bre

Housing Executive

www.bre.co.uk

Energy consumption in Northern Ireland's housing stock: 2016

Modelled using data from the Northern Ireland House Condition Survey 2016

Published: 17 August 2022

Ad-hoc official statistics

Table of Contents

This thematic report was produced by the Building Research Establishment (BRE) on behalf of the Northern Ireland Housing Executive. It is based on data collected through the 2016 Northern Ireland House Condition Survey (NIHCS) and estimates the energy consumption in Northern Ireland's dwelling stock.

Please note: The purpose of this report is to provide information on the domestic energy consumption which might contribute to and inform wider discussions around domestic energy use.

The main House Condition Survey 2016 report is published on the Housing Executive's website:

Northern Ireland House Condition Survey 2016 main report

The detail provided in the methodology section and in the user guide are summarised for the purposes of this report. However, for further information about the method used or the findings in the 'Energy consumption in Northern Ireland's housing stock: 2016' report or the House Condition Survey contact:

The Research Unit
Northern Ireland Housing Executive
2 Adelaide Street Belfast
BT2 8PB

Jahnet Brown (project leader)
Email: jahnet.brown@nihe.gov.uk

Ursula McAnulty (lead official)
Email: ursula1.mcanulty@nihe.gov.uk

Introduction & Executive Summary

The Northern Ireland House Condition Survey (NIHCS) was due to take place in 2021, but was postponed due to the Covid-19 pandemic. The decision to postpone was made following a comprehensive consultation process, during which users of the NIHCS highlighted a need for some key statistics in the interim.

This report was produced in response to users' indicating a requirement for more information and detail on how domestic energy consumption in Northern Ireland is split by fuel type and end use (space heating, water heating, lighting, cooking). The Housing Executive commissioned the Building Research Establishment (BRE) to create a table of total energy use split by fuel type and end use for Northern Ireland, modelled using data from the NIHCS 2016[1]. The BRE Domestic Energy Model (BREDEM) methodology was used to model the annual energy consumption of all dwellings in Northern Ireland in 2016, using fuel poverty specific assumptions e.g. for demand temperatures and heating regimes[2].

The energy requirement of the dwelling is modelled based on how much energy a household would need to heat their home to a reasonable standard, rather than actual heating behaviour. The total energy consumption for all dwellings in Northern Ireland in 2016 has been calculated and then disaggregated by the fuel type and end use, with the results shown in Table 1.

The key findings were:

- Energy use for all dwellings in Northern Ireland in terms of the total modelled annual energy consumption in 2016 was estimated at 19,300 GWh/year. For comparison, the energy use for all households in Northern Ireland was estimated at 18,100 GWh/year in 2016.
- More than half of the total modelled annual energy consumption in dwellings was for primary space heating (10,700Gwh/year).
- Primary space heating energy use in Northern Ireland was dominated by oil, accounting for more than three quarters (76%) of the primary space heating energy consumption in dwellings. This was expected since approximately 68% of central heating systems in Northern Ireland are oil-fired[3].
- A similar result (77%) was seen for water heating in dwellings, with energy use modelled to be 2,700 GWh/year from oil, with total energy consumption from all fuels modelled at 3,500 GWh/year.
- In contrast, for secondary space heating, energy consumption was dominated by dwellings with solid fuel heaters, accounting for 81% of secondary space heating energy use.
- Electricity consumption from lights and appliances was modelled at 2,800 GWh/year, accounting for 79% of all electricity use in dwellings.

[1] These are the latest figures available from a full House Condition Survey in Northern Ireland

[2] The BREDEM methodology is described in detail in 'BREDEM 2012 – A technical description of the BRE Domestic Energy Model, J Henderson & J Hart, version 1.1, BRE, 2015'.

[3] Northern Ireland House Condition Survey 2016 main report: see page 75 section 7.4

Dwelling energy use is a key input into the fuel poverty calculation. It is impacted by changes to energy efficiency in the housing stock, the type of heating systems and fuel used, along with characteristics of the household living in the home. As such, fuel poverty is calculated at the household level[4]. In 2016 the number of fuel poor households (using the 10% definition) in Northern Ireland was estimated from the Northern Ireland House Condition Survey (NIHCS)[5] data as 160,000 (22% of all households).

[4] Excluding vacant dwellings and households who did not complete an interview survey

[5] https://www.nihe.gov.uk/Documents/Research/HCS-2016-Main-Reports/HCS-Main-Report-2016.aspx

Methodology

The 2016 NIHCS data has been used as a base in conjunction with the 2016 fuel poverty methodology[6] to calculate the total domestic energy consumption for Northern Ireland, split by fuel type and end use. The energy requirement of each dwelling is modelled based on how much energy a household would need to heat their home to a reasonable standard, rather than actual heating behaviour. This approach is taken to standardise the assessment of whether a household can afford to heat their home to an adequate thermal standard. In the case of low-income households, actual expenditure on heating may be limited and might restrict heating to levels lower than those needed to keep warm.

The 2016 domestic energy consumption figures for Northern Ireland have been modelled at the housing stock level. This approach provides a consistent sample base with the 2016 energy efficiency statistics[7], calculated using the Standard Assessment Procedure (SAP), which is the Government's standard method of rating dwelling energy efficiency. SAP is not affected by individual household characteristics or the geographical location of dwellings. The BRE Domestic Energy Model (BREDEM) can also provide estimates of energy consumption for all dwellings, with minimal household information required. Where occupant information is missing (either due to non-response to the interview survey, or vacant dwellings), standard assumptions are used[8]. For the calculation of fuel poverty statistics, household information is used in combination with the dwelling characteristics, and therefore fuel poverty is calculated at the household level only.

Firstly, information from the 2016 NIHCS, providing details about both dwellings and households was collected to be used in the energy model. This includes: the floor area of the dwelling, building fabric and insulation levels and information on the heating systems (including the fuel type).

Secondly, the energy requirement for each dwelling was calculated using the BRE Domestic Energy Model (BREDEM), which is a methodology for calculating the energy use and fuel requirements of dwellings based on their characteristics. Total energy requirements include space and water heating to meet defined standards, energy for lights and appliances (including pumps, fans and electric showers, and energy generated by renewables), and energy for cooking.

[6] Please see Appendix E of the main 2016 HCS report: https://www.nihe.gov.uk/Documents/Research/HCS-2016-Main-Reports/HCS-Main-Report-2016.aspx

[7] See Chapter 7: Northern Ireland House Condition Survey 2016 main report

[8] There were 106 dwellings in the sample for which an interview survey was not obtained. For these dwellings, household occupancy was calculated using the BREDEM 2012 methodology, and a standard heating regime of 9 hours a day for a weekday, and 16 hours a day at the weekend was assumed. For more information see the BREDEM 2012 technical specification.

The BREDEM model makes several fuel poverty specific assumptions. These assumptions and the wider fuel poverty methodology were largely established following the publication of the UK Fuel Poverty Strategy in 2001, which first formally defined fuel poverty. The broader methodology is widely accepted as the standard for the calculation of fuel poverty across the UK (with some variations by nation). The key assumptions relating to heating and occupancy for Northern Ireland (which are aligned with those for England) are:

- The living room demand temperature is 21°C, with all other rooms being 18°C
- For households that reported to be at home during the day on weekdays, the heating is assumed to be on for 16 hours every day of the week
- If households reported they were not at home during the day on weekdays, the heating is assumed to be on for 9 hours on weekdays[9]
- For very large properties with few occupants, it is assumed only half of the floor area of the home is heated.

Additional assumptions about the relative use of primary and secondary space heating are based on the available appliances in each dwelling and will not necessarily reflect the actual use of heating appliances by occupants. Non-heating energy use for lighting, appliances and cooking are also calculated using the BREDEM model, producing estimates for consumption based on household characteristics and consumption.

Finally, the data has been aggregated to provide the total energy consumption for all dwellings in Northern Ireland in 2016, when split by the fuel type and end use. In the calculations, energy use was categorised into the following fuel types:

- **Solid Fuel** – coal, smokeless fuel, anthracite, wood, biofuels
- **Gas** – mains gas, communal, CHP
- **Electricity** – standard, on/off peak tariffs
- **Oil** – LPG, bottled gas, heating oil

For further details on the methodology used to calculate the energy consumption figures for Northern Ireland in 2016, please see the user guide in Appendix A of the Northern Ireland House Condition Survey 2016 main report, and the BREDEM 2012 technical specification.

[9] This is also the case where this information has not been provided for the dwelling.

Results

Energy use for dwellings in Northern Ireland, disaggregated for each of the main fuels and for each of the energy end uses, was assessed using the data gathered from the NIHCS 2016 data. The figures for energy consumption were obtained by BREDEM calculations which used the survey data for each dwelling, weighted to represent the whole Northern Ireland housing stock (780,000 dwellings). Table 1 shows the resulting overall dwelling energy use in gigawatt hours per year (GWh/year). Further details on the sample and confidence intervals for these estimates are provided in Appendix A. Note that comparable figures for England are not available.

Table 1: Total modelled annual consumption in 2016 by end use and fuel type, GWh/year

	Solid fuels	Gas	Electricity	Oil	**Total**
Primary space	343 (3%)	1,983 (19%)	193 (2%)	8,192 (76%)	**10,712 (100%)**
Secondary space	1,525 (81%)	71 (4%)	229 (12%)	62 (3%)	**1,887 (100%)**
Water	83 (2%)	659 (19%)	55 (2%)	2,742 (77%)	**3,539 (100%)**
Cooking	0	66 (19%)	281 (81%)	0	**347 (100%)**
Lights & appliances	0	0	2,769 (100%)	0	**2,769 (100%)**
Total	**1,951 (10%)**	**2,779 (14%)**	**3,527 (18%)**	**10,997 (57%)**	**19,254 (100%)**

Base: all dwellings, Northern Ireland 2016

A large proportion of dwellings in Northern Ireland in 2016 use oil heating systems, therefore the total energy consumption figures for primary space heating and water heating were greatest for dwellings using oil as a heating fuel, with total consumption figures of 8,200 GWh/year and 2,700 GWh/year, respectively. In comparison, gas consumption for primary space and water heating combined totalled 2,600 GWh/year for all dwellings. Total secondary space heating consumption was dominated by dwellings with solid fuel heaters, at 1,500 GWh/year.

Dwelling electricity consumption for lights and appliances was modelled at 2,800 GWh/year. For cooking, total energy consumption was 350 GWh/year with 81% of energy consumption provided by electricity, and 19% from gas, due to oil remaining as the predominant fuel source in Northern Ireland.

Total modelled annual energy consumption in Northern Ireland was estimated to be 19,300 GWh/year for all dwellings (780,000 dwellings), and 18,100 GWh/year for all households (742,500 households).

Appendix A: Confidence intervals

Standard errors measure the uncertainty around the survey estimates. Confidence intervals are calculated from standard errors and provide a method of assessing the magnitude of sampling errors by indicating the range of random variation in survey estimates. Note: The confidence intervals do not account for all potential sources of error e.g., the NIHCS 2016 survey design, measurement error and surveyor variability[10]. The BRE/NIHE team, monitoring by NIHCS supervisors, tablet and website validation, and validation by NIHE and BRE all help to minimise surveyor variability and reduce the possibility of measurement error. Tables A.1 to A.5 give confidence intervals for total modelled annual energy consumption for primary and secondary space heating systems, hot water, cooking, lights and appliances in the Northern Ireland housing stock in 2016.

Table A1: Total modelled annual consumption for primary space heating in 2016 by fuel type

	Unweighted base	Sum (GWh/year)	95% confidence interval	
			lower	upper
Solid fuels	34	343	236	449
Gas	524	1,983	1,879	2,088
Electricity	54	193	146	241
Oil	1,411	8,192	7,933	8,451
Total	**2,023**	**10,712**	**10,395**	**11,028**

Base: all dwellings, Northern Ireland 2016

10 Northern Ireland House Condition Survey 2016 main report: See Appendix A

Table A2: Total modelled annual consumption for secondary space heating in 2016 by fuel type

	Unweighted base	Sum (GWh/year)	95% confidence interval	
			lower	upper
Solid fuels	987	1,525	1,456	1,594
Gas	59	71	57	84
Electricity	678	229	221	237
Oil	62	62	56	69
Total	**1,786**	**1,887**	**1,801**	**1,973**

Base: all dwellings with secondary space heating, Northern Ireland 2016

Table A3: Total modelled annual consumption for water heating in 2016 by fuel type

	Unweighted base	Sum (GWh/year)	95% confidence interval	
			lower	upper
Solid fuels	36	83	67	99
Gas	522	659	630	688
Electricity	76	55	48	61
Oil	1,410	2,742	2,669	2,815
Total	**2,023**	**3,539**	**3,453**	**3,624**

Base: all dwellings, Northern Ireland 2016

Table A4: Total modelled annual consumption for cooking in 2016 by fuel type

	Unweighted base	Sum (GWh/year)	95% confidence interval	
			lower	upper
Gas	518	66	65	68
Electricity	2,023	281	276	285
Total	**2,023**	**347**	**343**	**351**

Base: all dwellings, Northern Ireland 2016

Table A5: Total modelled annual consumption for lights and appliances in 2016 by fuel type

	Unweighted base	Sum (GWh/year)	95% confidence interval	
			lower	upper
Electricity	2,023	2,769	2,714	2,824
Total	**2,023**	**2,769**	**2,714**	**2,824**

Base: all dwellings, Northern Ireland 2016

Appendix B: User Guide

Method

The BRE 'Modelled energy consumption in Northern Ireland's housing stock in 2016' comprises of:

- Collecting physical and interview data through the 2016 NIHCS. This includes: the floor area of the dwelling, building fabric and insulation levels, information on the heating systems (including the fuel type), the number of people in the household and habits of these individuals.
- Calculating the energy requirements for each dwelling based on its characteristics, using the BRE Domestic Energy Model (BREDEM).
- Extracting the data on total energy consumption for all dwellings in Northern Ireland in 2016, when split by fuel type and end use.

The BRE Domestic Energy Model (BREDEM) is used to estimate the energy consumption of a dwelling for the following end-uses: space heating, water heating, lights and appliances, and cooking. The total dwelling consumption is modelled to meet defined standards, and the calculation method is consistent with other standard energy models such as the Standard Assessment Procedure (SAP). Where no household information is available for the dwelling (either due to vacancy, or non-response to the household questionnaire), then standard assumptions for occupancy are used[11]. The process for calculating the dwelling energy requirements using BREDEM is as follows[12]:

1. Calculating dimensions

   Data from the NIHCS is used to calculate the dimensions of the dwelling, and the heated volume and heat loss areas. The key variables from the survey are the width and depth of the main and additional parts of the dwelling, which is used to determine the floor area. Additional derived variables that are calculated include: storey heights; wall areas; window and door areas; and the roof area.

2. Calculating fabric heat losses

   Fabric heat loss is calculated for the dwelling using information on the external building elements (wall, floor, roof, windows, and doors). The U-value (the effectiveness of a material as a conductor of heat) is assigned using RdSAP default values, based on age and fabric. In addition, the effect of non-repeating thermal bridges is calculated.

[11] There were 106 dwellings in the sample for which an interview survey was not obtained. For these dwellings, household occupancy was calculated using the BREDEM 2012 methodology, and a standard heating regime of 9 hours a day for a weekday, and 16 hours a day at the weekend was assumed. For more information see the BREDEM 2012 technical specification.

[12] Further detailed information on the calculation of dwelling energy requirements can be found in the latest England fuel poverty methodology handbook (see Chapter 5).

3. Identification of space and water heating systems

The type and characteristics of space and water heating systems are collected from the NIHCS form. This includes information on the: mains gas and electricity; primary space heating system; boiler names and models; heat distribution system; heating controls; secondary space heating system; water heating system; and hot water tank presence and insulation.

Within BREDEM, primary and secondary heating systems are defined. The primary heating group (e.g., central heating, storage radiators), fuel and type (e.g., boiler type), is used to allocate the primary heating system, which by definition must provide heat to more than one room. If a boiler is present, the Product Characteristics Database (PCDB) is used to match with efficiency details of the boiler recorded. Following this, the secondary heating system is allocated, using information on other heating systems in the dwelling, if they are present.

Using information on the presence of water heating systems, cylinder dimensions and insulation, a water heating system is assigned, and the water heating energy consumption is calculated.

4. Space heating assumptions and definition of heating regime

The space heating energy consumption is modelled using information on space heating systems, dwelling construction and materials, insulation, and external climate conditions. For modelling of fuel poverty using BREDEM, the demand temperature is assumed to be 21°C within the primary zone (living room) while the secondary zone (remaining areas) is assumed to be heated to 18°C. The heating season is defined as October to May in line with the SAP methodology.

Further assumptions are made on the extent of heating and heating duration based on under-occupancy of the dwelling, and whether occupants are in during the day, respectively. A standard heating regime is assumed when occupants are not at home during normal working hours; heating for 9 hours on a weekday (separated into two heating periods) and heating for 16 hours at the weekend. If occupants are at home during the day, a full heating region is assumed; heating for 16 hours every day. A dwelling is considered to be under-occupied if there are both surplus bedrooms and surplus floor area (modelled based on the occupants and Parker Morris Standard), resulting in the assumption that half of the dwelling is heated.

5. Water heating

The water heating energy consumption is modelled using information on the water heating system, and energy losses relating to the storage of water and distribution losses. The water heating demand is a function of the number of showers and baths taken per day, as well as the type of shower.

6. Lights, appliances and cooking energy requirements

Energy demand for electricity includes lights, appliances, pumps, fans and electric showers, as well as electricity generated by renewable electricity sources (PV and wind turbines where applicable). Low energy lighting is accounted for within the calculation.

Energy demand for cooking is calculated as a function of household size, and assumptions are used on cooker type based on whether a gas connection is present.

The total energy consumption for each of the end uses (primary space heating, secondary space heating, water heating, lights and appliances, and cooking) is then calculated for each fuel type (solid fuel, gas, electricity, and oil).

To aid understanding, further information about the methodology along with the various outputs is contained in the body of the report. For more information on the NIHCS sample see Appendix A of the main 2016 NIHCS report.

Northern Ireland House Condition Survey 2016 main report

Quality information

The quality assurance of the modelling work used to produce this report focused on ensuring that the data translation and modelling processes were performed correctly, to provide accurate and reliable results. The process of development and the creation of results followed an internal procedure so the work undertaken could be reviewed and assessed by project managers.

Examples of the quality assurance undertaken to validate the model and results included:

- Updating and revising the methodology using the latest assumptions for this area of work
- Checking of transformations undertaken and mathematical formulae
- Internal checks of data inputs to assure translation was completed correctly
- Checks of correct units for calculations
- Check correct and latest external data sources were used
- Sense check of results
- Internal review of results and reporting.

Surveyors working on the 2016 NIHCS received training and support to help ensure their collection of energy related data were consistent and robust. A re-fresher training session in 2016 explained the principles, how the form should be completed as well as conducting practical exercises with feedback sessions. While these measures ensure a good level of consistency in judgements, some surveyor variability is to be expected.

Strengths and weaknesses

Strengths

The basis of this report is the 2016 NIHCS dataset. All results should be taken in the context of this background, and the survey and modelling assumptions which occur within these. Specific strengths relating to the base data were:

- The publication of the NIHCS 2016 data as national statistics
- The robustness of the NIHCS survey approach and sample size. The size of the sample for the NI House Condition Survey 2016 was 3,000 addresses.
- The high response rate for the household questionnaire, at 99% of non-vacant dwellings
- The weighting and grossing process translated the information gathered into figures that reflected the real world.[13] This provided robust data at the Northern Ireland housing stock level.
- The substantial and detailed NIHCS base data, used in the modelling of energy consumption estimates and the calculation of fuel poverty.
- The defined methodology for modelling energy consumption in dwellings, using the BRE Domestic Energy Model (BREDEM)[14].

See Appendix A page 88 of the main 2016 House Condition Survey report for more information on for the survey's user guide.

Northern Ireland House Condition Survey 2016 main report

Confidence intervals have been included in the report to provide an indication of the accuracy of the calculated estimates of modelled energy consumption of all dwellings. In addition, a comprehensive quality assurance process was undertaken as part of the modelling (see 'Quality information' above).

Weaknesses

The BRE Domestic Energy Model (BREDEM) was used to identify how much energy is required to heat a dwelling to a reasonable standard. As such, it is a notional requirement rather than actual consumption.[15] The concept of fuel poverty attempts to identify households that are unable to afford the cost of the energy needed to heat their homes to a satisfactory level, therefore it is most suitable to use a notional requirement

[13] Further information on the sampling, and weighting and grossing processes for the Northern Ireland House Condition Survey 2016 is available in the NIHCS 2016 main report.

[14] BREDEM 2012 – A technical description of the BRE Domestic Energy Model, J Henderson & J Hart, version 1.1, BRE, 2015

[15] The BREDEM model is designed to estimate energy consumption for the calculation of fuel poverty estimates, and it is assumed that the living room demand temperature is 21°C and other rooms 18°C. Where households are home during the day, homes are assumed to be heated for 16 hours, while other households are assumed to be heated for nine hours.

of energy use in these calculations. However, these notional standards cannot reflect actual energy use or specific requirements of individual households which fall outside the assumptions made.

The total modelled energy consumption for dwellings in Northern Ireland in 2016 included vacant dwellings and households who did not respond to the interview survey. There were an estimated 28,500 vacant dwellings in the housing stock in 2016, with a high proportion in disrepair and with a low mean SAP rating[16]. While the method for reporting on energy consumption in dwellings provides a consistent sample base with the energy efficiency statistics, the total consumption figures will be impacted by the vacant dwellings and does not reflect the energy consumption of all households in Northern Ireland in 2016 (as used to calculate the 2016 fuel poverty statistics and projections from 2017).

Information from the NIHCS survey is used to inform the model. Where information is missing, assumptions are used within the BREDEM model which can have a minor impact on outputs e.g., boiler efficiency, or occupancy.

[16] See Chapter 5 and 7: Northern Ireland House Condition Survey 2016 main report

Report Ends