IEA Bioenergy Countries' Report

Bioenergy policies and status of implementation

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Bioenergy policies and status of implementation

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Table of Contents

Introduction

This report was prepared from IEA statistical data, information from IRENA, and IEA Bioenergy Tasks' country reports, combined with data provided by the IEA Bioenergy Executive Committee. All individual country reports were reviewed by the national delegates to the IEA Bioenergy Executive Committee, who have approved the content.

The individual country reports are ordered alphabetically with one exception: the EU is described as the first "country", with those countries that are EU member states directly behind the EU chapter. After that all other countries are ordered alphabetically.

In the first section of each country report, national renewable energy targets are presented (first table in each country report), and the main pieces of national legislation are discussed.

In the second section of each country report the total primary energy supply (TPES) by resources and the contribution of bioenergy are presented. All data is taken from IEA statistics for the year 2014. Where 2014 data was not available, 2013 data was used. It is worth noting that data reported in national statistics can differ from the IEA data presented, as the reporting categories and definitions are different.

The first figure presents the Total Primary Energy Supply (TPES) by source. TPES is defined as production plus imports minus exports minus marine and aviation bunkers and plus/minus stock changes (see definition in next section). Thus, according to the IEA definition of TPES, because of imports, both primary and secondary energy carriers are displayed. Nevertheless, this figure depicts the share of fossil energy carriers in the country's energy mix, with the drawback that the source of imported electricity is unknown. Resource categories displayed include coal and coal products; crude oil, natural gas liquid (NGL) and oil products; natural gas; nuclear; renewable energy and electricity (imported minus exported).

The second figure focuses on the share that different renewable energy sources provide to the total primary energy supply. Several renewable sources such as hydropower, geothermal, solar, wind and biofuels & wastes are taken into consideration.

In the third figure, the contribution of different biofuels is presented in detail. These include renewable municipal wastes, solid biofuels, biogases, biogasoline, biodiesel and other liquid biofuels. It is worth noting that biogasoline includes all types of biofuels being used in Otto engines, and biodiesel includes all types of biofuels being used in Diesel engines, see definitions in next section for details.

The fourth figure presents the trend in the evolution of bioenergy for each country from the year 1990 to 2014. Values presented are total primary energy supply in each of the categories liquid biofuels, biogases and solid biofuels. The share of bioenergy is calculated from the total TPES as depicted in Figure 1.

The second table presents Total Primary Energy Supply in 2014 per unit population, as well as the energy that bioenergy in total and solid, gaseous and liquid biofuels provide to this.

In the third section of each country report, the research focus related to bioenergy is discussed. Relevant funding programs, major research institutes and projects are described. In the fourth section, recent major bioenergy developments are described. Finally, in the fifth section, links to sources of information are provided.

DEFINITIONS

IEA statistical data is collated from national data, so that the data is the same as reported in e.g. Eurostat. However, data is presented as summarized data, and the way it is displayed differs from the way in which Eurostat and others display their data. The details of how IEA data is collated and displayed are explained in the IEA Energy Statistics Manual which is available from the IEA website in many different languages. Also available on the IEA website are the balance definitions, part of which are also displayed below. For more definitions please check www.iea.org/statistics/resources/balancedefinitions/#tpes.

Total Primary Energy Supply

is made up of:

+ Indigenous production

+ imports

- exports

- international marine bunkers

- international aviation bunkers

+/- stock changes.

Production

Production refers to the production of primary energy, i.e. hard coal, lignite, peat, crude oil, NGL, natural gas, combustible renewables and waste, nuclear, hydro, geothermal, solar and the heat from heat pumps that is extracted from the ambient environment. Production is calculated after removal of impurities (e.g. sulphur from natural gas). Calculation of production of hydro, geothermal, etc. and nuclear electricity is explained in the *Energy Statistics Manual* available for free download on the IEA website.

Imports and Exports

Imports and exports comprise amounts having crossed the national territorial boundaries of the country, whether or not customs clearance has taken place.

International marine bunkers

International marine bunkers covers those quantities delivered to ships of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways, and in coastal waters. Consumption by ships engaged in domestic navigation is excluded. The domestic/international split is determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship. Consumption by fishing vessels and by military forces is also excluded.

International aviation bunkers

International aviation bunkers includes deliveries of aviation fuels to aircraft for international aviation. Fuels used by airlines for their road vehicles are excluded. The domestic/international split should be determined on the basis of departure and landing locations and not by the nationality of the airline. For many countries this incorrectly excludes fuel used by domestically owned carriers for their international departures.

Note: In October 2008 the IEA hosted the 3rd meeting of InterEnerStat. This group is made up of 24 international organizations that collect or use energy statistics. One of the objectives of the group is to improve the quality of energy data by harmonizing definitions for energy sources and flows. As a result of this meeting, the IEA has decided to align its energy statistics and balances with most other international organizations and to treat international aviation bunkers in the same way as international marine bunkers. Starting with the 2009 edition, international aviation bunkers is subtracted out of supply in the same way as international marine bunkers.

Stock Changes

Stock changes reflect the difference between opening stock levels at the first day of the year and closing levels on the last day of the year of stocks on national territory held by producers, importers, energy transformation industries and large consumers. A stock buildup is shown as a negative number, and a stock drawdown as a positive number.

Biofuels and Waste

Biofuels & waste is comprised of solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste. Note that for biomass commodities, only the amounts specifically used for energy purposes (a small part of the total) are included in the energy statistics. Therefore, the non-energy

use of biomass is not taken into consideration and quantities are null by definition. Data under this heading are often based on small sample surveys or other incomplete information. Thus the data give only a broad impression of developments, and are not strictly comparable between countries. In some cases complete categories of vegetal fuel are omitted through lack of information. For more information on a fuel type, please see the following list:

Biogases

Biogases are gases arising from the anaerobic fermentation of biomass and the gasification of solid biomass (including biomass in wastes). The biogases from anaerobic fermentation are composed principally of methane and carbon dioxide and comprise landfill gas, sewage sludge gas and other biogases from anaerobic fermentation.

Biogases can also be produced from thermal processes (by gasification or pyrolysis) of biomass and are mixtures containing hydrogen and carbon monoxide (usually known as syngas) along with other components. These gases may be further processed to modify their composition and to produce substitute natural gas.

Liquid biofuels

Liquid biofuels includes biogasoline, biodiesel and other liquid biofuels. It does not include the total volume of gasoline or diesel into which the biofuels are blended.

Biogasoline includes bioethanol (ethanol produced from biomass and/or the biodegradable fraction of waste), biomethanol (methanol produced from biomass and/or the biodegradable fraction of waste), bioETBE (ethyl-tertio-butyl-ether produced on the basis of bioethanol; the percentage by volume of bio-ETBE that is calculated as biofuel is 47%) and bioMTBE (methyl-tertio-butyl-ether produced on the basis of biomethanol: the percentage by volume of bioMTBE that is calculated as biofuel is 36%).

Biodiesels includes biodiesel (a methyl-ester produced from vegetable or animal oil, of diesel quality), bio-dimethylether (dimethylether produced from biomass), Fischer Tropsh (Fischer Tropsh produced from biomass), cold pressed bio-oil (oil produced from oil seed through mechanical processing only) and all other liquid biofuels which are added to, blended with or used straight (unblended) as transport diesel. Other liquid biofuels includes liquid biofuels not reported in either biogasoline or biodiesels.

Industrial waste

Industrial waste of non-renewable origin consists of solid and liquid products (e.g. tyres) combusted directly, usually in specialised plants, to produce heat and/or power. Renewable industrial waste is not included here, but with solid biofuels, biogas or liquid biofuels.

Municipal waste

Municipal waste consists of products that are combusted directly to produce heat and/or power and comprises wastes produced by households, industry, hospitals and the tertiary sector that are collected by local authorities for incineration at specific installations.

Primary solid biofuels and charcoal

Primary solid biofuels and charcoal are defined as any plant matter used directly as fuel or converted into other forms before combustion. This covers a multitude of woody materials generated by industrial processes or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, sulphite lyes also known as black liquor, animal materials/wastes and other solid biomass).

Charcoal produced from solid biomass is also included here. Since charcoal is a secondary product, its treatment is slightly different than that of the other primary solid biofuels. Production of charcoal (an output in the transformation process) is offset by the inputs of primary solid biofuels into the charcoal production process. The losses from this process are included in the row 'other transformation'. Other supply (e.g. trade and stock changes) as well as consumption are aggregated directly with the primary solid biofuels. In most countries, only the primary solid biofuels are reported.

UNITS

The standard unit convertor of the International Energy Agency was used.

(Source: https://www.iea.org/statistics/resources/unitconverter/)

kilo (k) 10^3

mega (M) 10^6

giga (G)10^9

tera (T) 10^{12}

peta (P) 10^{15}

SYMBOLS AND ABBREVIATIONS

IEA International Energy Agency

EU European Union

NREAP National Renewable Energy Action Plans

GHG Green House Gases

SRES Small-scale Renewable Energy Scheme

LRES large-scale Renewable Energy Scheme

RES Renewable Energy Scheme

GC Green Certificates

RED Renewable Energy Directive

FQD Fuel Quality Directive

Data Overview

An overview of the percentage of renewable energy in the total primary energy supply in 2014 for all investigated countries is presented in Figure 1. Norway, Brazil and New Zealand have the highest shares of renewable energy, mainly coming from bioenergy in Brazil and from hydropower in Norway and New Zealand.

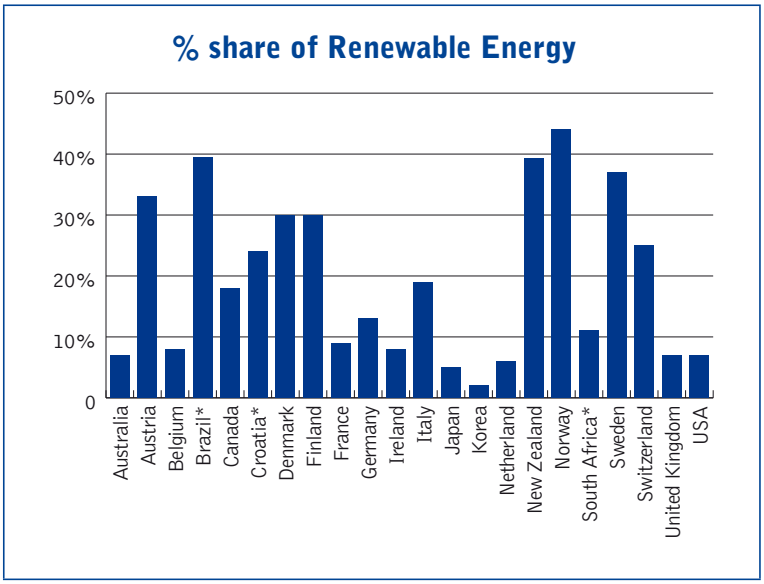

Figure 1: Percentage of renewable energy in year 2014
(Source: World Energy Balances © OECD/IEA 2015)

Note: values for Brazil, Croatia and South Africa are from year 2013

The percentage of bioenergy in the total primary energy supply in 2014 for all investigated countries is presented in Figure 2. Brazil, Finland, Denmark, Sweden and Austria have the highest shares.

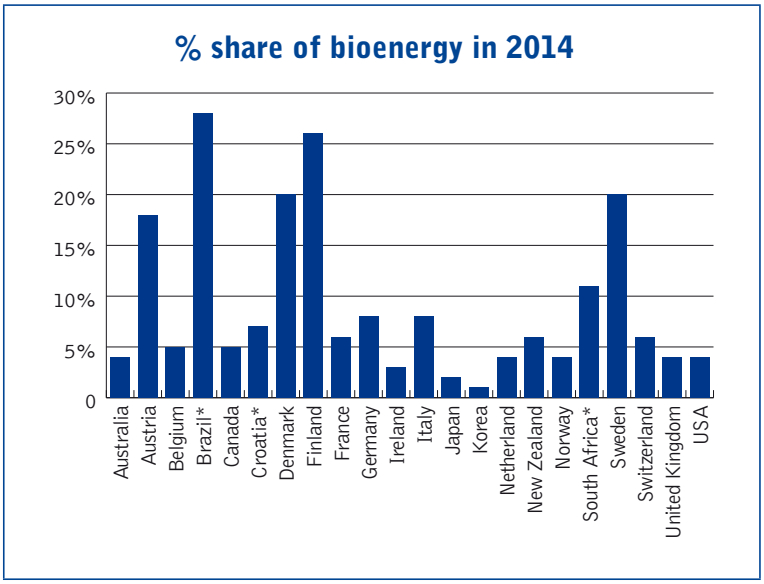

Figure 2: Percentage of bioenergy in year 2014
(Source: Renewables Information © OECD/IEA 2015)

Note: values for Brazil, Croatia and South Africa are from year 2013

The absolute amounts of bioenergy for each country are displayed in Figure 3. Finland is by far leading the pack, with Sweden ranked second.

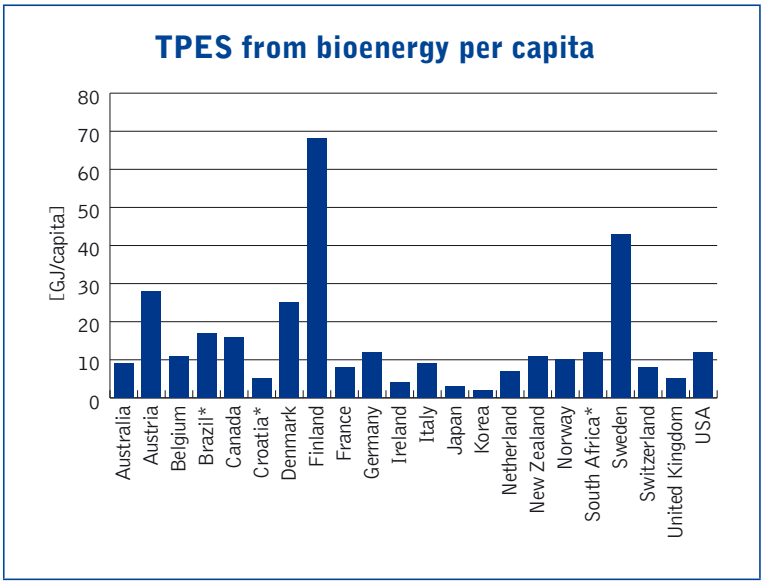

Figure 3: TPES from bioenergy in year 2014
(Source: World Energy Balances © OECD/IEA 2015)

Note: values for Brazil, Croatia and South Africa are from year 2013

Figure 4 presents an overview on the national targets for renewable energy, generally for the year 2014. Norway and Sweden have the highest ambitions for renewable energy shares.

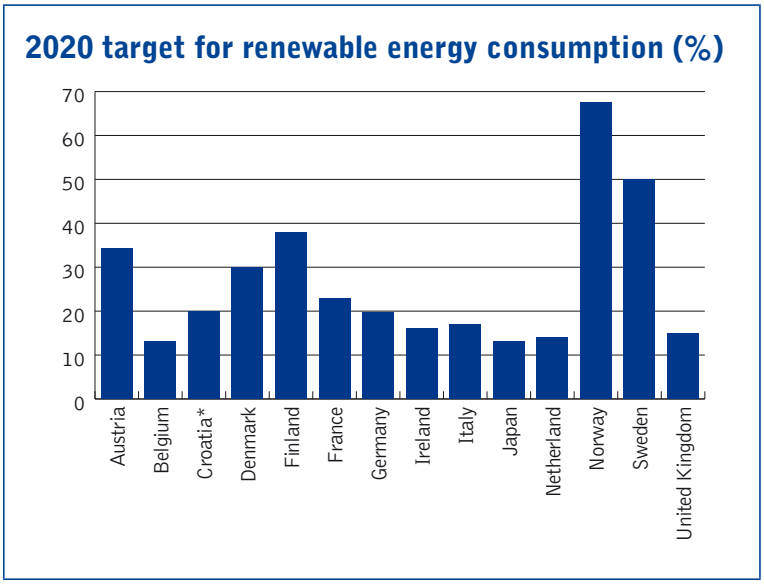

Figure 4: Renewable energy consumption targets for year 2020
(Source: own compilation)

Note: Only the countries with a clearly defined 2020 target are presented in this figure

EU and EU Member Countries

In this section of the report, an overview on the situation in the EU and the country reports of the EU member countries are presented. EU member countries are presented in alphabetical order.

European Union (EU)

EUROPEAN POLICY FRAMEWORK

The Renewable Energy Directive Directive (2009/28/EC)[1] established a European framework for the promotion of renewable energy, setting mandatory national renewable energy targets for achieving an overall 20% share of renewable energy in the EU final energy consumption by 2020, with a sub-target for the transport sector of 10% renewables (multiplication factors applied for several types of renewable energy). The Renewable Energy Directive also established sustainability criteria for transport biofuels that have to be met by any biofuel used to count towards this target, including a lifecycle greenhouse gas emission reduction of at least 35% until 2017 and 50% (to 60% for new installations) afterwards. Within this Directive, member countries of the European Union are obliged to draft and submit to the European Commission National Renewable Energy Action Plans (NREAPs)[2] outlining the pathway which will allow them to meet their 2020 renewable energy, energy efficiency and greenhouse gases (GHG) emission reduction targets. Summarizing the individual NREAPs, the split in sectors is envisaged as displayed in the table below (Table 1).

Table 1: EU's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	20%
Heating and cooling	21%*
Electricity	34%*
Transport	10%

(Source: NREAP)

A number of directives regulate the transport biofuels use in the EU including the Renewable Energy Directive 2009/28/EC, the Fuel Quality Directive 2009/30/EC and the iLUC Directive 2015/1513/EC. Furthermore, biofuels are covered by a number of existing EU policies and initiatives on bioenergy, sustainable transport and the bioeconomy, e.g.: the SET Plan comprising the European Industrial Bioenergy Initiative (EIBI); the Energy package "Energy 2020 – A strategy for competitive, sustainable and secure energy"; and the Strategy for a Sustainable European Bioeconomy.

The purpose of the EIBI is to boost the contribution of sustainable bioenergy to EU 2020 climate and energy objectives. The scope of the EIBI is focused on innovative bioenergy value chains which are not yet commercially available, and which could bring a significant contribution to the bioenergy markets by large scale deployment, whilst complying with the current sustainability requirements set in relevant EU legislation

On 28 April 2015, the European Parliament voted to approve new legislation, the "iLUC Directive 2015/1513/EC" (iluc: indirect land use change), which limits the way Member States can meet the target of 10% for renewables in transport by 2020. There will be a cap of 7% on the contribution of biofuels produced from 'food' crops, and a greater emphasis on the production of advanced biofuels from non-food and waste feedstocks. Member States must include the law in national legislation by 2017, and show how they are going to meet sub-targets for advanced biofuels. The other 3% will come from a variety of multiple counted alternatives:

- renewable electricity in rail (counted 2.5 times);
- renewable electricity in electric vehicles (counted 5 times);
- biofuels from used cooking oil and animal fats (double counted and with an indicative 0.5% sub-target).

The agreement also includes the reporting and publishing of data on iLUC-related emissions on both national and European level.

1 Available here: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0028 (last access March 1, 2016).

2 For more information see: http://iet.jrc.ec.europa.eu/remea/national-renewable-energy-action-plans-nreaps (last access March 1, 2016).

RESEARCH FOCUS RELATED TO BIOENERGY

The EU has supported bioenergy-related research and technology development (RTD) under several successive Framework Programmes, covering the whole chain from feedstock production to end-use. Between 1998 and 2002 around 100 projects were supported under Framework Programme FP5 with a total budget of EUR 140 million. Priority during this time was given to research into thermal processes (heat and electricity production from biomass), although eight projects on transport biofuels were supported. The following Framework Programme FP6, running from 2002 to 2006 funded 40 projects with a total amount of around EUR 150 million. In the area of biofuels seven projects with a clear focus on 2nd generation biofuel technologies were supported. Moreover, three Integrated Projects (IP) were established for hydrogen production, biorefineries and combustion/co-firing. A Network of Excellence (NoE) was set up to overcome barriers to bioenergy implementation. During FP6 the Biofuels Technology Platform was launched, which has become the core of the biofuels community in Europe. In the framework of the Intelligent Energy Europe Programme the EC is financing research aimed at overcoming non-technical barriers, which are impeding the market penetration of this type of renewable energy.

The Framework Programme (FP7), starting in 2007, has been focusing on biofuels and renewable electricity production from biomass. The predominance of biofuel projects was a direct result of the high oil prices during that period. Thus far, more than 20 projects have been supported with around EUR 70 million.

Horizon 2020 is the largest EU Research and Innovation programme ever with nearly EUR 80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract. It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market. Funding for bioenergy research is best placed under that part of H2020 that addresses societal challenges, in particular the challenge "Secure, Clean and Efficient Energy". The 2014 and 2015 budgets for such activities were EUR 640 million and EUR 670 million respectively.

RECENT MAJOR BIOENERGY DEVELOPMENTS

In 2014, the 2030 climate and energy framework was adopted. It builds on the 2020 climate and energy package, and it sets three key targets for the year 2030:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 27% share for renewable energy
- At least 27% improvement in energy efficiency

The framework is also in line with the longer term perspective set out in the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050 and the Transport White Paper.

In contrast to the Renewable Energy Directive, the Climate and Energy Package sets neither specific sub-targets for any of the sectors, nor binding targets for individual countries.

LINKS TO SOURCES OF INFORMATION

The following websites provide useful information and data on EU renewable energy policy, production and consumption.

- EU Transparency Platform for Renewable Energy
- https://ec.europa.eu/energy/en/topics/renewable-energy
- Directive 2009/28/EC on the promotion of the use of energy from renewable sources http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32009L0028
- A policy framework for climate and energy in the period from 2020 to 2030 http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52014DC0015
- Current policy & implications to NREAP implementation www.biomasspolicies.eu

EU policies and initiatives on bioenergy:

- Strategic Energy Technology Plan
  http://ec.europa.eu/energy/en/topics/technology-and-innovation/strategic-energy-technology-plan
- European Industrial Bioenergy Initiative (EIBI)
  http://www.biofuelstp.eu/eibi.html
- EU strategy for biofuels
  http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV:l28175
- Energy 2020 A strategy for competitive, sustainable and secure energy
  http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:en0024
- A resource-efficient Europe – Flagship initiative of the Europe 2020 Strategy
  http://ec.europa.eu/resource-efficient-europe/
- Strategic Energy Technologies Information System (SETIS)
  https://setis.ec.europa.eu/
- Renewable Energy Road Map
  http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV:l27065
- Clean Vehicles Directive
  http://ec.europa.eu/transport/themes/urban/vehicles/directive/
- Climate Change: 2050 – the future begins today
  http://www.biofuelstp.eu/downloads/040209_resolution_ep_climate_change.pdf

Austria

NATIONAL POLICY FRAMEWORK

Austria has committed to a target of 34% share of renewable energy in gross final energy consumption in 2020, with a split in sectors as displayed in the table below.

Table 2: Austria's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	34.2%
Heating and cooling	32.6%
Electricity	70.6%
Transport	11.4%

(Source: NREAP)

Austria has established a comprehensive legislative and administrative framework regulating and facilitating sustainable development of renewable energies. This framework is supported by various financial, fiscal, research and promotional measures and incentives.

The Green Electricity Act sets the following targets for new installations until 2020: Hydro 1,000 MW, Wind 2,000 MW, PV 1,200 MW, Biomass and Biogas 200 MW. A feed-in tariff scheme under the Green Electricity Act supports the recovery of the investments.

The fuel ordinance amendment 2012 sets a quota for biofuels and defines tax exemptions. By 2020, 8.45% (with regard to energy content) of the diesel and petrol provided to the transport sector have to be substituted by energy from renewable resources.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Austria

In addition to fostering the development towards renewable and bio-based energy feedstocks, measures for the material use of bio-based feedstock and the increase in resource efficiency complement the approach of a bio-based economy. On the one hand the Austrian energy-efficiency law aims at increasing energy efficiency by 20% by 2020 and at ensuring security of supply; on the other hand R&D effort is put into developing biorefinery systems to optimize resource use both for energy and for material.

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Austria in 2014 amounted to 1,342 Petajoule (PJ) with fossil fuels (oil, gas, coal) still contributing most. Renewable energy sources have a share of 32.8% or 441 PJ. Oil products account for a third of the energy supply (474 PJ), coal products (127 PJ) and natural gas are contributing to another third (267 PJ). Electricity as source has a share of merely 2.5% or 33 PJ.

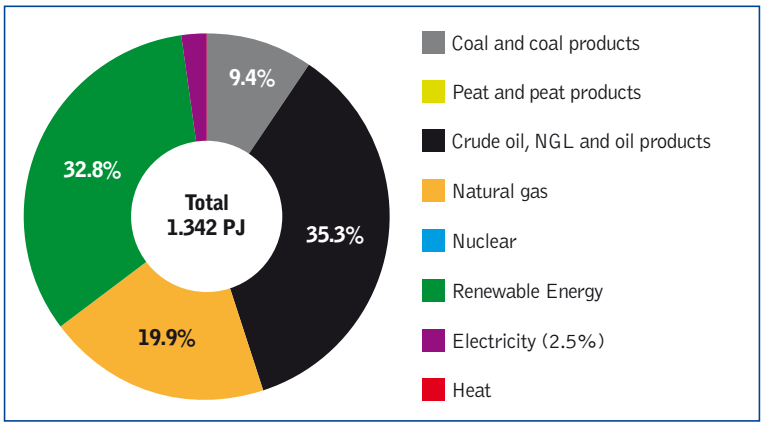

Figure 5: Total primary energy supply in Austria in 2014
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources comprises energy from biomass with 61.0%, followed by hydropower with 33.0%, solar and wind energy together with 6.0% and geothermal power with 0.3%.

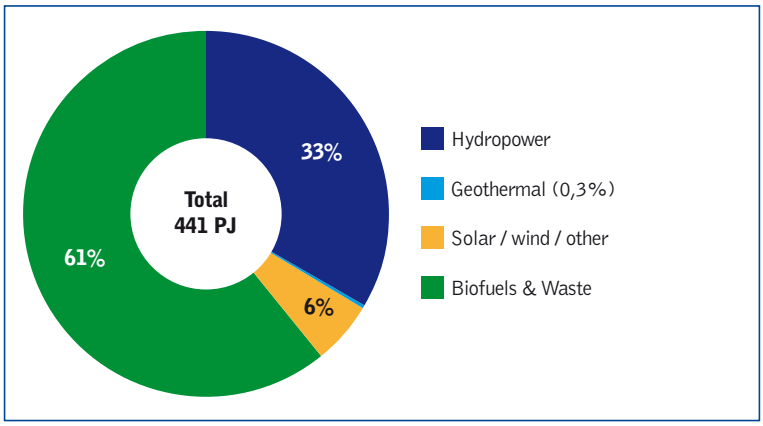

Figure 6: Total primary energy supply of Renewable Energy Sources in Austria in 2014
(Source: World Energy Balances © OECD/IEA 2015)

The major part (84%) of bioenergy consumed in Austria is composed of solid biofuels. Solid biofuels include fuel wood, wood chips, bark and sawmill by-products. Fuel wood is the most important biogenic source of energy in Austria with a share of 25% of total bioenergy consumed. Wood chips, bark and sawmill by-products together contribute a share of 37%. Wood chips and sawmill by-products are primarily used for energy production in forest based industries, as well as in cogeneration and district heating plants. Pellets are mainly used in domestic heating systems. Waste lye, sludge and bark are used for the production of electricity and process heat in the pulp and paper industry.

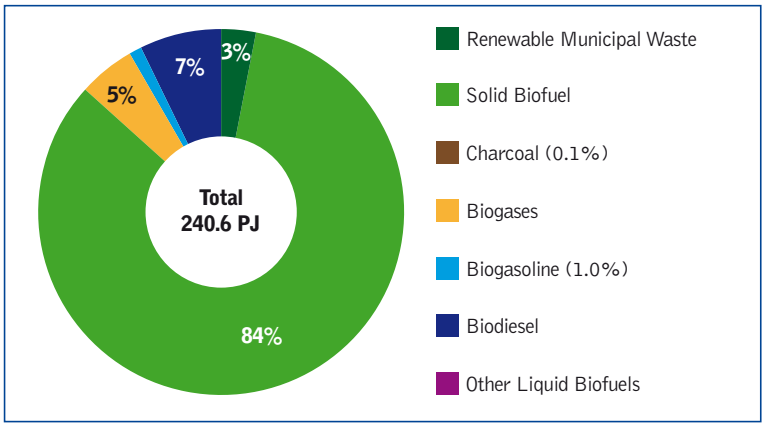

Figure 7: Total primary energy supply from bioenergy in Austria in 2014
(Source: Renewables Information © OECD/IEA 2015)

The supply of bioenergy in Austria more than doubled from 1990 to 2014. In 1990 bioenergy almost entirely originated from solid biomass and accounted for 97 PJ. In 2014 solid biomass contributed 209 PJ, liquid biofuels 20 PJ and gaseous 12 PJ. The share in total final energy consumption increased from 1990 (9.3%) to 2014 (17.9%). The sharpest rise in consumption occurred between 2005 and 2010, when the use of solid biomass increased and liquid biofuels were established on the market.

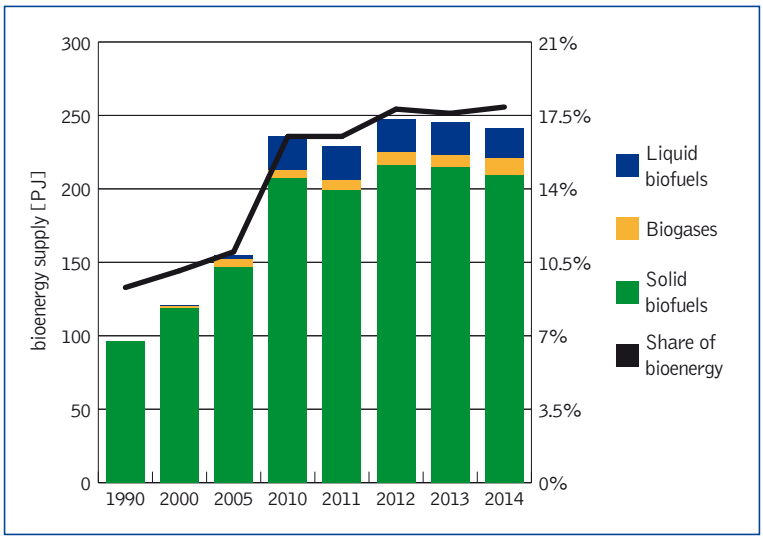

Figure 8: Development of total primary energy supply from bioenergy in Austria 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 156 GJ, which comprised of 28 GJ of biogenic, 24.3 GJ solid biomass, 2.3 GJ liquid biofuels and 1.4 GJ of gaseous biofuels.

Table 3: Total primary energy supply per capita in 2014

Total energy	156 GJ/capita
Bioenergy	28 GJ/capita
Solid biofuels	24.3 GJ/capita
Gaseous biofuels	1.4 GJ/capita
Liquid biofuels	2.3 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Austria's population in 2014 accounted for 8.6 million people

RESEARCH FOCUS RELATED TO BIOENERGY

In 2010 the Ministry of Transport, Technology and Innovation (BMVIT) prepared the Austrian Energy Research Strategy. Later on it released agendas for bioheating (2012) and most recently for a biobased industry. The successful development of the bioenergy sector is based on a long-lasting, internationally oriented R&D policy which aims to become innovation leader. Beside others the Ministry supports Austrian's participation in IEA Bioenergy since the first days of the Agreement.

The "Competence Centers for Excellent Technologies" program (COMET) financed by the BMVIT and the Ministry of Economy (BMWFW) is bundling existing expertise and supports cooperation with leading researchers, scientific and company partners. In the frame of this program pre-competitive bioenergy research has been concentrated in the Bioenergy2020+ Ltd.

In 2010 the Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) and the BMWFW published an energy strategy. The pillars of the strategy are the promotion of energy efficiency and renewable energies as well as long-term energy security. Specific programmes are financed by the Austrian Climate and Energy Fund (KLIEN). This fund is endowed by the BMVIT and the BMLFUW. It focuses on advancing the mobility and energy transitions and subsidizes measures for the reduction of greenhouse gas emissions. KLIEN is a hub for relevant issues of climate protection and reduces the time to market of research results. R&D projects are funded within the KLIEN's Energy Research Programme.

Research on bioenergy and biobased industries is also carried out at universities, especially the technical universities of Vienna and Graz and the University of Natural Resources and Life Sciences in Vienna. In addition, two large publicly-owned research institutes (Joanneum Research, Austrian Institute of Technology) work on bioenergy and biobased industries. Among others, the Energy Institute at the Johannes Kepler University Linz, as well as the Competence Centre for Wood Composites & Chemistry (Wood K plus) are linking basic research with industry needs. The International Institute for Applied Systems Analysis (IIASA), a non-governmental research organization, carries out systems analysis in general and also puts efforts on biobased systems.

Austrian's industry is involved in R&D through large industrial companies – including Siemens, Andritz and GE Jenbacher – that are engaged in researching power plant and process engineering, power stations and control centres. Last but not least a range of small and medium sized enterprises are strongly engaged in the development and production of bioenergy technologies. In the biorefinery sector companies like Lenzing, Mondi, Heinzl, Sappi, and Agrana are exploring and implementing integrated valorisation pathways.

LINKS TO SOURCES OF INFORMATION

The following websites provide useful information and data on national Austrian bioenergy policy, production and consumption.

Relevant ministries:

- Ministry of Agriculture, Forestry, Environment and Water Management: http://www.bmlfuw.gv.at/
- Ministry of Economy: http://www.bmwfw.gv.at
- Ministry of Transport, Technology and Innovation: http://www.bmvit.gv.at/

Funding programmes:

- Austrian Climate and Energy Fund: www.klimafonds.gv.at
- Funding programme "Future Production": https://www.ffg.at/produktionderzukunft; https://www.klimafonds.gv.at/assets/Uploads/Expertenbeirat/Climate-and-Energy-FundFunction-and-effect20140610.pdf

Relevant documents:

- Austrian energy research strategy: http://www.bmvit.gv.at/innovation/downloads/energieforschungsstrategie.pdf (German)

- Research agenda for bioheating and cooling: http://www.nachhaltigwirtschaften.at/nw_pdf/1254_fti_roadmap_bioheating_and_cooling.pdf (German)
- Research agenda biobased industry (forestry feedstock): http://www.nachhaltigwirtschaften.at/results.html/id7113 (in German)
- Research agenda biobased industry (other biogenic feedstock): http://www.fabrikderzukunft.at/results.html/id7793 (in German)
- Austrian energy strategy: www.energiestrategie.at

Sustainable development and statistical data:

- Sustainable development: http://www.nachhaltigwirtschaften.at/
- IEA Bioenergy in Austria: http://www.nachhaltigwirtschaften.at/iea/results.html/id1970
- Biobased Future: http://www.nachhaltigwirtschaften.at/results.html/id6874
- Network Biofuels: www.network-biofuels.at/
- Information on environment and energy: http://www.umweltbundesamt.at/umweltsituation/energie/erneuerbare/
- Statistical data on renewable energy, provided by Statistics Austria: http://www.statistik.at/web_de/statistiken/energie_umwelt_innovation_mobilitaet/energie_und_umwelt/index.html
- Information and data on renewable energy, provided by E-Control: http://www.e-control.at/marktteilnehmer/oeko-energie

Relevant stakeholders in academia and industry:

- Vienna University of Technology: www.tuwien.ac.at
- Vienna University of Natural Resources and Life Sciences: www.boku.ac.at
- Graz University of Technology: www.tugraz.at
- Joanneum Research: www.joanneum.at
- Austrian Institute of Technology: www.ait.ac.at
- Bioenergy 2020+: www.bioenergy2020.eu
- Kompetenzzentrum Holz GmbH: http://www.wood-kplus.at
- Energy Institute at the Johannes Kepler University Linz: http://www.energieinstitut-linz.at/
- AAE Intec: http://www.aee-intec.at/

Belgium

NATIONAL POLICY FRAMEWORK

Belgium has a national binding target for renewable energy stated in the EU Renewable Energy Directive (2009/28/EC) to account for 13% of gross final energy consumption in 2020. The targeted shares of the three sectors heating/ cooling, electricity and transport are shown in Table 4.

Table 4: Belgium's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	13%
Heating and cooling	12%
Electricity	21%
Transport	10%

(Source: NREAP)

Renewables policy is mainly the responsibility of the regions with the exception of offshore wind and biofuels. Regions support renewable energy technologies through investment subsidies and green certificates. Additionally, the Federal Government provides tax incentives (IEA country report Belgium 2009).

In order to foster electricity from renewable sources, green certificate schemes have been established. Electricity suppliers need to fulfil yearly quotas for green power. If an over supply of certificates is disturbing the market, grid operators are obliged to buy green certified power at minimum prices. Criteria for the attribution of a green certificate and minimum prices are set by the Federal Government for offshore wind power and ocean power, and by the regional governments, i.e. Brussels, Flanders, and Wallonia, for all other kinds of renewable sources, including from biomass.

Parallel to that, investment subsidy schemes exist in all regions in renewable energy projects. The grants vary between 20% and 50% of the invested sum. Wallonia runs an extra programme for micro-cogeneration from wood combustion. The dedicated fund accounts for 6 million Euro. Furthermore, Wallonia endowed 1 million euro to an energy fund that supports research in electricity production from natural gas and renewable sources.

In terms of biofuels, obligatory blending is governed by the law of obligation for the incorporation of biofuels in fossil fuels. The blending requirement was 4% in 2009. In addition, excise tax reduction is granted for biodiesel blends in diesel of at least 3.6% and for ethanol blends in gasoline of at least 7%.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Belgium

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Belgium in 2014 amounted to 2,262 Petajoule (PJ) and is still overwhelmingly dominated by fossil fuels. Oil products account for nearly half of the energy consumption (985 PJ), and natural gas is contributing another quarter (529 PJ). Renewable energy sources have a share of only 8% or 179 PJ. The statistic also features 292 PJ or 16% of electrical energy coming from nuclear power stations. After renewable energy sources coal takes 5.8%, electricity 2.8% and heat 0.3%.

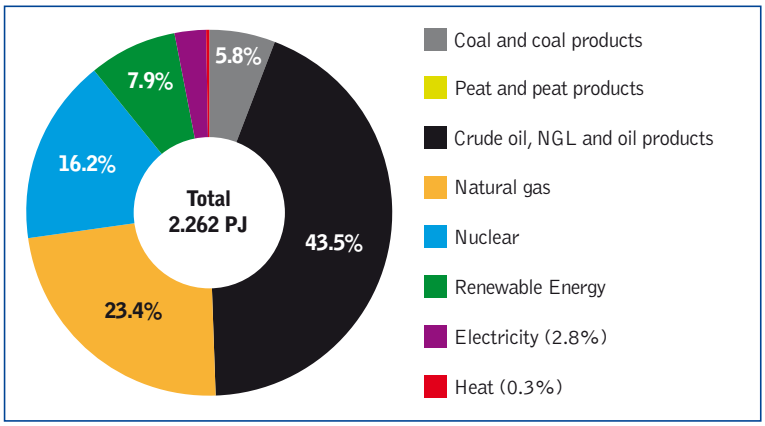

Figure 9: Total primary energy supply in Belgium in 2014
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources is largely covered by energy from biomass, with 83%. Wind and solar energy contribute the remaining 16%. Hydro energy amounts to 0.6% and the role of geothermal is not significant.

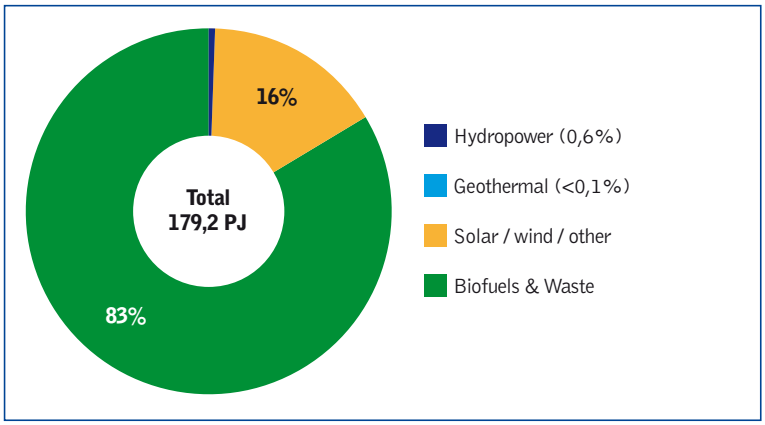

Figure 10: Total primary energy supply of Renewable Energy Sources in Belgium in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Belgium comes from solid biofuels; their share accounts for 70% of the total use of bioenergy or 84 PJ. Solid biofuels include fuel wood, wood chips, bark and sawmill residues. The second largest item is biodiesel (13% or 15 PJ) followed by the renewable share of municipal waste (9% or 11 PJ). Biogas contributes 7.7 PJ, biogasoline 1.5 PJ, charcoal 0,2% and other liquid biofuels 0.8%.

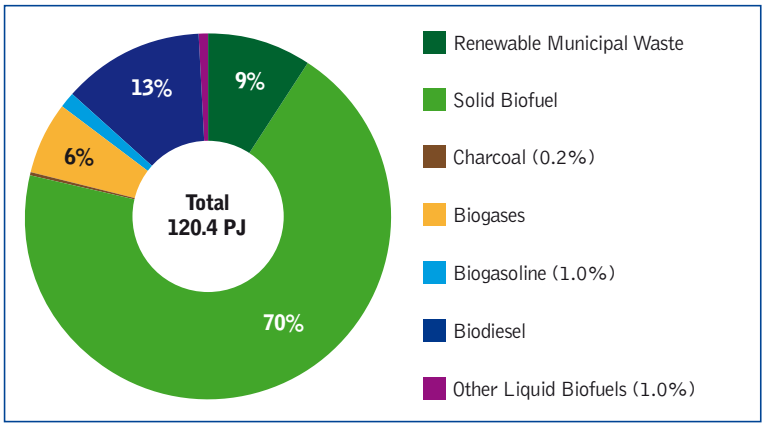

Figure 11: Total primary energy supply from bioenergy in Belgium in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Belgium increased more than fivefold from 1990 to 2010. Consumption was rather stable from 2010-2014. In 1990 bioenergy only came from solid biomass and accounted for 19 PJ. In 2014 solid biomass contributed 95 PJ, liquid biofuels 18 PJ and gaseous 8 PJ. The share in total final energy consumption climbed from 0.9% to 5.3% in the same period. The sharpest rise in consumption occurred between 2005 and 2010 when the use of solid biomass almost doubled and liquid biofuels were established on the market by the blending obligation.

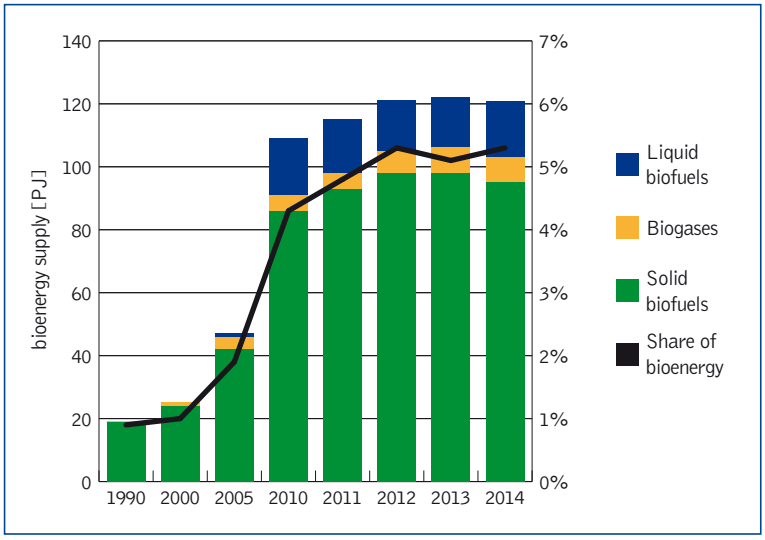

Figure 12: Development of total primary energy supply from bioenergy in Belgium 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 201 GJ, which comprised of 10.7 GJ of biogenic, 8.4 GJ solid biomass, 0.7 gaseous biofuels and 1.6 GJ liquid biofuels.

Table 5: Total primary energy supply per capita in 2014

Total energy	201 GJ/capita
Bioenergy	10.7 GJ/capita
Solid biofuels	8.4 GJ/capita
Gaseous biofuels	0.7 GJ/capita
Liquid biofuels	1.6 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Belgium's population in 2014 accounted for 11.3 million people

RESEARCH FOCUS RELATED TO BIOENERGY

In Belgium bioenergy research has broadened its scope to bio-based value chains, not only making energy out of biomass. The following bio-based value chains in a bio-based economy receive important attention in research:

- Wood, more specifically lignin based bio-refinery to bio-aromatics: Universities such as KUL, UGent and research institutes such as Vito and Bio Base Europe are researching possibilities of using lignin for the production of bio-aromatics in a bio-refinery concept.
- The region of Flanders has at the moment 40 anaerobic co-digestion installations producing biogas. Research is focusing on the use of the digestate after the digestion. Digestate cannot be returned to the agricultural fields due to environmental restrictions. Research is focusing on separating parts of the wet fraction and converting these fractions into fertilizer and soil improvers, with similar characteristics. A first demonstration at full scale on ammonia stripping will be implemented in 2016.
- During the last 5 years there was an impressive evolution in the amount of pocket digestion installations of cattle manure. Research is going on to see if such kinds of pocket digesters can also be used to process pig manure.

RECENT MAJOR BIOENERGY DEVELOPMENTS

Recently the region of Flanders awarded the environmental and building permit and the green certificate approval for **2 large scale solid biomass combustion power plants**: one in the harbor of Gent and the other in Langerlo (a complete transformation of a former coal combustion plant to a dedicated biomass power plant). Focus will be on producing electricity; the possibility of heat delivery in a CHP configuration is being investigated. The due date for first production will be 2018. Both installations will have a total installed capacity of 550 MWe.

Over the last 10 years, **40 anaerobic co-digestion installations** have been installed, using the biogas in a CHP-engine. The growth path has probably reached its ceiling based on the availability of co-digestion feedstock streams. No new investments are expected in this sector.

From 2011 to 2015 **anaerobic pocket digesters** on cattle manure at farm scale (circa 10 kWe) have had an exponential increase: from 2 installations in Flanders in 2011 to 76 installations in 2015. One company developed a concept suitable and manageable for individual farmers. Export of this system is taking off.

Residential organic waste fraction is being collected separately in different regions in Belgium. Until recently the organic waste was composted. At the moment local authorities are exploring the possibilities of investing in a **pre-digestion installation producing biogas before composting** the digestate. It is expected that in the coming years a transformation of the residential waste sector could take place. There is currently enough separate waste collection to install circa 11 pre-digesters (60,000 tonnes per year).

Wood for residential heating is an **important** part of the renewable heat in Belgium. Historically this was the case and no changes are expected in the future. **Wood in medium sized installations for heat production** didn't take off, as was forecasted. In the wood processing sector wood combustion is often applied, but outside the sector **no strong growth path** can be seen.

LINKS TO SOURCES OF INFORMATION

- Energy Policies of IEA Countries – Belgium 2009 Review: http://www.iea.org/publications/freepublications/publication/belgium2009.pdf.
- Sustainable use and creation of value from renewable raw materials for biobased industrial production such as biomaterials and green chemicals in Flanders: http://www.vlaanderen.be/nl/publicaties/detail/sustainable-use-and-creation-of-value-from-renewable-raw-materials-for-biobased-industrial-production-such-as-biomaterials-and
- Actieplan biomassareststromen 2015-2020: http://www.ovam.be/actieplan-biomassarestromen-2015-2020
- Biomass Policies: Benchmarking report Belgium: http://www.biomasspolicies.eu/?cat=23
- Progress Report Belgium 2013-2014 NREAP: https://ec.europa.eu/energy/en/topics/renewable-energy/progress-reports

Denmark

NATIONAL POLICY FRAMEWORK

Denmark's national binding target for renewable energy as stated in the EU Renewable Energy Directive (2009/28/EC) is 30% of gross final energy consumption in 2020. The targeted shares of the three sectors heating/ cooling, electricity and transport are shown in Table 6.

Table 6: Denmark's 2020 renewable energy targets

Sector	Expected share	Targets set in the RED and the NREAP
Overall target	35%	30%
Heating and cooling		40%
Electricity		52%
Transport		10%

(Source: NREAP)

The main vehicle to foster renewable energy is the Promotion of the Renewable Energy Act of 2009. The act provides detailed **feed-in tariffs/premium** for wind, biomass, biogas and other renewable energy sourced electricity production. In terms of biofuel, the blending quota accounts for 5.75% in diesel as well as gasoline. The Danish energy sector recently implemented its own set of sustainability criteria for biomass that go beyond the binding rules of the Renewable Energy Directive, which only apply for liquid biofuels. The principles in the Danish rules are close to the UK legislation on a sustainable biomass supply.

By 2050, Denmark wants to become independent from fossil fuels. To this end, the Danish Government adopted the "Energy Strategy 2050" in 2012. In the heating sector a solid district heating network, fed by renewable heat from biomass, will be the main motor of the energy transition. Back-up oil boilers are going to be banned in all new constructions by 2017. In the electricity sector, the Danish Government greatly focuses on wind energy, expected to provide 40% of total electricity needs, solid biomass and biogas. Transport will be based on electricity and biofuels.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Denmark

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Denmark in 2014 amounted to 686 Petajoule (PJ) and is still dominated by fossil fuels. Oil products account for more than one third (241 PJ). Natural gas accounts for 17.2% (118 PJ) and coal products for 15.9% (109 PJ). Renewable energy sources have a share of 30.3% or 208 PJ. 10 PJ come from electricity.

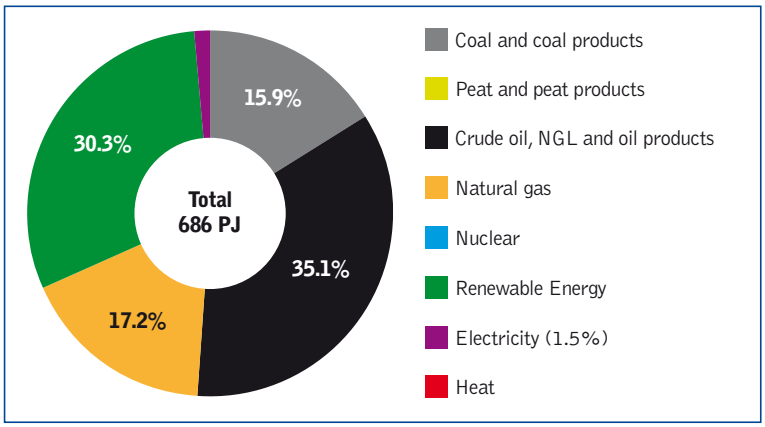

Figure 13: Total primary energy supply in Denmark in 2014
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources is mostly covered by energy biofuels and waste, with 76%. Solar and wind energy amount to 24%. Hydropower and geothermal energy are under 0.1%.

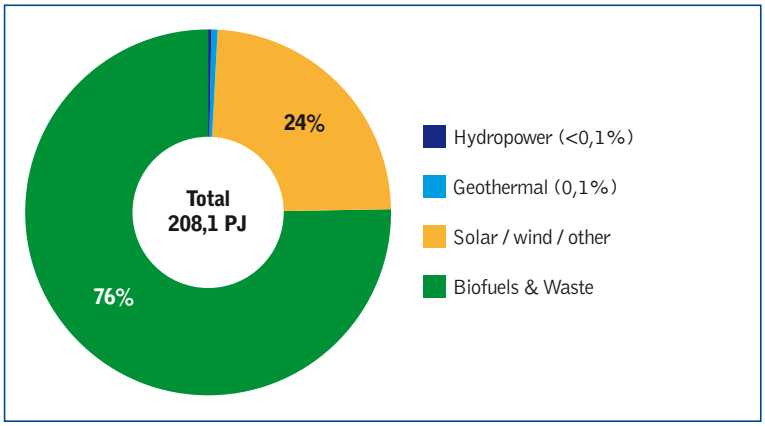

Figure 14: Total primary energy supply of Renewable Energy Sources in Denmark in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Denmark comes from solid biofuels; their share accounts for 72.8% of the total use of bioenergy or 102 PJ. The second largest item is renewable municipal waste (21.5 PJ) followed by biodiesel (10.9 PJ) and biogas (4.9 PJ).

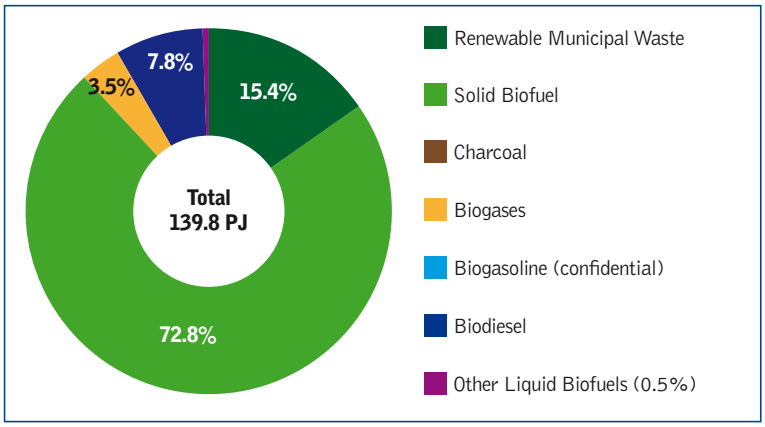

Figure 15: Total primary energy supply from bioenergy in Denmark in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Denmark increased from 1990 to 2014, with a considerable increase up to 2015 and rather stable development after. In 1990 bioenergy only came from solid biomass and accounted for 71 PJ. In 2014 solid biomass contributed 123 PJ, liquid biofuels 12 PJ and gaseous biofuels 5 PJ. The share in total final energy consumption doubled from 9.9% to 20.4% in the same period.

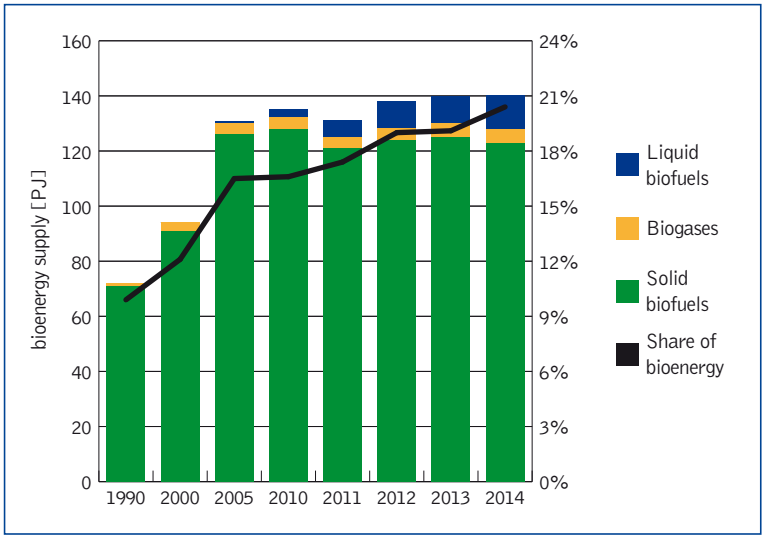

Figure 16: Development of total primary energy supply from bioenergy in Denmark 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 121 GJ, which comprised of 24.7 GJ of biogenic, 21.8 GJ solid biomass, 0.9 GJ gaseous biofuels and 2.1 GJ liquid biofuels

Table 7: Total primary energy supply per capita in 2014

Total energy	121 GJ/capita
Bioenergy	24.7 GJ/capita
Solid biofuels	21.8 GJ/capita
Gaseous biofuels	0.9 GJ/capita
Liquid biofuels	2.1 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Denmark's population in 2014 accounted for 5.7 million people

LINKS TO SOURCES OF INFORMATION

- The Danish Climate Policy Plan – Towards a low carbon society.
  https://ens.dk/en/our-responsibilities/energy-climate-politics

Finland

NATIONAL POLICY FRAMEWORK

Finland has a national binding target for renewable energy stated in the EU Renewable Energy Directive (2009/28/EC) to account for 38% of gross final energy consumption in 2020. The targeted shares of the three sectors heating/cooling, electricity and transport are shown in Table 8. Finland has reached the overall target already in 2014 (38.6%). The target for the transport sector was also reached in 2014 (21.6%). Most of the biofuel was produced from residue materials and therefore double counted. RES electricity and heat production was 33% in 2015.

Table 8: Finland's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	38%
Heating and cooling	47%
Electricity	33%
Transport	20%

(Source: NREAP)

Feed-in premiums for electricity from wind, biogas and forest residues (chips or hog fuel from tops, branches, thinning wood and stumps) are an important instrument to reach the above mentioned targets. In order to avoid distortion of wood for industrial use, the 60% feed-in-premium is not granted if larger stemwood (breast diameter > 16 cm) were used. Investment support enhance new RES technology innovations. A special support is granted for investments with high risks and high cost (>EUR 5 million) e.g. investments in advanced biofuels plants. A CO_2 tax for fossil fuels in heating has also been a long-term incentive to promote RES-heating. The amendment of the biofuel distribution obligation (Act on Promoting Use of Biofuels in Transport) of 2011 increases the share of biofuels corresponding to the obligation. Finland joined the Methane to Market Partnership in July 2008, seeking to expand its emissions reduction measures and to increase its cooperation with the private sector in areas such as the conversion of methane emissions into energy.

According to Statistics Finland, the share of renewable energy in the gross final energy consumption was approximately 38.6% in 2014. The Finnish Government has employed funding of research and development projects, energy taxation, tax relief, production subsidies for electricity and forest chips and investment subsidies as financial measures to implement the energy policy. Generally, the Finnish financial incentives to utilize biomass in energy production are at a quite moderate level compared to some other EU countries that apply considerably stronger financial measures. In addition, the support system for bioenergy has been almost constant for several years. CO_2 tax for fossil fuels in heat production has increased in 2016 to EUR 55/ton CO_2 and feed-in-premium for forest chips is EUR 18/MWh in 2016.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Finland

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Finland in 2014 amounted to 1,433 Petajoule (PJ). Oil products account for one quarter (364 PJ). Natural gas accounts for 7.3% (105 PJ) and coal products for 9.8% (141 PJ). Also peat and peat products hold a share of 4.2% (60 PJ). Renewable energy sources have a share of 30.3% or 435 PJ. The statistic also features 257 PJ or 18% of electrical energy coming from nuclear power stations. Nearly 5% are coming from electricity and heat.

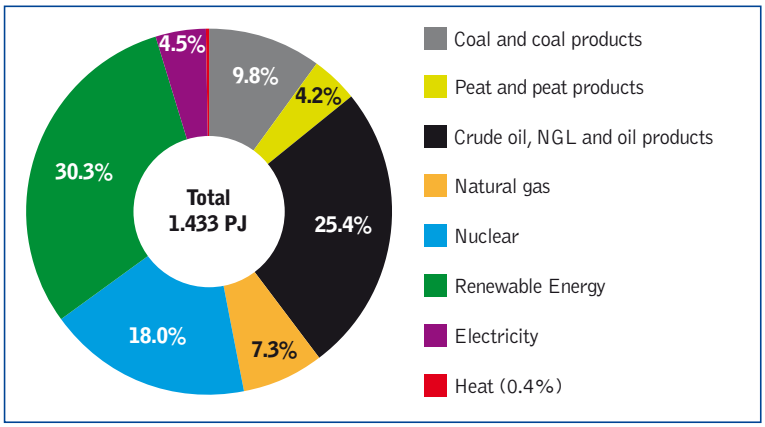

Figure 17: Total primary energy supply in Finland in 2014
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources is mostly covered by biofuels and waste, with 88%. Hydropower amounts to 11% and solar and wind energy to 1%.

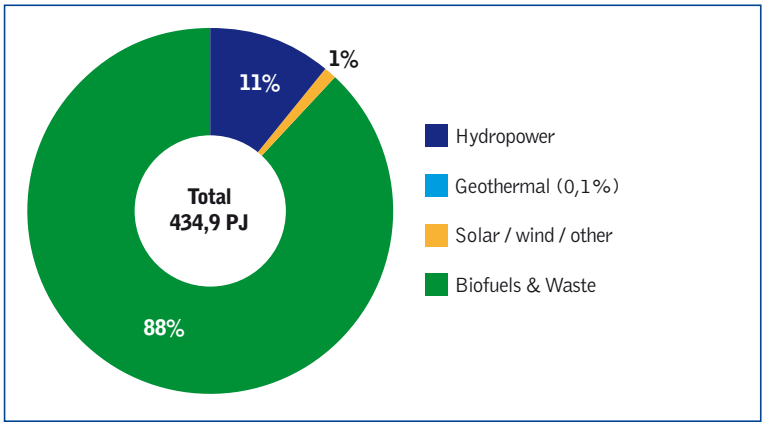

Figure 18: Total primary energy supply of Renewable Energy Sources in Finland in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Almost exclusively the bioenergy consumed in Finland comes from solid biofuels; their share accounts for 91.9% or 341 PJ. The next item is biodiesel (12.4 PJ) followed by renewable municipal waste (10.5 PJ), biogasoline (3.2 PJ) and biogas (2.7 PJ).

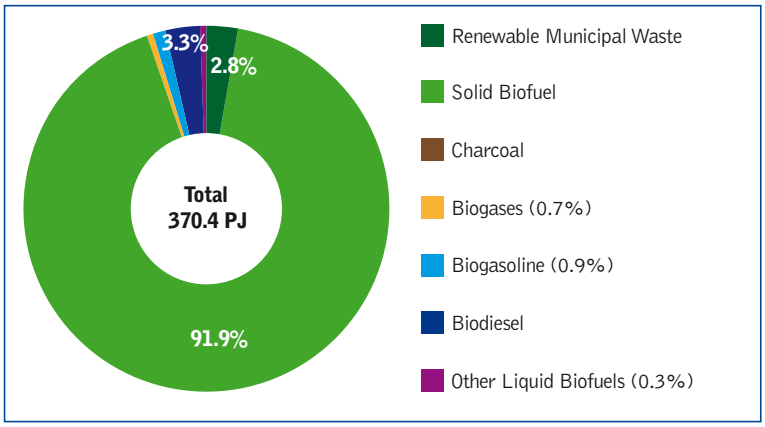

Figure 19: Total primary energy supply from bioenergy in Finland in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Finland increased from 1990 to 2014. In 1990 bioenergy only came from solid (forest) biomass and accounted for 191 PJ. In 2014 solid biomass contributed 351 PJ, liquid biofuels 17 PJ and gaseous biofuels 3 PJ. The share in total final energy consumption increased from 16.1% to 25.8% in the same period.

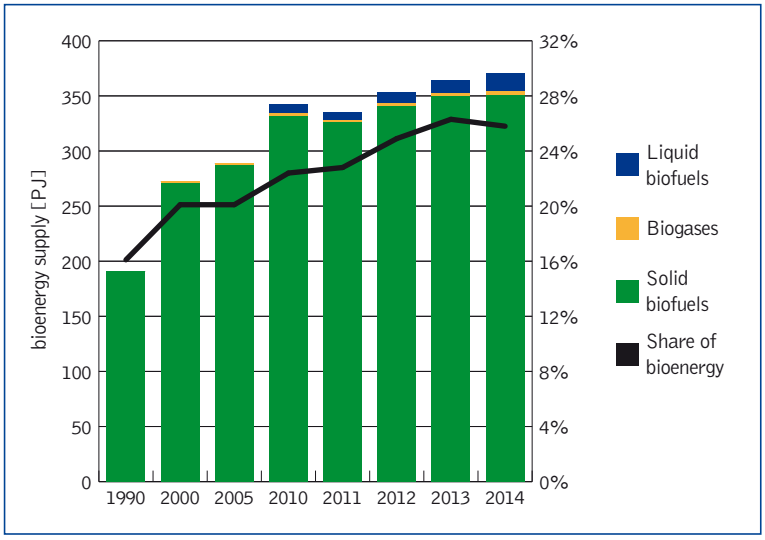

Figure 20: Development of total primary energy supply from bioenergy in Finland 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 262 GJ, which comprised of 67.7 GJ of biogenic, 64.1 GJ solid biomass, 0.5 GJ gaseous biofuels and 3.1 GJ liquid biofuels

Table 9: Total primary energy supply per capita in 2014

Total energy	262 GJ/capita
Bioenergy	67.7 GJ/capita
Solid biofuels	64.1 GJ/capita
Gaseous biofuels	0.5 GJ/capita
Liquid biofuels	3.1 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Finland's population in 2014 accounted for 5.5 million people

Figure 21 displays in more detail the split of renewable energy sources in Finland in the year 2013.

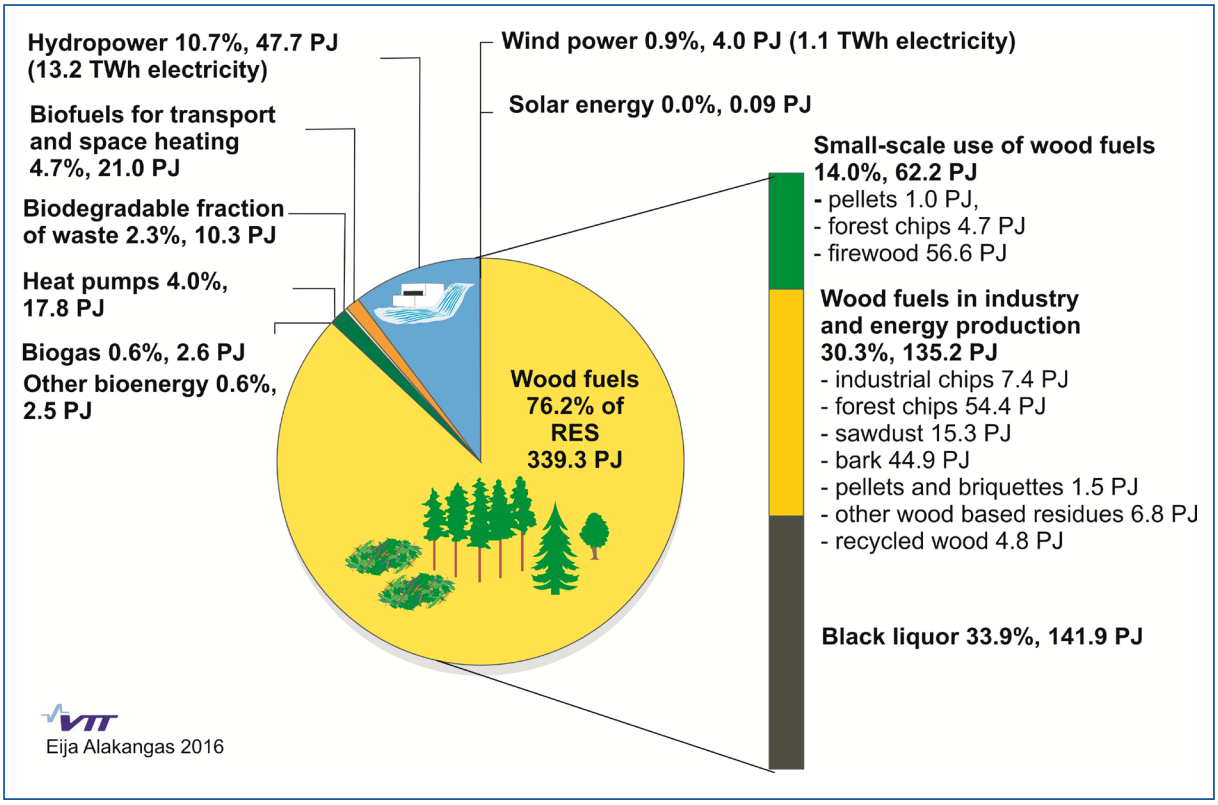

Figure 21: Renewable energy sources in Finland in 2013

RESEARCH FOCUS RELATED TO BIOENERGY

The objective of the Finnish Bioeconomy Strategy (published in 2014) is to generate new economic growth and new jobs from an increase in the bioeconomy business and from high added value products and services while securing the operating conditions for the nature's ecosystems. The principal idea of the strategy is that competitive and sustainable bioeconomy solutions for global problems will be created in Finland, and that new business will be generated both in the Finnish and international markets, thus boosting the welfare of the whole of Finland. Bioeconomy refers to an economy that relies on renewable natural resources to produce food, energy, products and services. The bioeconomy will reduce dependence on fossil natural resources, prevent biodiversity loss and create new economic growth and jobs in line with the principles of sustainable development. The objective of the Bioeconomy Strategy is to push bioeconomy output up to EUR 100 billion by 2025 and to create 100,000 new jobs.

Sustainable Bioenergy Solutions for Tomorrow (BEST) is a public-private research programme launched in early 2013. BEST crosses traditional business area boundaries and joins the strengths of forest, agriculture, waste, and energy sectors, complemented by the know-how of technology and consulting companies and research organizations. The program partners consist of 21 companies and 13 universities or research institutes, and its duration is four years (2013–2016) with an annual budget of roughly EUR 4 million. The program is coordinated by CLIC Innovation Ltd.

Finland's innovation policy is laid down in the Government Strategy to Promote Cleantech Business in Finland. It has four focus areas for spurring renewal and growth in the Finnish business and

industry: bioeconomy, cleantech, digitalization and the health sector. The Government is also increasing emphasis on the importance of service and creative sectors, including marketing, design, branding and other consumer focused value creating activities and business models as sources for economic growth. Increasing competences in utilizing the Intellectual Property rights are also an important focus area to ensure Finland remains a desirable place to do business for the IPR intensive businesses. The goal of the government's cleantech strategy is to accelerate growth in Finnish cleantech business and to renew the traditional industry through innovations in clean technology. The vision is that in 2020 Finland will be a global superpower in the cleantech business. Achieving the vision requires maintaining cooperation between administrations. Cleantech refers to products, services and processes which promote the sustainable use of natural resources while reducing emissions. (Alakangas 2016)

RECENT MAJOR BIOENERGY DEVELOPMENTS

Currently the new Energy and Climate Strategy for the year 2030 is under planning. The aim is to increase the share of renewable energy in a sustainable way in the 2020's to over 50%, to halve the use of imported oil for domestic purposes and to increase energy self-sufficiency to over 55%. This change is especially based on increasing the supply of bioenergy and other emission-free renewable options. The strategy extends until 2030. At this moment, 10% of Finland's total energy consumption comes from coal and 23% from oil. Reaching the goals requires investing billions in production as well as efforts from both companies and the state. The Finnish Government aims to start pilot, demonstration and reference institutions and projects for new energy technology as cost-effectively as possible. Support will be strongly directed towards the energy solutions of the future, and that is why the amount of electricity produced is not the only basis in distributing funds – the choice is based on a comprehensive view. In addition to the development of technology, export possibilities as well as employment effects of the projects in various areas in Finland will be taken into account. (Alakangas 2016).

LINKS TO SOURCES OF INFORMATION

http://www.biofuelstp.eu/country/progress-reports/Article_22_Finland_en.pdf

Alakangas, E. 2016. National policy landscape, Finland, Biomass Policies project. www.biomasspolicies.eu (see Finland)

France

NATIONAL POLICY FRAMEWORK

France has a national binding target for renewable energy stated in the EU Renewable Energy Directive (2009/28/EC) to account for 23% of gross final energy consumption in 2020. The targeted shares of the three sectors heating/cooling, electricity and transport are shown in Table 10.

Table 10: France's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	23%
Heating and cooling	33%
Electricity	27%
Transport	10.5%

(Source: NREAP)

France has set a number of objectives in its Energy policy law enacted in July 2015:

- reduce greenhouse gas emissions by 40% by 2030
- reduce fossil energy consumption by 30% by 2030
- boost the share of renewable energy to 27% in final use and to 40% of renewable electricity in 2030
- bring the use of biofuels to 7% of vehicle fuels by 2020

The Bioeconomy R & D Programme (GRAINE) which was established in 2016 has the principal objective to fund research and development into new technologies and processes: to convert biomass to fine chemicals, to substitute fossil fuels, to produce bioenergy, to produce renewable heat and power.

Since 2008, the Heat Fund also supports the development of the use of biomass through an annual national call for projects for industry and through direct financing for collective facilities.

Since 2016, a new annual call for projects (for 3 subsequent years) for electricity produced from biomass is in place. This applies to vegetable and animal agricultural waste, algae and some industrial biomass waste (pulp and paper, wood industries).

With the Energy Transition for Green Growth Act (promulgated in 2015) France has revealed a draft of its Energy Bill establishing climate and renewable energy targets to be reached by 2030. Instruments and actions that favor bioenergy are e.g.

- Greater support for the heat fund provides stronger backing for the production of heat from renewable sources (biomass, geothermal, solar thermal, etc.)
- The "Dynamic wood" (Dynamique bois) call for expressions of interest, launched in March 2015, allows for the provision of support for the mobilization of wood resources, in association with the Heat Fund (Fonds chaleur)
- Three calls for tender have been announced for the end of 2015: the generation of electricity from biomass and the development of small-scale hydroelectricity plants
- The multi-year energy programme (programmation pluriannuelle de l'énergie – PPE) sets out the conditions under which the main energy objectives of the Energy Transition and Green Growth Act will be achieved. The first PPEs (for continental metropolitan France and non-interconnected areas) shall concern electricity, gas and heat and all aspects of this energy until 2023: improvement of energy efficiency and energy savings, support for the exploitation of renewable energy sources and security of supply for the grids. They shall then be drawn up for two successive periods of five years.
- The savings fund (Caisse des dépôts) that supports key projects in the local public sector has been increased by EUR 5 billion. These loans are used to finance regional initiatives.
- The National Investment Bank BPI France grants loans for funding the investments of companies that generate renewable energy. The total value of the loans will be doubled between now and 2017, rising to EUR 800 million per year.

- The EUR 1.5 billion Energy transition financing fund (Fonds de financement de la transition énergétique) sponsored by the savings fund (Caisse des dépôts), strengthens the existing schemes (such as the Heat fund) and supports new projects, especially those of "Positive-energy regions for green growth" and "Zero waste, zero wastage" regions.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=France

http://www.developpement-durable.gouv.fr/IMG/pdf/14123-8-GB_loi-TE-mode-emploi_DEF_light.pdf

https://www.iisd.org/gsi/sites/default/files/bf_costeffectiveness_france.pdf

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of France in 2014 amounted to 10,137 Petajoule (PJ) with an export surplus of electricity of 242 PJ. The main share (45.9%) comes from nuclear energy with 4,762 PJ. Oil products account for more than one quarter (2,951 PJ). Natural gas accounts for 13% (1,351 PJ) and coal products for 3.7% (389 PJ). Renewable energy sources have a share of 8.9% or 926 PJ.

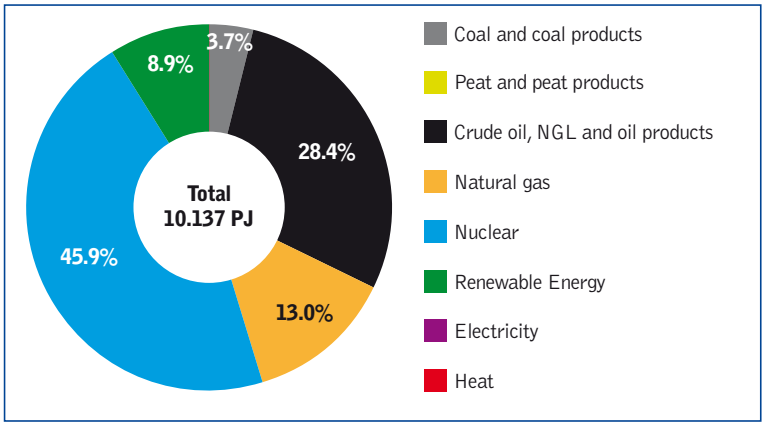

Figure 22: Total primary energy supply in France in 2014
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources is mostly covered by energy biofuels and waste, with 66%. Hydropower amounts to 24%, solar and wind energy to 10% and geothermal power to 0.5%.

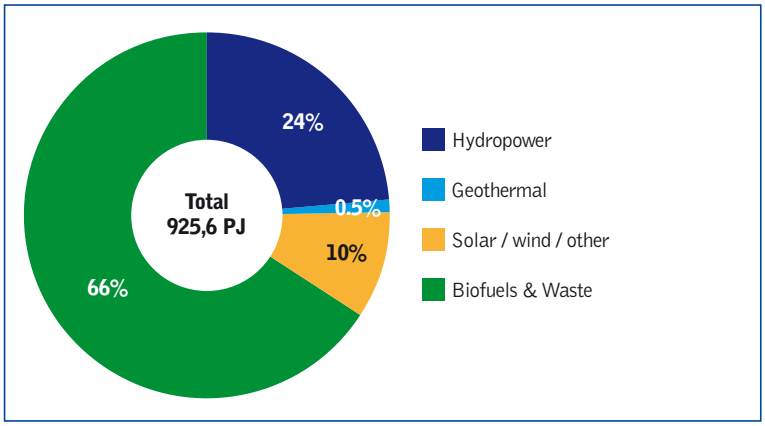

Figure 23: Total primary energy supply of Renewable Energy Sources in France in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in France comes from solid biofuels; their share accounts for 68.4% or 382 PJ. The second largest item is biodiesel (94PJ) followed by renewable municipal waste (46 PJ), biogas (20 PJ) and biogasoline (16 PJ).

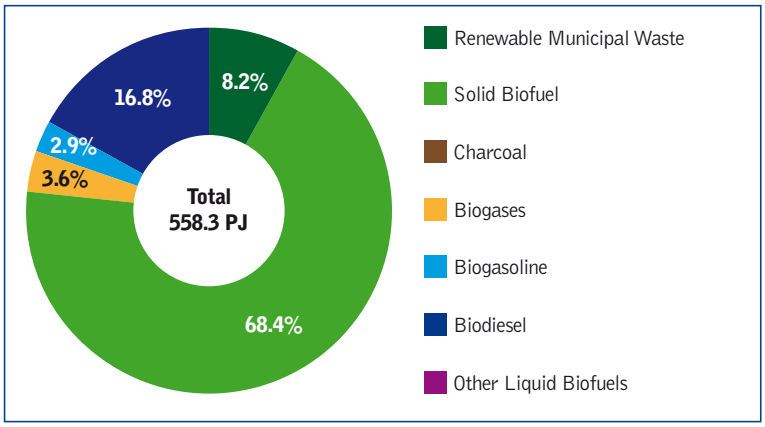

Figure 24: Total primary energy supply from bioenergy in France in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in France increased slightly from 1990 to 2014. In 1990 bioenergy only came from solid biomass and accounted for 433 PJ and gaseous biofuels 3 PJ. In 2014 solid biomass contributed 428 PJ, liquid biofuels 110 PJ and gaseous biofuels 20 PJ. The share in total final energy consumption ranged between 3.9 and 5.5%.

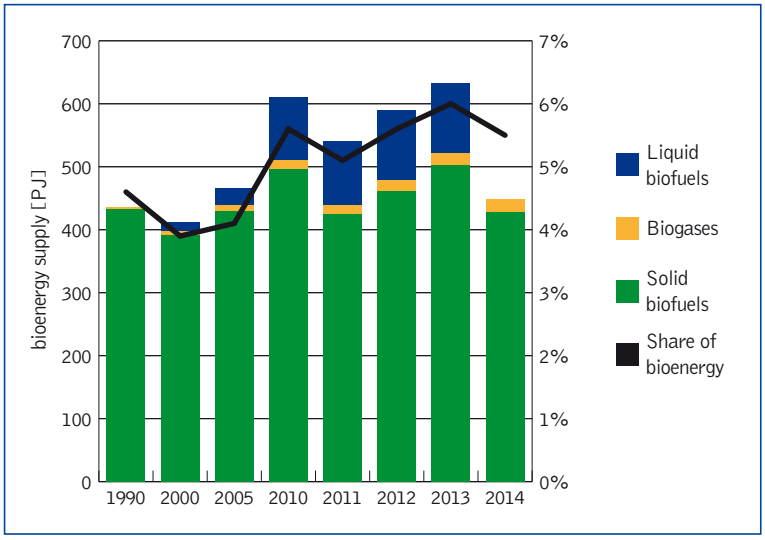

Figure 25: Development of total primary energy supply from bioenergy in France 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 153 GJ, which comprised of 8.4 GJ of biogenic, 6.5 GJ solid biomass, 0.3 GJ gaseous biofuels and 1.7 GJ liquid biofuels

Table 11: Total primary energy supply per capita in 2014

Total energy	153 GJ
Bioenergy	8.4 GJ
Solid biofuels	6.5 GJ
Gaseous biofuels	0.3 GJ
Liquid biofuels	1.7 GJ

(Source: Renewables Information © OECD/IEA 2015)
Note: France' population in 2014 accounted for 66.4 million people

RESEARCH FOCUS RELATED TO BIOENERGY

The Bioeconomy R & D Programme (GRAINE) established in 2016 has the principal objective to fund research and development into new technologies and processes: to convert biomass to fine chemicals, to substitute fossil fuels, to produce bioenergy, to produce renewable heat and power.

LINKS TO SOURCES OF INFORMATION

http://www.developpement-durable.gouv.fr/Sortie-du-rapport-Panorama.html

http://www.developpement-durable.gouv.fr/IMG/pdf/14123-8-GB_loi-TE-mode-emploi_DEF_light.pdf

www.ademe.fr

http://www.ademe.fr/expertises/energies-renouvelables-reseaux-stockage/passer-a-laction/produire-chaleur/fonds-chaleur-bref

Germany

NATIONAL POLICY FRAMEWORK

Germany has a national target of 18% share of renewable energy in the gross final energy consumption by 2020. The contribution from each of the sectors heating and cooling, electricity and transportation is displayed in the table below.

Table 12: Germany's 2020 renewable energy targets

Sector	Targets set in the RED and the NREAP – reference scenario	Targets set in the RED and the NREAP – scenario „with additional energy efficiency measures"
Overall target	18%	19.6%
Heating and cooling	14%	15.5%
Electricity	30%	38.6%
Transport	10%	13.2%

(Source: NREAP)

The corresponding German Energy Concept which has been passed in 2009 has at its core several policy goals: protecting the climate, increasing energy efficiency and a larger share of renewable energy sources in the final energy consumption while at the same time promoting the growth and competitiveness of the German industry. Climate protection targets agreed under the Energy Concept are: to achieve a 40% cut in greenhouse gas emissions by 2020, 55% by 2030, 70% by 2040 and between 80% and 95% by 2050 (reference year 1990). The Energy Concept sets out a basic strategic approach for the switch to renewables and increased energy efficiency for a secure, environmentally compatible and competitive supply of energy. The Energy Concept aims to address how to ensure a future energy supply that is both secure and affordable while fulfilling the ambitious climate protection targets of the coalition agreement (minus 80% CO_2 by 2050).

In the electricity sector, the current Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz – EEG)[3], a feed-in tariff system, is the crucial basis for further development in the production of renewable energies. This also applies to the production of combined power and heating/cooling based on renewable energies. The objective of the 2014 amendment to the EEG is to continue steady deployment of renewable energy in Germany in a cost efficient manner by integrating renewable energy sources (RES) more to the market and to achieve a share of renewable energy sources within the electricity sector of 80% by 2050. Within the amendment of 2014 the level of the tariffs for biomass has been significantly reduced and a cap of 100 MWel of additional capacity per year has been introduced. These two important changes are expected to lead to a significantly lower number of new biomass installations in the future. Furthermore, a shift from a feed-in tariff system towards auctions from 2017 onwards has been implemented within the EEG 2014.

The EEG is supplemented by the Combined Heat and Power Act (Kraft-Wärme-Kopplung-Gesetz – KWKG)[4], the biomass ordinance (Biomasseverordnung – BiomasseV)[5] and the biomass electricity sustainability ordinance (Biomassestrom-Nachhaltigkeitsverordnung – BioSt-NachV)[6]. In the heating/cooling sector, the main policy measures include a financial subsidy through the Market Incentive Program (Marktanreizprogramm – MAP)[7], a building regulation in the form of the Renewable Energies

3 Available here (in German): http://www.gesetze-im-internet.de/eeg_2014/ (last access March 1, 2016).

4 Available here (in German): http://www.gesetze-im-internet.de/kwkg_2016/index.html (last access March 1, 2016).

5 Available here (in German): http://www.gesetze-im-internet.de/biomassev/index.html (last access March 1, 2016).

6 Available here (in German): http://www.gesetze-im-internet.de/biost-nachv/index.html (last access March 1, 2016).

7 For more information see: http://www.bmwi.de/EN/Topics/Energy/Buildings/market-incentive-programme,did=707926.html (last access March 1, 2016).

Heat Act (Erneuerbare-Energien-Wärmegesetz – EEWärmeG)[8], as well as further support programs of the public bank KfW[9] and the Energy Saving Ordinance (Energieeinsparverordnung – EnEV)[10]. These instruments have allowed for a significant expansion in the use of renewable energies in recent years.

In the transport sector the European directives and regulations are implemented by § 37a of the Federal Immission Protection Act (Bundesimmissionsschutzgesetz – BImSchG)[11] including the Biofuel Sustainability Ordinance (Biokraftstoff-Nachhaltigkeitsverordnung – Biokraft-NachV)[12] related to EU Renewable Energy Directive (RED, 2009/28/EC)[13], § 36 Federal Immission Protection Ordinance (Bundesimmissionsschutzverordnung – BImSchV)[14] related Fuel Quality Directive (FQD, 2009/30/EC)[15], and Energy Tax Act (Energiesteuergesetz – EnergieStG)[16] related to Energy Taxation Directive (2003/96/EC)[17]. As the first and probably only European Member State Germany shifted from an energy-related quota to a GHG-related quota starting in January 2015 with the German Biofuels Quota Act (Biokraftstoffquotengesetz – BioKraftQuG)[18] and thus giving the FQD priority instead of the RED. This means that fossil fuel supplier companies are obligated to sell the respective biofuel or renewable fuel with its fossil counterpart petrol or diesel (which is usually done through blending), in order to produce a fuel mix which achieves a 3.5%/4%/6% GHG mitigation (compared to fossil gasoline and diesel mix) for the entire fuel sector from 2015/2017/2020 onwards. Because only actual emission savings count towards the quota (double counting is not allowed, GHG emissions of biofuels are to be calculated on a life cycle basis according to GHG methodology in RED/FQD), the exact increase of biofuels depends on its specific GHG intensity: the higher the specific GHG mitigation potential the lower the required renewable fuel consumption to fulfil the quota. This quota system will also be retained post-2020. Biofuels that are counted within the quota are fully taxed.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Germany

8 Available here (in German): http://www.gesetze-im-internet.de/eew_rmeg/index.html (last access March 1, 2016).

9 For more information see (in German): https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/Erneuerbare-Energien/# (last access March 1, 2016).

10 Available here (in German): http://www.gesetze-im-internet.de/enev_2007/index.html (last access March 1, 2016).

11 Available here (in German): http://www.gesetze-im-internet.de/bimschg/index.html (last access March 1, 2016).

12 Available here (in German): http://www.gesetze-im-internet.de/biokraft-nachv/index.html (last access March 1, 2016).

13 Available here: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0028 (last access March 1, 2016).

14 Available here (in German): http://www.gesetze-im-internet.de/bimschv_4_2013/index.html (last access March 1, 2016).

15 Available here: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32009L0030 (last access March 1, 2016).

16 Available here (in German): http://www.gesetze-im-internet.de/energiestg/index.html (last access March 1, 2016).

17 Available here: http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1456911765879&uri=CELEX:32003L0096 (last access March 1, 2016).

18 Available here (in German): https://www.jurion.de/Gesetze/BioKraftQuG (last access March 1, 2016).

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Germany in 2014 amounted to 12,712 Petajoule (PJ) with an export surplus of electricity of 122 PJ. It is still dominated by fossil fuels: 4221 PJ oil products, 3,268 PJ coal products, and 2,684 PJ natural gas. The statistic also features 1,060 PJ of electrical energy coming from nuclear power stations. Renewable energy sources have a share of 12.5% or 1,602 PJ.

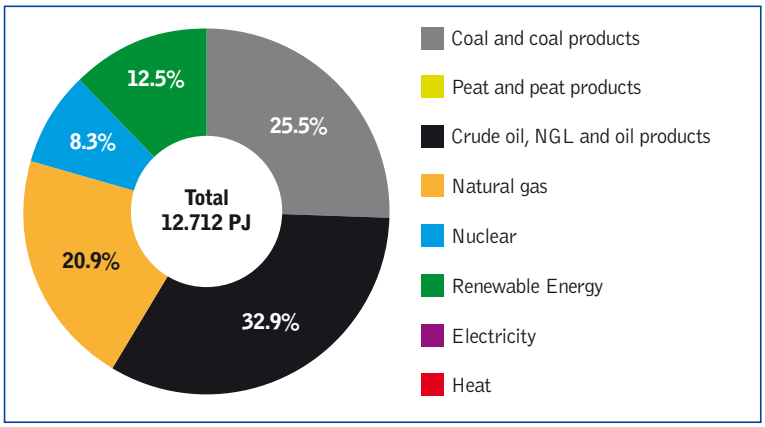

Figure 26: Total primary energy supply in Germany in 2014
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources is mostly covered by energy biofuels and waste, with 73%. Solar and wind energy amount to 22%, hydropower to 4%, and geothermal power to 0.5%.

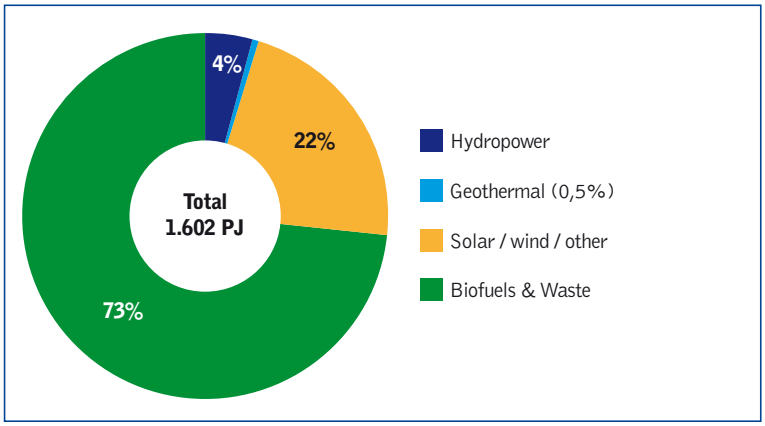

Figure 27: Total primary energy supply of Renewable Energy Sources in Germany in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Half of the bioenergy consumed in Germany comes from solid biofuels (430 PJ). The second largest item is biogas (302 PJ) followed by renewable municipal waste (130 PJ), biodiesel (85 PJ), and biogasoline (32 PJ).

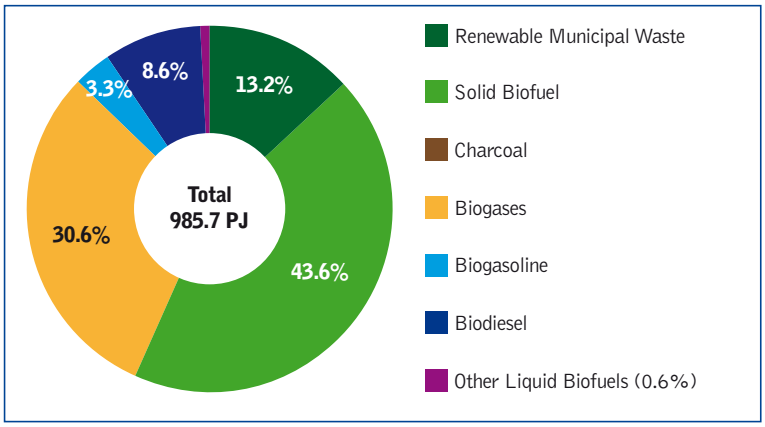

Figure 28: Total primary energy supply from bioenergy in Germany in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Germany increased more than fivefold from 1990 to 2014. In 1990 bioenergy only came from solid biomass and accounted for 147 PJ and gaseous biofuels 12 PJ. In 2014 solid biomass contributed 560 PJ, liquid biofuels 124 PJ, and gaseous biofuels 302 PJ. The share in total final energy consumption climbed from 1.1% to 7.8% in the same period.

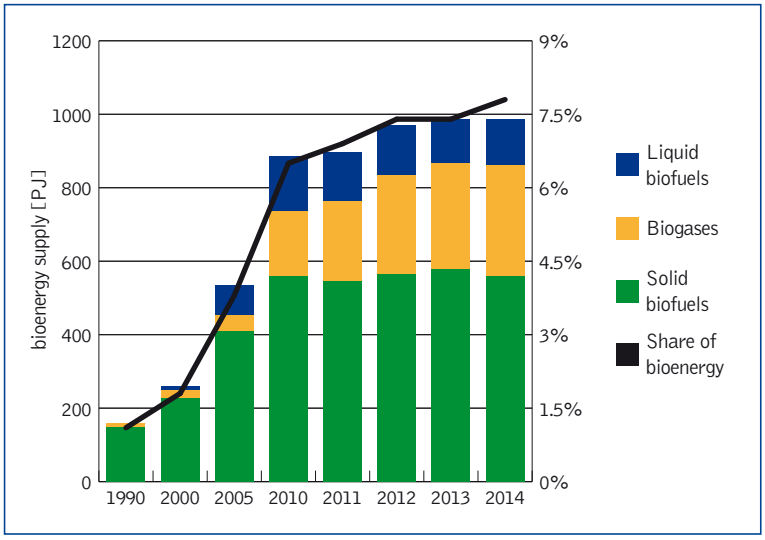

Figure 29: Development of total primary energy supply from bioenergy in Germany 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In year 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 157 GJ, which comprised of 12.1 GJ of biogenic, 6.9 GJ solid biomass, 3.7 GJ gaseous biofuels and 1.5 GJ liquid biofuels

Table 13: Total primary energy supply per capita in 2014

Total energy	157 GJ/capita
Bioenergy	12.1 GJ/capita
Solid biofuels	6.9 GJ/capita
Gaseous biofuels	3.7 GJ/capita
Liquid biofuels	1.5 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Germany's population in 2014 accounted for 81.2 million people

RESEARCH FOCUS RELATED TO BIOENERGY

Germany has implemented an active policy for the transition of the energy system towards greater use of renewable energy sources more than a decade ago, which has led to a strong increase in the amount of biomass used for electricity, heat and the provision of transport fuel.[19] At the same time bioenergy research is fostered by several research programmes on the national level funded e.g. by the German Federal Ministry of Research and Education[20], the Ministry for Economy Affairs and Energy[21], and the Ministry of Food and Agriculture (BMEL) which has the lead for bioenergy research on the federal level[22]. The funding areas in the area of bioenergy in Germany are crop plants from agriculture, forestry and aquatic biomass, the utilisation of biogenic waste from agriculture and forestry, aquaculture, the processing industry, commerce and households, and the generation, handling, processing and use of renewable resources, as well as cross-cutting issues in the area of bioenergy such as a dialogue with society.[23]

Germany has a rather complex bioenergy research landscape with a multitude of activities on federal and state level, and smaller and larger industries in many different application areas. Some examples of main actors:

- The Agency for Renewable Resources (Fachagentur Nachwachsende Rohstoffe, FNR) is the the coordinating agency for bioenergy and bioproducts in Germany; a key task is the administration of the R&D budget of the BMEL amounting to EUR 86 million in 2016 (bioenergy and bioproducts; no fixed budget share for one or the other). FNR represents Germany in IEA Bioenergy. See www.international.fnr.de
- The German Biomass Research Centre (Deutsches Biomasseforschungszentrum – DBFZ) was founded in 2008 by the BMEL and was commissioned to theoretically and practically promote the efficient use of biomass as a renewable energy source of the future within the scope of applied sciences.[24]
- The Federal Thuenen Institute covers other aspects of bioenergy, eg plant production, renewable resources forest management, GHG emissions etc. See http://www.thuenen.de/en/
- The Karlsruhe Institute of Technology (KIT) is one of Europe's leading energy research establishments with huge expertise eg on thermochemical conversion routes. See www.kit.edu
- The Technology and Support Centre (TFZ) is an institution of the Bavarian Ministry of Food, Agriculture and Forestry (Bayerisches Staatsministerium für Ernährung, Landwirtschaft und Forsten). The main goals of the TFZ are the support of agricultural production, the processing and utilization of renewable resources by applied research, the development and testing of products and methods, and the transfer of technology by demonstration and education. See http://www.tfz.bayern.de/en/index.php

A more detailed overview on the research activities in the field of biofuels for transport is depicted in the latest IEA Newsletter of Task 39.[25]

19 Thrän, D. (2015): Introduction. In D. Thrän (ed.): Smart bioenergy: technologies and concepts for a more flexible bioenergy provision in future energy systems (p. 1). Cham: Springer.

20 Focussing on bioeconomy and the use of plant biomass; for an overview see: https://www.bmbf.de/en/sustainable-development-2312.html and https://www.ptj.de/bioeconomy (last access March 1, 2016).

21 Focussing on biomass for energy use; for more information see: https://www.energetische-biomassenutzung.de/de/home.html (last access March 1, 2016).

22 Focussing on bioenergy as well; for more information see: http://international.fnr.de/renewable-resources/bioenergy/ (last access March 1, 2016).

23 See "Bioenergy Research in Germany", presentation by Andreas Schütte at the IEA Bioenergy Conference 2015 (http://ieabioenergy2015.org/proceedings/), www.ieabioenergy2015.org/fileadmin/veranstaltungen/2015/IEA_Bioenergy_Conference/P00-3_Andreas_Sch%C3%BCtte_FNR.pdf).

24 For more information on the DBFZ research see: https://www.dbfz.de/en/research.html (last access March 1, 2016).

25 IEA Bioenergy Task 39 | Newsletter 12/2015, Issue 42, available here: http://task39.sites.olt.ubc.ca/files/2015/12/IEA-Bioenergy-Task-39-Newsletter-Issue-41-December-2015-FINAL.pdf (last access March 1, 2016).

RECENT MAJOR BIOENERGY DEVELOPMENTS

In the heating sector, the energy supply from renewable energy sources from 1990 to 2009 more than tripled from just over 32 TWh to about 115 TWh.[26] The use of solid biomass (mainly wood) was predominant throughout this period, and in 2009 still amounted to approximately 68%. If biogas, bioliquids and the biogenic share of waste are also included, use of biomass for heating purposes even accounted for 92% of all renewable resources.

Electricity production from bioenergy has increased during the past years. While in the year 2000 just 0.21 TWh electricity was produced from biomass[27], bioenergy power plants produced 38.36 TWh electricity under the renewable energy sources act. In 2015 the electricity produced increased to appr. 39.13 TWh.[28]

Transport sector: Highly affected by policy framework and market developments (e.g. prices for feedstock and revenues for by-products as well as the increasing role of actual GHG emission savings per fuel portfolio), the development of production and the use of conventional biofuels such as biodiesel (FAME), bioethanol, HVO/HEFA and biomethane are a story of ups and downs. There are no production capacities for HVO/HEFA. Biomethane is produced in significant capacities but for different markets; only a share of roughly 7% is used for transport applications. In 2014 about 5.0% or 125 PJ/a of the transport fuels used were biofuels (2013 about 124 PJ/a or 5.5%) of which about 65 PJ/a were biodiesel (FAME, mainly based on rape oil and used cooking oil, UCO, due to the existing double counting for residue based biofuels) and HVO/HEFA with 15 PJ/a (mainly based on palm oil). About 32 PJ/a were used as ethanol (mainly based on wheat and sugar beet) and about 2 PJ/a biomethane from biogas (mainly based on residues)

26 Please note that the informational base was adjusted within the reporting period.

27 BMWi – Bundesministerium für Wirtschaft (Ed.) (2015): Zahlen und Fakten Energiedaten.

28 Scheftelowitz, M.; Rensberg, N.; Denysenko, V.; Daniel-Gromke, J.; Stinner, Walter; Hillebrand, K.; Naumann, K.; Peetz, David; Hennig, Christiane; et al (2015): Stromerzeugung aus Biomasse (Vorhaben IIa) Zwischenbericht Mai 2015. Leipzig: Deutsches Biomasseforschungszentrum gemeinnützige GmbH.

LINKS TO SOURCES OF INFORMATION

http://www.iea.org/policiesandmeasures/renewableenergy/

http://ec.europa.eu/energy/en/topics/renewable-energy/national-action-plans

http://www.iea.org/publications/freepublications/publication/energy-policies-of-iea-countries---germany-2013-review.html

http://www.erneuerbare-energien.de/EE/Navigation/DE/Service/Erneuerbare_Energien_in_Zahlen/erneuerbare_energien_in_zahlen.html (renewable energy statistics)

https://www.umweltbundesamt.de/tags/agee-stat (working grpup on renewable energy statistics

http://bioenergie.fnr.de/ (bioenergy portal of FNR with brochures for download, statistics, etc.)

www.dbfz.de/en/ (the website of DBFZ with bioenergy reports etc.)

Ireland

NATIONAL POLICY FRAMEWORK

Irish renewable energy policy is framed in the context of European legal obligations specified in various Directives and Regulations, as well as other international and national targets. The EU Renewable Energy Directive is the most important legislation influencing the growth of renewables in Europe and Ireland. Ireland's overall binding target under the Renewable Energy Directive is to ensure that at least 16% of gross final energy consumption is from renewable sources by 2020 (compared with 2.8% in 2005). The Renewable Energy Directive also specifies a mandatory national target of a 10% share of energy in transport to come from renewable sources by 2020. To meet the overall 16% renewable energy target Ireland has set further national targets of 40% of gross electricity consumption and 12% of gross final heat consumption to come from renewable sources by 2020. These targets are summarised in the table below.

Table 14: Ireland's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	16%
Heating and cooling	12%
Electricity	40%
Transport	10%

(Source: NREAP)

Current policies exist to support the use of bioenergy in Ireland in the electricity and transport sectors and policy to support the use of bioenergy in heat is expected by the end of 2016.

The first Draft Bioenergy action Plan was published by the Department of Communications Energy and Natural Resources in October 2014. This Draft Plan identifies 19 policy and enabling actions key to the development of the bioenergy sector. These actions fall into five broad, high-level, categories:

- Demand-side measures that contribute directly to delivering renewable energy. The plan proposes to introduce an exchequer-funded renewable heat incentive in 2016. The scheme will be aimed at larger commercial and industrial installations outside of the Emissions Trading System.
- Enabling policies that address the supply-chain challenges faced by domestic producers of biomass. These measures include the establishment of BioEnergy Ireland as a biomass joint venture between Bord na Móna and Coillte, which will create a streamlined commercial state company to procure biomass at market rates in order to optimise the supply chain. Also included is the continued support for the afforestation programme.
- Measures to support research, demonstration and development including conducting an economic assessment of the costs and benefits of biogas and biomethane.
- Further market support and sustainability measures, including the sustainable use of forest material.
- Governance; a bioenergy steering group, chaired by the DCENR, is to be established to coordinate implementation of the finalised plan.

The final Bioenergy Plan will underpin the development of the bioenergy sector in the period to 2020 and lay the foundations for its longer term growth.

The Department of Communications, Energy and Natural Resources published the White Paper "Irelands Transition to a low carbon future 2015-2030" in December 2015. This wide ranging policy document is a complete update of energy policy, which sets out a framework to guide policy and the actions that Government intends to take in the energy sector in the period up to 2030. On the subject of bioenergy the White Paper notes that it is a versatile source of energy that can be used for heating, transport and power generation. It states that consideration must be given to the most prudent uses for bioenergy, and that the most advantageous economic benefits arise when bioenergy is used in the heat sector.

A key measure identified in the Draft Bioenergy Plan to meet the Renewable Heat target of 12% in 2020 is the introduction of an exchequer-funded Renewable Heat Incentive Scheme for larger non-ETS industrial and commercial renewable heating installations. The scheme will be designed to reward users for each unit of heat used from renewable energy. This would provide stability and long term security for investors, ensure better value for money for consumers, and have a significant positive impact on non-ETS sector emissions. The scheme will be kept under review to assess its effectiveness. The scheme is currently in the design stage and will be subject to State Aid clearance from the European Commission and further Government approval once designed. It is envisaged that the scheme will be in place from the end of 2016.

The Renewable Energy Feed-in Tariff (REFIT) schemes 2 and 3 are the primary means through which electricity from renewable sources is supported in Ireland. REFIT 2 is designed to incentivise the addition of 4,000 MW of new renewable electricity capacity to the Irish grid from onshore wind, hydro, biomass and landfill gas technologies. REFIT 3 is designed to incentivise the addition of 310 MW of renewable electricity capacity to the Irish grid composed of High efficiency Combined Heat and Power (using both Anaerobic Digestion and the thermo-chemical conversion of solid biomass), biomass combustion and biomass co-firing. Both schemes are closed to new applicants as of December 2015.

The 2007 Government Energy White Paper set a target of 30% co-firing with biomass at the country's three peat powered power stations. To date one of these three plants is being co-fired with biomass and this is supported under the REFIT3 scheme. The 2015 Energy White Paper noted that a government-commissioned technical analysis considered biomass usage and concluded that Ireland's limited biomass resource would be more efficiently deployed in the heating sector than in co-firing with peat. Future government support for biomass for electricity will be decided in the context of the renewable electricity and renewable heat consultations that are currently underway.

The Irish Biofuel Obligation Scheme mandates fuel suppliers to include a percentage of biofuels in their yearly sales. The scheme is administered by the National Oil Reserves Agency and for the 2016 obligation period it is required that 6% by volume of transport fuel is biofuel. For biodiesel mixed with diesel a 6% share by volume equates to a 5.4% share by energy content, for bio-gasoline mixed with gasoline (petrol) a 6% share by volume equates to a 3.9% share by energy content. Since the introduction of Biofuel Sustainability Criteria Regulations in February 2012 only biofuel that meets the compliance requirements on sustainability are eligible, and biofuels produced from bio-degradable waste, residue, non-food cellulosic material, lignocellulosic material or algae receive a double weighting.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at:

http://www.iea.org/policiesandmeasures/renewableenergy/?country=Ireland

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Ireland in 2014 amounted to 535 Petajoule (PJ) and is still dominated by fossil fuels: 247 PJ oil products, 156 PJ natural gas, 53 PJ coal products and 29 PJ peat products. Renewable energy sources have a share of 7.9% or 42 PJ. 8 PJ are from electricity

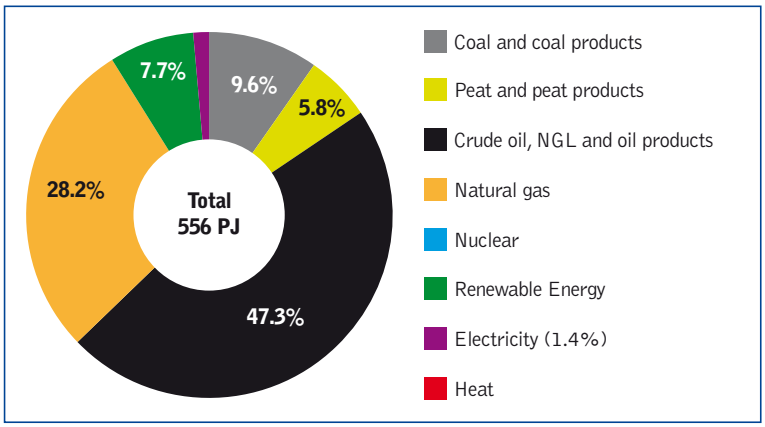

Figure 30: Total primary energy supply in Ireland in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Half of total primary energy supply of renewable energy sources is covered by energy from biofuels and waste. Solar and wind energy amount to 45% and hydropower to 6%.

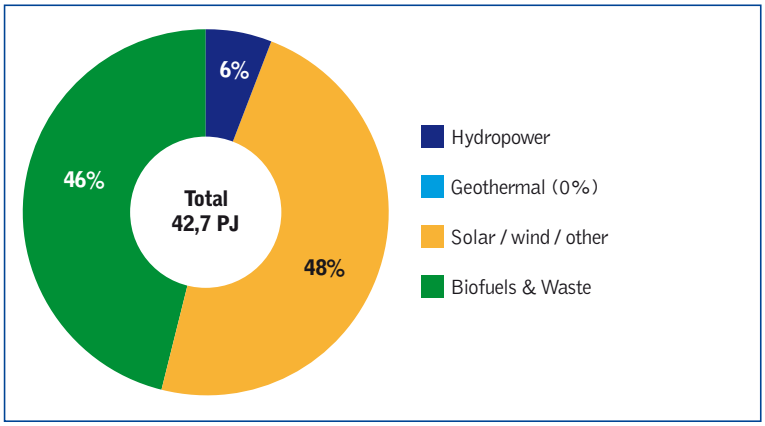

Figure 31: Total primary energy supply of Renewable Energy Sources in Ireland in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Ireland comes from solid biofuels (10.4 PJ). The second largest item is biodiesel (2.7 PJ) followed by renewable municipal waste (2.2 PJ), biogas (1.9 PJ) and biogasoline (1.1 PJ).

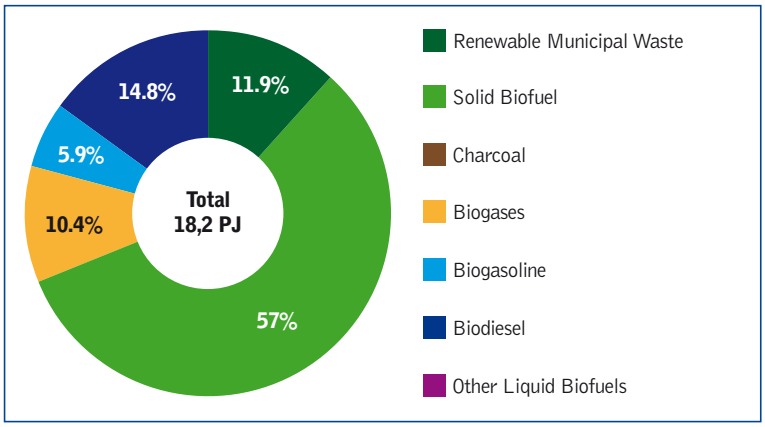

Figure 32: Total primary energy supply from bioenergy in Ireland in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Ireland increased more than fourfold from 1990 to 2014. In 1990 bioenergy only came from solid biomass and accounted for 4 PJ. In 2014 solid biomass contributed 13 PJ, liquid biofuels 4 PJ and gaseous biofuels 2 PJ. The share in total primary energy supply increased from 0.9% to 3.4% in the same period.

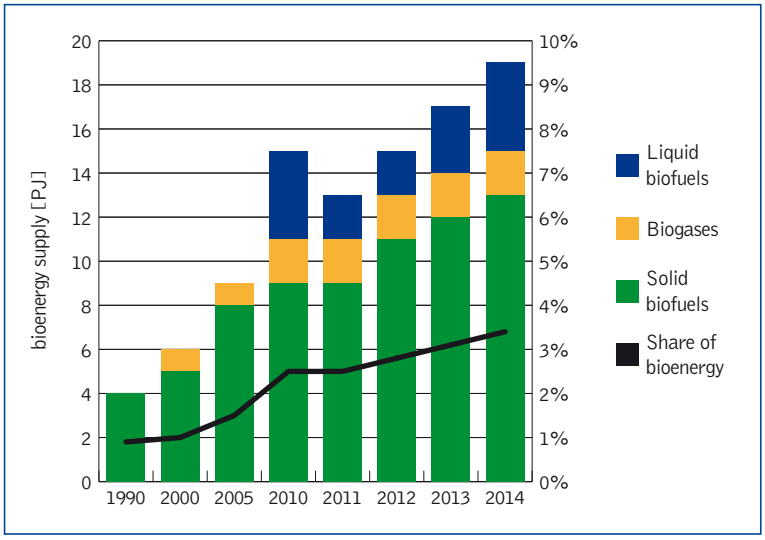

Figure 33: Development of total primary energy supply from bioenergy in Ireland 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 116 GJ, which comprised of 3.1 GJ of biogenic, 2.7 GJ solid biomass, 0.4 GJ gaseous biofuels and 0.8 GJ liquid biofuels

Table 15: Total primary energy supply per capita in 2014

Total energy	116 GJ/capita
Bioenergy	3.1 GJ/capita
Solid biofuels	2.7 GJ/capita
Gaseous biofuels	0.4 GJ/capita
Liquid biofuels	0.8 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Ireland's population in 2014 accounted for 4.6 million people

RESEARCH FOCUS RELATED TO BIOENERGY

Bioenergy research in Ireland is undertaken by State Government Agencies and Universities. Bioenergy innovation is key to the future development of the sector, as outlined in the Irish governments 2014 draft Bioenergy Plan. The 2014 draft Bioenergy Plan highlights the important role research, development and demonstration activities focusing on biogas and biomethane will play in contributing to Ireland's renewable energy targets as well as reducing reliance on land-based feedstocks and mitigating ILUC impacts, and the development of advanced or second generation biofuels. It remains a key priority of energy policy that appropriate bioenergy research is carried out in Ireland along the entire innovation chain from basic research to pre-commercial demonstration.

The Sustainable Energy Authority of Ireland (SEAI) provides national sustainable energy research funding in Ireland through its RD&D Programme. Bioenergy projects are funded through the Programme as are many different types of sustainable energy projects. SEAI supports the development and demonstration of new technologies, practises and/or supply chain innovations across the bioenergy sector. In 2015 under the RD&D programme, bioenergy projects supported by the RD&D Programme included the phased development of a pilot plant for anaerobic digestion, and the development of a low temperature anaerobic digestion (LtAD) technology.

In 2016 SEAI requested Bioenergy Harvesting/ Extraction, Densification, Refining and Conversion Technologies and Practices projects, under the RD&D Programme. As a result it will support bioenergy projects that include the design and development of biogas plants for the Irish market; the design and manufacturing of a pilot demonstration AD tank made by plastic based fabric, as well as continuing the research undertaken in 2015 on LtAD technology.

The most important Irish research institutions are Universities, and in relation to bioenergy research University College Cork (UCC) plays a significant role. The Technology Centre for Biorefining and Bioenergy co-hosted by 4 of Ireland's top academic institutions – National University of Ireland Galway (NUI Galway), University College Dublin (UCD), University of Limerick (UL) and Trinity College Dublin (TCD) – works to expand expertise and resources to serve a broad bio-economy audience. The Irish bioenergy industry is involved in RD&D through a range of small and medium sized enterprises in the bioenergy, bio-refining and bio-based sectors.

RECENT MAJOR BIOENERGY DEVELOPMENTS

The publication of the first Draft Bioenergy plan in October 2014 was the most significant recent development in the Irish Bioenergy sector and underpins the development of the bioenergy sector in Ireland for the period to 2020. The development of a Renewable Heat Incentive scheme, as recommended in the Draft Plan, is current and currently underway and is expected to be introduced late 2016.

LINKS TO SOURCES OF INFORMATION

- For further information on the Draft Bioenergy Action Plan see: http://www.dcenr.gov.ie/energy/en-ie/Renewable-Energy/Pages/Bio-Energy.aspx
- For further information on the 2015 Energy White Paper "Ireland's Transition to a Low Carbon Energy Future" see: http://www.dcenr.gov.ie/energy/en-ie/Energy-Initiatives/Pages/White-Paper-on-Energy-Policy-in-Ireland-.aspx
- For further information on Renewable Heat policy see: http://www.dcenr.gov.ie/energy/en-ie/Renewable-Energy/Pages/Heat.aspx
- For further information on Energy related RD&D in Ireland see: http://www.seai.ie/Publications/Renewables_Publications_/Energy_RD_D/
- For further information on the official Energy Statistics for Ireland see: http://www.seai.ie/Energy-Data-Portal/

Italy

NATIONAL POLICY FRAMEWORK

Italy has a national binding target for renewable energy stated in the EU Renewable Energy Directive (2009/28/EC) to account for 17% of gross final energy consumption in 2020. The targeted shares of the three sectors heating/cooling, electricity and transport are shown in Table 16.

Table 16: Italy's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	17%
Heating and cooling	17.09%
Electricity	26.39%
Transport	10.14%

(Source: NREAP)

In order to attain these results, the National Italian Energy Strategy (NES) has been broken down into seven priorities, each with its specific supporting measures that have already been set in motion or are currently being defined:

- Energy efficiency,
- Competitive gas market and Hub Southern Europe,
- Sustainable development of renewable energy,
- Development of electricity infrastructure and the electricity market,
- Restructuring the refining industry and the fuel distribution sector,
- Sustainable production of domestic hydrocarbons, Modernization of the system governance.

Once the strategy has been implemented, the system will be able to evolve, gradually but significantly, and to surpass the 20-20-20 European targets. The results expected by 2020 are the reduction of fuel consumption and an evolution of the energy mix with a focus on renewables.

Considering national potential, in addition to the NREAP, the Italian Government, in 2013, produced the National Energy Strategy (NES). This document identifies the main objectives that the Italian energy sector aims to achieve by 2020. A major role is given to energy efficiency but the contribution of RES is relevant as well. Main drivers of the Strategy are to:

- exceed the European 20-20-20 targets, achieving a better balance between different energy sources (with a greater focus on renewables for heating and cooling)
- promote economically sustainable development in the sector, with incentive costs aligned to European levels and support for a gradual move to grid parity
- give preference to technologies with greater spin-offs for the sector and for the Italian economy as a whole
- gradually integrate renewable electricity with the electricity market and the grid.

Targets:

Regarding RES, the main quantitative targets defined in the NES are listed below:

- Gross Final Energy Consumption: 126 Mtoe. In terms of the energy mix, a 19-20% share of renewable energy in gross final consumption (compared to about 10% in 2010) is expected.
- Gross Electricity Consumption: 345-360 TWh. It is expected that renewables will reach or exceed the levels of gas as the number one source in the electricity sector, accounting for approximately 34-38% of consumption (compared to 23% in 2010). The share of coal will remain essentially unchanged, while fuel oil will fall to near zero levels. The expected generation mix is as follow: 35-40% for gas, 35-38% for RES, 15-16% for coal, 7-10% for imports, 1% oil, 2% for other.

- RES Gross Final Energy Consumption: 23-24 Mtoe. The objective for RES is to account for 19-20% of gross final consumption (compared to the European objective of 17%).
- RES Gross Electricity Consumption: 10-11 Mtoe (120-130 TWh). In terms of the technology mix, it is envisaged that it will follow the development planned in the National Renewable Action Plan (NREAP), except for solar technology, which has had, and will continue to have, a much more rapid development. The expected mix is based on 30 TWh from PV and 90-100 TWh from other non PV RES.
- RES Gross Final Energy Consumption in the heating and cooling sector: 11 Mtoe. The goal here is to bring renewables production up to 20% of final consumption by 2020 (compared to the 20-20-20 target of 17%).
- RES Gross Final Energy Consumption in the transport sector: 2.5 Mtoe. Italy has confirmed the 2020 European consumption target of 10% for biofuels.

As regards the long and very-long term (2030-2050), environmental challenges, competitiveness, and security will require a more radical change to the system, which will largely involve not only the energy sector, but the entire functioning of society.

An analysis of possible evolutionary scenarios for the country – at present knowledge – to achieve the decarbonisation targets, allows a more accurate identification of the common implications that should guide the sector in its long-term choices, taking into account the choices made today. Among the most important:

- The need to strengthen efforts in energy efficiency. Primary consumption will have to reduce in the range of 17-26% by 2050 compared to 2010, by decoupling economic growth from energy consumption. In particular, efforts in building and transport will be critical.
- The high penetration of renewable energy, that in any of the scenarios envisaged at the time is expected to reach levels of at least 60% of gross final consumption by 2050, with much higher levels in the electricity sector. In addition to the need for research and development for the reduction of costs, it will be fundamental for rethinking the market and network infrastructure.
- A substantial increase in the degree of electrification, which will almost double by 2050, reaching at least 38%, particularly in electricity and transport.
- The key role of gas for the energy transition, despite a reduction of its weight both in percentage and in absolute value in the span of the scenario.

Support schemes for biomass electricity production

Overview of support schemes

In Italy, the growth of RES has been supported by different mechanisms and significant revisions occurred over time, in particular in the electricity sector.

In 2013, the "PV Conto Energia" reached the limit for the yearly cumulative cost of incentives equal to 6.7 billion euro; in the meantime, Green Certificates were substituted by a sliding Feed in Premium scheme with access procedures which, depending on the plant power class, include direct access, registries and auctions. For renewable technologies other than PV, a limit cost of 5.8 billion euros per year was defined.

Additionally, during recent years, other schemes were introduced such as a fiscal incentive for the private sector and a White Certificate scheme for energy utilities and ESCO companies. In 2013 a further mechanism, named Thermal Account ("Conto Termico"), for the H&C sector was introduced, in addition to those systems already in force. Even for the transport sector a biofuels quota obligation was defined.

Electricity sector

From 2009 onwards Italy has managed different schemes to support the growth of renewable energy sources:

- Feed in Premium scheme (changed in the last phase to a feed in tariff scheme/sliding FIP scheme) named "Conto energia" for PV installations (over 20 years) and CSP (over 25 years);

- Green Certificate scheme for all RES other than PV (over 15 years);
- Feed in Tariff scheme for all RES other than PV with a capacity up to 1 MW (over 15 years);
- New feed-in Tariff and sliding feed-in Premiums systems through registries and auction (over the plant lifetime);
- Fiscal incentive (tax credit).

In the following diagram a scheme of access periods of the support schemes for RES in the electricity sector is illustrated, including the first support mechanism (CIP6) introduced in 1992.

In addition to the previous mechanisms, there have been other facilitating measures available for RES in the electricity sector:

- Simplified purchase, accessible by all renewable non-programmable power plants and for other power plants up to 10 MW. It allows the operator to have the energy injected into the grid retired by GSE, who is responsible for bidding the energy into the market;
- Net Metering, accessible by renewable power plant and CHP power plants up 200 kW (extended up to 500 kW in 2015). It provides to the producers an economic contribution in order to pay back a part of the cost of purchased energy. The value of the contribution is determined on the basis of an economic valorization of the energy injected into the grid.

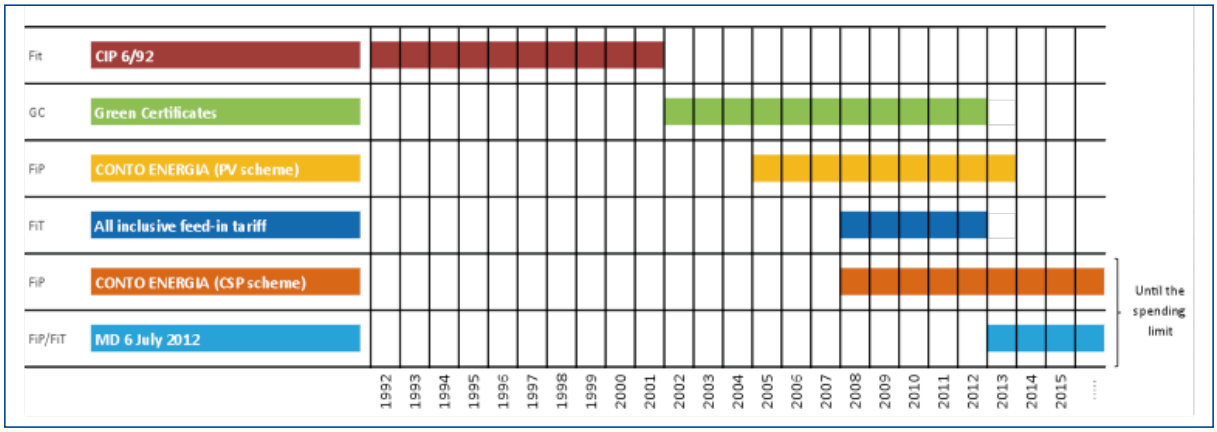

Figure 34: Access periods of the support schemes for RES in the electricity sector

Support schemes for biofuels for transport

Biofuel blending obligation quota

In order to comply with the 10% EU RES target in the transport sector, Italy introduced, through the legislative decree implementing Directive 2009/28, a quota obligation of biofuel on parties that inject into the grid, for consumption, petrol and diesel from fossil sources.

The obliged companies can fulfil their obligation by acquiring, in whole or in part, the equivalent quota or corresponding rights from others, buying the so called Biofuel Certificates.

It is relevant to say that a mandatory quota for "advanced biofuels" has been introduced, as well. The concept of "Advanced biofuels" has been introduced by ministerial decree: those are biofuels produced from materials listed in Annex 3 of the Decree and include agricultural and industrial wastes (apart from UCOs and animal fats), residues, ligno-cellulosic materials, cellulosic materials and algae.

Table 17: Mandatory quota for biofuels and "advanced biofuels"

Year	Q%	Q% Advanced biofuels
2015	5%	
2016	5.5%	
2017	6.5%	
2018	7.5%	1.2%
2019	9%	1.2%
2020	10%	1.6%
2021		
From 2022	10%	2%

Furthermore, all the biofuels released for consumption in Italy must comply with the sustainability criteria stated by RES Directive (2009/28/EC) and QFL Directive (2009/29/CE) and they must be certified by specific certification bodies according to the National Certification Scheme (DM 23 January 2012) or according to voluntary schemes approved by the EU Commission or according to bilateral or multilateral agreements with third countries.

The scheme encourages second and third generation biofuels by providing extra incentives (double counting mechanism – 5 Gcal of biofuels released gives rights to a certificate), while establishing, specific limits for biofuels produced from wastes and by-products.

Fees and penalty charges from EUR 60 to 90 /Gcal are provided for every Gcal not released. The average price of biofuels certificates (considering the case in which 1 certificate = 10 Gcal) amounts to EUR 400/450, equal to EUR 40/45/Gcal.

Biomethane

The Decree of 5th December 2013 provides incentives for biomethane:

- used in high efficiency cogeneration plants;
- injected into the natural gas grids;
- used as a biofuel for transport.

In the first two cases a feed-in tariff or feed-in premium is granted over a 20 year period.

If the biomethane is used in the transport sector it is supported by the above described biofuels' blending obligation (Ministerial Decree 10/10/2014 – Annex 2) for twenty years and fulfills the scheme's requirements.

Double counting is recognised:

- only for biomethane derived from the biodegradable part of urban waste;
- for biomethane derived from certain residues and by products described in a special list;
- for biomethane derived from non-food sources and algae.

The incentives are funded through the natural gas bills.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Italy

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Italy in 2014 amounted to 6,122 Petajoule (PJ) and is still dominated by fossil fuels: 2,157 PJ oil products, 2,122 PJ natural gas and 550 PJ coal products. Renewable energy sources have a share of 18.5% or 1.136 PJ. 157 PJ are from electricity

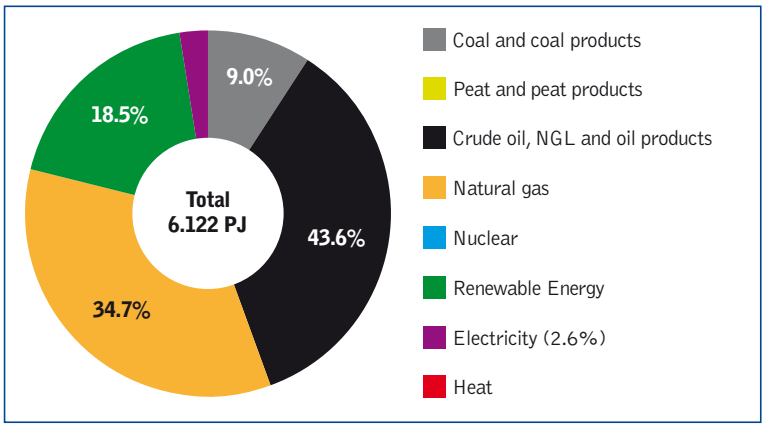

Figure 35: Total primary energy supply in Italy in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Half of total primary energy supply of renewable energy sources is covered by energy from biofuels and waste. Geothermal energy amounts to 19%, hydropower to 18% and solar and wind energy to 13%.

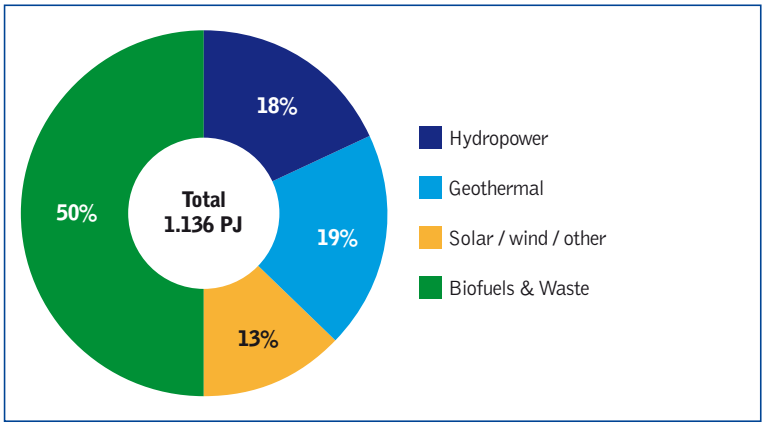

Figure 36: Total primary energy supply of Renewable Energy Sources in Italy in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Italy comes from solid biofuels (339 PJ). The second largest item is biogas (69 PJ) followed by biodiesel (44 PJ), renewable municipal waste (34 PJ), other liquid biofuels (30 PJ) and charcoal (2 PJ).

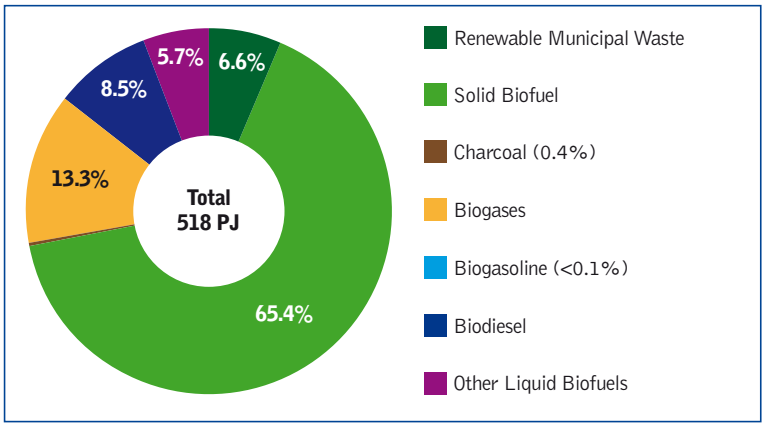

Figure 37: Total primary energy supply from bioenergy in Italy in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Italy increased more than fifteen fold from 1990 to 2013. In 1990 bioenergy only came from solid biomass and accounted for 34 PJ. In 2014 solid biomass contributed 375 PJ, gaseous biofuels 69 PJ and liquid biofuels 74 PJ. The share in total final energy consumption increased from 0.6% to 8.5% in the same period.

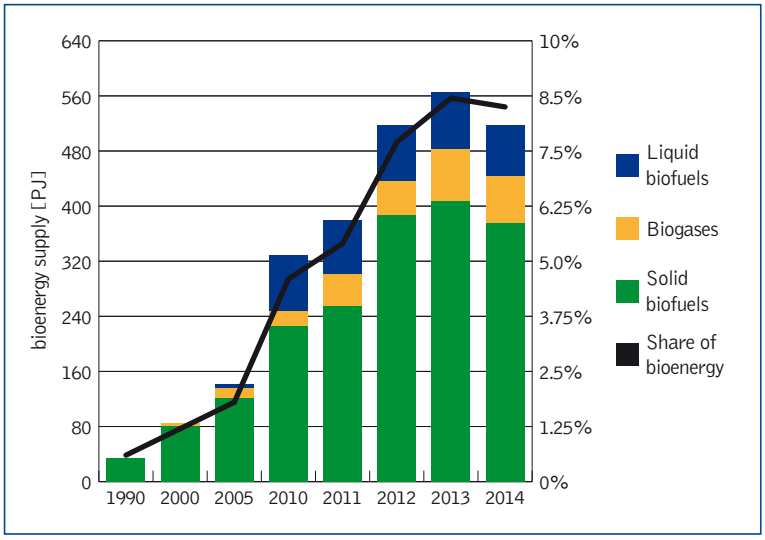

Figure 38: Development of total primary energy supply from bioenergy in Italy 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 101 GJ, which comprised of 8.5 GJ of biogenic, 6.1 GJ solid biomass, 1.1 GJ gaseous biofuels and 1.2 GJ liquid biofuels

Table 18: Total primary energy supply per capita in 2014

Total energy	101 GJ/capita
Bioenergy	8.5 GJ/capita
Solid biofuels	6.1 GJ/capita
Gaseous biofuels	1.1 GJ/capita
Liquid biofuels	1.2 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Italy's population in 2014 accounted for 60.8 million people

LINKS TO SOURCES OF INFORMATION

http://www.iea.org/policiesandmeasures/renewableenergy/?country=Italy

http://www.res-legal.eu/search-by-country/italy/

The Netherlands

NATIONAL POLICY FRAMEWORK

The Dutch energy policy aims to secure energy supply for the future and reduce emissions from the energy sector. Future targets for renewable energy are governed by the European Directive on the promotion of the use of energy from renewable sources (Renewable Energy Directive, EU-RED, 2009/28/EC) which sets an obligatory target for renewable energy sources for the Netherlands at 14% share of final energy consumption by 2020. The National Renewable Action Plan (NREAP) outlines pathways which will allow them to meet their 2020 renewable energy, energy efficiency and GHG cuts targets. The expectation is that the renewable energy share could be 14.5% in gross final energy consumption in 2020, with a split in sectors as displayed in the table below.

Table 19: The Netherlands' 2020 renewable energy targets

Sector	Excepted Share	Targets set in the RED and the NREAP
Overall target	14.5%	14.0%
Heating and cooling	8.7%	
Electricity	37.0%	
Transport	10.3%	10%

(Source: NREAP)

The European objective of 14% renewable energy in 2020 and the increased objective for 2023 of 16% in the Dutch Energy Agreement are the official targets. In 2013 this Energy Agreement[29] was established by different stakeholders (NGO's, government, industry) to agree on a pathway to realise the 14% Renewable Energy target in 2020 and 16% in 2023. Important pillars of this agreement are doubling the energy efficiency, increased solar and wind energy (10 times more) and also doubling the share of bioenergy. For cofiring of biomass in coal-fired power plants a cap of 25 PJ of exclusively sustainable biomass has been agreed. As a consequence the Netherlands has developed an advanced sustainability scheme for the use of wood pellets for heat production and cofiring in coal fired power plants

In order to achieve the above listed targets The Netherlands established a comprehensive legal and administrative framework nurturing deployment of renewables with a number of complementary financial, fiscal and promotional measures, like feed-in premium (SDE and SDE+), biofuels obligation, research support and green deals.

The Stimuleringsregeling Duurzame Energieproductie – SDE+ [Incentive Scheme for Sustainable Energy Production] initiates a new system of feed-in premium allocation subsidising renewable energy in the electricity, heat and gas sectors. It supports all different kinds of renewable energy. The SDE+ provides a feed-in premium (FIP)[30] subsidy that covers the difference between wholesale market prices of electricity and cost price of electricity from renewable sources. The budget is made available in auctions where the lowest bidder is awarded an 8 – 15 year contract first. The budget comes from a levy on the energy consumers.

Furthermore, the RED (Renewable Energy Directive) has been implemented by the Dutch Decree on Renewable Energy in Transport of 18 April 2011 (retroactive to 1 January 2011).

First of all this law obliges fuel suppliers bringing fuels onto the Dutch market to sell a certain share of biofuels on the market based on the energy content, which will increase in the coming years. In addition to this, additional sub targets have been set for diesel and petrol.

29 https://www.ser.nl/en/publications/publications/2013/energy-agreement-sustainable-growth.aspx

30 http://english.rvo.nl/subsidies-programmes/stimulation-sustainable-energy-production-sde

Table 20: Biofuel obligations for fuel suppliers based on energy content 2010-2020

	2010	2011	2012	2013	2014	2020
Total obligation	4.0%	4.25%	4.5%	5.0%	5.5%	10%
Diesel	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Petrol	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%

(Source: http://www.transportenvironment.org/sites/te/files/publications/CE_Delft_4786_Biofuels_on_the_Dutch_market_FINAL.pdf)

The law also prescribes that biofuels are only allowed to count towards the target where they meet the sustainability criteria of Article 17 of the RED, and provides the possibility of double-counting biofuels from waste and residues.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=netherlands.

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of the Netherlands in 2014 amounted to 3,029 Petajoule (PJ) and is still dominated by fossil fuels (91%): 1,192 PJ oil products, 1,190 PJ natural gas and 375 PJ coal products. Renewable energy sources have a share of 5.7% or 173 PJ. The statistic also features 45 PJ of electrical energy coming from nuclear power stations and 53 PJ coming from electricity.

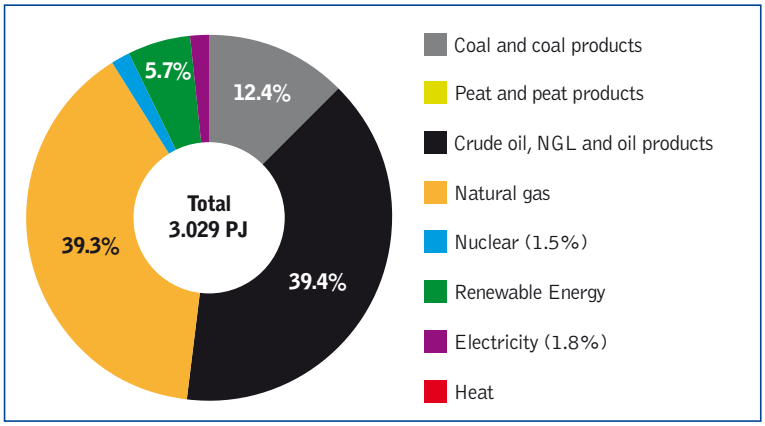

Figure 39: Total primary energy supply in the Netherlands in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the total primary energy supply of renewable energy sources is covered by energy from biofuels and waste (84%). Solar and wind power amount to 15%. Geothermal energy and hydropower add up to 1%.

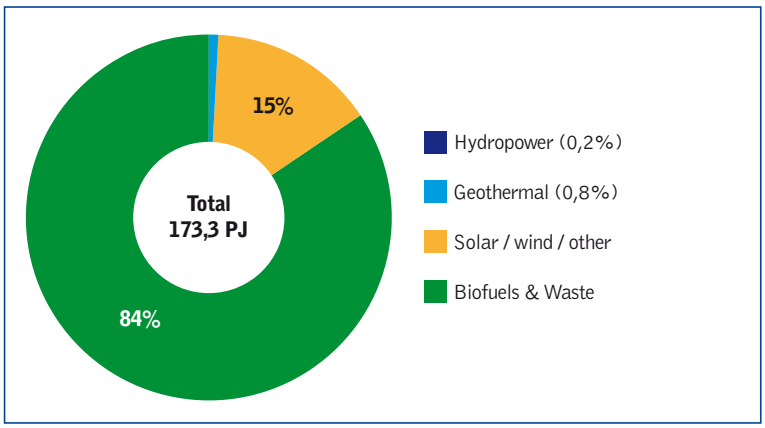

Figure 40: Total primary energy supply of Renewable Energy Sources in the Netherlands in 2014
(Source: World Energy Balances © OECD/IEA 2015)

More than one third of the bioenergy consumed in the Netherlands comes from solid biofuels (43 PJ). Another third comes from renewable municipal waste (41 PJ). 12% comes from biogas (14 PJ), 10 PJ from biodiesel, 5 PJ from biogasoline and 0.3 PJ from charcoal.

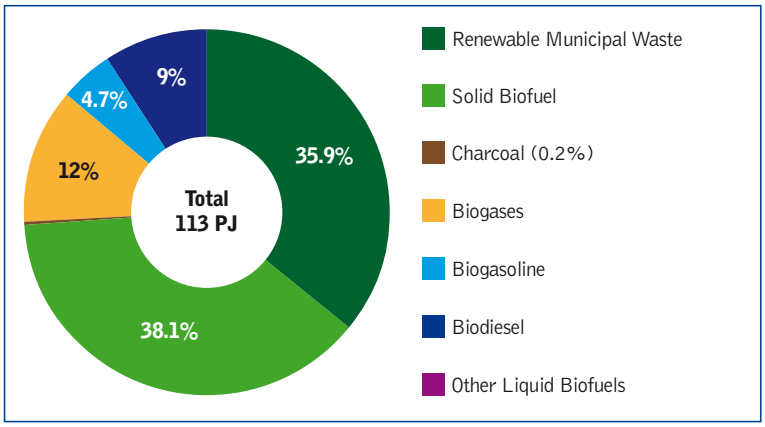

Figure 41: Total primary energy supply from bioenergy in the Netherlands in 2014

(Source: Renewables Information © OECD/IEA 2015)

Total primary energy supply from bioenergy in the Netherlands increased more than threefold from 1990 to 2012 and slightly decreased afterward. In 1990 bioenergy came from solid biomass (28 PJ) and gaseous biofuels (2 PJ). In 2014 solid biomass contributed 84 PJ, liquid biofuels 16 PJ and gaseous biofuels 14 PJ. The share in total primary energy supply increased from 1.1% to 3.7% in the same period. The sharpest rise occurred between 2005 and 2010. The share of solid biofuels decreased after 2012, because utilization in cofiring was much lower in 2013 and 2014.

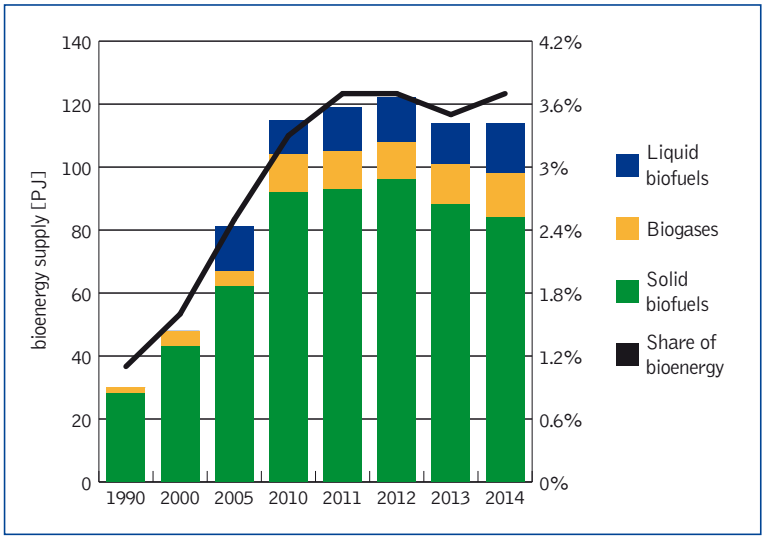

Figure 42: Development of total primary energy supply from bioenergy in the Netherlands 1990 – 2014

(Source: Renewables Information © OECD/IEA 2015)

These data differ from the normal statistics, because they are based on IEA statistics and not Eurostat or CBS.[32]

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 179 GJ, which comprised of 6.7 GJ of biogenic, 4.9 GJ solid biomass, 0.8 GJ gaseous biofuels and 0.9 GJ liquid biofuels

Table 21: Total primary energy supply per capita in 2014

Total energy	179 GJ/capita	Percent
Bioenergy	6.7 GJ/capita	3.7%
Solid biofuels	4.9 GJ/capita	2.6%
Gaseous biofuels	0.8 GJ/capita	0.4%
Liquid biofuels	0.9 GJ/capita	0.5%

(Source: Renewables Information © OECD/IEA 2015)

Note: Netherland's population in 2014 accounted for 16.9 million people

31 http://www.cbs.nl/en-GB/menu/methoden/dataverzameling/duurzame-energie-ob.htm

RESEARCH FOCUS RELATED TO BIOENERGY

In 2015 a new Research Agenda for the Biobased Economy was produced by the Top Consortium for Knowledge and Innovation BioBased Economy: TKI-BBE[32]. The TKI-BBE operates within the Top sector Chemistry and Top sector Energy[33]. Besides energy, biomass streams can also be used for materials. By separating biomass into fractions, and by valorisation of the molecular capital, financial gains are enhanced, and at the same time the use of fossil fuels in the chemical sector is reduced. The TKI BBE stimulates the development of this bio-cascading. The Research Agenda[34] is being developed through existing programme lines of the TKI BBE. These programme lines are linked to the relevant Top Sectors. They cover i) thermal conversion from biomass; ii) chemical catalytic conversion technologies; iii) biotechnological conversion technologies and iv) solar capturing (and biomass production). In addition there are action line.

RECENT MAJOR BIOENERGY DEVELOPMENTS

Green Growth, Circular Economy, Innovation and Biobased Economy are important pillars of the development of bioenergy in the Netherlands. A Biomass Vision 2030 was developed and sent to the Parliament in March 2016. The main elements are a steady growth in sustainable biomass production and integrated use for materials, biofuels for transport and high temperature heating. Sustainability is crucial and a scheme has been developed for the sustainability of wood pellets for co-firing and large scale heating. Major demonstrations of new technologies exist, such as the Empyro pyrolysis plant http://www.empyroproject.eu).

LINKS TO SOURCES OF INFORMATION

http://www.iea.org/policiesandmeasures/renewableenergy/

http://ec.europa.eu/energy/en/topics/renewable-energy/national-action-plans

http://www.iea.org/publications/countryreviews/

Table 22: R&D Support in Netherlands in EUR million

Sector		Investment in R&D		Governmental Support	
		2012	2013	2012	2013
Fiscal	WBSO	115	104	18,4	18,0
	RDA	60	95	6,2	12,8
Top sector	TKI-BBE	52,4	19,2	26,2	8,5
	TKI-Green-Gas	22,6	13,2	11,3	6,6
	MIT BBE/A&F	0,2	7,6	0,1	3,8
	TKI Addition	-	0,3	-	0,3
	NWO	-	-	-	3,3
	R&D Institutes	-	-	14,1	14,1
	TOTAL	**250**	**240**	**76,3**	**67,4**

32 http://www.kennisnetbiobased.nl/nl/biobasedeconomy/Innovatie-en-onderzoek.htm (dutch)

33 http://topsectorenergie.nl/english/

34 http://www.kennisnetbiobased.nl/nl/biobasedeconomy/Strategie-beleid-en-visie/onderzoeksagenda.htm

Norway

NATIONAL POLICY FRAMEWORK

As a member country of the European Economic Area, Norway also implemented the EU Renewable Energy Directive 2009/28/EC and produced a National Renewable Action Plan (NREAP). Norway has committed itself to a target of 67.5% share of renewable energy in gross final energy consumption in 2020, with a split in sectors as displayed in the table below.

Table 23: Norway's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	67.5%
Heating and cooling	43%
Electricity	114% *
Transport	10%

(Source: NREAP)

**Overshoot of renewable power production of 14%*

The Kingdom of Norway promotes renewable energy through a quota system including a certificate trading scheme:

The main incentive for the use of renewable energy is a quota system including quota obligations and a certificate trading system. The Electricity Certificates Act obliges electricity suppliers and certain electricity consumers to annually acquire renewable energy certificates in proportion to their electricity sales and their consumption by a set date. The act further stipulates the conditions under which owners of renewable energy generation plants may acquire electricity certificates.

Furthermore, Enova, a public enterprise that is owned by the Ministry of Petroleum and Energy, offers investment aid to renewable heat production, which shall contribute to increased use of other energy carriers than electricity, natural gas and oil for heating. Enova has support programmes in place aimed at small heating plants and larger district heating plants. Enova also has a support programme directed towards industrial production of biogas. In addition, Enova offers investment aid to households undertaking energy efficiency measures, measures aimed at decreasing energy consumption or conversion from heating sources based on fossil fuels or electricity to a renewable source.

The ENERGIX-programme provides funding for research on renewable energy, efficient use of energy, energy systems and energy policy. The programme is a key instrument in the implementation of Norway's national RD&D strategy, Energi21, as well as for achieving other energy policy objectives.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Norway

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

According to Statistics Norway, in 2014, 12 percent of the energy consumption in households was with wood. In total, 1.1 million tonnes of wood was used, of which 0.9 million tonnes was burned in private residences and 0.2 million tonnes was burned in holiday cottages. Compared with the previous year, 2014 saw a decrease in wood consumption in private residences and holiday cottages of 14 per cent. More than half of the wood consumption (56 per cent) was burned in clean-burning stoves. Clean-burning stoves are more energy efficient than older stoves manufactured prior to 1998, which means that more of the energy is utilised.

Consumption of wood and other biomass fuels such as wood chips and pellets decreased by 17 per cent in 2014 compared with the previous year. Solid biofuels are an important energy product in both households and in the manufacture of paper and paper products. Consumption of biofuels in Norway peaked in the relatively cold year of 2010, at around

15 TWh, but since then has dropped sharply. In 2014, the consumption of biofuels was approximately 10 TWh, which is the lowest consumption of biofuels since 1993. This is due to the mild 2014 winter in addition to the closures in the manufacture of paper and paper products. It may also be related to households having acquired heat pumps, which are often used as a substitute for wood stoves. Moreover, there has been a fall in electricity prices since 2010, making it cheaper to use heat pumps and electricity.

The use of biofuels for transport purposes has increased since it was first introduced in 2006. In 2006, the use of biofuels was 0.06 TWh. This energy use was around 1.5 TWh in both 2013 and 2014, and has curbed some of the decline in the total biofuel consumption.

Total consumption of biofuels amounted to no more than 5% of net domestic energy consumption in 2014, but is nevertheless important for fulfilling the commitments in the Renewable Energy Directive.

The total primary energy supply of Norway in 2014 amounted to 1,259 Petajoule (PJ) with an export surplus of electricity of 56 PJ. It is slightly dominated by fossil fuels: 505 PJ oil products, 211 PJ natural gas and 36 PJ coal products. Renewable energy sources have a share of 42.5% or 559 PJ.

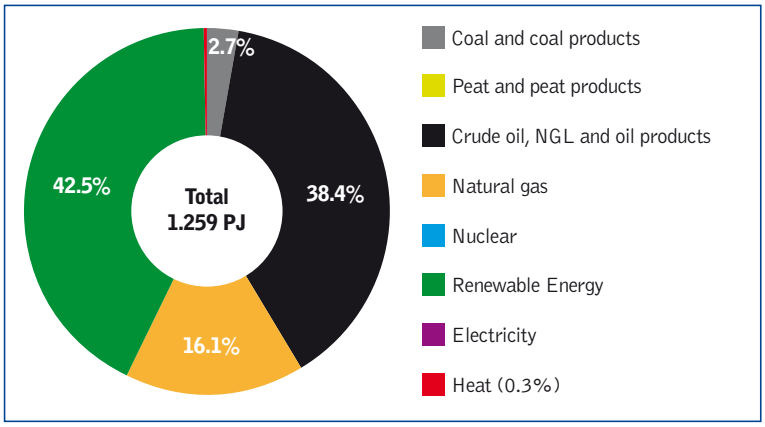

Figure 43: Total primary energy supply in Norway in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the total primary energy supply of renewable energy sources is covered by energy from hydropower (88%), followed by biofuels and waste (11%) and solar and wind energy (1%).

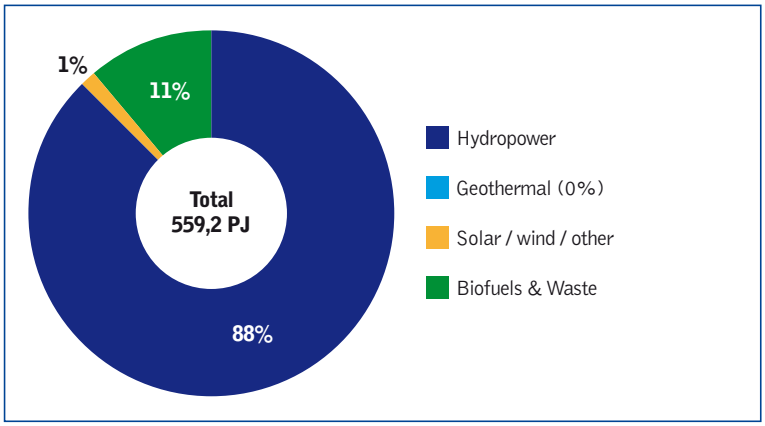

Figure 44: Total primary energy supply of Renewable Energy Sources in Norway in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Norway comes from solid biofuels (35 PJ). 8 PJ come from renewable municipal waste, 5 PJ from biodiesel, and 0.4 PJ from biogasoline and other liquid biofuels, respectively.

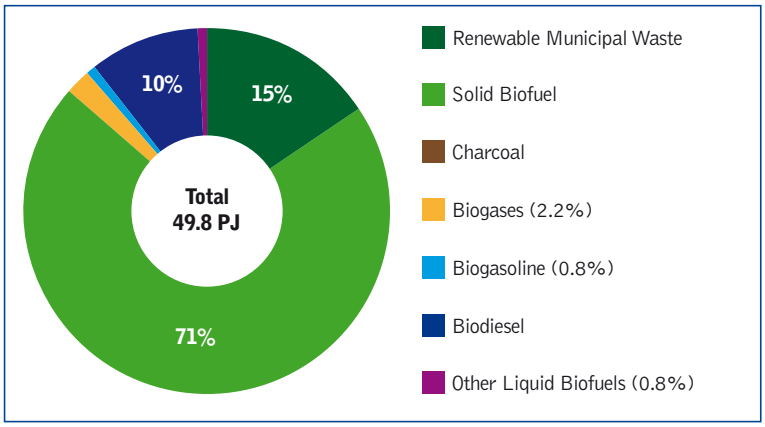

Figure 45: Total primary energy supply from bioenergy in Norway in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Norway increased from 1990 to 2010 and decreased afterwards. In 1990 bioenergy came from solid biomass (41 PJ). In 2014 solid biomass contributed 43 PJ, liquid biofuels 6 PJ and gaseous biofuels 1 PJ. The share in total final energy consumption decreased from 4.6% to 4.0% in the same period.

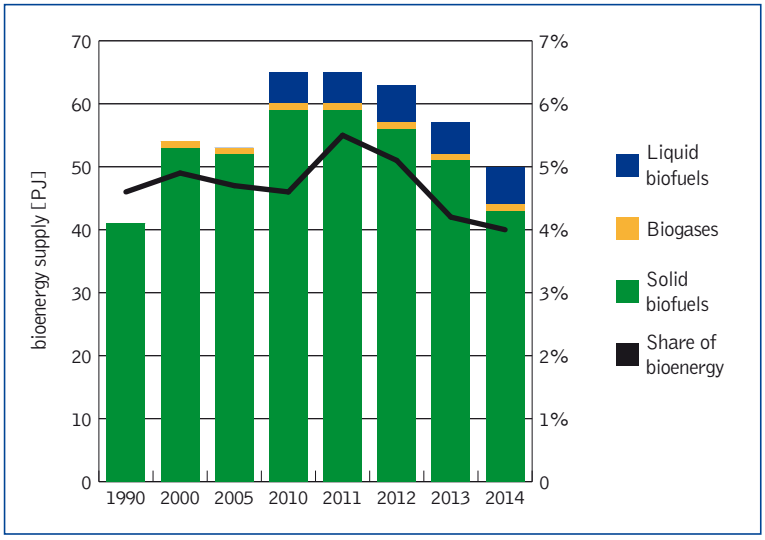

Figure 46: Development of total primary energy supply from bioenergy in Norway 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 244 GJ, which comprised of 9.6 GJ of biogenic, 8.3 GJ solid biomass, 0.2 GJ gaseous biofuels and 1.1 GJ liquid biofuels.

Table 24: Total primary energy supply per capita in 2014

Total energy	244 GJ/capita
Bioenergy	9.6 GJ/capita
Solid biofuels	8.3 GJ/capita
Gaseous biofuels	0.2 GJ/capita
Liquid biofuels	1.1 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Norway's population in 2014 accounted for 5.2 million people

RECENT MAJOR BIOENERGY DEVELOPMENTS

Currently, biomass used for energy purposes in Norway is mainly made up of firewood used for heating in private households, for industrial purposes in the forest industry and for district heating. The past two-year period saw few changes in the availability and use of biomass for energy purposes. The supply of biofuels, mainly from the forests, largely depends on logging activities, which in turn depend on prices and demand in international markets.

The woodchips energy scheme, a support scheme for the production of woodchips and energy from forest fuels, has had a favourable impact over the two-year period. In total, some 824 000 m^2 lv (loose volume) woodchips were produced with support from the scheme in 2011 and some 880 000 m^2 lv in 2012. Around 60-70% of the production went to domestic bioenergy generation while the remaining amount was exported.

LINKS TO SOURCES OF INFORMATION

The following websites provide useful information and data on national Norwegian bioenergy policy, production and consumption.

- Statistical data on renewable energy, provided by Statistics Norway: https://www.ssb.no/en/energi-og-industri/statistikker/energibalanse

Relevant ministries in Norway are:

- Norges vassdrags- og energidirektorat (NVE) – Norwegian Water Resource and Energy Directorate: http://www.nve.no/
- Olje- og energidepartementet (OED) – Ministry of Petroleum and Energy: https://www.regjeringen.no/no/dep/oed/id750/

Other relevant organisations:

- Statnett – Norwegian transmission system operator: http://www.statnett.no/
- Enova SF was established in 2001 in order to drive forward the changeover to more environmentally friendly consumption and generation of energy in Norway: http://www.enova.no/

Sweden

NATIONAL POLICY FRAMEWORK

In 2014 the share of renewable energy in Sweden was 52,6 percent which meant that Sweden already met the target for the EU Renewable Energy Directive (2009/28EC) of 49%, as well as the Swedish parliament national overall target for renewable energy of 50%. In addition the binding national target for transport of 10% (all MS have this transport target) were met in 2014 as well. Sweden opted not to divide the renewable energy target into further targets per sector, but projections per sector were made in the NREAP as displayed in the table below. In the Swedish progress report 2015 the reported shares for the year 2014 was 52.6% overall and 19.2% for transport. In 2015, the renewable share in transport was even higher, 23.6% based on the EU calculation method, including double-counting. The real share was 14.7%. The EU renewable energy targets for 2020 were reached already in 2012, both the overall target and the transport target.

Table 25: Sweden's 2020 renewable energy targets as stated in the NREAP

Sector	Share in gross final consumption per sector
Overall target	50.2%
Heating and cooling	62.1%
Electricity	62.9%
Transport	13.8%

(Source: NREAP)

Apart from the targets set by the EU Directive, Sweden has no specific targets for bioenergy. However, general policy stated an aim of a Fossil Free Society by 2050, and the new government in 2014 declared that Sweden shall be a "fossil free welfare state". The Swedish parliament decided in 2009 that Sweden shall have a fossil independent vehicle fleet by 2030.

Sweden`s policies regarding bioenergy have been rather stable for a long period of time. The development of biomass as a renewable energy source for heat was promoted from the late 1970's to decrease Sweden's dependence on imported oil, mainly by taxation of oil, and investment grants for heat plants using biomass. In 1991 a carbon tax was introduced, and this tax has since then been raised multiple times, mainly on the heating and service sector, and lately also on industries which are not part of emission trading (ETS). Beside the carbon tax there is also variable energy taxes and fees on sulphur and nitrous oxide emissions. The most important incentives and tax measures were:

- 1970's to present, energy taxes to diversify energy use and decrease dependence on oil.
- 1977 – Law on municipal energy planning
- 1991 – introduction of a carbon tax, high on heat, lower on industry.
- 1991 – 1995, 1997 – 2003, investment grants to build biomass fueled CHPs.
- 2000 – 2004, green tax shift. The carbon tax was increased while labour taxes were lowered.
- 1998-2012 klimat – Local investemnet programmes for municipalities
- 2002 – landfill ban for combustable waste
- 2003 – Green certificate scheme to promote new renewable electricity production,
- 2005 – landfill ban for organic waste
- 2007 Tax exemptions for biofuels for transport to be used until 2013. Annual prolongation since then with some major adjustments
- 2012 Electricity Certificates Act. Together with Norway, a common electricity certificate market was established in order to increase the production of renewable electricity by 26.4 TWh by 2020. In 2016 the goal was raised to 30 TWh.

However, the high oil prices during the last few years in combination with reduced prices on traditional biofuels has resulted in an "overcompensation" of biofuels relative to fossil transport fuels, which is not allowed by EU state aid regulations. Moreover,

the revision of the EU state aid regulation for energy 2014-2020 also limits Sweden's possibilities to exempt biofuels from energy and CO_2 tax, since it contains a limitation on giving tax exemptions to "food based" biofuels. Therefore the Swedish Government considers that the current tax exemptions should be replaced by another system and a proposal is expected in 2017. The structure of this system is under development and no information regarding its ambition or structure can be given. The stated political ambition is that the system shall not reduce the use of biofuels and that it shall promote climate efficient biofuels while still being compatible with the EU tax and state-aid regulations.

The Swedish support scheme for renewables has mainly been based on general incentives and technology neutrality, like the carbon tax and the green certificates. The carbon tax is based on PPP, the polluter pays principle, whereby the fossil fuels pay for their long-term environmental damage and cost and direct subsidies for any renewable alternative have in general been avoided. Bioenergy has thus not had any direct subsidies but has benefited because its greenhouse gas emissions, for good reasons, are estimated at zero.

A link is provided to the respective detailed description of all fiscal and non-fiscal supports for bioenergy development:

http://www.iea.org/policiesandmeasures/renewableenergy/?country=Sweden

Swedish energy statistics can be found at

http://www.energimyndigheten.se/globalassets/nyheter/2015/energy-in-sweden-2015_150826.xlsx

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Sweden in 2014 amounted to 2,016 Petajoule (PJ) with an export surplus of electricity of 56 PJ. Approximately one third comes from fossil fuels, one third from renewables and one third from nuclear energy: 485 PJ oil products, 81 PJ coal products, 33 PJ natural gas and 7 PJ peat products. Renewable energy sources have a share of 36.1% or 748 PJ. The statistic also features 708 PJ of electrical energy coming from nuclear power stations. However, this reflects total primary energy supply; due to the huge thermal losses in nuclear energy, the share of nuclear is lower in final energy consumption, and the share of renewable energy is higher.

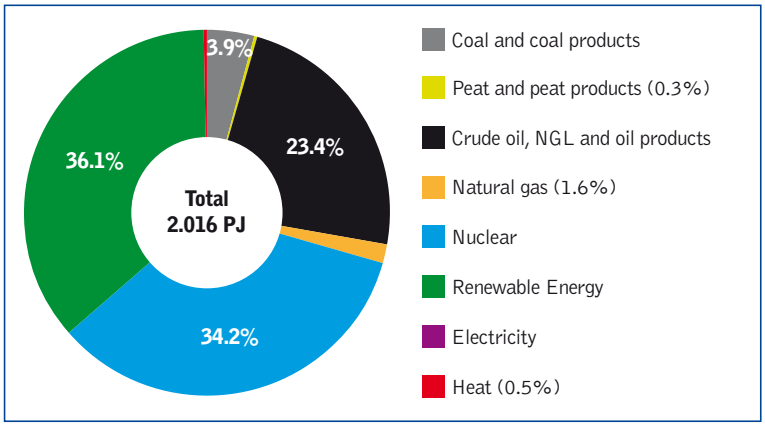

Figure 47: Total primary energy supply in Sweden in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the total primary energy supply of renewable energy sources is covered by energy from biofuels and waste (65%), followed by hydropower (30%) and solar and wind energy (5%).

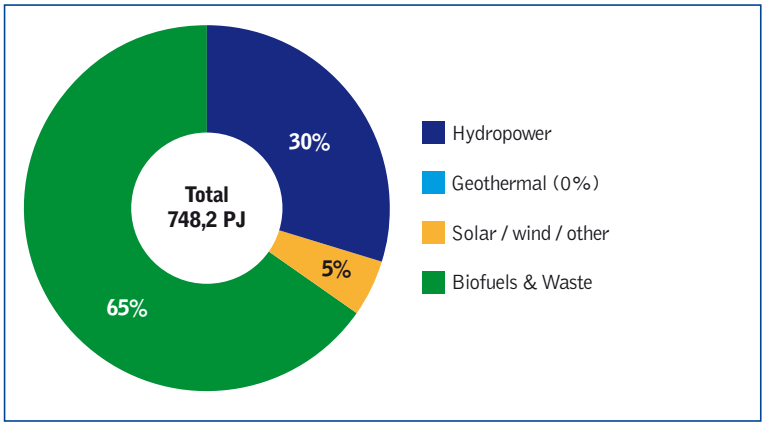

Figure 48: Total primary energy supply of Renewable Energy Sources in Sweden in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Sweden comes from solid biofuels (322 PJ). It should be mentioned that black liquor (158 PJ) is counted towards solid biofuels. 32 PJ are coming from municipal waste, 26 PJ from biodiesel, 7 PJ from biogasoline, 6 PJ from biogas and 4 PJ from other liquid biofuels.

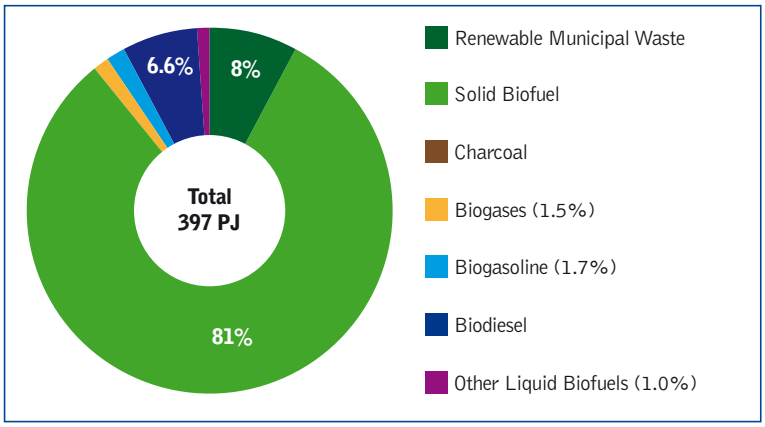

Figure 49: Total primary energy supply from bioenergy in Sweden in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Sweden increased from 1990 to 2014 with a peak in 2010 and a slight decrease in 2014. In 1990 bioenergy came only from solid biomass (222 PJ). In 2014 solid biomass contributed 354 PJ, gaseous biofuels 6 PJ and liquid biofuels 37 PJ. The share in total final energy consumption climbed from 11.2% to 20.3% in the same period.

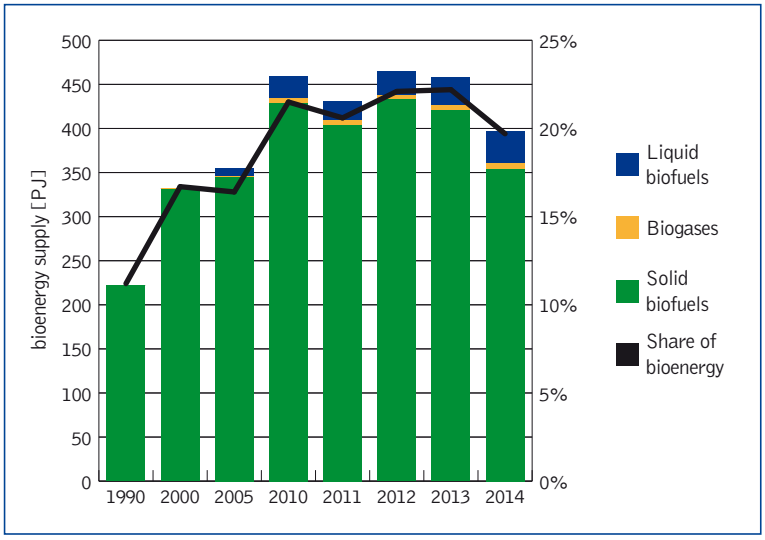

Figure 50: Development of total primary energy supply from bioenergy in Sweden 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual total primary energy supply (including industry) per unit population was 207 GJ, which comprised of 42.8 GJ of biogenic, 38.3 GJ solid biomass, 0.7 GJ gaseous biofuels and 3.8 GJ liquid biofuels.

Table 26: Total primary energy supply per capita in 2014

Total energy	207 GJ/capita
Bioenergy	42.8 GJ/capita
Solid biofuels	38.3 GJ/capita
Gaseous biofuels	0.7 GJ/capita
Liquid biofuels	3.8 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Sweden's population in 2014 accounted for 9.7 million people

RESEARCH FOCUS RELATED TO BIOENERGY

Sweden has a very high proportion of renewable energy production, due to long-standing utilisation of bioenergy and hydroelectric installations and recent advances in the deployment of wind power.

Various funding programmes are dedicated to research on hydropower, wind power, solar cells, sustainable biomass production and conversion into district heating as well as CHP plants. Bioenergy has been given high priority in the R&D portfolio. Over the years Swedish energy R&D has covered the main economically and environmentally relevant bioenergy topics. The three most ambitious projects by far in Sweden's overall energy R&D portfolio all concern development of new bioenergy technologies and processes: gasification of black liquor, fermentation of woody cellulose, and synthesis of liquid fuels via gasification. These technologies have all been considered central to advancing the current use of bioenergy.

The energy research programs in Sweden are mainly managed by the Swedish Energy Agency (SEA). In 2015 the Energy RD&D programme covered some 50 active sub-programmes and 1100 projects. For a detailed description of current R&D programmes please see the webpage of the energy agency (www.Energimyndigheten.se). During 2013-2016 there have been five priority areas: a vehicle fleet independent of fossil fuels; a power system designed around renewable electricity; energy efficiency in the built environment; increased use of bioenergy; and energy efficiency in industry.

RECENT MAJOR BIOENERGY DEVELOPMENTS

The first bio-methane plant at industrial scale in the world, GoBiGas in Gothenburg, was put into operation in 2014. The plant provides 20 MW (160 GWh) of bio-methane to the gas grid.

Forest biomass by-products such as tall oil and lignin are co-processed, or piloted to be co-processed, respectively, in a fossil refinery. Tall oil is used on a commercial scale by Sunpine in a new factory in Piteå to produce HVO biodiesel (100 000 tonnes/year).

The world's largest biomass CHP was inaugurated in May 2016 in Stockholm, owned by Fortum and the City of Stockholm. The plant is located in central Stockholm and is entirely supplied with woodchips (2.5 TWh/y) and supplies district heat to 190 000 households.

New CHPs using biomass and waste have been built in recent years also in Västerås, Linköping, Norrköping, Växjö, Jönköping, Gävle, Karlstad, Lund, and a number of other cities – a total investment of 30 billion SEK.

The use of fossil fuels in the forest industry, which is the biggest energy user in Swedish industry, has decreased by 73% in the last ten years. Oil has been substituted with pellets and bio-oils mainly in recovery boilers in the pulp industry.

The carbon tax has been increased in recent years in industries and other businesses outside ETS. This increase is promoting conversion from fossil fuels to wood fuels, bio-oils and district heating in breweries, dairies, asphalt preparation, etc. The Swedish greenhouses have in general switched from oil and gas to biomass and industrial waste heat.

HVO diesel has expanded very quickly on the transport fuel market in recent years, and in 2015 HVO accounted for 8% of the total use of transport fuels, with a total volume of 700 000 tonnes. HVO is based on feedstocks like tall oil, animal fats, and recovered vegetable oils.

LINKS TO SOURCES OF INFORMATION

The following websites provide useful information and data on national Sweden bioenergy policy, production and consumption.

- National Renewable Energy Action Plan (NREAP) http://ec.europa.eu/energy/renewables/action_plan_en.htm
- Swedish Energy Agency statistics https://www.svebio.se/
- Sweden. The framework: energy policy and climate change http://www.iea.org/textbase/nppdf/free/2013/sweden2013_excerpt.pdf
- An integrated climate and energy policy framework: "A sustainable energy and climate policy for the environment, competitiveness and long-term stability"
- The framework: energy policy and climate change http://www.iea.org/textbase/nppdf/free/2013/sweden2013_excerpt.pdf
- Energy Efficiency Policies and Measures inSweden http://www.odyssee-mure.eu/publications/national-reports/energy-efficiency-sweden.pdf
- The Swedish Climate Strategy http://www.government.se/contentassets/32e5a14843804c07a22c874b7418f79f/the-swedish-climate-strategy-a-summary
- Swedish board of forestry www.skogsstyrelsen.se
- Sweden large forest research programme www.futureforests.se
- The forest research institute. www.Skogforsk.se

Relevant ministries in Sweden are:

- Ministry of Enterprise and Innovation http://www.government.se/government-of-sweden/ministry-of-enterprise-and-innovation/
- Ministry of Education and Research http://www.government.se/government-of-sweden/ministry-of-education-and-research/
- Ministry of Environment and Energy http://www.government.se/government-of-sweden/ministry-of-the-environment/
- Ministry of Finance http://www.government.se/government-of-sweden/ministry-of-finance/
- Relevant stakeholders in academia and industry:
- Swedish Environmental Protection Agency http://www.swedishepa.se
- IVL Swedish Environmental Research Institute http://www.ivl.se
- Funding organizations at national level:
- Swedish Energy Agency (SEA) https://www.energimyndigheten.se/en
- Swedish Government Agency for Innovation Systems (Vinnova) http://www.vinnova.se/en
- Swedish Research Council (Vetenskapsrådet) http://www.vr.se
- Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS) http://www.formas.se/en

Programmes and initiatives: Competence Centres

- Biogas Research Centre (BRC) http://www.liu.se
- Competence Center CombustionProcesses (KCFP) http://www.lth.se/kcfp/english/
- Swedish Center of Excellence in Electrical Power Engineering (EKC²) http://researchprojects.kth.se
- Competence Centre for Catalysis (KCK) http://www.kck.chalmers.se
- High Temperature Corrosion Centre (HTC) http://www.htc.chalmers.se
- Combustion Engine Research Center (CERC) http://www.chalmers.se
- Competence Center for Gas Exchange (CCGEx) http://www.kth.se/en/itm/inst/mmk/forskning/centra/ccgex-competence-center-for-gas-exchange-1.279297
- Swedish gasification centre http://www.ltu.se/centres/Svenskt-forgasningscentrum-SFC
- www.F3center.se
- www.sp.se/Etc

United Kingdom

NATIONAL POLICY FRAMEWORK

The 2009 Renewable Energy Directive sets a target for the United Kingdom to achieve 15% of its total gross final energy consumption from renewable sources by 2020. This compares to only 1.5% in 2005. The delivery of 15% renewable energy by 2020 is considered highly stretching; the toughest target for any EU Member State, which it is aspiring to deliver with the following proportion of energy consumption in each sector coming from renewables:

- Around 30% of electricity generation, including 2% from small-scale power generation,;
- 12% of heat demand; from domestic and non-domestic use, and
- 10% of transport demand.

Table 27: UK's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	15%
Heating and cooling	12%
Electricity	30%
Transport	10%

(Source: NREAP)

The UK renewables policy framework has three key components:

- Financial support for the development and implementation of renewable energies;
- Unblocking barriers to renewable energy delivery; and
- Developing emerging renewable energy technologies

The Renewables Obligation (RO) was the main support mechanism for renewable electricity projects in Great Britain and Northern Ireland,. The RO came into effect in 2002 in England and Wales, and Scotland, followed by Northern Ireland in 2005. It placed an obligation on electricity suppliers to source an increasing proportion of their electricity from renewable sources or to purchase Renewables Obligation Certificates (ROCs). These were tradable green certificates issued to operators of accredited renewable generating stations for the eligible renewable electricity they generated.

When Electricity Market Reform (EMR) was introduced in 2013, arrangements were made to close down the Renewable Obligation (RO) and replace it, over time, with a new scheme.

The Contract for Difference (CfD) programme was introduced in UK in October 2014 as the replacement for the Renewable Obligations system. The CfD scheme was designed to support the deployment of large scale renewable electricity projects, and the RO is being closed down according to the following timetable.

- From the 1st of April 2015 the RO system was closed down for PV projects with a capacity greater than 5 MWe.
- Government has proposed that from 1st of April 2016 the RO system will be close for onshore wind projects (the relevant legislation is currently going through Parliament as part of the Energy Bill).
- The RO scheme will close completely to new entrants on 31st of March 2017; payments will continue to be made to projects under the scheme for their full contract term.

The CfD is based on the difference between the market price for electricity and an agreed "strike price" for renewable electricity. If the "strike price" is higher than the market price, the CfD Counterparty must pay the renewable generator the difference between the "strike price" and the market price. If the market price is higher than the agreed "strike price", renewable generator must pay the CfD Counterparty the difference.

CfDs are concluded between the renewable generator and Low Carbon Contracts Company (LCCC), a government-owned company. CfD contracts are awarded for a period of 15 years and are awarded on the basis of competitive allocation through an auction process.

Renewable electricity generators that wish to participate in the CfD scheme apply during allocation rounds. The renewable technologies eligible to participate in the CfD scheme are:

- onshore and offshore wind,
- solar PV,
- geothermal plants,
- hydropower,
- ocean power (tidal and wave),
- landfill and sewage gas,
- advanced conversion technologies; gasification and pyrolysis,
- enrgy from waste with CHP,
- anaerobic digestion,
- conversions of coal to biomass, and
- biomass CHP plants.

The CfD scheme is currently in place in Britain, with introduction in Northern Ireland in 2016.

The Feed-in Tariff (FIT) scheme is the primary support mechanism for technologies generating renewable electricity with a capacity of <5 MW. FITs were introduced in 2010 and cover solar, wind, hydro and anaerobic digestion (AD). FIT is currently the principal means of support for AD, with 168.5 MW accredited in January 2016. As part of the FIT Review, AD tariffs will be consulted on this year, while deployment caps have already been introduced.

The Renewable Transport Fuel Obligation (RTFO) was introduced in the United Kingdom in 2008. It places a requirement on the suppliers of transport fuels to ensure that 5% of all road vehicle fuel is from sustainable, renewable sources by 2010. The Government intends to set variable targets for the level of carbon and sustainability performance expected from all transport fuel suppliers claiming certificates for biofuels in the early years of the RTFO.

The Renewable Transport Fuel Obligation (RTFO) is intended to support the government's policy on reducing greenhouse gas emissions from vehicles by encouraging the production of sustainable biomass-based transport. The suppliers of fuels for transport and non-road mobile machinery (NRMM) must be able to show that a percentage of the fuel they supply comes from renewable and sustainable sources. Fuel suppliers who supply at least 450,000 litres of fuel a year are affected, and this includes the suppliers of biofuels and fossil fuels.

The Renewable Heat Incentive (RHI) was designed to increase the uptake of renewable heat and is the primary support mechanism available in this area. It is split into two schemes: the Non-Domestic RHI (available since 2011) and the Domestic RHI (available since 2014).

The Non-Domestic RHI is for industrial, commercial, public sector and not-for-profit organisations. These include, for example, businesses, hospitals, schools, and district heating schemes such as in the case of where one boiler serves multiple homes.

The technologies covered by the Non-Domestic RHI are: solid biomass; combined Heat and Power (CHP) systems for solid biomass, waste, geothermal and biogas; solid biomass contained in waste; heat pumps (ground source, water source and air-to-water); solar thermal; geothermal; biomethane, and; biogas.

Eligible generators receive regular payments over a 20 year period.

The Domestic RHI is the world's first long-term financial support programme for renewable heat, offering homeowners payments to offset the cost of installing low carbon systems in their properties.

The scheme is open to home owners, social and private landlords, and people who build their own homes. It is available to households both on and off the gas grid.

The technologies currently covered by the scheme are: biomass boilers and stoves; air and ground source heat pumps, and; solar panels.

The guaranteed payments are made quarterly over seven years for households in England, Wales and Scotland. (Northern Ireland has its own RHI scheme). The scheme is designed to bridge the gap between the cost of fossil fuel heat sources and renewable heat alternatives.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: https://www.gov.uk/government/policies/low-carbon-technologies

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply in Britain in 2014 was 7,444 PJ

Of this, total fossil fuel use was 6164 PJ, nuclear generation was 692 PJ and renewable energy was 514 PJ.

At 6.9%, the renewable contribution was fairly modest, and mostly from electricity generation

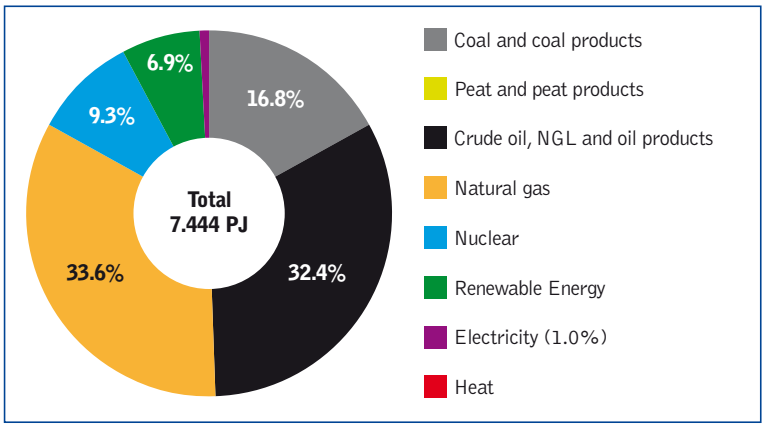

Figure 51: Total primary energy supply in the United Kingdom in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the total primary energy supply of renewable energy sources is covered by

- energy from biofuels and waste (318 PJ)
- solar and wind energy (118 PJ).
- Hydropower (18 PJ)

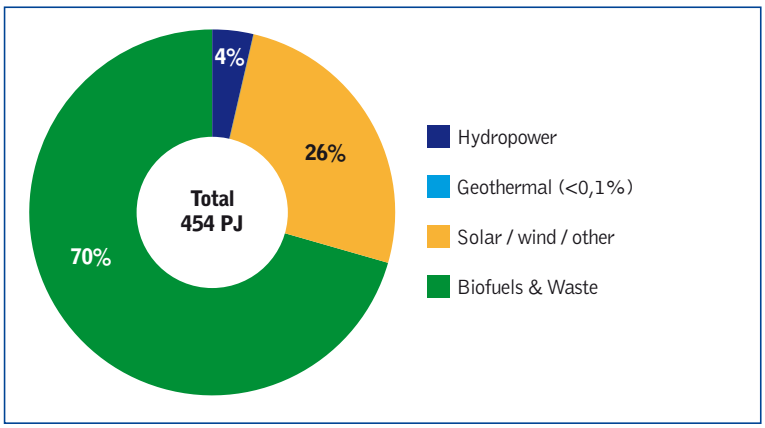

Figure 52: Total primary energy supply of Renewable Energy Sources in the United Kingdom in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in the United Kingdom comes from:

- solid biofuels (161 PJ)
- biogases (76 PJ).
- renewable municipal waste (33 PJ)
- biodiesel (31 PJ) and
- biogasoline (17 PJ)

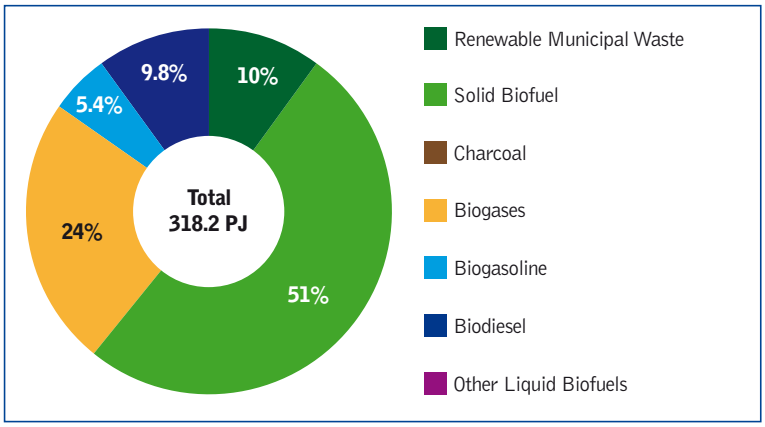

Figure 53: Total primary energy supply from bioenergy in the United Kingdom in 2014

(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in the United Kingdom increased more than thirteen fold from 1990 to 2014, albeit from a very low initial level.

In 1990 bioenergy came from solid biomass (16 PJ) and biogas (8 PJ).

The share in total final energy consumption climbed from 0.3% to 4.3% in the same period.

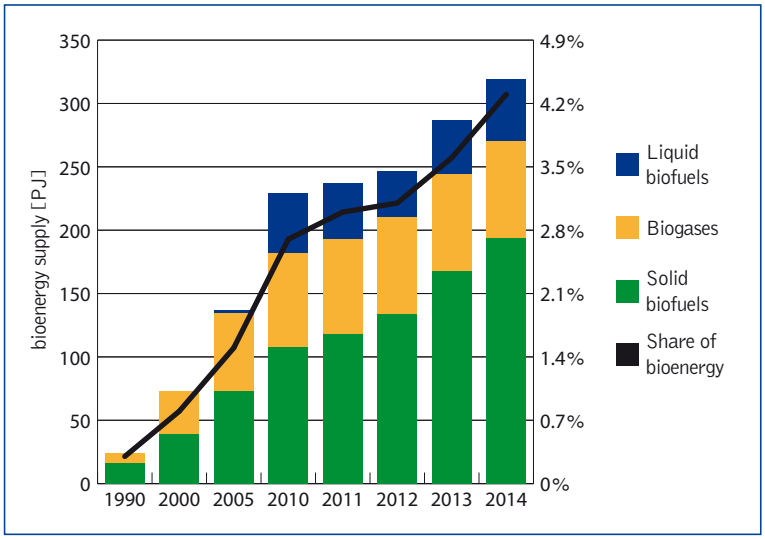

Figure 54: Development of total primary energy supply from bioenergy in the United Kingdom 1990 – 2014

(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 115 GJ, which comprised of 4.2 GJ of biogenic, 3 GJ solid biomass, 1.2 GJ gaseous biofuels and less than 0.1GJ liquid biofuels.

Table 28: Total primary energy supply per capita in 2014

Total energy	115 GJ/capita
Bioenergy	4.2 GJ/capita
Solid biofuels	3.0 GJ/capita
Gaseous biofuels	1.2 GJ/capita
Liquid biofuels	<0.1 GJ/capita

Note: United Kingdom's population in 2014 accounted for 64.8 million people

RESEARCH FOCUS RELATED TO BIOENERGY

In Britain the government's energy research is largely managed through the **Research Councils UK (RCUK) Energy Programme**, which has the following objectives:

- To support a full spectrum of energy research to help meet the objectives and targets of the 2007 Energy White Paper,
- To work in partnerships with the Energy Technologies Institute (ETI) and the Living with Environmental Change (LWEC) programme to contribute to the research and post-graduate training needs of energy-related business and other key stakeholders,
- To increase international visibility and the level of international collaboration, and
- To expand UK research capacity in energy-related areas.

The RCUK Energy programme has allocated funds for the **SUPERGEN Bioenergy Consortium** of British university research groups and industrial companies. This consortium is delivering a diverse range of bioenergy research projects from fundamental science to engineering challenges, social responses to technologies, economic context and policy development.

The **TSEC-BIOSYS consortium** was founded in 2005, under the principle of 'whole-systems analysis'. It brought together a multi-disciplinary team with strong expertise in bioenergy research, to explore the potential of bioenergy in the UK and to influence its successful development. TSEC BIOSYS research explored:

- The sectoral bioenergy demand in the UK,
- The spatial distribution of energy crops in the UK under current and future climates,
- The specific supply chain costs and environmental issues, and
- The impacts and stakeholder concerns.

The **Energy Technology Institute (ETI)** is a public-private partnership between a number of global energy and engineering companies and the British Government. Its role is to act as a conduit between academia, industry and the government to accelerate the development of low carbon technologies. They bring together engineering projects that develop affordable, secure and sustainable technologies to help address the long term emissions reductions targets as well as delivering nearer term benefits. They make targeted commercial investments under nine technology programmes across heat, power, transport and the infrastructure that links them.

The Department for Transport has also recently invested in biofuels production through the £25 million Advanced Biofuels Demonstration Competition. This aims to help support the development of a domestic advanced biofuel industry. The three winning projects were announced in 2015 and will use the funding to build three demonstration scale advanced biofuel plants in Swindon, Tees Valley and Grangemouth.

RECENT MAJOR BIOENERGY DEVELOPMENTS

Biomass utilization for power generation at utility scale

Britain has a long history of the utilisation of coal for electricity generation in large central power plants. In 2002, with the introduction of the Renewables Obligation, which provided subsidies for renewable power generation, the operators of the coal power plants embarked on a programme of investment in projects involving the replacement of increasing amounts of the coal with biomass materials. This was achieved in three ways:

- The mixing of the biomass material, in granular, chip or pellet form, with the coal, at less than 10% by mass, and the processing of the mixed fuel through the existing coal milling and firing systems.
- The direct injection of the pre-milled biomass material into the coal stream in the pneumatic conveying pipework between the coal mills and the burners, and
- The conversion of some or all of the coals mills on the boiler to process 100% biomass pellets.

Over the past few years a total of eight large pulverised coal boilers on three power stations have been converted successfully to 100% biomass pellets. In two cases, at Tilbury (3 x 350 MWe units) and Ironbridge (2 x 500MWe units), the converted plants were operated, as planned, for a couple of years before the station was closed.

At Drax power station in Yorkshire, three of the six 660 MWe coal boilers have been converted to 100% biomass pellets on a long term basis. The station now has the capability of the generation of around 2,000 MWe from biomass. This is by some margin the largest biomass power plant in the world.

Currently, a smaller pulverised coal power plant at Lynemouth in the north-east of England, which has 3 x 110 MWe boilers, is being converted to 100% wood pellet firing on a long term basis.

Based on the experience gained during these biomass conversions projects, the power industry in Britain, and the suppliers of materials handling, fuel processing and firing equipment, are clearly the most experienced in this type of project worldwide.

Biomass utilisation for power generation at medium scale

A number of smaller, dedicated biomass-fired power plants, based largely on fluidised bed and grate-fired boilers, have been built in Britain over the past 20 years or so. A listing of the plants that were in operation in 2014 is presented in Table 29.

Since then, three advanced conversion technologies were successful under the first CfD "Pot 2" auction for less established technologies, two projects in England and one in Wales. These projects have a combined capacity of 62 MW. Two energy from waste with CHP projects with a combined capacity of 95 MW were also successful.

It can be seen from the data in Table 29 below that the power plants vary in capacity from 2 to 44 MWe, and they fire a range of fuels, principally wood of various types, poultry litter and meat/bone meal, and a number of biomass-based process residue materials. The total capacity of these plants is around 326 MWe. In two cases, they provide renewable heat to local facilities. These plants were built and are owned and operated by a number of private companies, both large international utilities, and small British and local enterprises.

Biomass utilisation at small scale for electricity and heat

The number of small scale anaerobic digestion plants operating in the UK has increased as a result of the introduction of the Feed-in Tariff scheme. The number of installations accredited under FITs has more than doubled in the past two years, increasing from 108 installations in January 2014 to 247 installations in January 2016.

(Source: Monthly FIT commissioned installations)

The introduction of the Renewable Heat Initiative (RHI) in 2011 has also resulted in a significant increase in the utilisation of biomass in small scale heating applications.

For **non-domestic applications**, the following general technology categories apply:

- biomass boilers of a range of sizes,
- Solar thermal
- heat pumps, and
- biomethane and biogas.

Of the total of 14,439 accredited applications made under the scheme to quarter three 2015, more than 90% were for biomass boilers, and these had a total heat generation capacity of 1,973 MW.

For **domestic heating applications**, the following general technology categories apply:

- Air-source heat pumps
- Ground and water-source heat pumps
- Biomass boilers, and stoves with integrated boilers
- Solar thermal panels

Of the 45,869 accredited applications made under the scheme to quarter three 2015, 10,646 or around 25% were for biomass systems. Of the total of 436,849 MWh of subsidised heat generated under the RHI scheme up to quarter three 2015, 244,758 MWh had been generated by the biomass systems.

Table 29: List of the small-medium size dedicated biomass power plants in operation in Britain

Plant name	Location	Fuel	Capacity (MWe)
Balcas Timber	Enniskillen, N.I.	Wood	2.5
Balcas Timber	Invergordon, Scotland	Wood	8
Eccleshall Biomass	Eccleshall, Staffordshire	Miscanthus	2.6
Ely	Ely Cambridgeshire	Straw	38
Eye	Eye, Suffolk	poultry litter	12.7
Glanford	Scunthorpe, Lincolnshire	meat bone meal, poultry litter	13.5
Goosey Lodge	Northamptonshire	Biomass	16
Grainger sawmill	Enniskeane N.I.	Wood	2
Newry biomass	Newry N.I.	Wood	2 + 2 MW heat
PDM Group	Widnes, Cheshire	food residues	9.5
Slough Heat and Power	Slough, Berkshire	wood and fibre	35 + 12 MW heat
Stevens Croft	Lockerbie, Scotland	Wood	44
Thetford	Thetford, Norfolk	poultry litter	38.5
Tyrone	Strabane N.I.	recycled wood	2.1
UPM Caledonian	Irvine, Scotland	paper mill residues	26
UPM Shotton	Shotton, Wales	paper mill sludge	20
Westfield	Westfield, Fife	chicken litter	9.8
Western Wood Energy	Port Talbot, Wales	Wood	14
Wilton 10	Middlesborough, Teesside	Wood	30
		Total (MW)	**326.2 + 14 heat**

LINKS TO SOURCES OF INFORMATION

The following websites provide useful information and data on UK's bioenergy policy, production and consumption.

https://www.gov.uk/government/publications/uk-bioenergy-strategy

https://www.gov.uk/government/collections/electricity-market-reform-contracts-for-difference

www.gov.uk/government/uploads/system/uploads/attachment_data/file/469900/RHI_quarterly_statistics_-_September_2015.pdf

www.eti.co.uk/

www.supergen-bioenergy.net/

www.tsec-biosys.ac.uk/

www.bbsrc.ac.uk

Non EU Member Countries

In this section of the report, country reports of non EU member countries are presented. Countries are presented in alphabetical order.

Australia

NATIONAL POLICY FRAMEWORK

Some bioenergy technologies are well established in Australia and are currently in commercial use. Bioenergy currently accounts for nearly 1% of Australia's electricity production, and 7% of renewable electricity production. Biofuels account for approximately 1% of Australia's transportation fuel consumption.

Australia's bioenergy industry currently uses a range of biomass resources including:

- bagasse, which remains after sugar has been extracted from sugarcane
- landfill gas
- wood waste and black liquor
- energy crops
- agricultural products
- municipal solid waste.

The majority of Australia's installed bioenergy capacity is derived from bagasse cogeneration. Australia has several comparative advantages that increase its potential to develop a sustainable and competitive bioenergy industry, including:

- an abundance of sunlight, flat land and a climate suitable for growing dedicated energy crops
- world-class expertise in agricultural science
- a strength in natural resources and infrastructure industry development.

(Source: http://arena.gov.au/about-renewable-energy/bioenergy/)

Within Australia, The Clean Energy Council's Bioenergy Roadmap suggests that by 2020 the contribution from biomass for electricity generation could be 10,624 GWh per year or six times the current generation. It further identifies the long-term potential for electricity from biomass in 2050 to be as much as 72,629 GWh/year, which is approximately 40 times the current level.

CSIRO has reported that there is potential for second generation biofuels to replace between 10% and 140% of current petrol only usage over time (Bio fuels in Australia, RIRDC 2007). At AUD 1 a litre (before excise), replacing the current Australian transport fuels with renewable would represent sales of some AUD 45 billion per annum.

(Source: http://www.bioenergyaustralia.org/pages/bioenergy-in-australia.html)

The use of bioenergy for electricity generation in Australia has expanded considerably over the past decades. This expansion has been supported by Australian Government renewable energy schemes: The Renewable Energy Target (RET) is an Australian Government scheme designed to reduce emissions of greenhouse gases in the electricity sector and encourage the additional generation of electricity from sustainable and renewable sources. The RET mandates that an increasing amount of compliant renewable energy be produced by the creation and trading of Renewable Energy Certificates as stipulated by the Office of the Clean Energy Regulator. These certificates need to be surrendered to the Regulator as evidence of compliance. This mandate is legislated and regulated via the Renewable Energy (Electricity) Act and its Regulations. This Federal Government policy is designed to ensure that at least 33,000 Gigawatt-hour (GWh) of Australia's electricity comes from additional renewable sources by 2020. The RET was reviewed by the Government and reduced in June 2015 from the previously legislated 41,000 GWh to 33,000 GWh. The deal was a compromise brokered by the Clean Energy Council following 15 months of lost investment confidence caused by the review of the policy.

The RET consists of two main schemes:

- the Large-scale Renewable Energy Target (LRET), which creates a financial incentive for more and larger renewable energy power stations
- the Small-scale Renewable Energy Scheme (SRES), which encourages owners to install small-scale renewable energy systems such as rooftop solar, solar water heaters, heat pumps, and small-scale wind and hydro systems.

Large-scale Renewable Energy Target:

The LRET creates a financial incentive for the establishment or expansion of renewable energy power stations, such as wind and solar farms or hydro-electric power stations. It does this by legislating demand for Large-scale Generation Certificates (LGCs). One LGC can be created for each megawatt-hour of eligible renewable electricity produced by an accredited renewable power station. LGCs can be sold to entities (mainly electricity retailers) who surrender them annually to the Clean Energy Regulator to demonstrate their compliance with the RET scheme's annual targets. The revenue earned by the power station for the sale of LGCs is additional to that received for the sale of the electricity generated.

The LRET includes legislated annual targets which will require significant investment in new renewable energy generation capacity in coming years. The large-scale targets ramp up until 2020 when the target will be 33,000 gigawatt-hours of renewable electricity generation, and held at that level until 2030.

Small-scale Renewable Energy Scheme

The SRES creates a financial incentive for households, small businesses and community groups to install eligible small-scale renewable energy systems such as solar water heaters, heat pumps, solar photovoltaic (PV) systems, small-scale wind systems, or small-scale hydro systems. It does this by legislating demand for Small-scale Technology Certificates (STCs). STCs are created for these systems at the time of installation, according to the amount of electricity they are expected to produce or displace in the future. For example, the SRES allows eligible solar PV systems to create, at the time of installation, STCs equivalent to 15 years of expected system output.

RET-liable entities with an obligation under the LRET also have a legal requirement under the SRES to buy STCs and surrender them to the Clean Energy Regulator on a quarterly basis.

While it is possible for owners of renewable energy systems to create and sell the STCs themselves, in practice, installers of these systems usually offer a discount on the price of an installation, or a cash payment, in return for the right to create the STCs.

(Source: https://www.environment.gov.au/climate-change/renewable-energy-target-scheme)

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Australia

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

Australia has extensive energy resources and is currently the largest exporter of coal in the world. Australia's total energy consumption in 2007-2008 was 5,772 PJ, while overall production was far greater, at 17,360 PJ. In 2012, Bioenergy provided approximately 4% of Australia's Total Primary Energy Supplies and made up 78% of the reported renewable energy. The latter percentage is in part due to the use of some four to six million tonnes of firewood per year. Other large energy contributions are from bagasse (sugar cane residues) and wood waste in heating and electricity generation, as well as capture and use of methane gas from landfill and sewage facilities. In recent years ethanol and biodiesel have also provided significant inputs.

Some bioenergy technologies are well established in Australia and are currently in commercial use. Bioenergy currently accounts for nearly 1% (2400 GWh) of Australia's electricity production, and 7% of renewable electricity production. Biofuels account for approximately 1% of Australia's fuel consumption. Ethanol and biodiesel are manufactured locally from materials such as molasses, waste starch, tallow and used cooking oil. The Table below indicates generation of electricity in 2014 by different renewable resources.

(Source: http://www.cleanenergycouncil.org.au/technologies/bioenergy.html#sthash.ROeiq6Us.dpuf)

Table 30: Renewable Energy Generation in 2014

Technology	Generation (GWh)	Percent of renewable generation	Percent of total generation	Equivalent number of households powered over course of the year
Hydro	14,555	45.9%	6.19%	2,049,900
Wind	9777	30.9%	4.16%	1,377,000
Household and commercial solar <10 kW	4834	15.3%	2.06%	680,900
Bioenergy	2400	7.6%	1.02%	338,000
Large-scale solar	118	0.4%	0.05%	16,700
Geothermal	0.50	0.002%	0.00%	70
Marine	0.04	0%	0.00%	6
Total	**31,684**	**100%**	**13.47%**	**4,462,600**

(Source: http://www.cleanenergycouncil.org.au/)

The total primary energy supply of Australia in 2014 amounted to 5,388 Petajoule (PJ) and is still overwhelmingly (93%) dominated by fossil fuels. Oil products account for a third of the energy supply (1,880 PJ) similar to coal products (1,819 PJ) and natural gas is contributing another quarter (1,329 PJ). Renewable energy sources have a share of only 6.7% or 360 PJ.

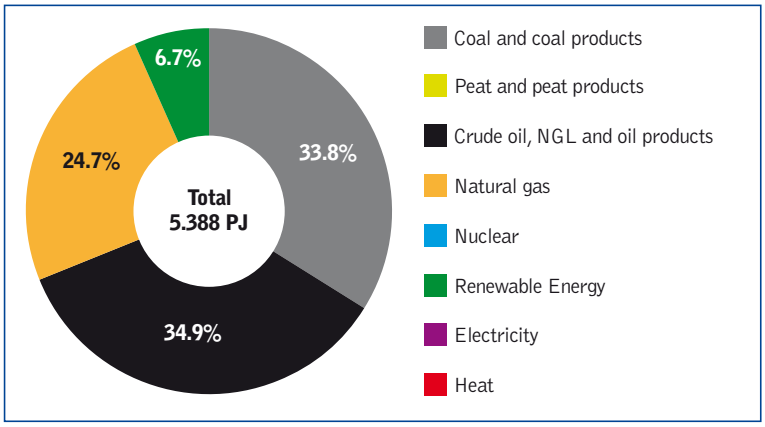

Figure 55: Total primary energy supply in Australia in 2014
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources is covered by energy from biomass with 63%. Solar and wind energy contribute with 19% and hydropower with 18%. Geothermal is negligible.

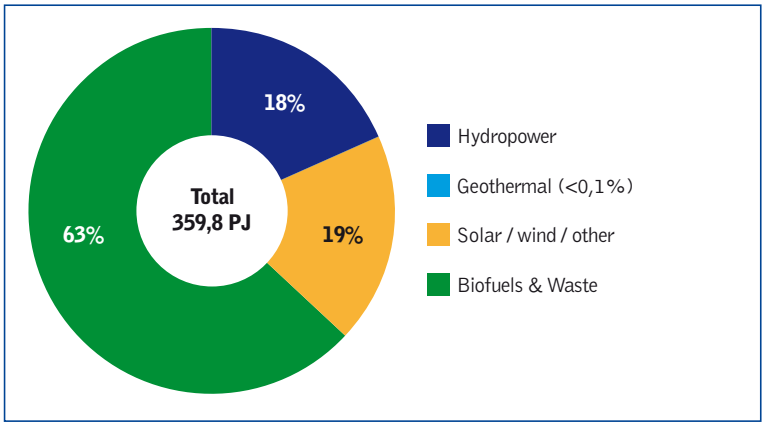

Figure 56: Total primary energy supply of Renewable Energy Sources in Australia in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Australia comes from solid biofuels; their share accounts for 89% (197 PJ). Solid biofuels include fuel wood, wood chips, bark and sawmill. The other bioenergy sources contribute with 7% (biogas), 2% (biogasoline) and 2% (biodiesel).

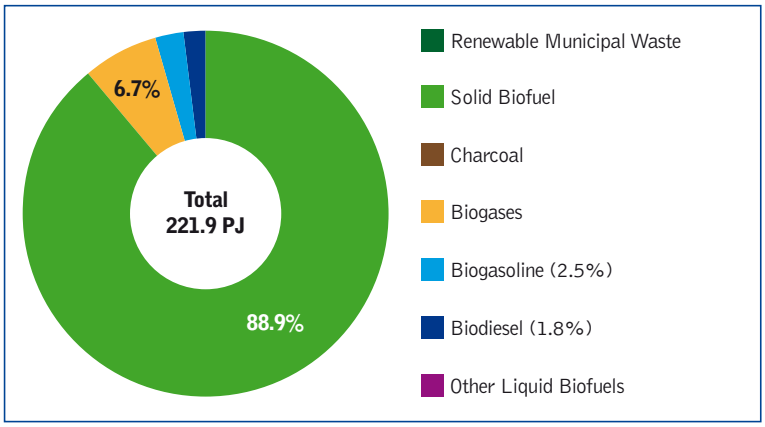

Figure 57: Total primary energy supply from bioenergy in Australia in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy supply in Australia increased slightly from 1990 to 2014. In 1990 bioenergy only came from solid biomass and accounted for 158 PJ. In 2014 solid biomass contributed 197 PJ, liquid biofuels 10 PJ and gaseous 15 PJ. The share in total final energy consumption was higher in 1990 (4.4%) than in 2014 (4.1%). The sharpest fall in consumption occurred between 2005 and 2010; consumption increased again after 2011.

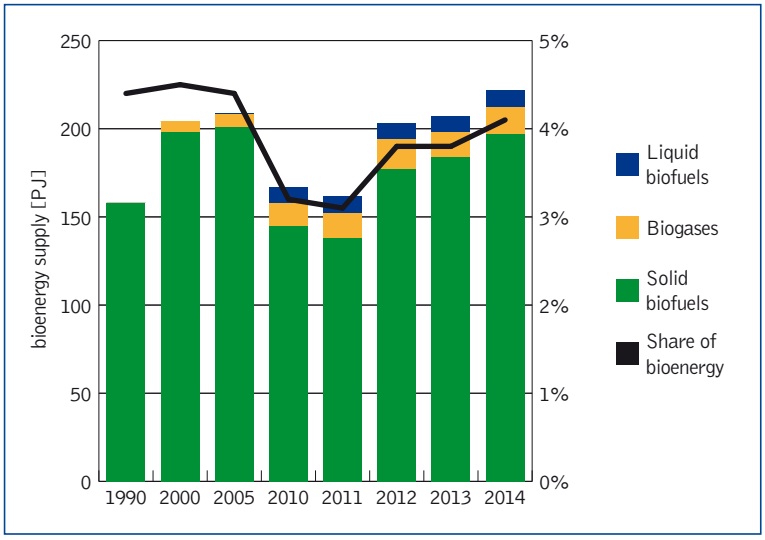

Figure 58: Development of total primary energy supply from bioenergy in Australia 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 226 GJ, which comprised of 9.3 GJ of biogenic, 8.3 GJ solid biomass, 0.4 GJ liquid biofuels and 0.6 GJ of gaseous biofuels.

Table 31: Total primary energy supply per capita in 2014

Total energy	226 GJ/capita
Bioenergy	9.3 GJ/capita
Solid biofuels	8.3 GJ/capita
Gaseous biofuels	0.6 GJ/capita
Liquid biofuels	0.4 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Australia's population in 2014 accounted for 23.9 million people

Table 32: Bioenergy Capacities Accredited under the Renewable Energy Target as at November 2015 (source – presentation to the Bioenergy Australia 2015 conference by the Office of the Clean Energy Regulator).

Fuel Source	Number of accredited power stations	Capacity in megawatts
Black liquor	2	84
Wood waste	16	213
Bagasse	28	539
Landfill gas	62	667
Sewage gas and biomass-based components of municipal solid waste	23	49
Agricultural waste and food waste	14	73
Total	**145**	**1626**

RESEARCH FOCUS RELATED TO BIOENERGY

Research is conducted on many aspects of bioenergy, ranging from production and supply systems, conversion processes (advanced biofuels, pyrolysis, hydrothermal liquefaction, biogas…), sustainability criteria, life cycle climate impacts and input into policy. It is undertaken by state government agencies and universities. A national bioenergy Research, Development and Extension strategy for the primary industry sector has been established in Australia.

AREMI – The Australian Renewable Energy Mapping Infrastructure (AREMI) project is being developed to share mapping data and information with the renewable energy industry. The mapping platform has been developed by National ICT Australia (NICTA), Australia's Centre of Excellence in Information and Communication Technology Research and Development. A recently announced AUD 6 million project will see bioenergy resource information integrated into the AREMI platform. See more at www.nationalmap.gov.au/renewables

RECENT MAJOR BIOENERGY DEVELOPMENTS

Because of a difficult financial environment, policy uncertainty and grid connectivity, bioenergy uptake in Australia remains fairly slow. However, there are numerous large sustainable biomass resources across the country that remain underutilised. Given more favourable financial conditions and better policy support, bioenergy has the potential for extremely strong growth over the coming decades.

(Source: http://www.cleanenergycouncil.org.au/)

Bioenergy Australia, the leading organisation representing bioenergy in Australia has produced a comprehensive status report entitled 'Bioenergy in Australia – status and opportunities' which profiles the bioenergy situation in Australia (see http://www.bioenergyaustralia.org).

It is predicted that Australia's overall energy consumption will continue to grow slowly over coming decades, with one major review suggesting average growth of 1.4%/year to reach consumption of 7,715 PJ/year by 2029-2030. Bioenergy production is expected to grow at a faster rate

and progressively provide a greater proportion of Australia's electricity and transport fuel needs. Work by ABARE, CSIRO, the Clean Energy Council, and the Australian Business Roundtable on Climate Change describes the potential for increased production of bioenergy. These reports suggest that, in the longer term, bioenergy could provide 20% or more of Australia's electricity or transport fuels.

Such increased bioenergy use can be supported in particular by:

- The development of large resources of sustainable biomass around Australia that are not currently being used for bioenergy. Particular opportunities involve existing agricultural residues, and future tree planting on farms for biomass and other environmental benefits (such as belts of mallee trees).
- The commercial development of multiple technologies for conversion of biomass into biofuels.

LINKS TO SOURCES OF INFORMATION

The following websites provide useful information and data on national Australian bioenergy policy and production.

- The Clean Energy Council is a peak body for the clean energy industry in Australia: http://www.cleanenergycouncil.org.au/
- Australian Government – Department of the Environment: https://www.environment.gov.au/climate-change/renewable-energy-target-scheme
- Bioenergy Australia: http://www.bioenergyaustralia.org
- Australian Renewable Energy Agency: http://arena.gov.au/about-renewable-energy/bioenergy/
- Clean Energy Finance Corporation: http://www.cleanenergyfinancecorp.com.au
- Western Australia University-Bioenergy research group: http://uwa.edu.au/bioenergy

Brazil

NATIONAL POLICY FRAMEWORK

The Official document that is driving the national policy framework of renewable energy today is the Federative Republic of **Brazil intended nationally determined contribution (iNDC)** towards achieving the objective of the United Nations framework convention on climate change. This document, announced in December, 2015, in the Paris Conference (COP 21), gives the broad perspective of the Brazilian energy trends for the coming years and provides orientation for the main energy planning document, the PDE (Ten Year's Energy Plan, also known as Plan for Energy Expansion), elaborated by EPE (Energy Research Agency) and published every year by the Ministry of Mines and Energy.

iNDC to GHG Emission Mitigation

Contribution: Brazil intends to commit to reduce greenhouse gas emissions by 37% below 2005 levels in 2025.

Subsequent indicative contribution: reduce greenhouse gas emissions by 43% below 2005 levels in 2030.

Type: absolute target in relation to a base year.

Coverage: 100% of the territory, economy-wide, including CO2, CH4, N2O, perfluorocarbons, hydrofluorocarbons and SF6.

Reference point: 2005.

Timeframe: single-year target for 2025; indicative values for 2030 for reference purposes only.

Metric: 100 year Global Warming Potential (GWP-100), using IPCC AR5 values.

Also, all policies, measures and actions to implement Brazil's iNDC are carried out under the National Policy on Climate Change (Law 12,187/2009), the Law on the Protection of Native Forests (Law 12,651/2012, hereinafter referred to as Forest Code), the Law on the National System of Conservation Units (Law 9,985/2000), related legislation, instruments and planning processes. The Government of Brazil is committed to implementing its iNDC with full respect to human rights, in particular rights of vulnerable communities, indigenous populations, traditional communities and workers in sectors affected by relevant policies and plans, while promoting gender-responsive measures.

Brazil is a developing country with several challenges regarding poverty eradication[35], education, public health, employment, housing, infrastructure and energy access. In spite of these challenges, Brazil's current actions in the global effort against climate change represent one of the largest undertakings by any single country to date, having reduced its emissions by 41% (GWP-100; IPCC SAR) in 2012 in relation to 2005 levels.[36]

Brazil is nevertheless willing to further enhance its contribution towards achieving the objective of the Convention, in the context of sustainable development. Brazil's iNDC represents a progression in relation to its current undertakings, in both the type and levels of ambition, while recognizing that emissions will grow to meet social and development needs.

Brazil already is a large producer and consumer of bioenergy. Brazil has reduced the deforestation rate in the Brazilian Amazonia by 82% between 2004 and 2014. Brazil's energy mix today consists of 40% of renewables (75% of renewables in its electricity supply). This already qualifies Brazil as a low carbon economy.

Brazil intends to adopt further measures that are consistent with the 2°C temperature goal, in particular:

i) increasing the share of sustainable biofuels in the Brazilian energy mix to approximately 18% by 2030, by expanding biofuel consumption, increasing ethanol supply, including by increasing the share of advanced biofuels (second generation), and increasing the share of biodiesel in the diesel mix;

35 Brazil has 15.5 million people living below the poverty line, of which 6.2 million live in extreme poverty (2013). Source: MDS. Data Social 2.0. Available at http://aplicacoes.mds.gov.br/sagi-data/METRO/metro.php?p_id=4, accessed on 24 September 2015.

36 Source: MCTI. Estimativas anuais de emissões de gases de efeito estufa no Brasil. Second edition (2014). Available at http://www.mct.gov.br/upd_blob/0235/235580.pdf, accessed on 2 September 2015.

ii) in land use change and forests:

- strengthening and enforcing the implementation of the Forest Code, at federal, state and municipal levels;
- strengthening policies and measures with a view to achieve, in the Brazilian Amazonia, zero illegal deforestation by 2030 and compensating for greenhouse gas emissions from legal suppression of vegetation by 2030;
- restoring and reforesting 12 million hectares of forests by 2030, for multiple purposes;
- enhancing sustainable native forest management systems, through georeferencing and tracking systems applicable to native forest management, with a view to curbing illegal and unsustainable practices;

iii) in the energy sector, achieving 45% of renewables in the energy mix by 2030, including:

- expanding the use of renewable energy sources other than hydropower in the total energy mix to between 28% and 33% by 2030;
- expanding the use of non-fossil fuel energy sources domestically, increasing the share of renewables (other than hydropower) in the power supply to at least 23% by 2030, including by raising the share of wind, biomass and solar;
- achieving 10% efficiency gains in the electricity sector by 2030.

In addition, Brazil also intends to:

iv) in the agriculture sector, strengthen the Low Carbon Emission Agriculture Program (ABC) as the main strategy for sustainable agricultural development, including by restoring an additional 15 million hectares of degraded pasturelands by 2030 and enhancing 5 million hectares of integrated cropland-livestock-forestry systems (ICLFS) by 2030;

v) in the industry sector, promote new standards of clean technology and further enhance energy efficiency measures and low carbon infrastructure;

vi) in the transportation sector, further promote efficiency measures, and improve infrastructure for transport and public transportation in urban areas.

Table 33: Brazil's 2023 renewable energy targets

Sector	2023 [Mtoe]	Δ 2014-2023 [%]
Logwood	14,057	-15
Charcoal	6,570	2
Sugarcane bagasse	40,471	39
Ethanol	22,189	78
Biodiesel	4,602	78
Renewable electricity*	56,243	47
		38
Total energy consumption	351,350	38

(Source: Plan for Energy Expansion 2023)

** Estimation based on capacity forecast (see below)*

Source	2023 [GW]	Share of total capacity [%]	Δ 2014-2023 [%]
Hydro	112.2	57.5	35.8
Small hydro	7.3	3.7	32.7
Biomass	14.0	7.1	30.8
Wind	22.4	11.5	314.8
Solar	3.5	1.7	100
All renewables	159.4	83.8	0.6

http://www.iea.org/policiesandmeasures/renewableenergy/?country=Brazil

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Brazil in 2014 amounted to 12,296 Petajoule (PJ). Fossil fuels account for 58% (oil 5,102 PJ, coal 689 PJ and natural gas 1,343 PJ). Renewable energy sources have a share of 39.5% or 4,856 PJ, which is among the highest within all countries assessed in this report. The statistic also features 160 PJ or 1.3% of electrical energy coming from nuclear power stations and 144 PJ or 1.2% of electricity.

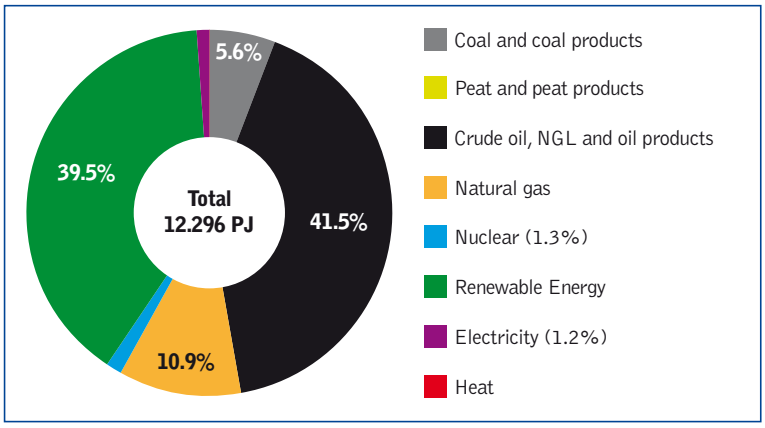

Figure 59: Total primary energy supply in Brazil in 2013
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources is mostly covered by energy from biomass, at 70%. Brazil is one of the countries with the highest share of bioenergy in its Total Primary Energy Supply. Hydro energy amounts for 29%. Wind and solar energy contribute the remaining 1%.

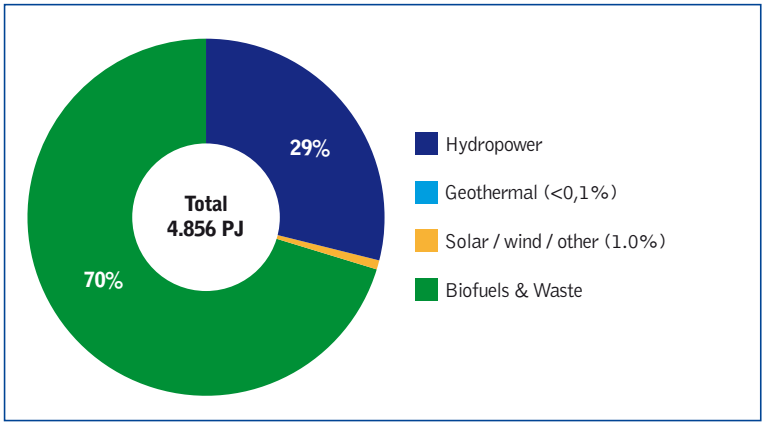

Figure 60: Total primary energy supply of Renewable Energy Sources in Brazil in 2013
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Brazil comes from solid biofuels; their share accounts for 83% of the total use of bioenergy or 2,813 PJ. The second largest item is other liquid biofuels (9% or 286 PJ). Biogasoline contributes 217 PJ and biodiesel 82 PJ.

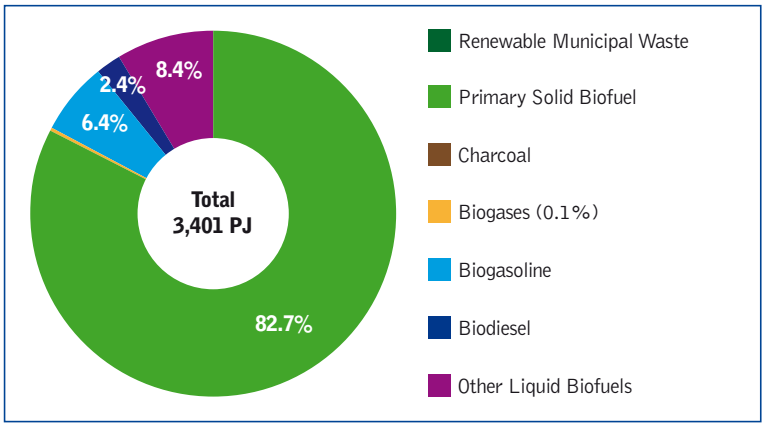

Figure 61: Total primary energy supply from bioenergy in Brazil in 2013
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Brazil increased from 1990 to 2010. Brazil has a long history in using ethanol in flex-fuel vehicles, and already in 1990 utilized 245 PJ of liquid biofuels. In 2013 solid biomass contributed 2,813 PJ, liquid biofuels 584 PJ and gaseous 4 PJ. The share in total final energy consumption decreased from 34.1% to 27.7% in the same period. The sharpest drop in consumption occurred between 1990 and 2000, with a slight rising curve afterwards.

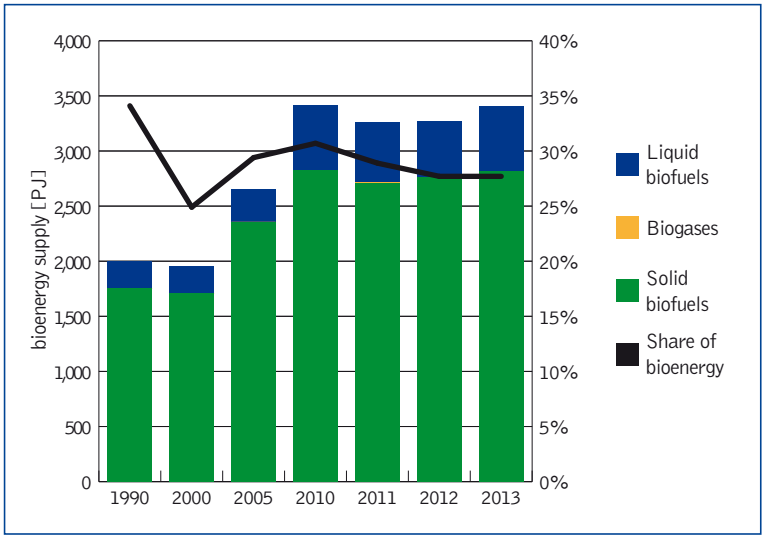

Figure 62: Development of total primary energy supply from bioenergy in Brazil 1990 – 2013
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 61.4 GJ, which comprised of 17 GJ of biogenic, 14 GJ solid biomass and 2.9 GJ liquid biofuels

Table 34: Total primary energy supply per capita in 2013

Total energy	61.4 GJ/capita
Bioenergy	17 GJ/capita
Solid biofuels	14 GJ/capita
Gaseous biofuels	0 GJ/capita
Liquid biofuels	2.9 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Brazil's population in 2014 accounted for 200.4 million people

Brazil Domestic Energy Supply (1970-2014)

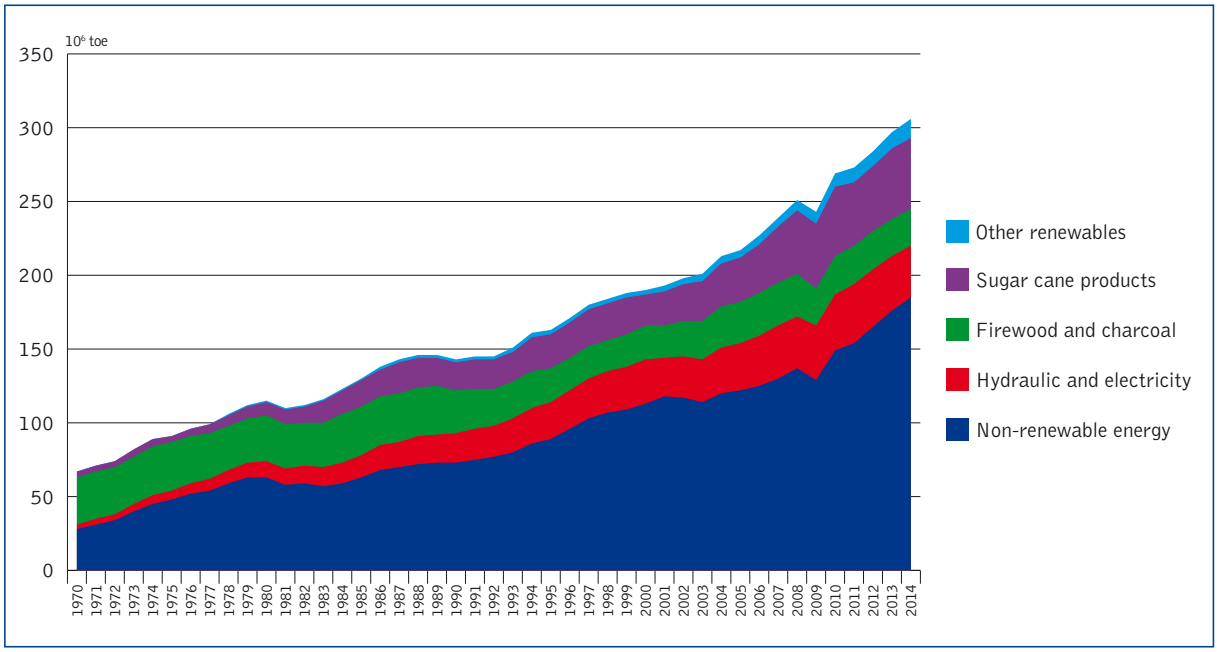

Figure 63: Evolution of total energy supply in Brazil from 1971-2014. (Source: EPE/MME (2016))
Link: https://ben.epe.gov.br/BENSeriesCompletas.aspx

Figure 63 shows the development of energy and bioenergy consumption in Brazil from 1970 to 2014. The total energy consumption has increased steadily.

LINKS TO SOURCES OF INFORMATION

Ministry of mining and energy: http://www.mme.gov.br/

Energy research agency (Empresa de pesquisa energetica) http://epe.gov.br/

Canada

NATIONAL POLICY FRAMEWORK

Canada does not have any binding national or provincial targets concerning the share of renewable energy in gross final consumption yet. An overview of important policies and measures is given below.

Table 35: Canada's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	No national or provincial targets
Heating and cooling	
Electricity	
Transport	

(Source: https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/www/pdf/publications/emmc/renewable_energy_e.pdf and http://www.fpac.ca/publications/2014_CanBio_Report.pdf)

The Federal Renewable Fuel Regulations, finalized and established in September 2010, specified that an annual average renewable content of 5% bio-ethanol was required in the gasoline pool as of December 15th 2010. A 2% requirement for renewable content in diesel fuel and heating oil began on July 1st 2011, with a compliance period ending December 31st 2012.

Federal and provincial governments are helping the bioenergy industry based on sustainably managed renewable resources with initiatives and programs targeting R&D and innovation, greenhouse gas (GHG) reductions, energy efficiency, and tax incentives. Programs support the development of biotechnologies at the R&D stage, and also help move demonstration projects through to commercialization.

While government policies and incentives were initially focused on biofuels, more recently there has been increased focus on policy development supporting bio-heat and power. Through the NRCan Program of Energy Research and Development (PERD), research work is being done on the development of tools and knowledge for an in-depth understanding of the availability of Canada's renewable resources, including biomass from forestry, agriculture and municipal sources, as well as for developing improvements in biomass conversion technologies. A comprehensive report by the Canadian Bioenergy Association CanBio gives an overview of federal and provincial bioenergy policy in Canada: http://www.fpac.ca/publications/2014_CanBio_Report.pdf

Between 2004 and 2009, several federal programs to support the renewable sector have expired. In their place, the federal government has established a number of new initiatives. In general, these programs fall under three headings: market assistance, fiscal measures, and research and development. The ecoENERGY program targets several areas including biofuels, energy efficiency and renewable energy. Additionally the provinces and territories have their own policy framework such as the Green Energy and Green Economy Act, 2009 in Ontario.

In 2008, the Alberta government implemented the Climate Change Strategy and introduced the Specified Gas Emitters Regulation. This regulation targets the GHG emissions of large industrial emitters. Manitoba has introduced the CAD 400,000 Biomass Energy Support Program to help users of coal and biomass processors make the transition from coal towards bio-based energy systems and supply chains. A major policy success was on-farm biogas where Ontario is a leader. The Farm Innovation Program (FIP), the Canadian Agricultural Adaptation Program (CAAP), and the Ontario FIT/MicroFIT Programs, made funding and tax incentives available for initial planning, building, and implementing of farm biogas projects. Quebec allowed regional economic development groups, or CRE's (Conseil régionale de l'environnement) to examine local bioenergy proposals and allocate wood where it would best help communities. CREs are comprised of mayors, economic development organizations, and local stakeholders. British Columbia had spent CAD 16.1 million to advance bioenergy developments by the end of 2013.

A detailed description of fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Canada and http://www.fpac.ca/publications/2014_CanBio_Report.pdf

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Canada in 2014 amounted to 10,785 Petajoule (PJ) with an export surplus of electricity of 167 PJ. The main share comes from natural gas (3,651 PJ) followed by oil and oil products (3,333 PJ). Coal and coal products account for 815 PJ. Renewable energy sources have a share of 18.1% or 1,986 PJ. The statistic also features 1,167 PJ or 10.7% of electrical energy coming from nuclear power stations.

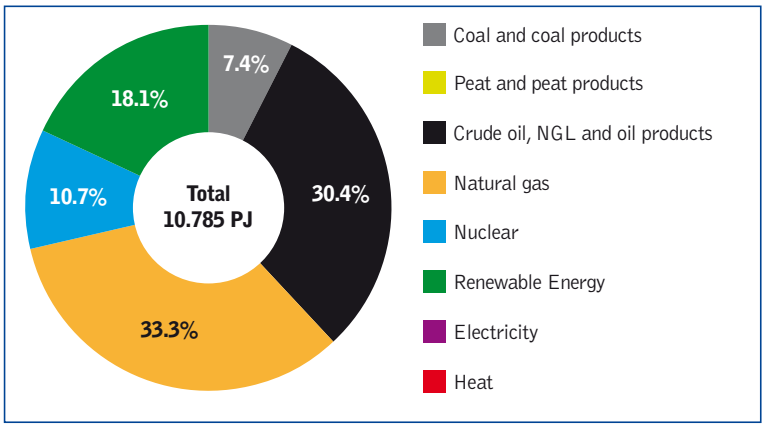

Figure 64: Total primary energy supply in Canada in 2014
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources is mostly covered by energy from hydropower, with 69%. Biofuels and waste amount for 29% and solar and wind energy for 2%.

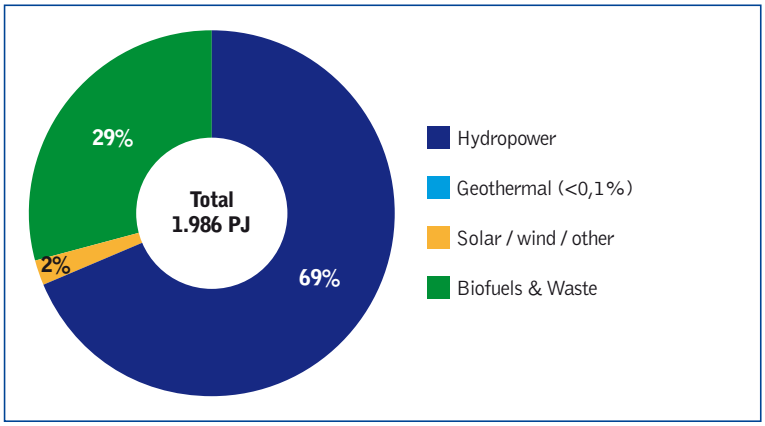

Figure 65: Total primary energy supply of Renewable Energy Sources in Canada in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Canada comes from solid biofuels; their share accounts for 84% of the total use of bioenergy or 478 PJ. The second largest item is biogasoline (61 PJ) followed by biodiesel (18 PJ). Biogas contributes 10 PJ and renewable municipal waste 4 PJ.

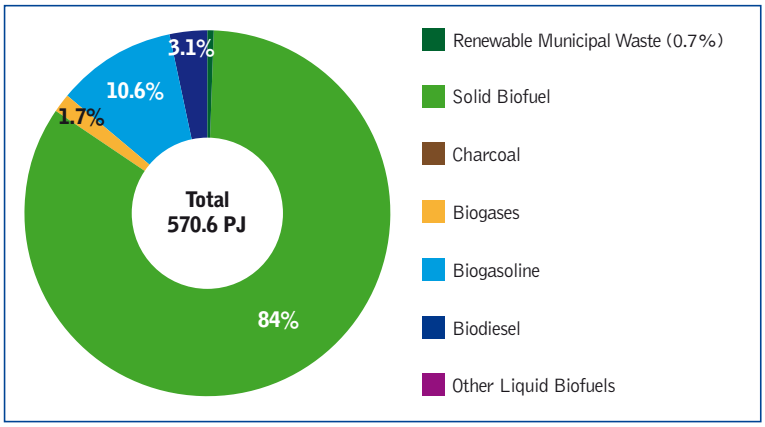

Figure 66: Total primary energy supply from bioenergy in Canada in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Canada nearly doubled from 1990 to 2005, and slightly reduced afterwards. In 1990 bioenergy only came from solid biomass and accounted for 338 PJ. In 2014 solid biomass contributed 482 PJ, liquid biofuels 78 PJ and gaseous 10 PJ. The share in total final energy consumption climbed from 3.9% to 5.3% in the same period. The highest point of supply occurred in 2005.

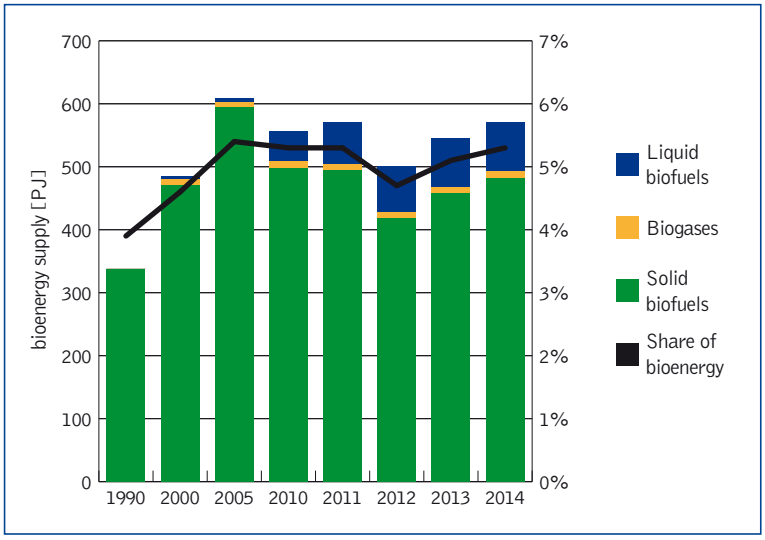

Figure 67: Development of total primary energy supply from bioenergy in Canada 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 307 GJ, which comprised of 16.2 GJ of biogenic, 13.7 GJ solid biomass, 0.3 GJ gaseous biofuels and 2.2 GJ liquid biofuels

Table 36: Total primary energy supply per capita in 2014

Total energy	307 GJ/capita
Bioenergy	16.2 GJ/capita
Solid biofuels	13.7 GJ/capita
Gaseous biofuels	0.3 GJ/capita
Liquid biofuels	2.2 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Canada's population in 2014 accounted for 35.2 million people

RESEARCH FOCUS RELATED TO BIOENERGY

Canada ranked 5th amongst OECD countries for public expenditures on energy RD&D as a percentage of GDP in 2012.[37] Expenditures by the federal government, provincial governments and industry on renewable and clean energy RD&D totalled approximately CAD 630 million in 2013/14. Bioenergy related research is being conducted across Canada in universities and colleges, federal and provincial laboratories, and industry. RD&D has been supported at both the federal and provincial/territorial levels.

At the federal level there are a number of programs that support research and development of bioenergy. For example, the AgriInnovation program of Agriculture and Agri-Food Canada is designed to accelerate the pace of innovation by supporting R&D activities and facilitating the demonstration, commercialization and/or adoption of innovative products, technologies, processes, practices and services.

The Canadian Forest Service (CFS) of Natural Resources Canada has identified the emerging bioeconomy as an important driver for transformation and change in the Canadian forest industry. CFS scientists are conducting research to determine biomass availability and sustainable harvesting guidelines. Through programs such as the Transformative Technologies Program, CFS supports the innovation of renewable energy and novel pre-commercial products and processes. Importantly, CFS conducts economic and market research on bioenergy, bioproducts, and biochemicals to estimate the size and potential of the Canadian industry.

The Office of Energy Research and Development of Natural Resources Canada manages a suite of programs to support the advancement of bioenergy such as the Program of Energy Research and Development, the ecoENERGY Technology Initiative, the Clean Energy Fund and the ecoENERGY Innovation Initiative. These programs fund bioenergy research and development both within and outside the federal government, along with demonstration projects across Canada, in order to support energy technology innovation that produces and uses energy in a cleaner and more efficient way.

The Natural Sciences and Engineering Research Council of Canada (NSERC) supports research and innovation undertaken by universities and companies. NSERC funds scholarships, fellowships, research chairs, strategic projects and networks. Relevant networks include The BiofuelNet Network of Centres of Excellence (2012 to 2017), the recently completed NSERC Bioconversion Network, the NSERC Biomaterials and Chemicals Strategic Network (2010-2015) and the NSERC Industrial Biocatalysis Network (2014-2019). In 2015, NSERC undertook a review of the research priorities for its Strategic Partnership Grants, the goal of which is to increase research and training in targeted areas that could strongly enhance Canada's economy, society and/or environment within the next 10 years. Bioenergy and Bioproducts are one of four research areas under the Natural Resources and Energy Target Area.

Sustainable Development Technology Canada operates the SD Tech Fund™ which supports the late-stage development and pre-commercial demonstration of clean technology solutions. Biofuel and bio related technology projects include novel biomass feedstock development, new conversion processes to biofuels, biochemicals, bioenergy, bio-product development, and enabling technologies.

37 http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/files/pdf/2014/14-0173EnergyMarketFacts_e.pdf

RECENT MAJOR BIOENERGY DEVELOPMENTS

Ensyn Renewable Fuel Oil Facility

In 2014 Ensyn Corporation converted its production plant in Renfrew, Ontario to a dedicated fuels facility with a twelve million litre/year production capacity. Using Ensyn's patented RTP® pyrolysis technology, the plant has been supplying renewable heating fuel to clients in the Northeast US since 2014. Production capacity is also being used for demonstrations of refinery coprocessing, and the use of Ensyn's biocrude as a renewable feedstock for refineries.[39]

Figure 68: Ensyn Renewable Fuel Oil Facility

Enerkem Alberta Biofuels Facility

Enerkem Inc. has built the world's first commercial biorefinery to use municipal solid waste to produce methanol and ethanol in Edmonton, Alberta. It is based on a gasification technology and it has an annual capacity of 38 million litres per year. Methanol production was initiated in late 2015 and the ethanol production is expected in 2017.[40]

Figure 69: Enerkem Alberta Biofuels Facility

Ontario Power Generation Atikoken Generating Station

Located in Atikokan, Ontario, the conversion of the Atikokan Generating Station in 2014 from coal to biomass will make it the largest capacity 100 per cent biomass fueled plant in North America.[41] Once operating on biomass fuel, the plant will retain its ability to produce approximately 200 MW at full capacity. The conversion project included plant modifications, and the construction of a fuel storage and handling system. Wood pellet suppliers for the station were selected through a competitive process that requires the wood-fibre to be sourced from sustainably managed forests. Aboriginal businesses are involved in the fuel supply chain.

Figure 70: Ontario Power Generation Atikoken Generating Station

38 http://www.ensyn.com/

39 http://enerkem.com/facilities/enerkem-alberta-biofuels/

40 http://www.opg.com/generating-power/thermal/stations/atikokan-station/pages/atikokan-station-biomass-conversion-project.aspx

LINKS TO SOURCES OF INFORMATION

Canadian Energy Statistics
http://www.statcan.gc.ca/pub/11-402-x/2012000/chap/ener/ener-eng.htm

http://www.statcan.gc.ca/daily-quotidien/151210/dq151210e-eng.htm

Energy fact Book 2015-2016 (Natural Resources Canada)
http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/files/pdf/EnergyFactBook2015-Eng_Web.pdf

Canadian Bioenergy Statistics
http://www.nrcan.gc.ca/energy/renewable-electricity/7295#bio

Relevant Documents

http://www.iea-bioenergy.task42-biorefineries.com/upload_mm/2/0/d/fde86651-77ca-41d6-9177-49b49f19fccb_Canada%202014%20Country%20Report%20IEA%20Bioenergy%20Task42.pdf

https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/www/pdf/publications/emmc/renewable_energy_e.pdf

http://www.fpac.ca/publications/2014_CanBio_Report.pdf

Croatia

NATIONAL POLICY FRAMEWORK

Croatia`s target to increase the share of renewable energy by 20% in the annual gross energy consumption of the country by 2020 is defined in the National Energy Strategy 2009 – 2020.

The Croatian National Energy Strategy 2009-2020 has three basic objectives: 1) to increase the security of energy supply, 2) to develop a competitive energy system and 3) to ensure development of the sustainable energy sector. These objectives are particularly important due to Croatia's heavy dependence on energy imports which results in the country's vulnerability to energy price volatilities.

Croatia follows the targets of the EU. The targeted shares of the three sectors heating/ cooling, electricity and transport are shown in Table 37.

Table 37: Croatia's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	20%
Heating and cooling	19.6%
Electricity	35%
Transport	10%

(Source: NREAP)

To achieve the RES target, quotas are set for each renewable energy source.

Table 38: Progress on achieving the target capacities for power from renewable energy sources

	Eligible producers, operating plants	Project holders; pending plants	Quota left by 2020	Equivalent of installed power
Wind	46%	54%	0%	744
Small hydro	9%	14%	77%	35
Solid biomass*	20%	79%	1%	120
Biogas**	38%	49%	13%	70
Geothermal	0%	33%	67%	30

** there are 51,694 MW under revision*
*** there are 3.7 MW under revision*

In Croatia, renewable energy is mainly supported through a feed-in tariff (Art. 28 Energy Act). Every producer, who holds the status of "qualified producer" ("povlašteni proizvođač", Art. 9 Qualified Producer Rulebook) and has signed a formal agreement with the Croatian Energy Market Operator HROTE (as defined in Art. 53 Electricity Market Act), has the right to receive an incentive depending on the type of RES technology and power output of his RES-E plant or PV installation, as defined in the Tariff System (Art. 4 Tariff System for RES-E).

The Fund for Environmental Protection and Energy Efficiency awards interest-free loans to renewable energy projects (§ 10 Fund Criteria Rulebook) through a tendering process (Art. 2 § 1 Fund Decision Rulebook). They apply to all natural and legal persons resident in Croatia (Art. 8 Fund Criteria Rulebook).

Renewable energy loans are issued by the Croatian Bank for Reconstruction and Development (HBOR). In accordance with the provisions of the Environmental Protection Act (Art. 1, 18 and 34 Environmental Protection Act), the State is bound to support and finance projects aiming at environmental protection. The HBOR is obliged to support projects aiming at environmental protection (Art. 10 par. 2 no. 5 HBOR Act). On this basis, the HBOR has launched the Loan Programme for Environmental Protection, Energy Efficiency and Renewable Energy, which supports investments in primary sources, such as initial funding, land, buildings, equipment and devices (Point 1 HBOR Programme for Environmental Protection).

In Croatia, there are currently no support schemes for RES heating and cooling. However, the Energy Strategy adopted in 2009 obliges the Croatian State to encourage the future use of RES and to achieve a higher percentage of primary use of RES in the heating sector. (Cooling is not mentioned.)

The Biofuel Act establishes that the Croatian State needs to adopt an Energy Action Plan and file annual reports on placing biofuels on the market (Art. 7 and 8 Biofuel Act). The last Energy Action Plan was adopted in 2010 and sets the goal of a biofuel market share of 10% in the transport sector by 2020.

These objectives oblige the actors on the market to follow the goals set in the action plans and to prepare their own plans and programmes for placing biofuels on the market (Art. 14 and 15 Biofuel Act).

The Act also foresees that the Ministry of Economy issues Quota Obligation Rules and an Environmental Penalty Decree issued by the Government in case the obligations are not met (Art. 14a and 29 Biofuel Act).

In Croatia, there is a special subsidy for the promotion of biofuels (Art. 18 Biofuel Act). This subsidy is paid by the Croatian Energy Market Operator (HROTE) to the eligible producers (Art. 19 Biofuel Act). This measure was abruptly abandoned in 2012.

The Biofuel Act also sets the procedure for obtaining the subsidy as well as the minimum and maximum production that is promoted. The amount of the subsidy is set by the Government annually for the upcoming year by the end of November in the Subsidy Decision (Art. 19, 21 and 22 Biofuel Act, Art. 1, 2, 7 and 8 Biofuel Promotion Decree and Art. 1 Subsidy Decision 2014).

The Excise Duty Act sets the excise duty on biofuels to 0 in order to increase their distribution.

(Source: http://www.res-legal.eu/search-by-country/croatia)

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Croatia

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Croatia in 2014 amounted to 353 Petajoule (PJ) and is still dominated by fossil fuels. Oil products account for one third (130 PJ), natural gas for more than a quarter (96 PJ) and coal products another 8% (28 PJ). Renewable energy sources have a share of 23.7% or 84 PJ. 4.6% comes from electricity.

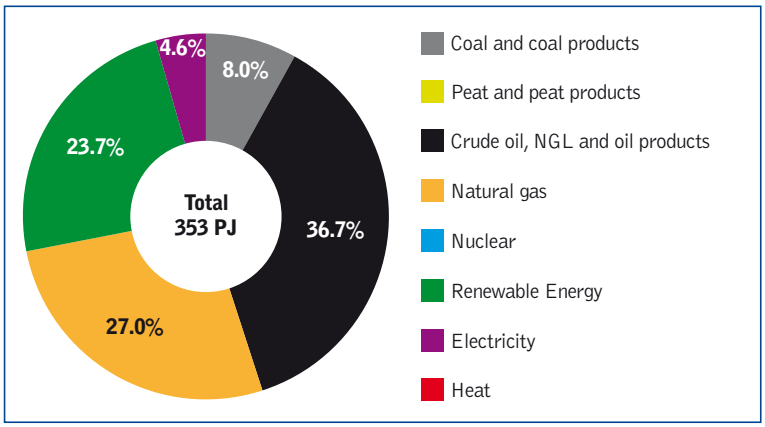

Figure 71: Total primary energy supply in Croatia in 2013
(Source: World Energy Balances © OECD/IEA 2015)

The total primary energy supply of renewable energy sources is mostly covered by energy from hydropower, with 54%. Biofuels and waste amount to 41%, solar and wind energy to 4% and geothermal energy to 0.5%.

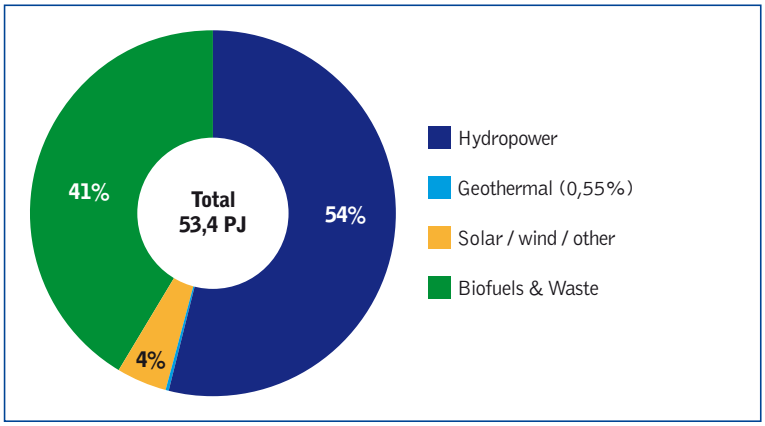

Figure 72: Total primary energy supply of Renewable Energy Sources in Croatia in 2013
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Croatia comes from solid biofuels; their share accounts for 91% of the total use of bioenergy or 19.7 PJ. The second largest item is biodiesel (1.3 PJ) followed by biogas (0,7 PJ) and biogasoline.

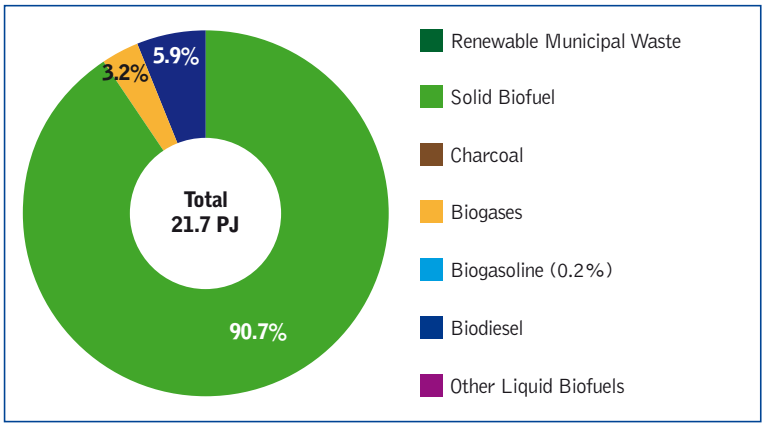

Figure 73: Total primary energy supply from bioenergy in Croatia in 2013
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Croatia increased from 1990 to 2013. In 1990 bioenergy only came from solid biomass and accounted for 13 PJ. In 2013 solid biomass contributed 20 PJ, liquid biofuels and gaseous 1 PJ, respectively. The share in total final energy consumption climbed from 3.5% to 6.7% in the same period.

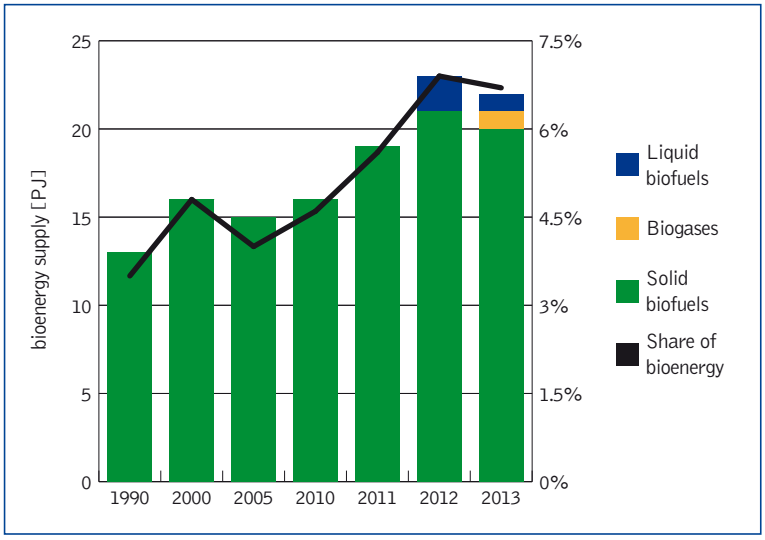

Figure 74: Development of total primary energy supply from bioenergy in Croatia 1990 – 2013
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 77 GJ, which comprised of 5.2 GJ of biogenic, 4.7 GJ solid biomass, 0.2 GJ gaseous biofuels and 0.2 GJ liquid biofuels

Table 39: Total primary energy supply per capita in 2013

Total energy	77 GJ/capita
Bioenergy	5.2 GJ/capita
Solid biofuels	4.7 GJ/capita
Gaseous biofuels	0.2 GJ/capita
Liquid biofuels	0.3 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Croatia's population in 2014 accounted for 4.2 million people

Table 40: Share (%) of energy from renewable sources in gross final energy consumption

	2011	2012	2013	2014	2020 target
Total RES	25.4	26.8	28.1	27.9	20.0
RES-E	37.6	38.8	42.2	45.3	39.0*
RES-H/C	33.7	36.5	37.2	36.2	19.6*
RES-T	0.4	0.4	2.2	2.1	10.0*

** – targets defined in the framework of the National Renewable Energy Action Plan 2020*

In 2016, the national energy balances methodology has changed in recording wood fuel for heating. The outcome of the nation-wide survey on fuel consumption in households applied to census 2011, revealed that 72% of Croatian households use solid biomass for space heating (71% of which is fuel wood) in 2012. In total final energy consumption in households, biomass accounts for 53% and only 0.56% is attributed to modern biomass fuels.

RECENT MAJOR BIOENERGY DEVELOPMENTS

Since January 2016, the Croatian support system for renewables changed from FiT to a market premium through the Law on Renewable Energy Sources and High Efficient Cogeneration (Zakon o obnovljivim izvorima energije i visokoučinkovitoj kogeneraciji, OG 100/2015). The implementing regulations are pending.

The change of the supporting system has accelerated quota take-up with projects in development in late 2016. In the bioenergy sector, the solid biomass quota is fully exploited (120 MWe) while there is still some space in the biogas quota of ~5 MWe out of total 70 MW. All projects that have earned quota rights by 2016 are eligible for the FiT.

(Source: HROTE www.hrote.hr Croatian Energy Market Operator)

In early 2016, Eurostat has reported that "in Croatia, the share of energy from renewable sources in gross final consumption of energy in 2014 was 27.9%, as against 28.1% in 2013. In that way Croatia exceeded the 2020 target of 20% and reached the EU target for 2030, according to the Eurostat's report." https://about.hr/news/croatia/croatia-achieves-2020-target-share-renewables-energy-consumption-9766

This is due to the change of national methodology when recording heating energy demand. Specifically, the survey has revealed that fuel wood consumption was underestimated 3-4 fold in the previous methodology based on the heating energy supply. The change in methodology made a shift to the base 2005 also. At this point it is unclear how the situation will develop.

http://www.dzs.hr/Hrv_Eng/Other/Podaci%20o%20energetskoj%20ucinkovitosti%20u%20kucanstvima%20i%20uslugama%20u%202012.pdf

LINKS TO SOURCES OF INFORMATION

www.hrote.hr Croatian Energy Market Operator

https://about.hr/news/croatia/croatia-achieves-2020-target-share-renewables-energy-consumption-9766

http://www.dzs.hr/Hrv_Eng/Other/Podaci%20o%20energetskoj%20ucinkovitosti%20u%20kucanstvima%20i%20uslugama%20u%202012.pdf

Energy Institute Hrvoje Požar

http://www.eihp.hr/wp-content/uploads/2015/02/Energija2013.pdf

Japan

NATIONAL POLICY FRAMEWORK

Japan has national targets in FY2030 as follows. The overall target is that renewable energy should account for 13 to 14% of primary energy supply. The target for electricity is that the power source mix should include 22 to 24% of total power generation coming from renewable energy, and 3.7 to 4.6% of total power generation coming from biomass.

Table 41: Japan's 2030 renewable energy targets

Sector	Share in primary energy supply per sector
Overall target	13 to 14%
Heating and cooling	
Electricity	22-24%
Transport	

(Source: Long-term Energy Supply and Demand Outlook)

The main instrument to promote bioenergy in Japan is the Feed-in tariff for electricity from renewable energy sources, which has been in force since 2012.

The "Strategic Energy Plan" by the Cabinet of the Japanese government is the basis for the orientation of Japan's new energy policy and it has been reviewed about every 3 years. The latest version was formulated in April 2014, which was the first after the Great East Japan Earthquake and the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi Nuclear Power Plants in 2011.

Following that plan, the Ministry of Economy, Trade and Industry released the "Long-term Energy Supply and Demand Outlook" in July 2015. Utilization of biomass energy is one of the major approaches to expand positively as well as geothermal and hydroelectric. They can operate stably independent of the natural conditions, thereby securing base load power sources and reducing dependence on the nuclear power plants.

The Long-term Energy Supply and Demand Outlook drew up the outlook of the energy supply-demand structure in FY2030 from a mid- to long-term viewpoint in light of the Strategic Energy Plan. For primary energy supply, renewable energy accounts for 13 to 14%, which is greater than nuclear power at 10 to 11%. For power sources mix, biomass power accounts for 3.7 to 4.6%, which surpasses wind power at 1.7%.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Japan

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Japan in 2014 amounted to 18,471 Petajoule (PJ) and is largely dominated by fossil fuels (95%): 8,061 PJ oil products, 4,924 PJ coal products and 4,514 PJ natural gas. Renewable energy sources have a share of 5.3% or 972 PJ.

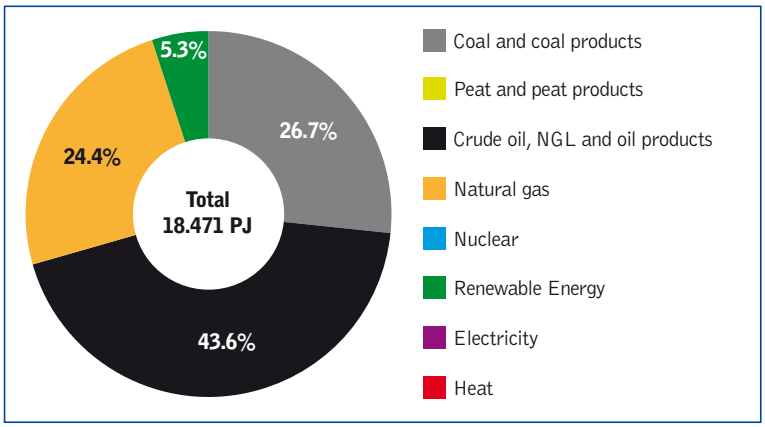

Figure 75: Total primary energy supply in Japan in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Nearly half of total primary energy supply of renewable energy sources is covered by energy from biofuels and waste. Hydropower amounts to 30%, geothermal energy to 19% and solar and wind energy to 12%.

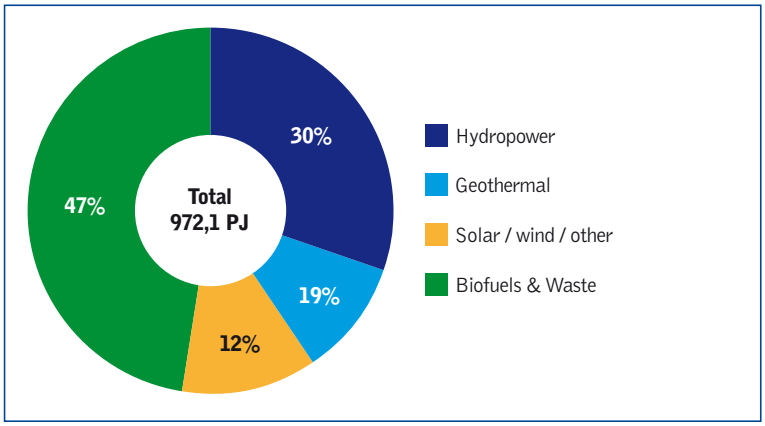

Figure 76: Total primary energy supply of Renewable Energy Sources in Japan in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Japan comes from solid biofuels (358 PJ). The second largest item is renewable municipal waste (26 PJ).

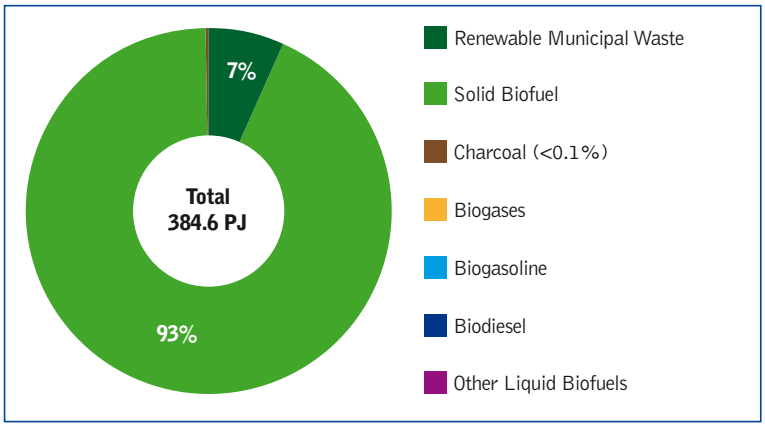

Figure 77: Total primary energy supply from bioenergy in Japan in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Japan nearly doubled from 1990 to 2014. In 1990 bioenergy only came from solid biomass and accounted for 198 PJ. In 2014 solid biomass contributed 385 PJ. The share in total final energy consumption increased from 1.1% to 2.1% in the same period. No significant contribution from liquid biofuels and biogases was reported.

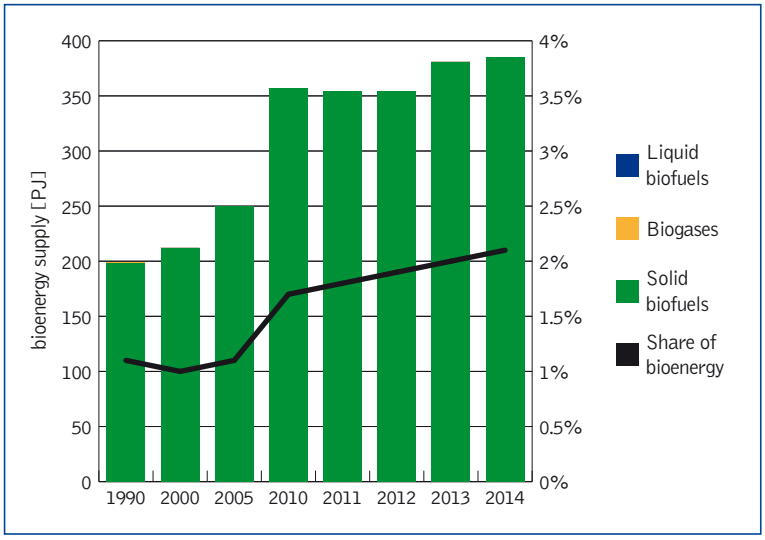

Figure 78: Development of total primary energy supply from bioenergy in Japan 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 145 GJ, which comprised of 3 GJ of biogenic and 3 GJ solid biomass fuels.

Table 42: Total primary energy supply per capita in 2014

Total energy	145GJ/capita
Bioenergy	3 GJ/capita
Solid biofuels	3 GJ/capita
Gaseous biofuels	0 GJ/capita
Liquid biofuels	0 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Japan's population in 2014 accounted for 127.3 million people

LINKS TO SOURCES OF INFORMATION

http://www.developpement-durable.gouv.fr/IMG/pdf/14123-8-GB_loi-TE-mode-emploi_DEF_light.pdf

Republic of Korea

NATIONAL POLICY FRAMEWORK

Korea has a national binding target of 11% for renewable energy by 2030. The targeted share of electricity is set to 8% by the year 2020, as shown in Table 43.

Table 43: Korea's 2030 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	11% in 2030
Heating and cooling	
Electricity	8% in 2020
Transport	

In January 2012 the Renewable Portfolio Standard (RPS) replaced the previous feed-in tariff system in order to accelerate Korea's renewable energy deployment with a goal to create a competitive market environment for the sector. Korea has instituted several policy measures to promote the production and use of biofuels. For example, biodiesel is fully exempted from the fossil fuel tax (CAD 0.5/L) to enhance its cost competitiveness. In September 2008, the Tax Incentive Program was announced: various types of businesses would be kept off the list of tax audit targets, including those involved in alternative energy development. The Framework Act on Low Carbon, Green Growth from 2010 includes the provision to increase energy independency by deployment of new and renewable energy sources. Furthermore The National Strategy for Green Growth of Korea (period of 2009-2050), which was announced in July 2009 provides an outline for further sustainable, environmentally friendly, based on renewable energy and energy efficiency economic development of Korea. Korea also joined the Methane to Markets Partnership in 2004.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=Korea

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Korea in 2014 amounted to 11,109 Petajoule (PJ) and is still dominated by fossil fuels: 3,959 PJ oil products, 3,393 PJ coal products and 1,808 PJ natural gas. Renewable energy sources have a share of 2.1% or 238 PJ. The statistic also features 1,707 PJ of electrical energy coming from nuclear power stations.

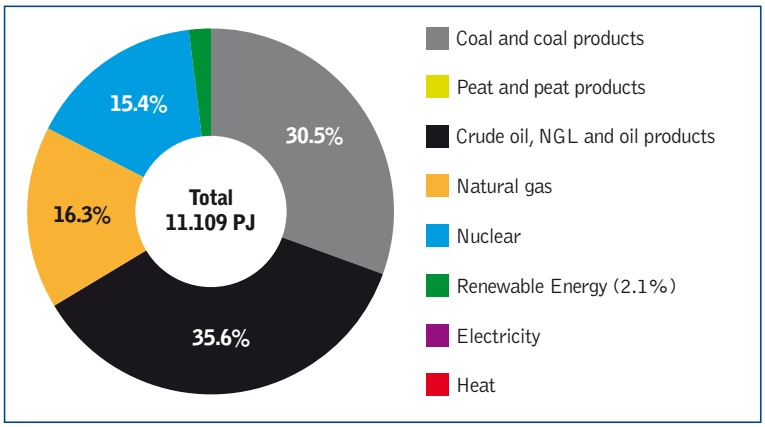

Figure 79: Total primary energy supply in Korea in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the total primary energy supply of renewable energy sources is covered by energy from biofuels and waste (86%). Hydropower and solar and wind power amount to 6%, respectively. Geothermal energy amounts to 2%.

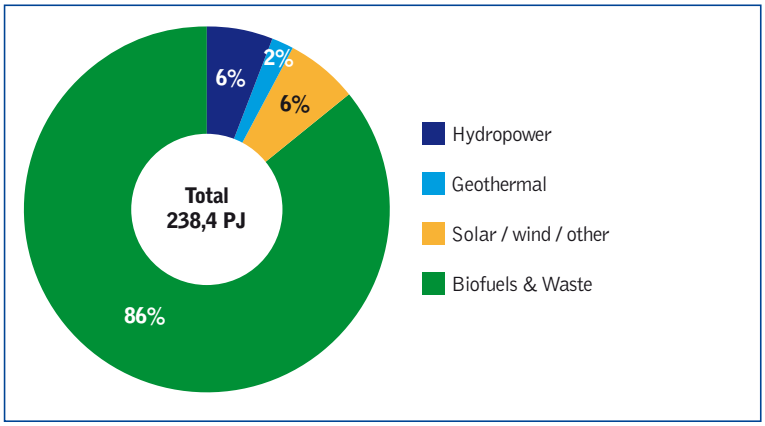

Figure 80: Total primary energy supply of Renewable Energy Sources in Korea in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in Korea comes from solid biofuels (45 PJ). The second largest item is renewable municipal waste (14 PJ) followed by biodiesel (13.5 PJ) and biogas (10 PJ).

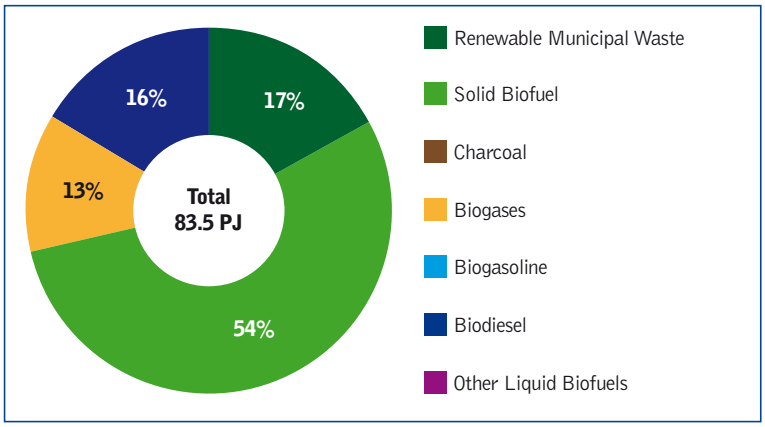

Figure 81: Total primary energy supply from bioenergy in Korea in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in Korea increased more than threefold from 1990 to 2014. In 1990 bioenergy only came from solid biomass and accounted for 18 PJ. In 2014 solid biomass contributed 60 PJ, liquid biofuels 14 PJ and gaseous biofuels 10 PJ. The share in total final energy consumption increased from 0.5% to 0.8% in the same period with a sharp drop in 2000.

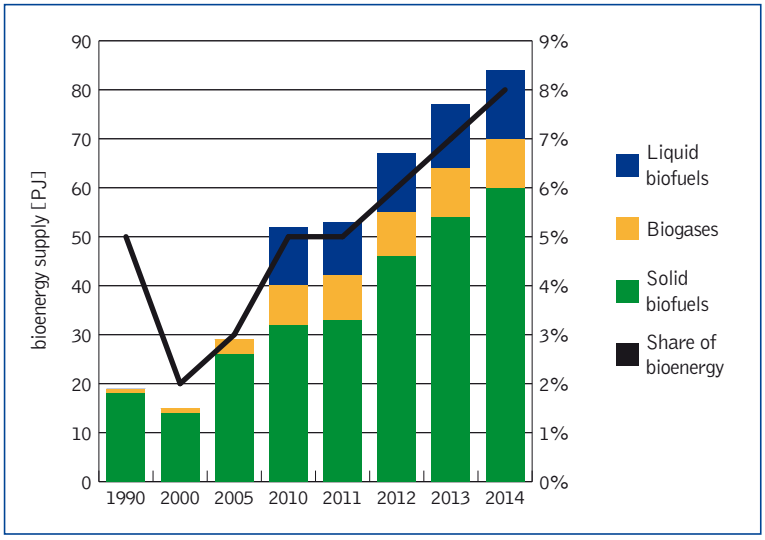

Figure 82: Development of total primary energy supply from bioenergy in Korea 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 221 GJ, which comprised of 1.7 GJ of biogenic, 1.2 GJ solid biomass, 0.2 GJ gaseous biofuels and 0.3 GJ liquid biofuels

Table 44: Total primary energy supply per capita in 2014

Total energy	221 GJ/capita
Bioenergy	1.7 GJ/capita
Solid biofuels	1.2 GJ/capita
Gaseous biofuels	0.2 GJ/capita
Liquid biofuels	0.3 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)
Note: Korea's population in 2014 accounted for 50.2 million people

New Zealand

NATIONAL POLICY FRAMEWORK

The National Policy Statement for Renewable Electricity Generation 2011 (NPS REG) sets out the objective and policies for renewable electricity generation under the Resource Management Act 1991. It came into effect on 13 May 2011. This NPS drives a consistent approach to planning for renewable electricity generation in New Zealand. It gives clear government direction on the benefits of renewable electricity generation and requires all councils to make provision for it in their plans. The Government has identified clear goals for increasing renewable electricity generation through the New Zealand Energy Strategy 2011-2021 which includes a target that 90% of electricity generation be from renewable sources by 2025 providing this does not affect security of supply.

Table 45: New Zealand's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	
Heating and cooling	
Electricity	90%
Transport	

Under the United National Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, New Zealand has commitments to reduce its greenhouse gas emissions. New Zealand's INDC as part of the COP21 discussions was a 30% reduction in GHG emissions off the 2005 baseline emissions by 2030.

The Government has chosen the New Zealand Emissions Trading Scheme (NZ ETS) as its primary tool to reduce emissions, as it is the least-cost way of reducing emissions. The NZ ETS puts a price on emissions and therefore creates a financial incentive for all New Zealanders – especially businesses and consumers – to change behavior. The NZ ETS provides an incentive to:

- reduce emissions
- invest in clean technology and renewable power generation, and
- plant trees.

The New Zealand Emissions Trading Scheme (NZ ETS) is the principal policy tool underpinning New Zealand's domestic emissions reduction action. It requires emitters that are participants in the scheme to report on their emissions and surrender emissions units that correspond to their obligations.

Introduced in 2008, the NZ ETS was reviewed in 2011 with consequential amendments made in 2012. The resulting changes were designed to ensure the NZ ETS remains flexible and able to respond to a range of international agreement outcomes in the 2013 to 2020 period, while more effectively supporting Government's economic growth priorities. The NZ ETS is a long-term tool and the Government is committed to regularly reviewing the NZ ETS and making any modifications as needed to ensure New Zealand meets its international climate change obligations and reduces emissions.

In 2012 amendments were made to the NZ ETS to:

- support New Zealand contributing its fair share to international action to reduce emissions, including meeting international obligations
- deliver emission reductions in the most cost-effective manner
- support efforts to maximize the long-term economic resilience of the New Zealand economy for the least cost.

The changes maintain transition phase settings and aim to ensure the NZ ETS is flexible enough to cater for future international scenarios by giving the Government the power to auction NZ Units and introducing a number of technical amendments to improve the operation and administration of the NZ ETS.

The ETS scheme is still seen as a principle mechanism to manage New Zealand's emissions, however, post Cop21, the scheme is currently under review. Key areas of review are the transitional two-for-one scheme and the CAD 25/te ceiling price.

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=New%20Zealand

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of New Zealand in 2014 amounted to 841 Petajoule (PJ) and is still dominated by fossil fuels: 271 PJ oil products, 183 PJ natural gas and 57 PJ coal products. Renewable energy sources have a share of 39.3% or 330 PJ.

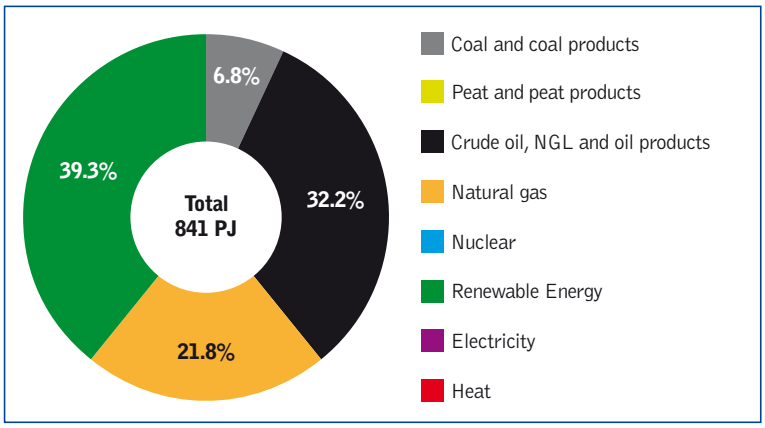

Figure 83: Total primary energy supply in New Zealand in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the total primary energy supply of renewable energy sources is covered by energy from geothermal power (56%) and hydropower (27%), followed by biofuels and waste (15%) and solar and wind energy (3%).

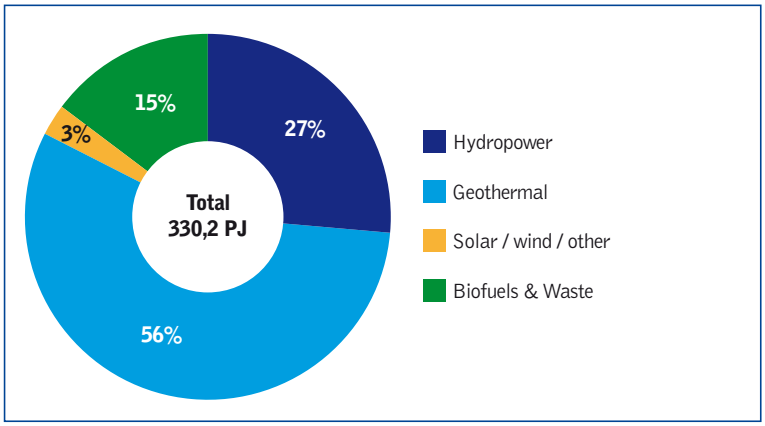

Figure 84: Total primary energy supply of Renewable Energy Sources in New Zealand in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in New Zealand comes from solid biofuels (45 PJ). The remaining 3 PJ are coming from biogas and liquid biofuels.

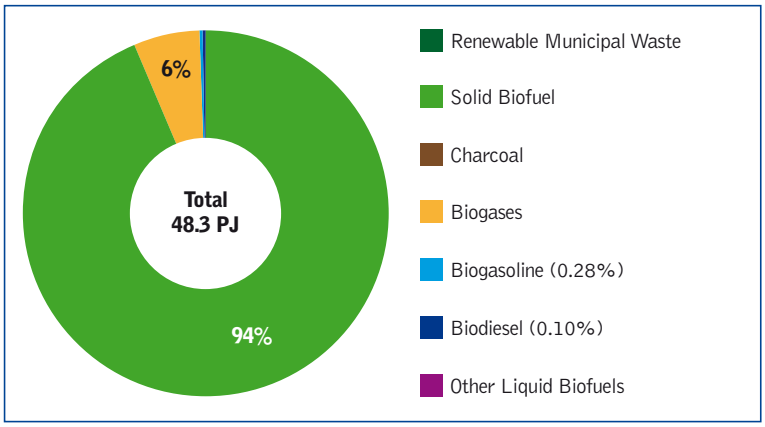

Figure 85: Total primary energy supply from bioenergy in New Zealand in 2014

(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in New Zealand increased from 1990 to 2014 and peaked in 2005. In 1990 bioenergy came from solid biomass (30 PJ) and gaseous biofuels (2 PJ). In 2014 solid biomass contributed 45 PJ and gaseous biofuels 3 PJ. The share in total final energy consumption decreased from 5.9% to 5.7% in the same period.

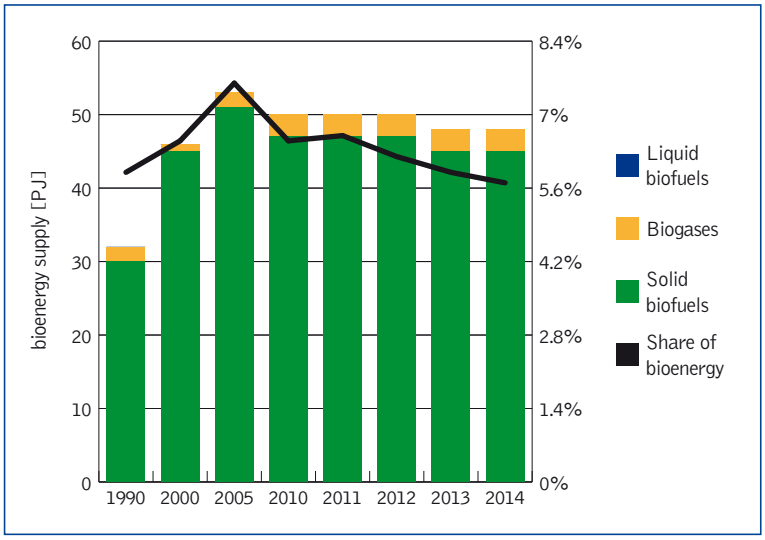

Figure 86: Development of total primary energy supply from bioenergy in New Zealand 1990 – 2014

(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 188 GJ, which comprised of 10.8 GJ of biogenic, 10.1 GJ solid biomass, 0.6 GJ gaseous biofuels and less than 0.1 GJ liquid biofuels.

Table 46: Total primary energy supply per capita in 2014

Total energy	188 GJ/capita
Bioenergy	10.8 GJ/capita
Solid biofuels	10.1 GJ/capita
Gaseous biofuels	0.6 GJ/capita
Liquid biofuels	<0.1 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)

Note: New Zealand's population in 2014 accounted for 4.5 million people

LINKS TO SOURCES OF INFORMATION

The following websites provide useful information and data on national New Zealand bioenergy policy, production and consumption.

http://www.mfe.govt.nz/publications/climate-change/new-zealands-2020-emissions-target/new-zealands-2020-emissions-target

http://www.bioenergy.org.nz/bioenergy-market

https://www.mfe.govt.nz/climate-change/reducing-greenhouse-gas-emissions/new-zealand%E2%80%99s-post-2020-climate-change-target

Bioenergy Association: http://www.bioenergy.org.nz

Energy Statistics New Zealand: http://www.stats.govt.nz/browse_for_stats/industry_sectors/Energy.aspx

http://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications

South Africa

NATIONAL POLICY FRAMEWORK

In March 2011 the Renewable Energy Independent Power Producer Programme (REIPPP), a public procurement programme, replaced the Feed-in Tariff system, which was introduced in 2009. Qualifying technologies: onshore wind, solar PV, solar thermal, biomass solid, biogas, landfill gas and small hydro plants. A ceiling tariff level is established for each technology in the auctions. Winning bidders sign PPAs, which are guaranteed for a period of 20 years. From 2011 to the beginning of 2015 five rounds of reverse auctions were held for construction and supply of 3,625MW of large-scale (>5MW) renewable energy capacity.

For biofuels, the Industrial Biofuels Strategy (IBS) was published 5 Dec 2007 to stimulate a biofuels industry in South Africa (DME, 2007). In March 2011 the first Industrial Policy Action Plan (IPAP) of the South African Government was published, that amongst others, acknowledged that the biofuels industry has to be revitalized (the dti, 2011). Key milestones were identified, which included (i) mandatory blending and (ii) a price support/incentive mechanism for biofuels producers. Mandatory blending was gazetted by the Department of Energy on 23 Aug 2012: As of 1 Oct 2015, the minimum concentration for biodiesel blending would have been 5% v/v; for bio-ethanol blending minimum level of 2% v/v and maximum of 10% v/v (DoE, 2012). Furthermore, bioethanol falls outside the fuel tax net, and is therefore 100% exempt from fuel tax. Biodiesel falls within the fuel tax net, and biodiesel manufacturers receive a rebate of 50% on the general fuel levy.

The Department of Energy gazetted the Draft Position Paper on the South African Biofuels Regulatory Framework that proposed an incentive of a guaranteed return on assets (ROA) of 15% for biofuels manufacturers on 15 January 2014 (DoE, 2014). The Department undertook to publish the Final Position Paper later the same year, however, beginning 2016 the paper has not been published. In the meantime eight licenses for major biofuel manufacturers have been granted or issued, that would already cover the proposed mandatory target for 1 Oct 2015. However, with the Position Paper not been published, none of the manufacturers have committed to build commercial plants yet and mandatory blending cannot commence yet. Unfortunately, the biofuels industry in South Africa remains in stalemate.

All renewable energy projects (including biofuels) qualify for an Accelerated Depreciation Allowance of 50:30:20 over three years.

Table 47: South Africa's renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	none
Heating and cooling	none
Electricity	10% by 2030
Transport	2 – 10% v/v blending of bioethanol 5% blending of biodiesel by 2015

(Source: REIPPP)

A detailed description of all fiscal and non-fiscal supports for bioenergy development is available at: http://www.iea.org/policiesandmeasures/renewableenergy/?country=South%20Africa.

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of South Africa in 2014 amounted to 5,915 Petajoule (PJ) with an export surplus of electricity of 16 PJ. It is dominated by fossil fuels, in particular coal: 3,996 PJ coal products, 962 PJ oil products and 171 PJ natural gas. Renewable energy sources have a share of 10.9% or 648 PJ. The statistic also features 154 PJ of electrical energy coming from nuclear power stations.

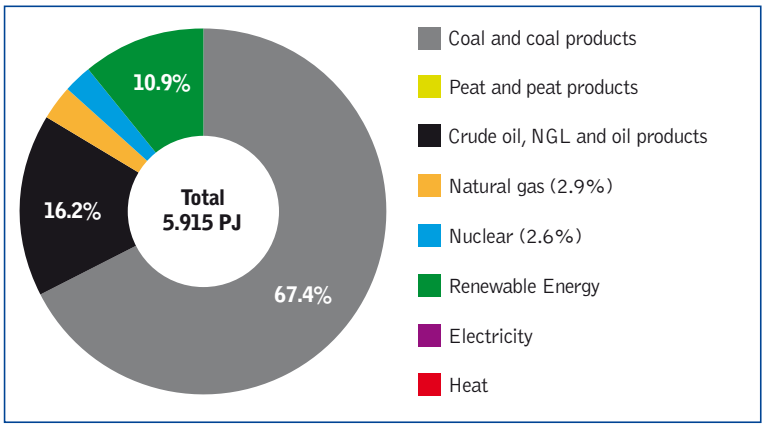

Figure 87: Total primary energy supply in South Africa in 2013
(Source: World Energy Balances © OECD/IEA 2015)

Nearly all of the total primary energy supply of renewable energy sources is covered by energy from biofuels and waste (98.6%), the remaining 1.4% is split into hydropower and solar and wind energy.

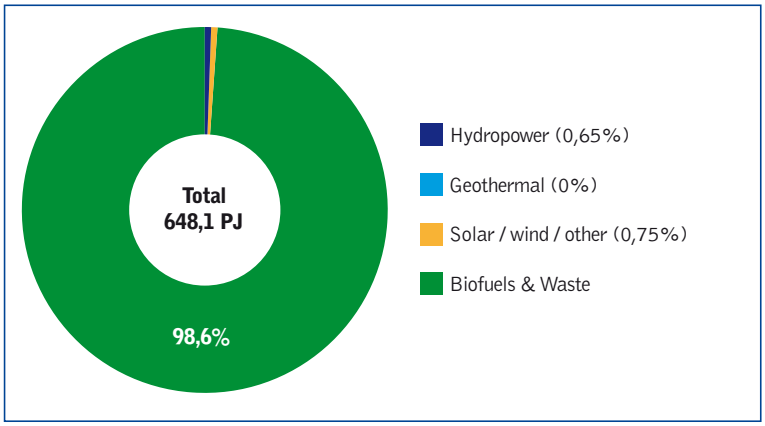

Figure 88: Total primary energy supply of Renewable Energy Sources in South Africa in 2013
(Source: World Energy Balances © OECD/IEA 2015)

All of the bioenergy consumed in South Africa comes from solid biofuels (651 PJ), mostly being used in traditional ways (cooking, heating, open fire); modern boilers are not common. 12 PJ are charcoal exports.

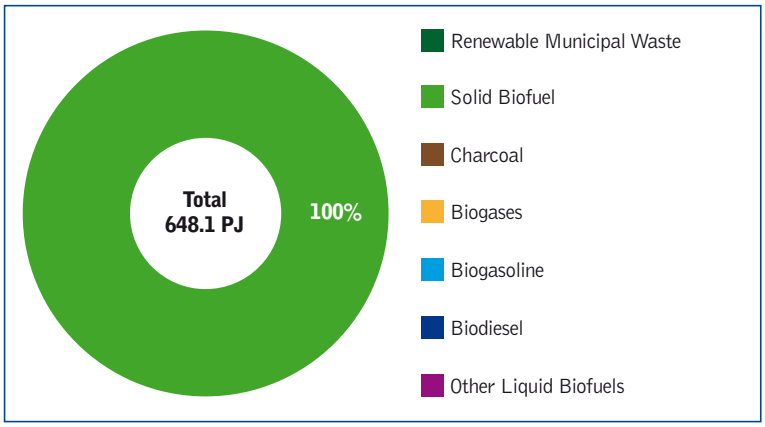

Figure 89: Total primary energy supply from bioenergy in South Africa in 2013

(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in South Africa increased from 1990 to 2013, but was outpaced by a growth in energy consumption so that the share of bioenergy fell between 2000 and 2010. In 1990 as well as in 2013 bioenergy came only from solid biomass (436 and 639 PJ, respectively). The share in total final energy consumption stabilized around 11% recently.

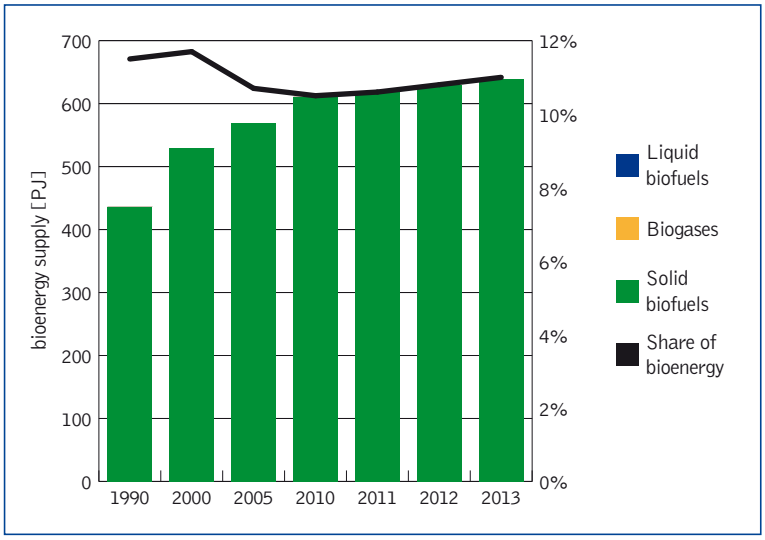

Figure 90: Development of total primary energy supply from bioenergy in South Africa 1990 – 2013

(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 112 GJ, which comprised of 12.2 GJ of biogenic and 12.1 GJ solid biomass biofuels.

Table 48: Total primary energy supply per capita in 2013

Total energy	112 GJ/capita
Bioenergy	12.2 GJ/capita
Solid biofuels	12.1 GJ/capita
Gaseous biofuels	0 GJ/capita
Liquid biofuels	0 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)

Note: South Africa's population in 2014 accounted for 53.0 million people

RESEARCH FOCUS RELATED TO BIOENERGY

Research projects are underway at a number of South African universities on the production of biofuels, including biodiesel from algae (University of the Western Cape, Durban University of Technology, University of the North West and University of Cape Town) and bioethanol from biomass (Stellenbosch, Rhodes, Free State Universities). Significant progress has been made in the conversion of cellulosic feedstocks, such as agricultural residues, to biofuels at Stellenbosch University.

When advanced second generation biofuel technologies come to fruition and 50% of the residual lignocellulosic biomass (almost 50 Mt on an annual basis) is used, biofuels could play a significant role in South Africa's transport fuel future (Lynd et al., 2003). If integrated BtL (biomass-to-liquid fuels using both biochemical and thermochemical processes) technology is used, the contribution from biofuels could represent 25% from agricultural residues, 8.2% from forestry residues, 26% from burned grasses, and 10.8% from invasive plants. The production of biofuels from 50% of lignocellulosic biomass available could potentially replace 70% of current fossil fuel usage, which would far exceed the expectations of the IBS if advanced second technologies come to fruition (ASSAf, 2014).

LINKS TO SOURCES OF INFORMATION

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http://www.energy.gov.za/files/policies/Mandatory%20Blending%20Regulations%2024%20August%202012.pdf

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Lynd, L.R., Von Blottnitz, H., Tait, B., De Boer, J., Pretorius, I.S., Rumbold,K. and van Zyl, W.H., 2003: Plant biomass conversion to fuels and commodity chemicals in South Africa: a third chapter? South African Journal of Science, 99, 499 – 507.

Switzerland

NATIONAL POLICY FRAMEWORK

Historically, Switzerland's longest-serving and most important source of renewable energy has been hydropower. But the "new" renewables, including bioenergy, are also playing an increasingly important role in today's Swiss energy mix. National binding target for renewable energy stated in the Action Plan on Renewable Energy to account for 24% of gross final energy consumption in 2020 as shown in Table 49.

Table 49: Switzerland's 2020 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	24%
Heating and cooling	n.a.
Electricity	n.a.
Transport	n.a.

(Source: NREAP)

The 2007 revised Energy Act contains a package of measures aimed at promoting renewable energies and energy efficiency, the mainstay of which is the compensatory feed-in remuneration at cost (KEV, "Kostendeckende Einspeisevergütung") scheme for electricity generated from renewable energies. It covers the difference between the production cost and the market price, and guarantees producers of electricity from renewable sources a price that corresponds to their production costs. Feed-in tariff at cost is available for the following technologies: hydropower (installed capacity up to 10 MW), photovoltaics (installed capacity from 10 kW), wind energy, geothermal energy, biomass and biological waste.

A surcharge of up to 2.3 Swiss cents per kilowatt-hour can be levied on high-voltage grid transmission costs in order to fund the compensatory feed-in remuneration. The actual surcharge of 1.3 ct./kWh (per 1.1.2016) comes to CHF 850 million in a year. The actual objective of the Energy Act is to increase the electricity production from renewable energies by 5400 GWh/a between 2000 and 2030.

In 2008, the Federal Council approved an action plan to further promote renewable energies mainly in the areas of heat production for buildings and streamlining hydropower regulation.

According to the CO_2 law, the CO_2 tax on fuels for stationary applications was raised to CHF 84 per tonne of CO_2 on 1.1.2016 (previous rate was CHF 60 per tonne of CO_2). The tax generates some CHF 1.1 billion revenues, one-third of which are earmarked for the national buildings refurbishment programme.

In the mobility sector, the amendment of the Mineral Oil Tax Act from July 2008 enables the fiscal promotion of environmentally friendly and socially acceptable fuels. Biofuels (e.g. biogas, bioethanol, biodiesel, vegetable and animal oils) are completely or partially exempted from the mineral oil tax if they comply with minimum ecological and social criteria.

In 2011, the Federal Council and Parliament decided that Switzerland is to withdraw from the use of nuclear energy on a step-by-step basis. In view of this, the Federal Council has developed a long-term energy policy ("Energy Strategy 2050") based on the energy perspectives, which have been updated and extended for this purpose.

On 4 September 2013, the Federal Council submitted an initial package of measures to parliament aimed at securing the country's energy supply sustainably over the long term. The conciliation process between both chambers of Parliament over the legal package for the Energy Strategy 2050 is underway. The key objectives of the strategy are to phase out nuclear power (which currently provides up to 40% of the electricity demand) through more forceful promotion of renewables and efficiency measures. A possible supply gap could be covered by increased electricity imports or by natural gas fired power production (the latter would be a novelty for Switzerland and a climate policy challenge). The goal is to reduce the total energy demand by 43% by 2035 compared to the year 2000.

The main measure for the promotion of the renewable energies in the initial package remains the feed-in remuneration for electricity generated from renewables.

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

Biomass is the second most significant domestic source of renewable energy. Proportionally, however, biomass provides less than 5% of the total energy consumed in Switzerland, while its share in electricity production is around 2.5%. With regard to renewable heat 69% comes from biomass of which 52% comes from wood combustion alone. It is estimated that 10% of the final Swiss energy consumption could be covered by domestic biomass sources and in an ecologically acceptable manner. To what extent this potential can actually be exploited depends in particular on developments in technology and energy efficiency, the cost of raw materials and prices for bioenergy on the domestic and international markets, and not least on political measures to encourage use of biomass and social acceptance of the technology.

The total primary energy supply of Switzerland in 2014 amounted to 1,054 Petajoule (PJ) with an export surplus of electricity of 20 PJ. Approximately one third comes from fossil fuels, one quarter from renewables and one quarter from nuclear energy: 396 PJ oil products, and 112 PJ natural gas. Renewable energy sources have a share of 24.1% or 259 PJ.

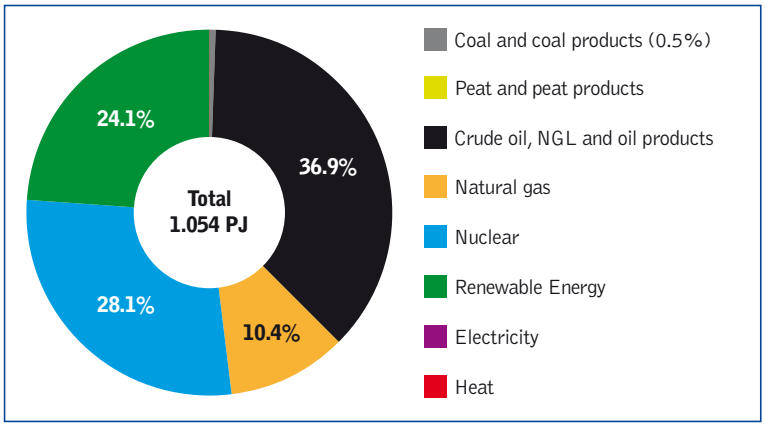

Figure 91: Provisional total primary energy supply in Switzerland in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the total primary energy supply of renewable energy sources is covered by energy from hydropower (53%) followed by biofuels and waste (40%). Geothermal power has a share of 5% and solar and wind energy 2%.

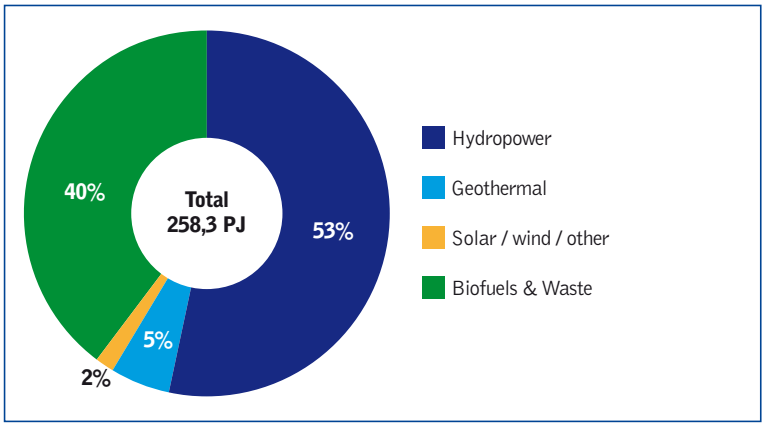

Figure 92: Provisional total primary energy supply of Renewable Energy Sources in Switzerland in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the primary bioenergy supply in Switzerland comes from solid biofuels (38 PJ) followed by renewable municipal waste (23 PJ), biogas (5 PJ), biodiesel (0.62 PJ) and biogasoline (0.16 PJ).

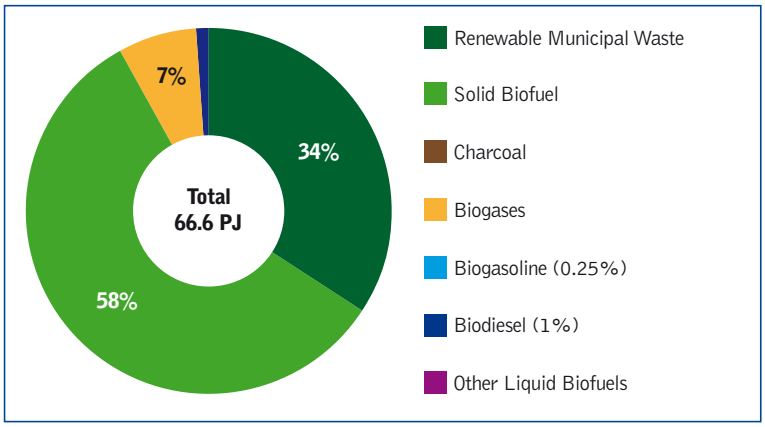

Figure 93: Provisional primary energy supply from biofuels and renewable waste in Switzerland in 2014

(Source: Renewables Information © OECD/IEA 2015)

Primary bioenergy consumption in Switzerland increased from 1990 to 2014. In 1990 bioenergy came from solid biomass (40.2 PJ) and biogas (1.6 PJ). In 2014 solid biomass contributed 61.2 PJ, liquid biofuels 0.8 PJ and gaseous biofuels 4.6 PJ. The share in total final energy consumption climbed from 4.1% to 6.3% in the same period.

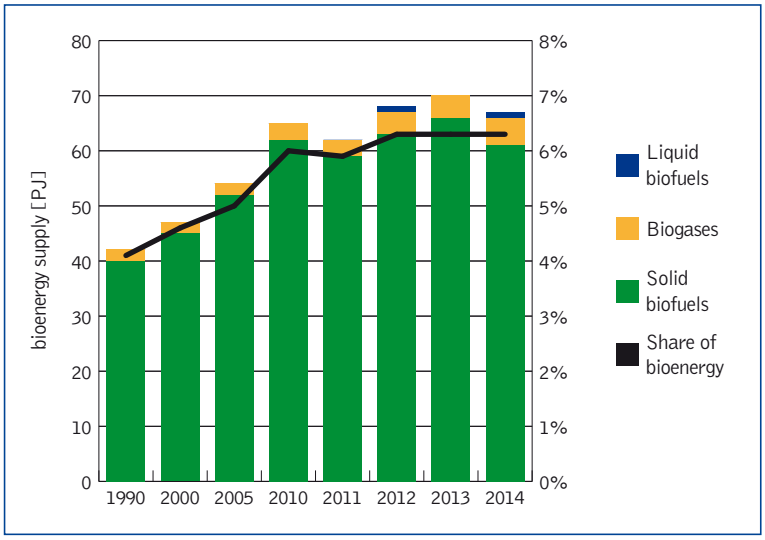

Figure 94: Primary bioenergy supply in Switzerland 1990 – 2014

(Source: Renewables Information © OECD/IEA 2015)

In 2014, annual final total primary energy supply (TPES) (including industry) per unit population was 128 GJ, which comprised of 8.1 GJ of biogenic, 7.4 GJ solid biomass, 0.6 GJ gaseous biofuels and less than 0.1 GJ liquid biofuels.

Table 50: Total primary energy supply per capita in 2014

Total energy	128 GJ/capita
Bioenergy	8.1 GJ/capita
Solid biofuels	7.4 GJ/capita
Gaseous biofuels	0.6 GJ/capita
Liquid biofuels	<0.1 GJ/capita

(Source: Renewables Information © OECD/IEA 2015)

Note: Switzerland's population in 2014 accounted for 8.17 million people

RESEARCH FOCUS RELATED TO BIOENERGY

The Bioenergy research programme focusses on innovative concepts of relevance to Switzerland, in particular in the fields of combustion, gasification and anaerobic digestion. Of special interest are improved substrate digestion of input materials leading to higher gas yields in fermentation processes, system optimisation and integration to increase efficiency, and a complete evaluation of the value-chain. Furthermore, standardisation and principles of quality control and efficient communication to raise awareness and therefore increase acceptance of the technology in general.

The programme coordinates research at the national level, utilizes synergies between academic and industrial partners and promotes networking at an international level.

The National Research Programme "Resource Wood" (NRP 66) which started in 2012 establishes basic scientific knowledge and practical methods for increasing the availability of wood as a resource and expanding its utilisation.

Since 2014, the following four thematic dialogue platforms facilitate inter- and transdisciplinary work within NRP 66:

- Dialogue field 1: Advancements in timber constructions
- Dialogue field 2: Novel ways in bio-refining of wood
- Dialogue field 3: Innovative wood-based materials for new applications
- Dialogue field 4: Provisioning and sustainable use of wood.

In dialogue field 2, the energy production of wood plays a major role.

Since 2014 the Swiss Competence Centre for Energy Research BIOSWEET, a consortium of 9 Academic Institutions and more than 50 partners from the private and public sector focuses on the engineering and implementation of biochemical and thermochemical biomass conversion processes with a high level of technological readiness and sustainability. One major innovation challenge is the development of small, decentralized but still economic technologies to convert biomass to gaseous and liquid fuels, and electricity. Another challenge for the conversion of biomass to gaseous or liquid fuels is related to the scaling up of technologies and to bridging the gap between laboratory and industrial scale. The activities are structured in three work packages: Biochemical fuels and power/ Thermochemical fuels and power/ Assessment and availability. In a second phase 2017 – 2020 the activities will focus on anaerobic digestion and hydrothermal gasification of wet biomass, on medium scale production of ligno-cellulosic bioethanol, on biogas upgrading and methanation technologies, and on the increase of the system efficiency of dry biomass conversion for heat and for combined heat and power (CHP). Furthermore, cross cutting issues such as the evaluation of biomass availability, improvements in biomass collection processes and thermo-economic characterization of energy systems will be addressed.

RECENT MAJOR BIOENERGY DEVELOPMENTS

Anaerobic digestion (AD)

In Switzerland there are around 617 biogas plants and six landfills, see Table 51. The total gross biogas production was 1114 GWh in 2014.

Table 51: Status of biogas production in Switzerland (values from 2014).

Plant type	Number of plants	Biogas production* (GWh/year)
Sewage sludge	~465	573
Biowaste (co-digestion)	25	195
Agriculture	98	258
Industrial waste water	23	77
Landfills	6	11
Total	617	1,114

(Source: Bachmann (2014): IEA Bioenergy Task 37 Country report)

** = produced raw biogas expressed as its energy content from the different plant types*

The biogas is mainly used to produce electricity and heat in CHP plants, but the biomethane production is growing rapidly, see Table 52.

Table 52: Utilization of biogas in Switzerland (values from 2014)

Utilisation type	GWh
Electricity	289
Biomethane	192
Flare	n.d.

(Source: Bachmann (2014): IEA Bioenergy Task 37 Country report)

In 2015, there was a total of 25 upgrading plants (mainly pressure swing absorption (PSA) units, amine scrubbers, and organic physical scrubbers), two are on agricultural sites, twelve on wastewater treatment plants, nine at biowaste AD sites, and two at industrial wastewater treatments plants with total biomethane production of approximately 300 GWh/a (2016). Today more than 11,000 vehicles run on methane and there are 140 natural gas filling stations (http://www.ngvaeurope.eu/european-ngv-statistics).

Wood combustion

In 2014 there were 603,470 wood combustion installations (stoves, boilers, automatic boilers, wood CHP installations, excluding waste incineration plants). The installed combustion capacity in 2014 was 10,383 MW.

Thermal gasification

In 2015, there were three commercial thermal gasification plants in operation (2x690 kWel 2 gasifier lines; 1x 140 kWel; 1x 45 kWel. In addition, two units are under construction and two more units in planning.

Table 53: Combustion installations in Switzerland in 2014

Type of installation	Units 2014	Installed capacity	Final energy consumption	
		GW	GWh/a	%
Room heater	539,039	5.72	2569	21.1
Heat supply for buildings	56,175	1.89	2113	17.4
Automated boiler (> 50 kW)	8,192	2.25	5733	47.1
Combustion plants for renewable wastes (without municipal solid waste incineration plants)	63	0.52	1756	14.4
Total	**603,469**	**10.38**	**12,171**	**100**

(Source: Swiss Federal Office of Energy (2015): Schweizerische Holzenergiestatistik – Erhebung für das Jahr 2014)

LINKS TO SOURCES OF INFORMATION

The following websites provide useful information and data on national Swiss bioenergy policy, production and consumption.

- Related documents: http://www.bfe.admin.ch/themen/00526/00527/index.html?lang=en
- Renewable Energy Statistics Switzerland: http://www.bfe.admin.ch/themen/00490/00496/index.html?lang=en&dossier_id=00772
- Biomass and Wood Energy Research Programmes: http://www.bfe.admin.ch/forschungbiomasse/index.html?lang=en
- National Research Programme "Resource Wood" NFP 66 http://www.nfp66.ch/en/Pages/Home.aspx
- Swiss Competence Center for Energy Research – Biomass for Swiss Energy Future (SCCER BIOSWEET) http://sccer-biosweet.ch/
- "Infothek Biomasse" Literature Database on Biomass Research (German, French, Italian) http://www.infothek-biomasse.ch/index.php?lang=de
- Swiss Association on Wood Energy (German, French, Italian) www.holzenergie.ch

USA

NATIONAL POLICY FRAMEWORK

Table 54: USA's 2030 renewable energy targets

Sector	Share in gross final consumption per sector
Overall target	none
Heating and cooling	none
Electricity	20% by 2030
Transport	Volumes mandated by RFS

Some information on policy and support schemes of bioenergy development can be found here:

https://www.iea.org/countries/membercountries/unitedstates/

https://www.whitehouse.gov/sites/default/files/docs/cap_progress_report_final_w_cover.pdf

In July 2014, the DOE (Department of Energy) issued a loan guarantee solicitation[41] for up to USD 4 billion in loan guarantees available for innovative renewable energy and energy efficiency projects located in the U.S. that avoid, reduce, or sequester greenhouse gases. Another USD 500 million was added in 2015.[42] Another supporting initiative by the DOE is the State Energy Program (SEP)[43] to help advance the clean energy economy while contributing to national energy goals. A Clean Energy Investment Initiative was launched by the White House[44] – this year a goal was set to catalyse USD 2 billion of expanded private sector investment in solutions to climate change, including innovative technologies with breakthrough potential to reduce carbon pollution.

State Renewable Portfolio Standards (RPSs) are flexible-market based policies which ensure that public benefits of renewable energy are recognised. An RPS requires electricity providers to obtain a minimum percentage of their power from renewable energy resources by a certain date. Each state chooses to fulfil its mandate using a combination of renewable energy sources, including wind, solar, biomass, geothermal, or other renewable sources.

The previous in-depth review by the IEA, however, highlighted the absence of a clear link at the federal policy level between energy, environmental and security policies, and suggested that benefits could come from closer coordination among Congress, the Administration, and state governments, as well as between executive and legislative branches of the federal government. It also emphasized the need for greater coordination in order to ensure that energy policy challenges facing the country were addressed in a consistent manner.

In 2007, Congress passed the Energy Independence and Security Act (EISA), amending the Renewable Fuel Standard (RFS) as established by EPACT in 2005. The law states that by 2022, the U.S. shall consume 36 billion gallons of biofuels. Of that, 21 billion gallons shall be advanced biofuels.

The Food, Conservation, and Energy Act of 2008 (2008 Farm Bill) established new energy programs, including the Biorefinery Assistance Program, the Biobased Marketing Program and the Biomass Crop Assistance Program (BCAP). The Agricultural Act of 2014 (2014 Farm Bill) reauthorized and provided USD 880 million for energy programs established in the 2008 Farm Bill; expanded the Biorefinery Assistance Program to include biobased products and renewable chemical manufacturing; and expanded the Biopreferred program to include forestry products. The USDA Biomass Crop Assistance Program (BCAP) was created to support the establishment and production of eligible crops for conversion to bioenergy in selected BCAP project areas; and to assist agricultural and forest

41 http://energy.gov/articles/energy-department-makes-additional-4-billion-loan-guarantees-available-innovative-renewable

42 http://energy.gov/lpo/articles/doe-finalizes-1-billion-new-loan-guarantee-authority-and-announces-new-application

43 http://energy.gov/eere/wipo/state-energy-program

44 https://www.whitehouse.gov/the-press-office/2015/02/10/fact-sheet-obama-administration-announces-initiative-scale-investment-cl

land owners and operators with collection, harvest, storage, and transportation of eligible material for use in a biomass conversion facilities. The 2014 Farm Bill authorized USD 3 million support for biomass research and development grants.

At the end of 2015, the biodiesel blender's tax credit of 1.0 USD per gallon was extended through 2016 (and to retroactively cover 2015).

(Source: http://www.biodieselmagazine.com/articles/654945/obama-signs-spending-bill-tax-extenders-legislation)

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of the USA in 2014 amounted to 92,362 Petajoule (PJ) with fossil fuels still dominating: 32,931 PJ oil products, 25,947 PJ natural gas and 18,023 coal products. Renewable energy sources have a share of 6.7% or 6,226 PJ. The statistic also features 9,061 PJ of electrical energy coming from nuclear power stations.

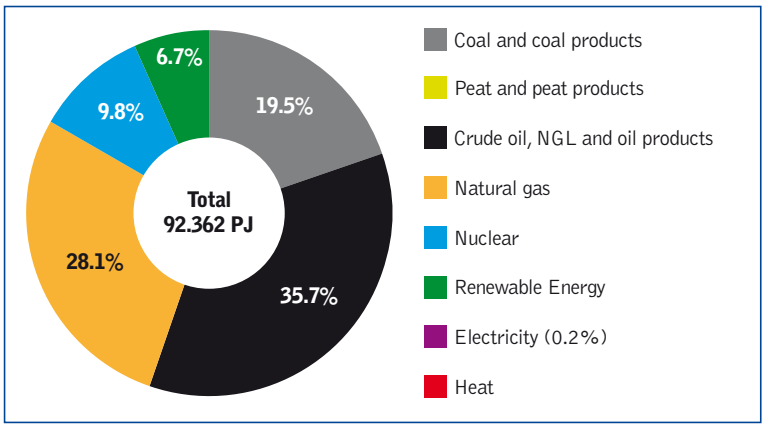

Figure 95: Total primary energy supply in the USA in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the total primary energy supply of renewable energy sources is covered by energy from biofuels and waste (66%) followed by hydropower (16%) and solar and wind energy (12%) and geothermal power (6%).

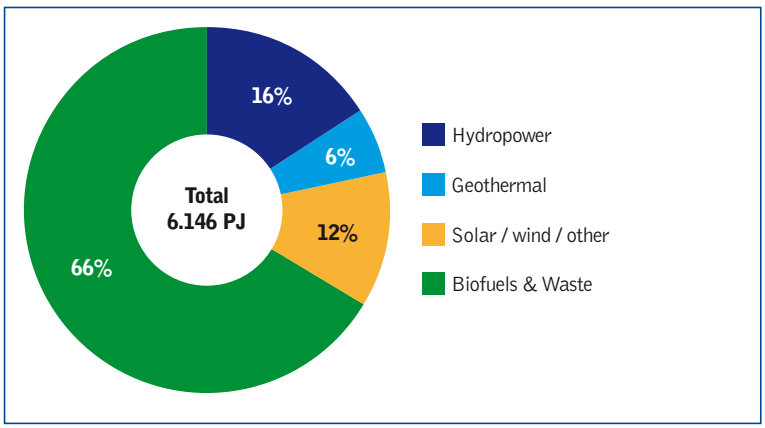

Figure 96: Total primary energy supply of Renewable Energy Sources in the USA in 2014
(Source: World Energy Balances © OECD/IEA 2015)

Most of the bioenergy consumed in the USA comes from solid biofuels (2,192 PJ) followed by biogasoline (1,060 PJ). 263 PJ are coming from biogas, 187 PJ from biodiesel, 151 PJ from renewable municipal waste and 14 PJ from other liquid biofuels.

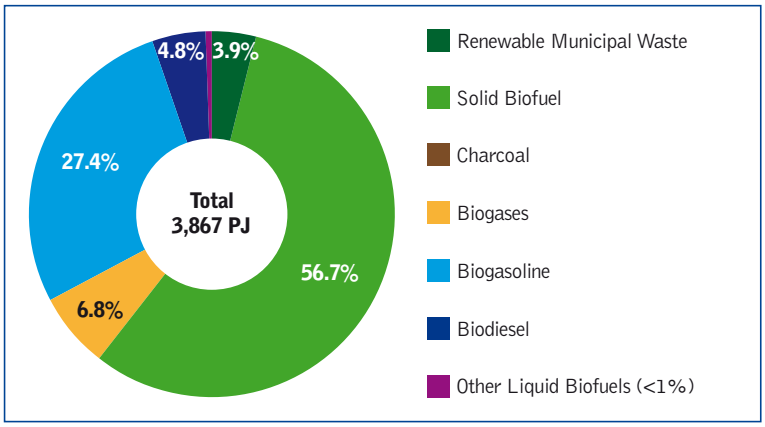

Figure 97: Bioenergy sources in the USA in 2014
(Source: Renewables Information © OECD/IEA 2015)

Bioenergy consumption in the USA increased from 1990 to 2014. In 1990 bioenergy came from solid biomass (2,409 PJ) and biogas (31 PJ). In 2014 solid biomass contributed 2,343 PJ, gaseous biofuels 263 PJ and liquid biofuels 1,261 PJ. The share in total final energy consumption changed from 3.0% to 4.2% in the same period.

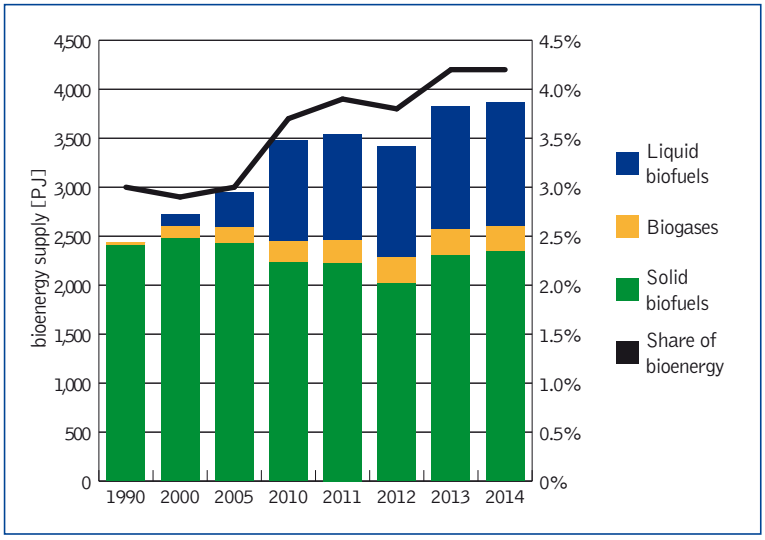

Figure 98: Total primary energy supply from bioenergy in the USA 1990 – 2014
(Source: Renewables Information © OECD/IEA 2015)

Measured in final energy use per capita, one US American consumed a total average of 292 GJ energy in 2014 of which 12.2 GJ were biogenetic. 7.4 GJ per capita came from solid biomass, 0.8 GJ gaseous biofuels and 4.0 GJ liquid biofuels.

Table 55: Total primary energy supply per capita in 2014

Total energy	292 GJ
Bioenergy	12.2 GJ
Solid biofuels	7.4 GJ
Gaseous biofuels	0.8 GJ
Liquid biofuels	4.0 GJ

(Source: Renewables Information © OECD/IEA 2015)
Note: USA's population in 2014 accounted for 316.5 million people

RESEARCH FOCUS RELATED TO BIOENERGY

The recently released report, the Federal Activities Report on the Bioeconomy[45] provides an overview of the wide-ranging, federally funded activities that are currently helping to bolster the bioeconomy through the production and use of biofuels, bioproducts, and biopower, including research.

LINKS TO SOURCES OF INFORMATION

The following websites provide useful information and data on US bioenergy policy, production and consumption

http://www.eia.gov/totalenergy/data/annual/index.cfm

www.eia.gov/totalenergy/data/annual/archive/flowimages/2014/css_2014_energy.pdf

http://www.eia.gov/renewable/

http://www.iea.org/Textbase/npsum/US2014SUM.pdf

https://www.whitehouse.gov/sites/default/files/docs/cap_progress_report_final_w_cover.pdf

45 http://www.biomassboard.gov/pdfs/farb_2_18_16.pdf

IEA Bioenergy

Further Information

IEA Bioenergy Website
www.ieabioenergy.com

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