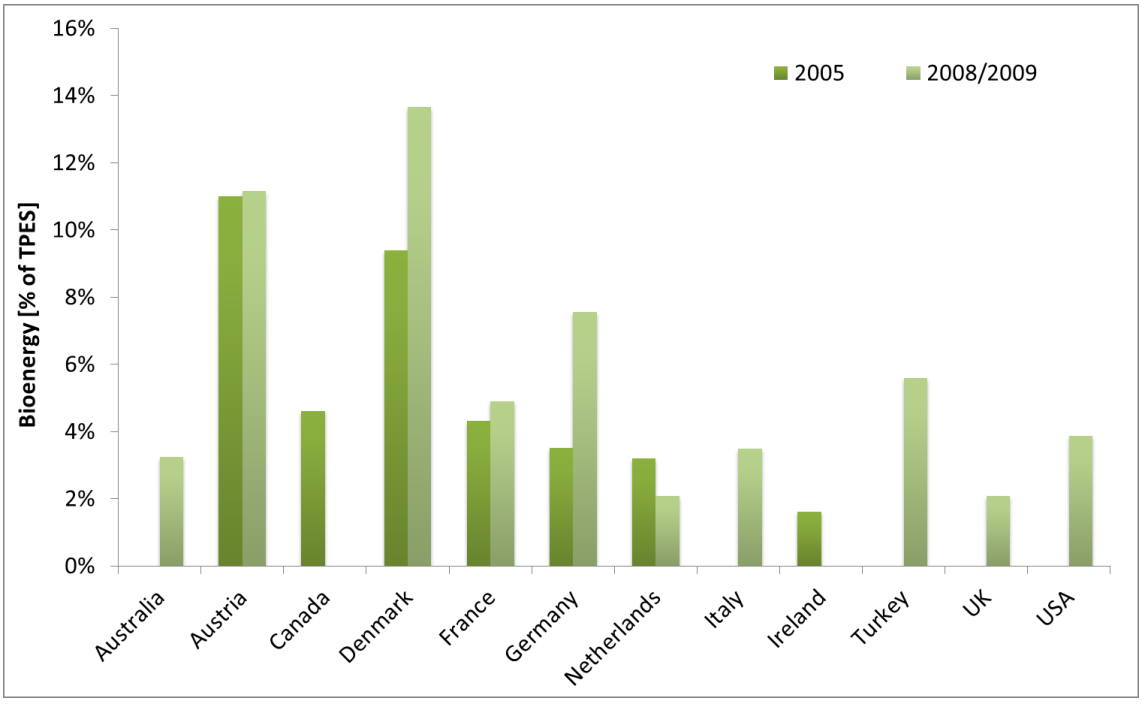

Figure 1: Bioenergy supply relative to total primary energy supply (TPES) for the IEA Bioenergy Task 42 member countries for the years 2005 and 2008/2009 (Values from country reports).

An interesting view upon the use of bioenergy in the countries is to relate it to economics or demographics (Figure 2). Here, it can be seen that a country such as Turkey has a high use of bioenergy per GDP, whereas the use per capita is low compared to the other member countries. Based on the limited number of countries, there is no obvious correlation between economic welfare in the country and the use of bioenergy. Less developed countries might have a relative higher use of bioenergy for domestic heating and cooking, however, a high use of bioenergy in countries with high GDP might be driven by intentions to reduce GHG-emissions, energy security issues and technological developments.

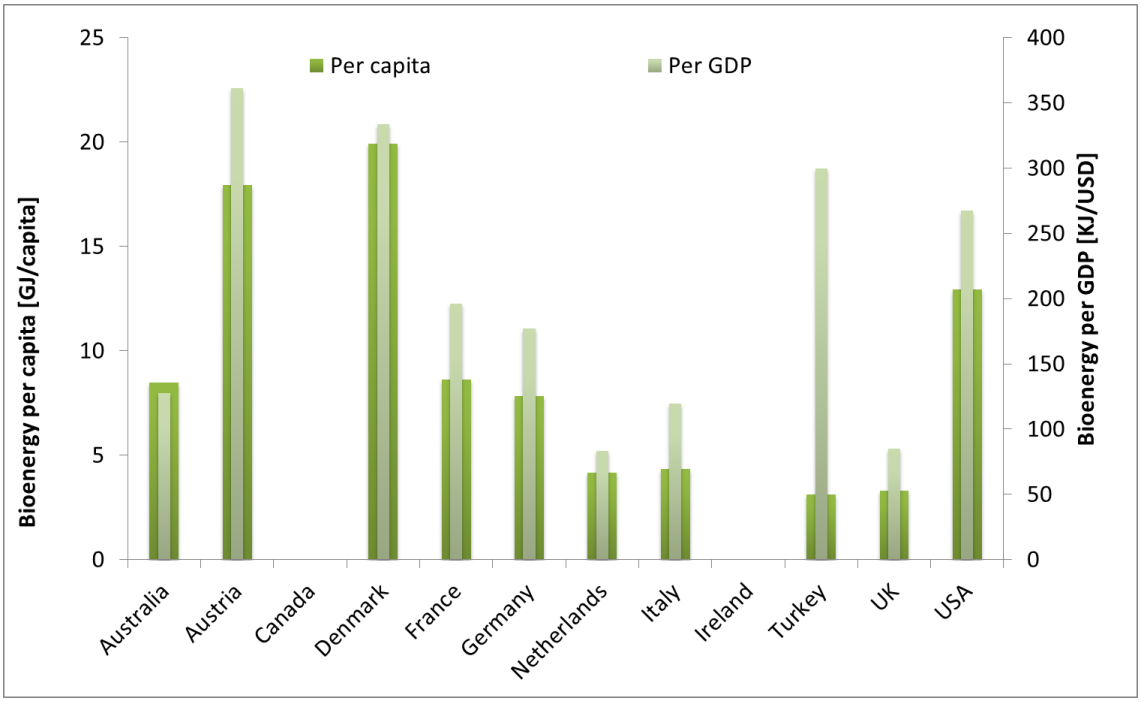

Figure 2: Bioenergy supply relative to country population or gross domestic production (GDP)

The use of liquid biofuels for transportation has also been taking off during the last few years. However, in the EU most of this growth has happened after 2008/2009, and is therefore not reflected in the data from the country reports (Figure 3). There is no doubt that the USA is the main producer of bioethanol among the member countries of IEA Bioenergy Task 42, with a production surpassing all other countries collectively. USA was not part of the 2005 country report, but the ethanol production has been increasing steadily over the last decade in USA. Germany has traditionally been very much engaged in biodiesel production due to strong financial support schemes for biodiesel. For this reason Germany had for a number of years a large production from rapeseed, but after a change in the support scheme, the production dropped significantly, which is truly reflected in Figure 3.

One of the arguments for implementing liquid biofuels is besides the environmental concerns the wish to secure the energy supply and have a domestic production. For biodiesel the production capacity matches rather well the actual usage (in 2009) in the individual countries. Contrary to this most of the Task 42 countries from the EU have a bioethanol production substantially lower than the consumption. In this case the ethanol is usually imported from the USA or Brazil. The Netherlands represented in 2009 a special case, as there was no production of neither biodiesel nor bioethanol.

In a few countries (e.g. Austria and Germany) biogas is also used for transportation fuel after being upgraded to bio-methane. Compared to the other biofuels for transportation this share is however still very small, but might increase in the future due to expansion of the biogas production capacity.

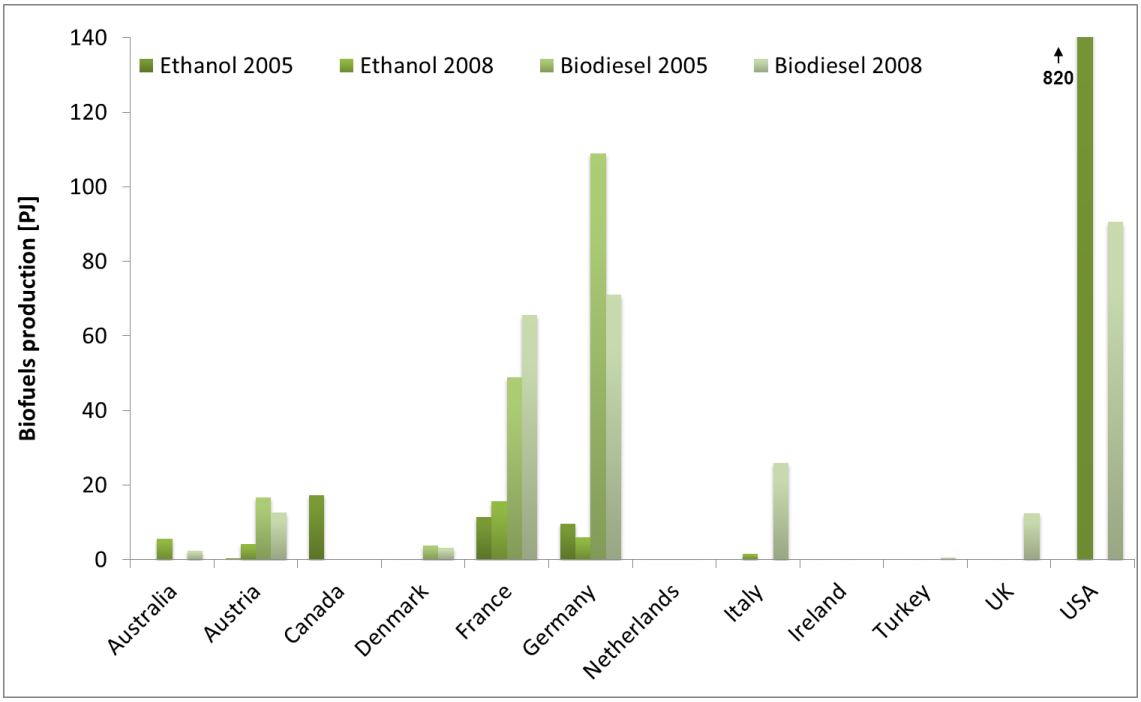

Figure 3: Biofuels production (bioethanol and biodiesel) in the IEA Bioenergy Task 42 member countries for the years 2005 and 2008/2009 (values from country reports).

From Figure 4 it is also clear that bioenergy is mostly used in the more traditional form for incineration to produce heat and power. For Denmark, with a very high share of bioenergy in the energy system, the use is almost exclusively heat and power. On the contrary, the USA has had a strong focus on use of liquid biofuels to replace gasoline and here the share of bioenergy for transportation is 23% of the total bioenergy supply. The gradual introduction of liquid biofuels (bioethanol and biodiesel) in the transportation sector in Europe as demanded by EU directives was not fully implemented in 2008. The liquid biofuels share has therefore further increased in most European countries compared to those reported in Figure 4.

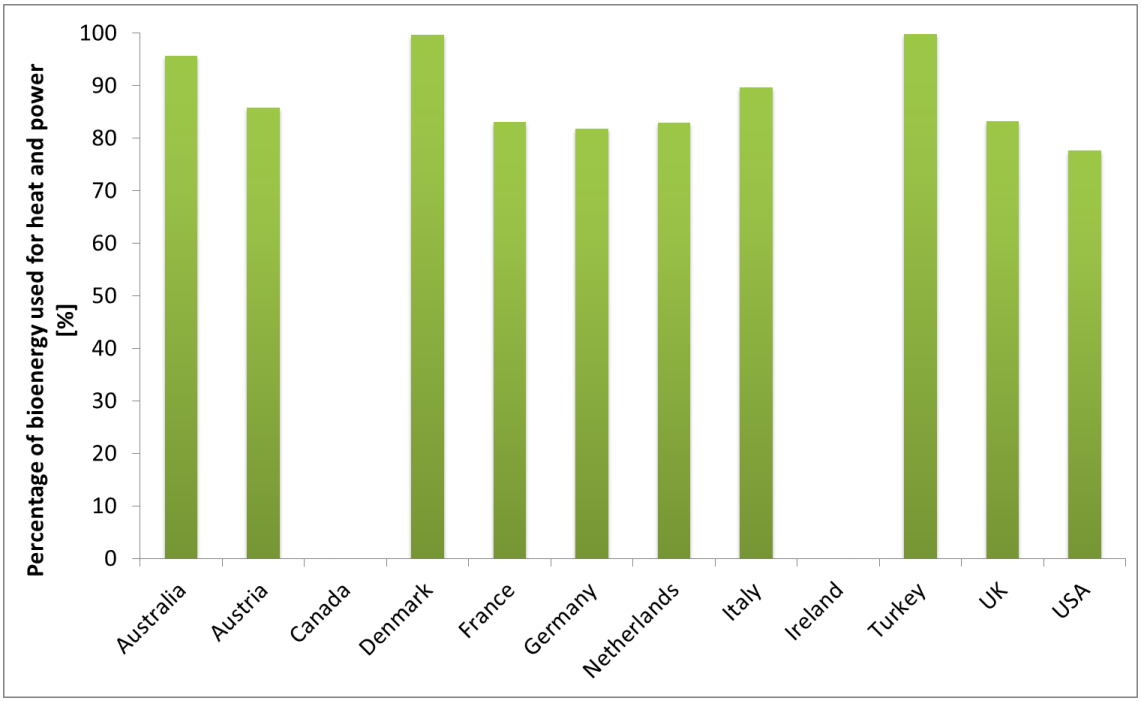

Figure 4: Percentage of bioenergy used for heat and power (2008/2009)

It has only been possible to collect detailed information on the amounts of biomass feedstocks used in the bioenergy generation from five countries (Figure 5). Although there is a wide spread in relative amount of the different biomasses used in the five countries, wood or wood derived biomass collectively accounts for half or more of the biomass. And although exact numbers have not been reported in the remaining country reports, forest derived biomass is believed to sustain a substantial part of the present bioenergy production. Cereals and sugar crops are only used for liquid biofuels production, which is still relatively minor in most countries (Figure 4). Agricultural residues have traditionally not been used extensively for heat and power generation among others because they are very bulky, which increases the transportation costs. Wood and wood pellets are characterised by much higher energy density and have better storage stability and is therefore easily transported over longer distances. An example is the global trade of wood pellets, where pellets from North America are transported to consumers in Europe. On the other hand this also means that agricultural residues/straw holds a large potential as a domestic feedstock source for biorefineries as also reported in some country reports (e.g. Italy and Turkey).

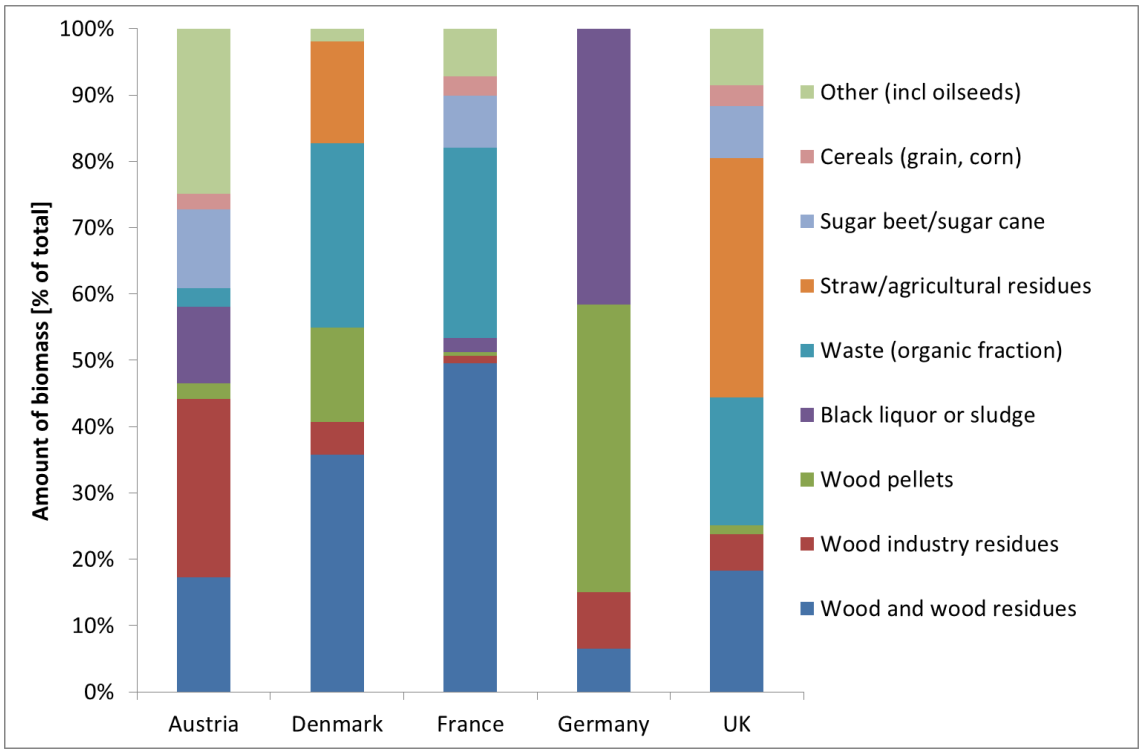

Figure 5: The relative share of the various biomass feedstock used for generation of bioenergy. The values are relative to the total amount and based on weight. For Germany no figures were available for straw, sugar beet, cereals and others.

Non-energy use of biomass

With the exception of the pulp and paper industry (forest biorefineries), most biomass used for biorefining is currently derived from sugar/starch containing crops such as cereals, sugar beet/sugar cane, potatoes or oil containing crops such as rape seed. Currently most of this is used in "traditional" biorefineries such as sugar mills, starch processing, brewing and in general for processing into food or feed products, which do not necessarily produce an energy product (heat, power or biofuels). Table 1 summarizes the production of these crops within the Task 42 member countries. Whereas there is good statistical information on the use of wood for various wood products and pulp and paper (Table 1), the information regarding the use of e.g. sugar and starch for production of various chemicals (non-energy products) by e.g. fermentation is very limited.

From the Task 42 report "Bio-Based Chemicals – Value Added Products from Biorefineries"[1] it is apparent that fermentation of biomass (typically sugar/starch) to chemicals, enzymes and amino acids is already a developed industry with an annual production of 8 million tonnes of product. However, it is still a growing industry and examples of biomass derived products are:

- Ethylene, which is precursor for production of various plastics (polypropylenes)
- Lactic acid, which is growing due to increased interesting in producing biodegradable plastic (poly lactic acid)
- Succinic acid

For more detailed information see[1].

Table 1: Production of main agricultural feedstocks and selected non-energy products from biomass

	Creals*	Sugar cane/sugar beet*	Potatoes*	Rapeseed*	Sugar*	Starch§	Chemicals from biomass§	Wood for particle boards§	Wood for pulp and paper§	Wastes from pulp and paper§
	1000 tonnes							1000 m^3		
Australia	31701	30284	1179	1920	4634			1089	6476	0
Austria	4796	3083	722	171	427	300	780	1500	2875	1875
Canada	49035	658	4581	12417	71			0	0	0
Denmark	10117	1898	1618	635	445	215		0	0	0
France	69215	35160	7175	5589	4327	2800	160	8500	7875	0
Germany	49676	25919	11618	6307	4207	886	725	17000	5300	0
Ireland	2063	0	361	22	0			0	0	0
Italy	15788	3308	1774	50	513	9650		370		2960
Netherlands	1994	5735	7181	12	1078			0	0	0
Turkey	32810	17275	4398	114	2753	267		2407	5816	0
UK	21589	8457	6396	1912	1308	897	51692	2810	300	3207
USA	399393	54626	19623	669	7081					

* Numbers from FAO stat for year 2009

§ Numbers reported in individual country reports

Despite the current growth in non-energy products derived from biomass, it is apparent that this growth is still mainly based on feedstocks that in principle compete with food/feed, i.e. sugar and starch. Despite many years of research and development, the production of bioethanol from lignocellulosic materials is still confronted by technical problems and high productions costs and these issues are not less problematic for production of fine chemicals. The expectation is nevertheless, that once the technology is developed and commercialized for biofuels then other high value products will start being produced as a side stream or part of the biofuels production.

Policy trends

Increased use of bioenergy and development of biorefineries has in recent years politically been driven by the strong focus on energy security and independence. As an example the USA mandates regarding use of biofuels in the transportation sector was part of the "Energy Independence and Security Act of 2007"[2]. Another political motivator is the desire to replace fossil energy sources due to the growing awareness of climate change and intentions to reduce GHG emissions.

Within IEA Bioenergy Task 42 there are generally two motivations recognized for the development of biorefineries[3]:

1) "Energy driven" biorefineries: production of big volumes of road transportation biofuels".

2) "Product driven" biorefineries: production of bio-based materials and chemicals.

[2] http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf

[3] For more information see the brochure "Energy driven biorefineries - A Selection of the Most Promising Biorefinery Concepts to Produce Huge Volumes of Road Transportation Biofuels until 2025" by Jungmeier et al., IEA Bioenergy Task 42, 2013.

In "energy driven" biorefineries biomass is primarily used for the production of secondary energy carriers (road transportation biofuels, power and/or heat); process residues are sold as feed (current situation), or even better upgraded to value-added bio-based products to optimise economics and environmental benefits.

In "product driven" biorefineries biomass is fractionized into a portfolio of bio-based products with maximum value-added and overall environmental benefits, after which the process residues are used for power and/or heat production.

Summarizing the policies implemented in the IEA Bioenergy Task 42 countries there is no doubt that due to the political emphasis on securing energy supplies and ensuring the transition towards non-fossil energy sources, energy driven biorefineries have drawn most attention. Table 2 gives an overview of the energy policy in the Task 42 countries and otherwise the reader is referred to the individual country reports for more in-depth information.

The energy policy for those Task 42 countries that are part of the EU is largely influenced by EU directives. A central element in this legislation is the "Directive 2009/28/EC on the promotion of the use from renewable sources"[4]. This directive, also commonly referred to as 20-20-20 plan, sets targets for use of renewable energy in EU, energy savings and reduction in greenhouse gas emissions. The target is 20% overall share of energy from renewable sources with 10% share of renewables in the transportation sector, 20% improvement in energy efficiency and 20% reduction in GHG emissions by 2020. Due to large variation in initial share of renewable energy (see e.g. Figure 1), individual targets are set for each EU member country. The target for renewables in the transport sector is however the same across all EU member countries to ensure consistency in transport fuel specifications. The actual target for biofuels in the transport sector has been much debated due to sustainability concerns and emphasis has been put on favouring advanced biofuels (e.g. 2nd generation bioethanol from lignocellulose).

Australia, Turkey and USA are the only non-EU countries included in the analysis. Neither Australia nor Turkey has strong policies in place to promote and support bioenergy and biofuels. In contrast to this, USA has due to strong focus on energy security and independence focus on increasing the share of renewables especially in the transportation sector. USA has clear targets for implementing biofuels and also advanced biofuels. This include support schemes to develop and commercialize biorefineries producing advanced biofuels, chemicals and power.

Table 2: Overview of policies related to energy, renewable energy and biorefining in Task 42 countries

	Energy policy	**Biorefining**
Australia	No specific policy target for renewable energy or biofuels, but renewable fuels incl. biofuels are excise free until at least 2021.	Working on policies regarding biorefineries. Have formed a Pulp and Paper Innovation Council, which works on establishing a Biorefinery Research Institute
Austria	Overall target is 45% of energy from renewables by 2020. This includes 85% electricity and 20% of transportation energy from renewables (mainly biofuels). National biomass action plan to secure future domestic biomass supply.	No
Canada	-	-
Denmark	The policy implemented in 2008 aims at a general reduction in energy consumption and increasing the share of renewables to	No

[4] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0028:EN:NOT

	30% by 2025. "Green growth plan" from 2009 includes support scheme for short rotation crops and expanding the biogas production. Follows EU directive on renewable energy in transport sector (10% renewable by 2020). Mandatory blending of biofuels to reach 5.75% (energy basis) in 2012.	
France	Follows EU directive. In 2020 renewables to account for 23% of total energy. Renewable energy in transportation sector 10% (mainly from biofuels) by 2020.	No
Germany	Legal framework for bioenergy but not biobased chemicals and materials. 14% of heat from renewables by 2020. Renewable energy in transportation sector 10% by 2020.	No
Ireland	-	-
Italy	Follows EU directive. National Actions Plan for Renewable Energies from 2010. Set targets for 20% energy from renewables by 2020, and 10% renewables in transportation incl. biofuels.	No
Netherlands	Follows EU directive. Renewable energy, power and heat to cover 20% in 2020. Biofuels (5.75%) by 2012 and 10% by 2020. Focus on advanced biofuels (2nd generation)	No
Turkey	Strategy for increased use of renewables for electricity generation. Marginal focus on biofuels or renewables for transportation.	No
UK	Follows EU directive. 15% of energy from renewables by 2020. Renewable energy strategy from 2009. Renewable transportation fuel obligation from april 2008. 5.26% by volume in 2013/2014. UK biomass strategy published in 2007 with focus on securing biomass supply in an environmentally sustainable manner	No
USA	Energy Policy Act of 2005 and Energy Independence and Security Act of 2007. Both introduce a Renewable Fuel Standard (RFS) mandating targets for biofuels and advanced biofuels (36 bgy by 2022). Include tax credit schemes, funding and loan guaranty programs for pilot, demo and commercials scale biorefineries.	Yes, Energy Policy Act of 2005 solicit proposals for cellulosic biorefinery demo plants that produce biofuels in addition of chemicals and power

For more detailed information the reader is referred to the individual country reports.

From the country reports it is clear that so far a political framework setting targets for the share of biochemicals and bioproducts has not been introduced in a similar way as seen for bioenergy. So far the introduction of biochemicals and biomaterials is driven by the chemical industry itself or the consumers demand for green and renewable products. Australia and USA have indicated that political measures have been taken to support the development of biorefineries, but still no specific targets have been mandated.

Biorefinery related funding programs

The funding programs and structures available in the Task 42 countries are rather diverse and subjected to change over time. For detailed information the reader is referred to the individual country reports or to contact the country representative. This section is only meant to give an overview of activities supported and general trends.

In line with the clear policy directives on bioenergy, all countries have indicated that they have national funding programs that are specifically targeted towards support of bioenergy research, i.e. the goal is R&D related to production of bioenergy products (Table 3). In this report programs supporting combustion or traditional use of biomass for bioenergy have not been included. Funding programs for biorefining are typically found in a grey zone between bioenergy projects and e.g. (industrial) biotechnology projects. This is especially the case for projects involving biochemical conversion routes where development of fermentation platforms for new chemicals is not necessarily regarded as biorefinery projects. This type of projects may therefore be funded through various programs that are not directly related to development of biorefineries, e.g. general funding agencies supporting applied research. Consequently it can be difficult to track and categorise these activities. In Table 3 the goal has been to indicate whether the countries have programs where R&D is specifically focused on biorefineries alone (i.e. the topic of the program is biorefineries). In addition, it is not always possible to make a clear distinction between bioenergy projects and biorefinery projects and this has been indicated in the table as well.

Most countries have also funding programs supporting pilot and demonstration scale projects on bioenergy. Only four countries have funding programs directly supporting biorefinery pilot/demonstration projects. Again, although these funding programs support biorefinery projects it is often seen in relation to development of the bioenergy part as well.

Table 3: Overview of national funding programs related to bioenergy and biorefining research and development

	Funding for bioenergy research (thermochemical and biochemical conversion routes)	**Funding for biorefining research**	**Funding for pilot/demo scale projects in bioenergy (not traditional combustion)**	**Funding for pilot/demo scale projects specific for biorefining (not only energy products)**
Australia	●	●	●	
Austria	●	●	●	○
Canada	n.d.	n.d.	n.d.	n.d.
Denmark	●	○	●	
France	●	●	●	
Germany	●	●	●	●
Ireland	n.d.	n.d.	n.d.	n.d.
Italy	●			
Netherlands	●	●	●	○
Turkey	●			
UK	●	●	●	
USA	●	●	●	○

● - dedicated funding programs, ○ - funding programs with most weight on energy products or not clearly defined, n.d. – no data/information

For more detailed information the reader is referred to the individual country reports.

Specifically for the member countries in EU there are also possibilities to get funding through various EU programs. Over the years the EU Framework Programs FP 6 and FP 7 have supported many bioenergy and biorefining funding programs. The current Framework Programme (FP7, 2007-2013[5]) has been focussing on advanced biofuels production from biomass, including funding for demonstration projects. But FP 7 addresses related topics in other programs. For example the "Food, Agriculture and Fisheries", and the "Biotechnology" themes include sustainable production of renewable bio-resources (biomass production) and research and development within biotechnology and biochemistry for production of sustainable non-food products and processes. Some of these calls have also involved international cooperation e.g. biofuels with Latin America. FP 7 also has joint calls, e.g. "Biorefineries" that were published in 2008 and brought together four different research areas (Energy, Materials, Environment, Agriculture).

In addition to the Framework Program, EU also supports research activities within the bioenergy and biorefinery area through ERA-NET. The objective of the ERA-NET scheme is to step up the cooperation and coordination of research activities carried out at national or regional level in the Member States and Associated States through the networking of research activities conducted at national or regional level, and the mutual opening of national and regional research programmes. Currently there are two relevant networks: 1) ERA-net on Industrial Biotechnology (industrially relevant applied research projects)[6] , 2) ERA-net on Bioenergies (focus on solid fuel combustion and 2nd generation bioethanol)[7].

In USA the support for research, development and demonstration of advanced biofuels production (thermochemical and biochemical) have been funded and supported through various programs mainly coordinated by US Department of Energy (USDOE) or US Department of Agriculture (USDA)[8]. The programs have supported basic research by e.g. setting up research centres (Great Lakes Bioenergy Center, Joint Bioenergy Institutes, Bioenergy Science Center) and by offering funding and loan guaranties to companies and consortia to construct demonstration and commercial scale plants. In addition to the national funding programs, several states also have their own funding programs for bioenergy and biorefining.

Running pilot, demo and commercial biorefineries

The increased interest and focus on biofuel and biorefining has resulted in many pilot and demonstration plants being constructed in recent years. In the country reports a total of 44 pilot and 33 demonstration scale plants or facilities have been listed (Table 4). However, the list is not exclusive and will not represent the current situation. New plants are continuously being built and unfortunately, the economic crisis in 2008 and successive low economic growth has made it difficult for many pilot and demonstration plants to attract the necessary funding from investors to keep operating or expanding to commercial scale. The intention of the list is therefore more to give an impression of the activities and interest areas in the countries rather than a fully updated list of plants in operation. USA is not included in the list as the number of projects is very large when accounting for all plants in operation in all states. For biorefinery plants funded or supported by USDOE and overview is available at the USDOE website[9].

[5] http://cordis.europa.eu/fp7/home_en.html
[6] http://www.era-ib.net/
[7] www.eranetbioenergy.net
[8] http://www1.eere.energy.gov/biomass/index.html
[9] http://www1.eere.energy.gov/biomass/integrated_biorefineries.html

Another important source of updated information is the on-line database of biorefineries plants producing liquid biofuels (both thermochemical and biochemical processes) from biomass, which have been made available by IEA Bioenergy Task 39[10]. For further inquiries and latest updates the country representative should be contacted.

Table 4: Number of pilot and demonstration scale plant/facilities in the Task 42 member countries

	Number of pilot plants/facilities	Number of demonstration plants/facilities	Keywords for technologies
Australia	4	5	Algae, bioethanol, biodiesel, biooil
Austria	2	1	Algae, SNG, FT-fuels, biogas, chemicals
Canada	n.d.	n.d.	
Denmark	4	2	Bioethanol, biogas, biooil
France	1	5	SNG, FT-fuels, bioethanol, chemicals
Germany	15	13	Algae, SNG, FT-fuels, bioethanol, chemicals, polymers
Ireland	n.d.	n.d.	
Italy	1	2	Algae, bioethanol, chemicals
Netherlands	14	2	Algae, bioethanol, chemicals, polymers
Turkey	0	0	
UK	3	3	Algae, bioethanol, biobutano
USA	Many		

n.d. – no data/information

For more detailed information the reader is referred to the individual country reports.

A number of commercial biorefineries are also running in the Task 42 countries (Table 5). Note that the conventional use of biomass for wood, pulp and paper and CHP is not listed. In addition, traditional ethanol production (first generation) has for some countries been excluded as the number is too big to be included in the list, e.g the USA has more than 200 ethanol plant in operation[11].

Table 5: List of commercial biorefineries running (2009)

Country	Company	Feedstock(s)	Product(s)	Description	Size
Australia	Proserpine Sugar	bagasse	furfural	Production of furfural from bagasse	yield of up to 5,000 t/yr
Austria	Lenzing AG	Fibre and pulp	Furfural, acetic acid, sodium sulfate, potassium-lignin-sulfate	Separation of chemicals as a co-product of fibre and pulp processes. CHP from lignin	
	Danisco	Wastewater of pulp and paper industry	Xylose	Separation of xylose out of wastewater	

[10] http://demoplants.bioenergy2020.eu/

[11] http://www.ethanolproducer.com/plants/listplants/US/Existing/Sugar-Starch

Denmark	CP Kelco	Citrus peel and algae	Pectin, carageenan	www.cpkelco.com	
	Daka biodiesel	Animal waste	Biodiesel, glycerol	www.dakabiodiesel.com	
France	Pomacle Bazancourt biorefinery: ARD, IAR, Cristal Union, Chamtor, Cristanol, Champagne-cereales, Soliance, BioAmber, CIMV	Wheat, sugar beet	Food, feed, ethanol, succinic acid, cosmetics, other bioproducts...	Several industries / partners are located in the Pomacle Bazancourt biorefinery, working on physical, chemical and fermentation processes. BioAmber: joint venture between France-based ARD and US-based DNP Green Technology, producing acid succinic. Soliance: production and marketing of plant-based cosmetic active ingredients. Other agro-industries: Cristal Union (Sugar beat in ethanol), Cristanol (sugar beet, wheat / subsidiary of Cristal Union and Blétanol), Chamtor (wheat): production of sugar for ethanol / food / feed.	BioAmber (succinic acid): Initial annual capacity of 2,000 metric tons (industrial production started in Dec. 2009).
	Novance (Prolea - Sofiproteol)	Vegetable oil	Oleochemistry for non-food markets	Subsidiary of Diester Industrie (which is a subsidiary of Sofiproteol). Production of different oleochemical products: solvents, lubricants, coating (paints, inks), plant protection, biomaterials	
	DRT	Pine tree (paper and pulp by-products)	Resins, gum rosin, fine chemicals, tall oil derivatives, surfactants	250 different products. Applications: adhesives, inks, rubber, perfumes et aroma, pharmaceuticals, cosmetics, surfactants, industrial oils …	
	Roquette	Wheat, potato, maize, pea	Starch, food, feed, bulk and fine chemicals, succinic acid, ethanol… Major production: diester isosorbid / isosorbid (building blocks)	Physical, chemical and fermentation processes. 650 products from starch for food, feed and industry (paper, pharmacy, chemicals, cosmetics…) Consumption of 6 Mt/y of feedstock	Isosorbid / Diester isosorbid: production > 1.1 ktons/y
	Solvay	Rapeseed-oil derived glycerin	epichlorhydrin	Production of epichlorohydrin from glycerin, major rapeseed biodiesel by-product. Epichlorhydrine is mainly used for producing epoxy resins,	43ktons/year

				paper reinforcement and water.	
Germany	Südzucker	Sugar beet, grain	Palatinit, Ethanol	www.palatinit.de	80,000 t/a
	Emsland Stärke				
	Zellstoff Stendal				
	Choren			See demo plants	
	Biopetrol	Plant oil (rapeseed)	Biodiesel, Glycerin	Schwarzheide, Rostock	Each 150,000 and 200,000 t/a biodiesel
	Linde-KCA, Dresden	Wheat, cap. 120,000 t/a	Modified starch 60000 t/a, gluten 10000 t/a, feed 30000 t	Starch-based 1. Generation biorefinery, Zeitz (Germany) Investment: > 50 Mio EUR	Capacity 120,000 t/a
	Biowert Industrie GmbH, Brensbach	grass	30 % Insulation material, 70% composites, fertilizer, biogas	Since 2007 Composites made from recycling polymer material reinforced by gras fiber www.biowert.de	Capacity 5000 t/a
Netherlands	BioMCN	Glycerin	Bio-methanol	Upgrading of the biodiesel byproduct glycerin to methanol for transport. Plant in Delfzijl opened officially on the 25th of June 2010. www.biomcn.eu	Production capacity of 250 million litres
	Cargill	Wheat and corn	Starches, starch derivates, wheat proteins and glucose	Integrated biorefinery together with Royal Nedalco plant in Sas van Gent	
	Ecoson - Vion	Waste meat industry	Biogas, CHP, biodiesel	Integrated production of biogas, CHP and biodiesel from animal waste. www.ecoson.nl	Production capacity per year: 9,000 MWh from biogas, 50,000 ton refined fat and 5,000 ton biodiesel
	Greenmills	Waste frying fat/oil and food waste	Biodiesel, Bioethanol and biogas	Greenmills is a joint initiative of Rotie, Noba, Tankstorage Amsterdam, Biodiesel Amsterdam, Tank & truck cleaning Amsterdam and Orgaworld BV. The waste cooking oils is collected, cleaned and processed further by Rotie BV to turn them into suitable raw materials for the biodiesel plant in The Port of Amsterdam (Hornhaven). www.greenmills.nl	Biodiesel 100 Mton = 113 Ml/a, Bioethanol 5 Ml/a and biogas 25 m3/a

	Royal Nedalco	Wheat (by-products of nearby Cargill plant)	Bioethanol		1st generation plant (2005): 2.2 Ml/a; 2nd generation plant (2007) 2.0 Ml/a
	Vierhouten Vet BV (Biodiesel Kampen BV)	Waste oils / fats	Biodiesel	Waste plant oils and animal fats from the food industry are upgraded to biodiesel. The plant is in production since January 2007. www.vierhoutenvet.nl and www.biodieselkampen.com	In 2009 the production capacity was expanded to 100,000 tons of biodiesel
Turkey	PANKOBİRLİK	Sugar cane			capacity of 80,000 tons ethanol/year
	TARKİM	Sugar cane			capacity of 30,000 tons ethanol/year
	TEZKİM	Sugar cane			capacity of 40,000 t tons ethanol/year
UK	British Sugar	Sugar Beet	Sugar products, bioethanol, animal feed, lime, tomatoes, betaine	The Wissington site produces a wide range of products from sugar beet. The plant exhibits considerable integration with other processes, for example, CO2 and low grade heat from the factory is channeled into adjacent greenhouses which are used for tomato production.	3 million t/yr sugar beet Sugar products (400,000 t) bioethanol (55,000 t), animal feed (100,000 t)
	Ensus	Wheat	Bioethanol, DDGS, carbon dioxide	Ensus operate the EU's largest cereal grain biorefinery. The plant is located on Teesside in North East England and began production in 2010.	Over 1 million t/yr wheat Bioethanol (over 320,000 t), DDGS 350,000 t), carbon dioxide (300,000 t)
	Cargill	Wheat	Starch, distillers grains, glucose syrup, ethanol (potable), gluten	Cargill acquired the Cerestar starch factory and sweeteners site in Manchester in 2002. Fermentable sugars are used to produce bioethanol at the adjacent Royal Nedalco plant.	750,000 t/yr wheat
	Roquette	Wheat	Starch, distillers grains, glucose	Wheat starch processing plant located in the centre of the UK feed wheat growing area.	150,000 t/yr wheat
USA	POET	Corn Cobs	Ethanol	Cellulosic ethanol facility utilizing biochemical	25 M gals/yr capacity

				conversion technology located in Emmetsburg, IA	
	Abengoa	Agricultural Residues	Ethanol	Cellulosic ethanol facility utilizing biochemical conversion technology located in Hugoton, KS.	11.4 M gal/yr capacity
	BlueFire	Wood, Wood Waste, and Sorted MSW	Ethanol	Cellulosic ethanol facility utilizing biochemical – concentrated acid hydrolosis – technology located in Fulton, MS	19 M gal/yr capacity
	Range Fuels	Wood Waste	Mixed Alcohols	Facility utilizing gasification and mixed alcohol systhesis technology to produce mixed alcohol fuels located in Soperton, GA.	20 M gal/yr capacity
	Mascoma	Woody Biomass	Ethanol	Cellulosic ethanol facility utilizing biochemical conversion technology located in the Upper Peninsula of MI.	5 M gal/yr capacity
	Flambeau River Biofuels LLC	Forest Residues and Wood Waste	Ficher-Tropsch Liquids	Facility using thermochemical conversion technology to produce FT liquids from Forest Residues located in Park Falls, WI.	9M gals FT Liquids/yr and 50M lbs of FT wax

IEA Bioenergy Task 42: National task leaders

The IEA Bioenergy implementing agreements (Tasks) are running in three-year periods. This country report was the result of the work done in the period 2010-2012. In Table 6 is listed the national task leaders in the period 2010-2012. From 2013 to 2015 the participating countries have changed and the current list of country representatives is given in Table 7.

Table 6: List of national task leaders in the triennium 2010-2012

	National Task leader	Affiliation	E-mail
Australia	Gil Garnier	Monash University	Gil.Garnier@eng.monash.edu.au
Austria	Gerfried Jungmeier	Joanneum Research	Gerfried.jungmeier@joanneum.at
Canada	Maria Wellisch	Agriculture and Agri-Food Canada	maria.wellisch@agr.gc.ca
	Kisty Piquette	Alberta Agriculture and Rural Development	Kisty.piquette@gov.ab.ca
Denmark	Henning Jørgensen	University of Copenhagen	hnj@life.ku.dk
France	Alba Departe	ADEME - Direction Productions et Energies Durables	alba.departe@ademe.fr
Germany	Thomas Willke	Johann Heinrich von Thünen Institut	Thomas.willke@vti.bund.de
	Heinz Stichnothe	Johann Heinrich von Thünen Institut	heinz.stichnothe@vti.bund.de
Ireland	Patrick Walsh	Energy Research Group, National University of Ireland	patrick.j.walsh@nuigalway.ie
Italy	Isabella De Bari	ENEA C.R. TRISAIA	Isabella.debari@trisaia.enea.it
Netherlands	Rene van Ree (Task 42 leader)	Wageningen University and Research Centre	rene.vanree@wur.nl
	Ed de Jong	Avantium Technologies BV	Ed.dejong@avantium.com
Turkey	Ozlem Atac	TÜBİTAK Marmara Research Center	Ozlem.atac@mam.gov.tr
UK	Adrian Higson	The National Non-Food Crops Centre	a.higson@nnfcc.co.uk
USA	Melissa Klembara	US Department of Energy	Melissa.klembare@ee.doe.gov

Table 7: List of participating countries and national task leaders in the triennium 2013-2015.

	National Task leader	Affiliation	E-mail
Australia	Gil Garnier	Monash University	Gil.Garnier@monash.edu.au
Austria	Gerfried Jungmeier	Joanneum Research	Gerfried.jungmeier@joanneum.at
Canada	Maria Wellisch	Agriculture and Agri-Food Canada	maria.wellisch@agr.gc.ca
Denmark	Henning Jørgensen	University of Copenhagen	hnj@life.ku.dk
Germany	Heinz Stichnothe	Thünen Institut of Agricultural Technology	heinz.stichnothe@ti.bund.de
Ireland	Patrick Walsh	Energy Research Group, National University of Ireland	patrick.j.walsh@nuigalway.ie
Italy	Isabella De Bari	ENEA C.R. TRISAIA	Isabella.debari@enea.it
Japan	Kazunori Habu	NEDO	habukzn@nedo.go.jp
	Akihiko Kondo	Kobe University	akondo@kobe-u.ac.jp
Netherlands	Rene van Ree (Task 42 leader)	Wageningen University and Research Centre	rene.vanree@wur.nl
	Ed de Jong	Avantium Technologies BV	Ed.dejong@avantium.com
New Zealand	Kirk Torr	Scion Research	Kirk.Torr@scionresearch.com
USA	Melissa Klembara	US Department of Energy	Melissa.klembara@ee.doe.gov

For more and updated information please visit the website:
http://www.iea-bioenergy.task42-biorefineries.com