IEA Bioenergy

United Kingdom – 2018 update

Bioenergy policies and status of implementation

Country Reports

IEA Bioenergy: 09 2018

This report was prepared from the 2018 OECD/IEA World Energy Balances, combined with data and information provided by the IEA Bioenergy Executive Committee and Task members. Reference is also made to Eurostat. All individual country reports were reviewed by the national delegates to the IEA Bioenergy Executive Committee, who have approved the content. General background on the approach and definitions can be found in the central introductory report[1] for all country reports.

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NATIONAL POLICY FRAMEWORK IN THE UNITED KINGDOM

The 2009 EU 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, 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 1: *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: National Renewable Energy Action Plan for the United Kingdom (2010)[2]

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

[1] Available at https://www.ieabioenergy.com/iea-publications/country-reports/2018-country-reports/

[2] https://ec.europa.eu/energy/en/topics/renewable-energy/national-action-plans

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 MW_e.
- 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,
- energy 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 description of 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 of the UK in 2016 amounted to 7,490 petajoule (PJ) and is dominated by fossil fuels (80%). Natural gas accounts for almost 40% of TPES (2,906 PJ), and oil products contribute another third (2,543 PJ). The role of coal is limited to a little over 6% (496 PJ). Nuclear energy in nuclear power stations (producing 20% of electricity) represents 782 PJ or 10% of UK TPES. Renewable energy sources have a share of 8.6% or 643 PJ – 6.0% bioenergy and 2.6% other renewable energy sources. 63 PJ of electricity is imported, which represents 0.8% of UK TPES.

Compared to 5 years earlier (2011) the share of coal has dropped dramatically from 16.3% to 6.6%. In the same period the share of renewable energy increased from 4.2% to 8.6%. The share of other energy carriers (oil, natural gas, nuclear) increased slightly.

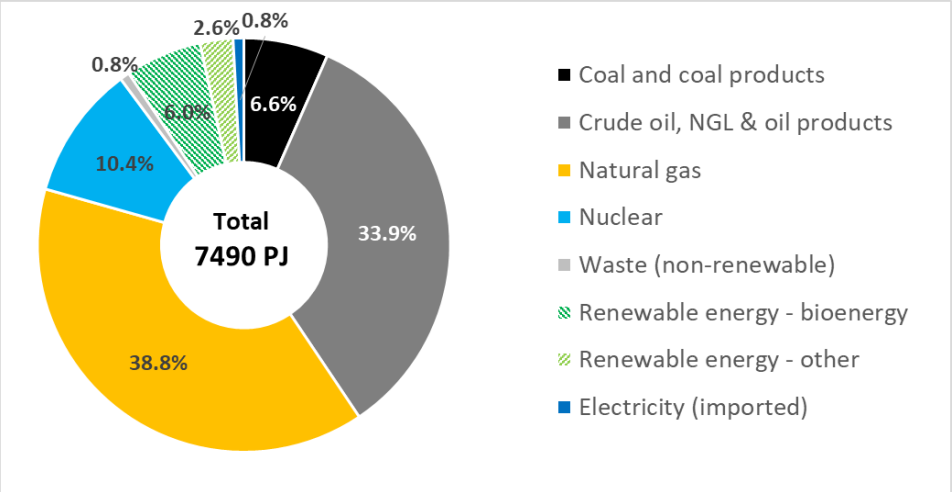

***Figure 1**: Total primary energy supply[3] in the UK in 2016 (Source: World Energy Balances © OECD/IEA 2018)*

The total primary energy supply of renewable energy sources is largely covered by energy from biomass, with 450 PJ or 70%. Wind energy contributes 21% (135 PJ), solar energy around 6% (40 PJ) and hydro energy 3% (19 PJ).

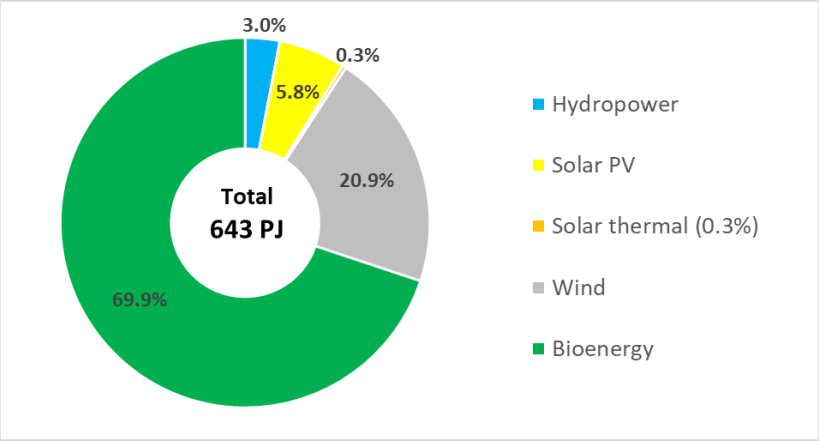

***Figure 2**: Total primary energy supply of Renewable Energy Sources in the UK in 2016 (Source: World Energy Balances © OECD/IEA 2018)*

[3] TPES underestimates the actual role of pure electricity sources like PV, wind or hydro energy, and overestimates the role of resources producing electricity with a high share of unused waste heat (like nuclear).

Most of the bioenergy consumed in the UK comes from solid biofuels; their share accounts for 60% of the total use of bioenergy or 267 PJ. Solid biofuels include fuel wood, wood pellets and chips, bark and industry residues. Around 69 PJ are used in the residential sector. The second largest item is biogas (mostly landfill gas) at 109 PJ, followed by the renewable share of municipal waste (34 PJ), biodiesel (23 PJ) and biogasoline (16 PJ).

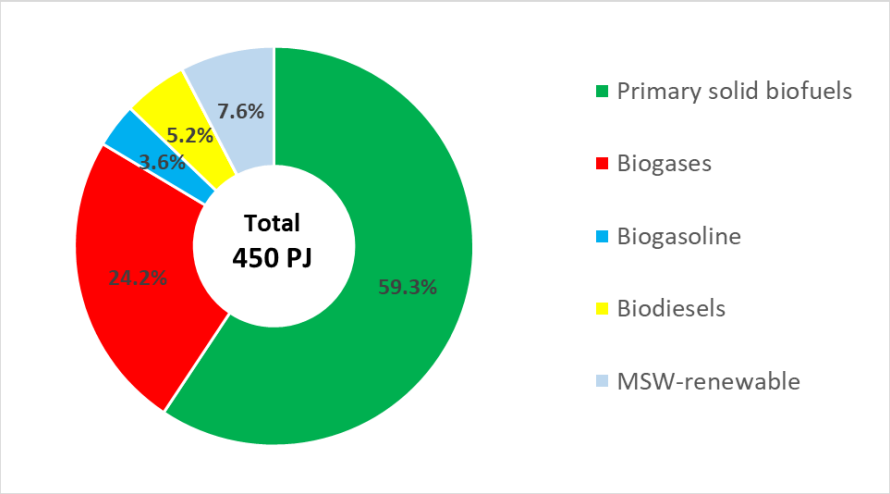

***Figure 3**: Total primary energy supply from bioenergy in the UK in 2016 (Source: World Energy Balances © OECD/IEA 2018)*

Bioenergy consumption in the UK was very low in 1990, with a share of 0.3% of UK TPES. There has been a steady increase of bioenergy, up to a level of 6% in 2016. Solid biomass, biogas and renewable waste all experience continuous growth since 2000. Liquid biofuels were established in the UK market between 2005 and 2010, but have stabilized since then around 40-45 PJ.

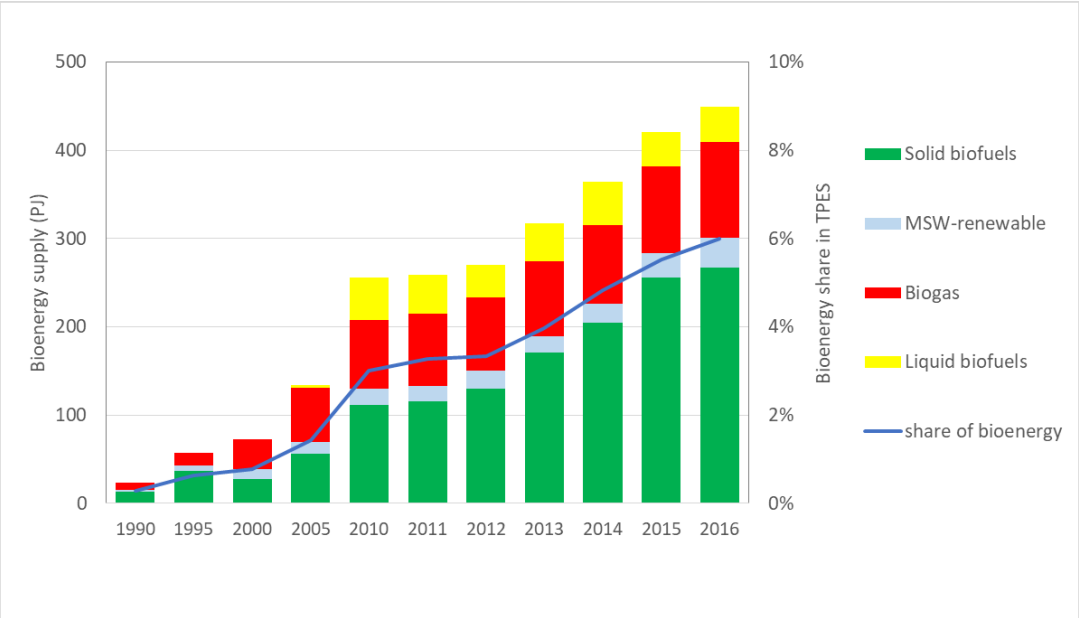

***Figure 4**: Development of total primary energy supply from bioenergy in the UK 1990 – 2016 (Source: World Energy Balances © OECD/IEA 2018)*

Table 2 expresses the 2016 TPES figures per capita, considering the UK's population of 65.6 million people. Compared to the other 22 member countries of IEA Bioenergy (expressed per capita), the UK ranks at the top 5 for biogas, halfway for renewable MSW, and in the low end for liquid biofuels and solid biofuels.

***Table 2**: Total primary energy supply per capita in the UK in 2016*

	GJ/capita
Total energy	114.1
Bioenergy	6.8
Solid biofuels	4.1
Renewable MSW	0.5
Biogas	1.7
Liquid biofuels	0.6

Role of bioenergy in different sectors

The UK has an average share of renewable electricity, of which almost half from wind energy and about one third from bioenergy.
The share of biofuels for transport amounts around 2.3%, which is below European average. Given the RTFO mechanism, the sector focuses on advanced/double counting biofuels, which are mostly based on used cooking oil.
Biomass represents about 6% of fuel/heat consumption in the different sectors together. Biomass also represents around 6% of fuel consumption in the residential sector. Heat output generated and sold by CHP plants and heat plants represents only 2% of fuel/heat provided, of which on average 1.1% is produced from biomass.

***Table 3:** Role of bioenergy and renewable energy in electricity production, transport energy consumption and fuel/heat consumption in 2016*

Sector	Share of bioenergy	Share of renewable energy	Overall production/ consumption
Electricity production	8.9%	24.7% (11.1% wind)	336 TWh (1,211 PJ)
Transport energy (final consumption)	2.3%	2.5%	1,718 PJ
Overall fuel and heat consumption[4]	5.9%	6.0%	2,202 PJ

(Source: 2018 World Energy Balances © OECD/IEA)

[4] This includes final consumption of fuels and heat in industry, the residential sector, commercial and public services and agriculture/forestry. Transport fuels are excluded. Energy used for transformation and for own use of energy producing industries is also excluded.

According to Eurostat[5], the following renewable energy shares in gross final energy consumption were reached in the UK in 2016:

- Overall share: 9.3%
- In heating and cooling: 7.0%
- In electricity: 24.6%
- In transport: 4.9%

The electricity sector seems to be on track towards its 2020 target, but important additional efforts are still to be made in the other sectors (see Table 1). Mind that some of these figures can differ from the IEA derived data because of different accounting rules, particularly for renewable energy in transport (waste/residue based biofuels).

RESEARCH FOCUS RELATED TO BIOENERGY

In the UK 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 the 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,

[5] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_ind_335a&lang=en

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 the 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 MW_e units) and Ironbridge (2 x 500MW_e units), the converted plants were operated, as planned, for a couple of years before the station was closed.

At Drax power station in Yorkshire, four of the six 660 MW_e coal boilers have been converted to 100% biomass pellets on a long term basis (with the last conversion completed mid 2018). The conversion cost of the fourth generating unit was significantly below the level of previous conversions. The station now has the capability of the generation of around 2,600 MW_e 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 140 MW_e 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, is 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 3.

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.

Table 4: List of the small - medium size dedicated biomass power plants in operation in Great Britain (2014)

Plant name	Location	Fuel	Capacity (MW_e)
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 + 2MW 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

It can be seen from these data that the power plants vary in capacity from 2 to 44 MW_e, 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 MW_e. In two cases, they provide renewable heat to local facilities. These plants were built and are owned and operated by a number 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 increased from 106 installations in January 2014 to 415 installations in December 2016, which represents an installed capacity of 288 MW. In 2016, the FIT system has been revised (introducing deployment caps per technology and lowering support levels for AD), and growth of AD has stalled since then. [Source:

Monthly FIT commissioned installations]

The introduction of the Renewable Heat Initiative (RHI) in 2011 has 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 19,745 accredited applications made under the scheme since November 2011 up to June 2018, 85% were for small and medium biomass boilers. Small biomass applications have significantly reduced since the end of the 2014/15 financial year. To date, non-domestic applications account for approximately 4,960 MW capacity. Approximately 85% of the capacity of full applications comes from biomass (Small, Medium or Large). Non-domestic RHI installations have generated almost 24,700 GWh of heat since the scheme was launched (2,833 GWh in the latest quarter). Three technologies (small biomass, medium biomass and biogas) account for over 80% of this generation.

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 68,399 accredited applications made under the scheme since April 2014 up to June 2018, 13,167 or around 20% were for biomass systems. The biomass tariff for new applicants has been reduced several times since April 2014 and air source heat pump are gaining importance. Of the total of 2,796 GWh of subsidised heat generated under the RHI scheme up to June 2018, more than half (1,467 GWh had been generated by the biomass systems.

LINKS TO SOURCES OF INFORMATION

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

2012 UK Bioenergy Strategy: https://www.gov.uk/government/publications/uk-bioenergy-strategy

Electricity Market Reform: Contracts for Difference:
https://www.gov.uk/government/collections/electricity-market-reform-contracts-for-difference

Monthly feed-in tariff commissioned installations - Cumulative installation numbers and capacity of schemes under 5MW installed in Great Britain. Update July 2018
https://www.gov.uk/government/statistics/monthly-small-scale-renewable-deployment

RHI deployment data: June 2018: https://www.gov.uk/government/statistics/rhi-deployment-data-june-2018

Renewable Heat Incentive evaluation: https://www.gov.uk/government/collections/renewable-heat-

incentive-evaluation

Energy Technologies Institute: www.eti.co.uk/

Supergen Bioenergy Hub: www.supergen-bioenergy.net/

UK Research & Innovation – BBSRC, Bioscience for the future: www.bbsrc.ac.uk