Department of Energy & Climate Change

Renewable Energy Statistics Data Sources and Methodologies

1. Introduction

RESTATS, the UK's Renewable Energy STATisticS database, is a project that has been running for nearly 25 years and over this period has become the primary source of accurate, up-to-date statistics of UK renewable energy sources. These cover active solar heating, solar photovoltaics, onshore and offshore wind power, wave power, large- and small-scale hydro, bioenergy (biomass and biowastes, including co-firing), deep geothermal, heat pumps and liquid biofuels for transport. Data are gathered on project details (where known), technology type, installed capacity, generation (electricity and/or heat), fuel-type and biofuels for transport.

1.1 Uses of renewable data

These data are used by the Department of Energy and Climate Change (DECC), the Statistical Office of the European Communities (SOEC, also referred to as Eurostat) and the International Energy Agency (IEA) in establishing the wider deployment of renewable technologies. The UK data are published in the Digest of UK Energy Statistics (DUKES) and also via the DECC and RESTATS web sites.

The growing importance of renewables makes gathering such statistics an even more important activity than in the past. They provide a means of monitoring progress against the UK target of achieving 15% of energy from renewable soruces by 2020 as required by the 2009 Renewable Energy Directive. These data are arguably the most reliable means by which the success of the UK's renewable energy activities can be measured and monitored.

In addition, the data are used to examine the effectiveness of electricity generation from renewable sources by examining comparisions of individual schemes with the load factors and other metrics for specific generation technologies.

2. Publications

The results of this survey and associated analytical work are published on an annual and quarterly basis and, as they are regarded as National Statistics, these data are published according to an agreed timetable.

Energy Trends (June)
This contains the highlights of the UK Renewble Statistics at the National level, and can be found on the DECC website at:
https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/energy-trends

DUKES Chapter 6 (July)
This contains details of the complete UK Renewble Statistics at the National level, and can be found on the DECC website at:
https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/digest-of-uk-energy-statistics-dukes

In DUKES, the following tables of data are produced:

Tables 6.1 to 6.3: Commodity balances (thousand tonnes of oil equivalent) for renewable energy sources, including transport fuels and heat pumps, covering each of the last three years.

Table 6.4: A 5-year table showing capacity (MW) of, and electricity generated (GWh) from, renewable sources. It also summarises the total generation from renewable sources eligible for the Renewables Obligation (RO).

Table 6.5: A 5-year table showing plant load factors that are calculated in terms of installed capacity and express the average hourly quantity of electricity generated as a percentage of the average capacity at the beginning and end of the year. This table also contains a second set of statistics to describe the load factor for schemes that have operated on an unchanged configuration basis throughout the calendar year.

Table 6.6: This shows renewable sources used to generate electricity, to generate heat, and for transport purposes in the most recent five years.

Table 6.7: This brings together the renewable sources data used to indicate progress under the 2009 EU Renewable Energy Directive (measured using net calorific values) towards the target of 15 per cent of UK energy consumption to be sourced from renewables by 2020.

Table 6.1.1: Renewable sources used to generate electricity and heat (thousand tonnes of oil equivalent) from renewable sources. This is an internet only table (see 'Long Term Trends' on the DUKES webpage) and is not included in the main DUKES report.

Table 6.1.2: Renewable orders and operational capacity (MW DNC[1]). This is an internet only table (see 'Long Term Trends' on the DUKES webpage) and is not included in the main DUKES report.

Statistical Indicators are used throughout the document to highlight general trends in the development of renewable energy technologies and include:

- Trends in the use of renewable energy sources for electricity, heat and transport;
- Increase in the electricity generation capacity from all significant renewable sources;
- Growth in the proportion of electricity produced from renewable sources, including the progress towards the renewables targets set under the Renewables Obligation and Renewable Energy Directive;
- Renewable generating capacity from the Non-Fossil Fuel Obligation (NFFO) schemes, former NFFO contracts (including equivalents in Scotland and Northern Ireland) and capacity outside of NFFO.
- Load factors for renewable electricity generation.

Energy Trends (September)
This contains Regional Renewable electricity statistics plus an analysis of load factors for on-shore and off-shore wind, hydro, landfill gas, sewage and other bioenergy. The former is in response to many requests for regional information, and the statistics from 2000 onwards on the amount of electricity generated from renewable sources in the UK and the capacity to generate electricity from renewables have been disaggregated below the national level. In some cases, particularly for early years, it has been necessary to combine the data for certain regions so that information about individual sites provided in confidence is not disclosed.

[1] DNC – Declared Net Capacity: discussed in further detail in Section 4

Energy Trends Section 6 (Quarterly)

Excel spreadsheets and commentary relating to quarterly estimates of renewable electricity capacity and generation. It also includes the following statistical indicators:

- Renewables share of electricity generation
- Renewables electricity generation
- Renewable electricity capacity (as at end of quarter)
- Renewable electricity load factors
- Feed in Tariffs: installed capacity confirmed on FiTs, as at end of quarter
- Liquid biofuels for transport consumption

RESTATS Web site – (https://restats.decc.gov.uk)
This has links to the publications pages on the DECC web site; major updates are undertaken in July and September in line with the release dates for DUKES and Energy Trends publications outlined above. The RESTATS website also contains data on the development of renewable generation facilities, through planning to operation.

3. Data Collection

3.1 Sources of data

Data on the performance of renewable energy schemes in the UK are collected from a number of sources and are used to update a database of renewables schemes (known as the "RESTATS Database"), maintained by Ricardo-AEA on behalf of DECC. Table 1 details these data sources.

TABLE 1: Data sources currently in use

Data Source	Primary Source	Comments
British Hydropower Association Database	British Hydropower Association	Used to provide both new site data and information for cross checking
Building Services Research and Information Association (BSRIA)	Heat pump industry	Heat pump data
Renewable UK Wind Database (via web site)	Renewable UK (formerly, the British Wind Energy Association)	Cross checking of addresses and Installed Capacities; data on small-scale wind
CHAPSTATS, the Combined Heat And Power STATisticS database	Ricardo-AEA on behalf of DECC and Defra	Usually one of the last datasets to be included since this is carried out in parallel with RESTATS
Clinical Waste; database of all UK clinical waste incinerators	Environment Agency (EA)	These data are used as a starting point for the Gap Analysis Survey.
Domestic Wood Use	Forestry Commission (FC)	Discussion with FC and other organisations (National Association of Chimney Sweeps, Insurance Assessor, HETAS, etc)
Farm Management Survey	Defra	Information on straw though currently of limited value
FiT Register	Ofgem	Data issues discussed directly with Ofgem
Landfill Gas Sites	Environment Agency (EA)	These data are used as a starting point for the Gap Analysis Survey.
Liquid Biofuels	Renewable Fuels Agency (RFA) and HM Revenue & Customs	General data source, published as "official" or "national" statistics
Major Power Producers (MPP) Survey (large-scale hydro, co-firing and poultry litter combustion)	DECC	Reliable dataset that complements other areas. MPPs currently defined as those organisations whose portfolio of projects have a total installed capacity of ≥ 80MW
NFFO Database; includes Scottish Renewables Obligation (SRO) and the Northern Ireland NFFO (NI-NFFO)	Non Fossil Purchasing Agency (NFPA) for England, Wales and Scotland and shortly to incorporate Northern Ireland.	Reliable datasets used regularly throughout the data analysis stage; data are sometimes late for the analysis. Data are collated by Ricardo -AEA on behalf of DECC
National Non-Food Crops Centre (NNFCC) Website (Farm and food waste AD)	Defra	Used in Farm AD; interactive map available. Funded by Defra

REA, the Renewable Energy Association	REA	Liaise with REA for information; interactive map available.
Renewable Energy Planning Database (Data on schemes working their way through Planning Applications)	DECC (currently being integrated with the RESTATS database)	Database used for cross checking when schemes go live.
Renewables Heat Incentive (RHI) and Renewable Heat Premium Payments (RHPP)	Ofgem	Contribution from these schemes are increasing
ROCs Database of Accredited Generating Stations and the **ROCs Register**	Ofgem	Contains information on projects claiming ROCs
Technology Experts and Trade Associations	(Ricardo-AEA, Forestry Commission, Ground Source Heat Pumps Association, HETAS, Renewable Energy Association and Solar Trade Association)	Used for cross-checking
Tyres for cement production	British Cement Association (via (DECC)	An annual report listing various renewables as fuels for cement production.

Data are also gathered by surveys, and are described in more detail in section 3.2.

3.2 Data items collected

The annual survey is an important source of new data. Technologies covered include:

- Co-firing (biomass with fossil fuels)
- Bioenergy (dedicated)[1]
- Bioenergy (wastes)[2]
- Deep geothermal
- Heat Pumps
- Hydro (large- and small-scale)
- Liquid Biofuels for Transport
- Solar (PV & Active Solar Heating)
- Tidal and Tidal Stream
- Wave
- Wind Offshore
- Wind Onshore

[1] Landfill gas, Sewage Gas, Domestic Wood, Industrial Wood, Energy Crops & Forestry Residues, Straw
[2] Municipal and industrial waste, Specialised waste – Anaerobic Digestion, Hospital, Meat & Bone, Poultry Litter, Scrap Tyres

The following data are gathered about these schemes:

- Project details (address, technology, Installed Capacity)
- Generation (Electricity and/or Heat) and Uses
- Fuel Input (Energy Input - Indigenous or imported)
- Energy content of each type of fuel consumed (Gross Calorific Value and Net Calorific Value basis)

The following information is extracted from the Ofgem ROCs and Accredited Stations database:

- Name and address details of the accredited stations
- Electrical generating capacity
- Number of ROCs issued. This is a proxy for electricity generated. Up until 31 March 2009, 1 ROC was issued in respect of each MWh of electricity generated. From 1 April 2009, the number of ROCs issued per MWh is dependent upon the electricity generating technology employed. The Ofgem ROCs database includes a factor to convert the number of ROCs issued into the number of MWh of generated.

The following information is provided by Ofgem to DECC from the Ofgem FiT and RHI Registers:

- Electrical and heat generating capacity and generation by supported technologies
- Regional data so as to allow these to be apportioned by country and region

3.3 Approach to data collection and collation

The **Renewable Energy Projects Survey** serves three purposes:

- To update the information held on the RESTATS database;
- To improve the quality of information held on these projects;
- To collect information from projects not already on the database and not already known to RESTATS.

No one approach has been shown to be completely effective so the protocol for conducting these surveys is summarised below:

- Where the data required are not available from other sources, large projects are surveyed through an annual questionnaire, issued by email (rarely post) with telephone follow-up of non-respondents.
- Where there are large numbers of small projects, estimates are based on a sub-sample.
- On-line survey forms are also made available from a secure web site as an alternative method of responding.
- Modelling and estimates are made where surveys are not practical, with independent assessment and verification of the data where practicable.

The estimated proportion of respondents and the percentage of energy that comes from each is summarised in Table 2.

TABLE 2: Data sources currently in use

Approach	% of Respondents	% of Energy
Small number of Large projects	14%	21%
Large number of Small projects	78%	3%
On-line form	8%	<1%
Models/est	0%	7%
Other sources	0%	67%
TOTAL	**100%**	**100%**

Planning work begins late November to update the (e-) mailing lists with a full survey commencing in mid-January. Survey return forms are collected and collated for the reporting period from January through to March.

Two different questionnaires are used:

- Renewable Energy Projects Survey (REPS) Questionnaire - a broad, general questionnaire
- Waste-to-Energy Questionnaire - for small-scale specialised waste combustion projects (a much simpler and more appropriate questionnaire)

Experience with on-line survey forms continues to show that, at present, this is not a substitute for conventional approaches to surveying that would make this a major data entry route. This is partly due to the fact that, like all DECC energy surveys, participation is based on co-operation and a joint understanding of rationale and use of the results and, as such, participation is not compulsory so response rates remain heavily dependent on telephone follow-up calls. Nevertheless, it has been useful in helping to improve the response rate. We would aspire to making this a major focus of future RESTATS surveys as moving towards an on-line process takes less time, requires less effort and ties up less resource for UK businesses.

Estimates and Modelling

In a few cases, such as domestic wood use, active solar and straw combustion for heat, where good data are not available, these are estimated by an appropriate Technical Expert (having a good knowledge of both the technology and industry), and peer reviewed by a competent external organisation/contractor (e.g., Forestry Commission). This approach is reviewed in the light of new data sources and methodologies and undertaken as part of the 'Gap Analysis' work (see 3.4). The information on which these estimates are based is supplemented, where possible, by carrying out a limited survey on a sub-sample of projects and modelling.

Active Solar Heating employs solar collectors to heat water mainly for domestic hot water systems but also for swimming pools and other applications. The breakdowns into the replacement of gas, electricity and oil that would otherwise be used to provide energy for these tasks are based on a model using sales figures provided by the Solar Trade Association. The calculations into the energy supplied by Active Solar would be based on the quantity of fossil fuel that is displaced by its use. 2012 saw a change in methodology, as recommended by the IEA Solar heat and cooling program and ESTIF (European Solar Thermal Industry Foundation). Details of the new methodology can be found at:
www.estif.org/area_to_energy_conversion_method/

DECC intends to examine the case for active solar heating and other renewable heat solutions during the next scheduled review for the non-domestic RHI, due to start in 2014.

Domestic Wood Use continues to be a notoriously difficult area to assess and for a long time the estimate was based on historic surveys. The results of many of these historic studies did not warrant changes to these current data and up to 2002 the figure given for each year was an approximate estimate based on a survey carried out in 1989. During the survey of 2003, Ricardo-AEA was asked to examine an accumulating body of anecdotal evidence that implied that there was considerable growth in this area, suggesting that the use of this resource might start to be underestimated. This was based on the amount that was being burnt on open fires rather than dedicated wood-burning stoves and had been overlooked until now. A revision in 2003 to subsequent domestic wood use figures was based on a 50 per cent growth rate in sales/installations over a 2-3 year period supported with anecdotal information from the sources listed below:

- HETAS, the official body recognised by Government to approve solid fuel domestic heating appliances, fuels and services,
- the National Association of Chimney Sweeps and
- Discussions with a risk assessor acting on behalf of insurance companies.

Future estimates from 2003 onwards are now made from annual discussions with representatives of these associations, using 2002 baseline data that are extrapolated forward, that are independently peer reviewed by the Forestry Commission prior to publication. The accuracy of these estimates is, however, dependent on the accuracy of the base level figure s for domestic wood use in 2002.

The amount of Straw combustion for heat is considered to be a particularly weak estimate and is currently based on historic data. The figures given are estimates based partly on 1990 information and partly on a survey of straw-fired boilers carried out in 1993-94. A 40 MW straw fired power station near Ely, Cambridgeshire is currently the only electricity generation scheme in operation. There are plans to work with Defra to investigate opportunitites to improve these data.

Heat Pumps: Estimates are made of the renewable heat from air to water heat pumps (ASHP), ground source heat pumps (GSHP) and exhaust air heat pumps in the UK in 2012. It currently does not include air to air heat pumps. Information for this is obtained has been obtained from the BSRIA heat pump report on total number of heat pumps installed, split between small domestic, large domestic and commercial/ industrial. 5% of GSHP installations in the commercial/ industrial category are assumed to be industrial. Data on the split between domestic and commercial installations for 2008 to 2011 are based on estimates from DECC Renewable Heat Incentive Team.

All heat pumps installed after 2008 are assumed to meet the minimum performance factors required under the Renewable Energy Directive (RED). Annual hours of operation and Seasonal Performance Factor are based on default values proposed by the EC in Commission Decision (C92013) 1082 final. The allocation of heat pumps to climatic zones is based on the regional data available for schemes installed under the UK RHPP scheme. The average installed capacity for small and large domestic installations are also based on RHPP data. All data are entered into a spreadsheet developed by DECC and the renewable heat contribution is calculated according to the methodology prescribed in RED.

Liquid Biofuels Survey

This presents information on the quantity of biofuels produced in the UK, and the quantities of biofuels supplied to UK road markets. To date, this has been restricted to biodiesel and bioethanol, as these are the only biofuels currently produced at significant volume in the UK. Production and consumption of other biofuels would be included when they enter the UK market. The most usual way for biofuels to be sold is for them to be blended at a low level (about 5%) with fossil fuel and thus biofuel consumption is reported as part of the road transport use of diesel and petrol, in the hydrocarbon oils bulletin.

Biodiesel consumption figures are obtained from figures published by HM Revenue and Customs (HMRC) derived from road fuel taxation statistics. The HMRC data are converted from litres to tonnes of oil equivalent and the data are now shown in the commodity balances.

A further source of statistical information on liquid biofuels is from the Department for Transport Renewable Transport Fuel Obligation (RTFO) Statistics. These do not include the amount of biodiesel and bioethanol produced in the UK and so this information is currently obtained from a survey of UK biodiesel and bioethanol producers led by DECC Oil and Gas Statisitics. Since the market for biofuels in the UK is evolving rapidly from a low base, the survey has been carried out annually to ensure information published in DUKES reflects these changes. This position is reviewed on an annual basis. The RTFO data are used to identify the sustainable nature of the biofuels, which are necessary for reporting against the Renewable Energy Driective.

3.4 'Gap Analysis' Survey

The RESTATS project continually strives to make continuous improvements to the quality of the data held in the database. As part of this task, 'Gap Analysis Surveys' are undertaken to improve the quality and completeness of the data for all renewables technologies that contribute. Experience to date has shown that surveying fewer technology areas in a more intensive manner, especially where their contributions to the overall final result is small, by means of questionnaire and telephone follow-up, has enabled a good response rate to be achieved with a corresponding improvement to data quality and completeness. Furthermore, time spent cross-referencing sites between different

databases is well spent as it makes importing year data less problematical so tying up with other existing surveys becomes easier. The results of these surveys are published on the RESTATS web site as detailed abstracts.

3.5 Data quality checking

Historically, the RESTATS project annually surveyed all renewables technologies but has now gradually integrated with other data collection activities (e.g. DECC's Major Power Producers Survey) which in turn made it more effective. In addition, incorporating new data sources (e.g. Ofgem's ROCs database) gave the project more complete coverage. 'Gap Analysis' Surveys for less important technologies (e.g. clinical waste incinerators) are undertaken on a 3 year cycle.

This approach, however, gave rise to issues of data quality from these disparate sources and led to the development of appropriate quality checking procedures. This includes data cleansing (duplicates), where GIS is helpful, crosschecking with other data sources to ensure, to best endeavours, that these data are both complete and consistent, and undertaking 'sanity' checks (e.g., comparison of load factors) to confirm that data are meaningful prior to acceptance.

Ofgem ROCs database: Data relating to electrical generating capacity and electricity generation are submitted by operators to Ofgem every month. As the quantity of electricity generated has a financial value in the form of ROCs, a minimum standard of electricity metering accuracy is stipulated by Ofgem. These standards are subject to audit by Ofgem at which time a check is also made that site held data corroborates the data and calculations submitted to Ofgem.

Whilst DECC's Major Power Producers (MPP) Survey, the NFFO Database, CHAPSTATS, and the Renewable Energy Planning Database, all have their own internal checking procedures to ensure data quality procedure, checking is also undertaken by RESTATS before these data are imported into the database.

3.6 Data accuracy/consistency between other data sources

The activities described in the previous section have allowed a view to be formed of the accuracy and consistency of the data from these and other various data sources. The ROCs generation figures should be at least the same as NFFO and could be greater if the site is generating more than its NFFO contract; it can never be less. NFFO data therefore provide a good crosscheck with ROCs as these schemes are recorded in both databases. When ROCs first began, there were a number of discrepancies that were primariliy related to combustion schemes as the latter required proof of the nature and calorific value of the fuels and would result in a delay in the issuing of certificates. At present, there is usually a good correlation in >99% of the schemes.

It is recognised that one of the shortcomings of the differences in the reporting periods for the data contained in DUKES (end of calendar year) and Ofgem's finalised ROCs data (end of financial year), is that the finalised Ofgem figures are not available for use during the compilation process for both Annual and Quarterly reporting, and data for the most recent month for ROCs are estimated when included in DECC's quarterly statistical reports.

Following the request by DECC that Major Power Producers provide hydro data on a site-by-site basis, rather than on an aggregated basis, data quality has improved enormously and there is now a > 99% correlation with both NFFO and ROCs data sources if they also hold information on these schemes. MPP data are now provided for many wind, biomass and MSW schemes with plans to extend this to cover Co-firing

The REPD provides a crosscheck with electricity generating schemes that have become operational during the reporting year to ensure the completeness of schemes being reported. There are some limitations as the database only holds data on schemes >0.01MW that require a planning approval and provides only installed capacity and address details. In addition, some technologies, such as Sewage Gas and Cofiring, which do not require planning approval, will not be picked up.

Accuracy and consistency of other data sources is varied, especially when they are only used for estimates.

3.7 Revisions to Data

In DUKES, data on renewables operation are reported for a number of years in order to give a historic time series perspective. Where better data have been identified, it is normal practice for revisions to be made to the data for previous years. The data entries concerned are suffixed with an 'r'; e.g., in the 2012 Dukes publication, the installed capacity shown in table 6.4 for the 2010 entry for sewage sludge digestion was enterd as 186r.

4. Data Analysis (to UK/EU requirements)

These data are analysed to **standardised statistical methodologies** and conversion factors in line with International Energy Agency (IEA) and Statistical Office of European Commission (SOEC) definitions.

Conversion Factors
Conversion factors are used to convert and express energy figures in different units. Energy units used are therms, tonnes of oil equivalent (toe – the energy content of one tonne of oil), MegaWatt hours (MWh) and Giga-Joules (GJ). The conversion factors used are not the same for each of the combustion technologies and do not convert all the energy released from the fuel into electricity, therefore the conversion factor needs to take into account the energy lost during electricity generation.

The conversion factors used are summarised in Table 3 below:

TABLE 3: Conversion factors

Conversion Factors	Technology	Adopted IEA/SOEC Definitions
therms/toe toe/MWh MWh/toe	Standard conversion factors	396.83 0.08598 11.63
MWh/toe	Wind	11.63
MWh/toe	Hydro (small-scale <5MW)	11.63
MWh/toe	Hydro (large-scale ≥5MW)	11.63
MWh/toe	Wave Energy	11.63
MWh/toe	Tidal Currents	11.63
MWh/toe	Biomass electricity conversions, including Others Category, landfill gas + sewage.	3.05*
GJ/toe	All Heat Conversions	41.868

** This is a two-stage process; x 11.63 to convert from MWh to toe thermal; x 0.262, the fractional electrical conversion efficiency, to convert from thermal to electrical toe.*

There are two points to note:

- One tonne of oil equivalent is defined as 396.83 therms.
- Primary electricity contributions from wave, tidal, hydro and wind are expressed in terms of an 'energy-supplied' model

Figures on fuel use for electricity generation can be compared in two ways. The fuel input basis (after conversion to an oil equivalent unit) is the most appropriate to use for analysis of the quantities of particular fuels used in electricity generation but it takes no account of how efficiently that fuel is converted into electricity. The output (energy-supplied) basis uses the amount of electricity generated and supplied by each fuel.

While biomass appears to dominate the picture when fuel inputs are being measured, hydro electricity and wind power together provide a larger contribution when the output of electricity is being measured. This is because, on an energy supplied basis, the inputs are deemed to be equal to the electricity produced for hydro, wind, wave and solar. However for landfill gas, sewage sludge, municipal solid

waste and other renewables, a substantial proportion of the energy content of the input is lost in the process of conversion to electricity.

The **Renewable Energy Directive** (RED), which came into EU law in April 2009, is designed to help Member States progress towards meeting the EU 2020 target of 20% energy derived from renewable sources. The target for the UK is 15% of **final energy consumption** calculated on a net calorific basis[2]. It would therefore have a major impact on the contribution from biomass which up to now has been calculated on the basis of the energy content of the fuel. In addition, 10% of energy used in transport must be renewable. This has resulted in changes to the methodology required to provide data to monitor progress to this target. Data are reported annually to Eurostat, with comparative statistics on progress for all member states being published at:
http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/other_documents

Capacities
These represent the amount of generation the renewable energy projects are capable of producing. There are many different types of capacity figures that may be used but Installed Capacities are used now, with Declared Net Capacity (*DNC*) in a few special cases:

Installed Capacity

Installed Capacity, also the same as the 'Nameplate' capacity, is literally what the manufacturer says the equipment is capable of producing. This is stamped on the side of the machine, hence the term 'Nameplate' capacity.

Declared Net Capacity (DNC)

DNC is defined as the maximum continuous rating of the generating sets in the stations less the power consumed by the plant itself and is reduced by a specified factor (B) to take into account the intermittent nature of some of the renewable energy sources. It is used for presenting data in Table 6.1.2.

DNC represents the nominal maximum capability of a generating set to supply electricity to consumers; it is calculated from the following equations:

$$DNC = (\textit{name plate capacity} \times B) - \textit{'in-house' load}$$

B has the following values for the different renewable sources.

B	**Resource**
0.43	Wind
0.17	Solar
0.33	Tidal/Wave
1.00	All Others

Calorific Values for Biofuels
Table 4 shows the estimated average Gross Calorific Values (GCV) and Net Calorific Values (NCV) for biofuels that are used to convert the data from tonnes of fuel processed by the plant; these feedstock figures are supplied in the survey returns. These data are supplemented with information gathered via the various surveys and fine-tuned on an annual basis.

[2] Renewable Energy Directive http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF

TABLE 4: Calorific values of biofuels

Renewable Energy Source	NCV (GJ/te)	GCV (GJ/te)	Moisture Content
Domestic Wood[3]	12.3	13.9	16%
Industrial Wood[4]	12.1	13.7	16%
Straw	13.4	15.8	15%
Poultry Litter	7.6	9.1	16%
Meat and bone	16.8	20.0	16%
General Industrial Waste	15.2	16.0	5%
Hospital Waste	13.3	14.0	5%
Municipal Solid Waste	6.7	9.5	30%
Refuse Derived Fuel	13.0	18.5	30%
Short rotation coppice	9.3	11.1	16%
Tyres	30.4	32.0	5%
Wood pellets	16.8	17.2	3%
Biodiesel	37.2	38.7	4%
Bioethanol	26.8	29.7	10%

Fuel Calorific Value and Moisture Content: The calorific value (CV) of a fuel is the heat available from that fuel when it is completely burned, expressed as heat units per unit of fuel weight or volume.

The gross, or higher, value (GCV) is determined in the laboratory using a calorimeter. It can be defined as the total heat liberated by the complete combustion of the fuel. It is determined by measuring the heat removed when cooling the products of combustion to a standard reference temperature, and it includes latent heat recovered from condensation of the water vapour component. This water vapour forms as a result of the combustion of any hydrogen molecules contained within the fuel, and the vaporisation of any moisture present.

The net, or lower, value (NCV) is determined by calculation[5] and equals the gross calorific value minus the latent heat of the water vapour formed from the combustion of hydrogen and from any moisture present in the fuel.

The net value is more representative of the heat available in practice when fuels are burned in equipment such as furnaces and boilers. The latent heat of the water vapour contained in exhaust gases is not normally recoverable, except where low-temperature heat recovery involving condensation is used.

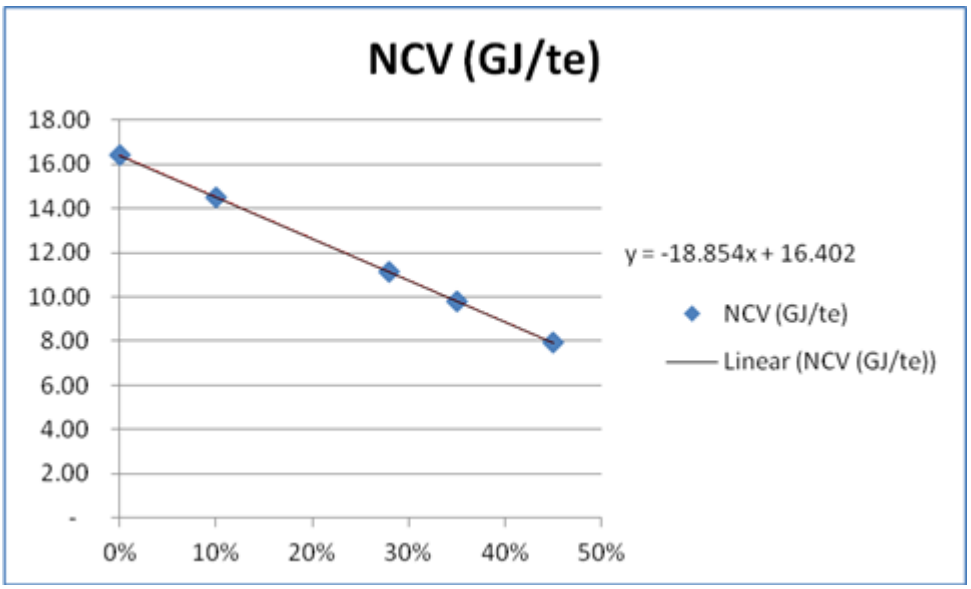
Calorific values for the biomass fuels above are quoted on an “as received” (ar) basis which includes the effect of the moisture in the fuel. Other bases are used such as dry, air dried, oven dried etc. for particular purposes.

The calorific value of used poultry litter, and the effects of moisture content, was investigated as part of the independent monitoring of the Fibropower (Eye) power litter-fired power station commissioned by the former DTI.

Use of Poultry Litter for Power Generation - Monitoring of 'Eye' Power station
FEC Ltd
ETSU B/FW/00235/REP Crown Copyright (1995)
Available via the British Lending Library

On an as received basis, the Moisture Content typically ranges from 25 - 50% throughout the season. The Net Calorific Value (NCV) is variable but typically in the range 10-12 GJ/te; its variation with moisture content is shown in the following graph which would be more helpful to developers. A copy of this report is available via the British Lending Library.

[3] On an “as received” basis; seasoned logs at 25% moisture content (Air dried tonnes). On a “dry” basis 18.6 GJ per tonne.
[4] All survey data have been reported on an “oven dry” basis of 18.6 GJ per tonne
[5] http://www.biodat.eu/pages/FuelSpecificationCalculation.pdf



Energy from non-bio-degradable wastes

The European Union's Renewables Directive (RD) of October 2001 redefined what were to be regarded as eligible renewables. The Directive's definition is the same as the international definition used (in that it excludes non-biodegradable wastes) but with the addition of imports of renewable sources electricity because the Directive is concerned with consumption of electricity from renewable sources. Although part of waste tyre combustion is of biodegradable waste, because there is no agreed method of calculating the small biodegradable content, all of the generation from waste tyres would continue to be included under non-biodegradable wastes. Municipal Solid Waste (MSW) and General Industrial Waste (GIW) both fall under this category as well. Generation from these sources would be split between biodegradable sources and non-biodegradable sources using information on calorific values of the constituent parts. This composition, however, does vary with time and AEA (experts in waste analysis for Defra) currently estimate that 36½ per cent of MSW was non-biodegradable and 100 per cent of waste tyres. At present, all hospital waste is also considered non-biodegradable.

Load Factors

Load factors - based on average beginning and end of year capacity: these are calculated, using the following equation, in terms of installed capacity (ie the maximum continuous rating of the generating sets in the stations) and express the average hourly quantity of electricity generated as a percentage of the average of the capacities at the beginning and end of the year. The method can be expressed as:

$$\frac{\text{Electricity generated during the year (kWh)}}{(\text{Installed capacity at the beginning of the year} + \text{Installed capacity at the end of the year (kW)}) \times 0.5 \times \text{hours in year}}$$

Load factors on an 'unchanged configuration basis': this statistic uses the same methodology as the other load factor statistics, but are restricted to those schemes that have operated continuously throughout the year without a change in capacityA full account of the exercise to derive these factors for wind can be found in *Energy Trends*, March 2006 pages 28 to 32. *Energy Trends* is available on the DECC energy web site at although here the term "capacity factor" was used. The load factor on an unchanged configuration basis for a calendar year is calculated from:

$$\frac{\text{Electricity generated during the year (kWh)}}{(\text{Installed capacity operating throughout the year with unchanged configuration (kW)}) \times \text{hours in year}}$$

As a result of the differences in DUKES (end of calendar year) and Ofgem's finalised ROCs data (end of financial year) discussed earlier, it should be noted that this can have an impact on the schemes included in the unchanged configuration definition as new data could include or remove particular schemes. This should be kept in mind if users wish to reanalyse these results.

Categorisation of schemes according to sector

For the purposes of informing policy it is sometimes instructive to associate generation figures from each scheme with an economic sector in which the majority of the energy is consumed. Schemes are therefore classified, where possible, in the RESTATS database according to the "Economic Sectors" in which they operate. These sectors include:

- Grid
- Own Use/Site
- Commercial
- Agricultural
- Industrial
- Domestic
- Public
- Utilities
- Other

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