

"Beyond average consumption"

Development of a framework for assessing impact of policy proposals on different consumer groups

Updated report to Ofgem

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1 Background

Ofgem has committed to incorporating analysis of distributional impacts into its policy development and impact assessment process. Previous work by CSE has provided Ofgem with a dataset on electricity and gas consumption for different consumer segments, which can form the basis of this analysis. To enable this, the dataset needs to be updated to incorporate more recent ONS data releases. Ofgem also require some expert support to develop its thinking and practices around how best to undertake and interpret distributional analysis within its policy development and impact assessment process.

2 Updating the consumer archetypes dataset

The original Ofgem consumer archetypes dataset, developed by CSE in 2012, was based on a dataset of Living Costs and Food Survey (LCF) data from 2004-2009. Since then two more Living Costs and Food (LCF) Survey datasets (2010, 2011) have been released by the Office for National Statistics, together with a more recent English Housing Survey (2010-11).

By incorporating data from these surveys into CSE's underlying household energy consumption dataset (to displace the oldest data), the Ofgem consumer archetypes dataset can be remodelled and updated to reflect the latest information on patterns of energy consumption across households in Great Britain. The consumer archetypes modelling is undertaken using the methodology previously outlined to Ofgem¹.

This update will ensure that any impact analysis undertaken by Ofgem using the consumer archetypes dataset is based on latest available data.

3 Results

The updated dataset uses Living Costs and Food survey data from 2006 to 2011 inclusive. Data is combined into a signal dataset, giving a sample size of over 32,700 cases. The dataset is re-weighted to be representative of a single year, representing 25.1 million in Great Britain.

The results and descriptions presented in this report are designed to be read in conjunction with the detailed spreadsheet of results provided as part of this update. All output tables have been provided in spreadsheet format to facilitate Ofgem's own analysis and scrutiny of policy impacts. The tabs in the spreadsheet are referenced in the relevant sections of results tables shown here. Some high level / example results and summaries of the Archetypes are presented in this document.

3.1 Average annual fuel consumption

The first tab in the accompanying spreadsheet ("DIMPSA kWh Values") shows the mean and median annual energy consumption for all households in Great Britain and broken down by heating fuel².

¹ <u>https://www.ofgem.gov.uk/publications-and-updates/beyond-average-consumption-development-</u> <u>framework-assessing-impacts-policy-proposals-different-consumer-groups-report-ofgem-centre-sustainable-</u> <u>energy.</u>

² All figures shown are derived from CSE's 2006-2011 "Distributional Impacts Model for Policy Scenario Analysis" (DIMPSA) dataset. <u>http://www.cse.org.uk/resources/open-data/domestic-energy-consumption-data</u>

The latter is an important distinction in reviewing electricity consumption values, which are significantly higher in the electrically-heated subset of the population, as shown below.

Population	Fuel	Count of HHs	Mean	Median	
All GB Households	Electricity	25,118,129	4,217	3,792	
Gas Heated HHs only	Electricity	20,879,515	3,738	3,563	
	Gas	20,879,515	15,911	15,654	
	Total Gas + Electricity	20,879,515	19,649	19,320	
Electrically Heated HHs	Power	2,603,573	1,472	1,307	
only	Heat	2,603,573	6,508	4,978	
	Total Electricity	2,603,573	7,981	6,229	
Non-Metered Fuel Heated	Electricity	1,635,042	4,334	4,291	
HHs only	Heat (non-metered fuels)	1,635,042	21,763	20,988	
	Total	1,635,042	26,096	24,481	

Table 3.1. Average annual	l energy consumption in	GB households,	overall and by	heating fuel

Figure 3.1. Average annual electricity consumption in GB households, overall and by heating fuel



3.2 Consumption by socio-demographic

This tab in the spreadsheet ("Mean & Med by SocioDems") provides a vast amount of data on the mean and median consumption of electricity and gas by different socio-demographic variables³. Figures are shown according to the population breakdown described in Table 3.1 above (i.e. all GB households; gas heated households only; electrically-heated households only; and households heated by non-metered fuels). For information the mean and median disposable and equivalised disposable income is also shown.

The table and graphs shown below are derived from this spreadsheet to illustrate some of the information contained therein.

³ Disaggregating the dataset in this way results in small sizes for some variable categories. Any sample of less than 200 cases (unweighted count) should not be used. These are highlighted in red in the spreadsheet.

Disposable	ALL HOUSEHOLDS (GB)						
income			Elec. kWh	Average HH D	isposable Income		
quintile	Count (000s)	Mean	Median	Mean	Median		
1	5,024	3,239	2,738	£7,615	£7,834		
2	5,024	3,740	3,222	£15,058	£14,942		
3	5,024	4,145	3,725	£23,445	£23,368		
4	5,024	4,610	4,285	£34,395	£34,075		
5	5,023	5,351	5,031	£65,746	£55,012		

Table 3.2. Average annual electricity consumption and disposable income by income quintile in all GB households

Table 3.3. Average annual electricity and gas consumption by income quintile in gas-heated households

Disposable	GAS-HEATED HOUSEHOLDS ONY					
income		1	Elec. kWh	Ga	s kWh	
quintile	Count (000s)	Mean	Median	Mean	Median	
1	3,884	2,574	2,434	11,879	11,796	
2	4,018	3,155	3,124	14,076	13,943	
3	4,259	3,686	3,566	15,626	15,654	
4	4,334	4,188	4,225	17,091	17,249	
5	4,383	4,911	4,844	20,275	20,750	

Table 3.4. Average annual electricity consumption by income quintile in electrically-heated households

Disposable	ELEC-HEATED HOUSEHOLDS ONLY				
income		Elec. kWh			
quintile	Count (000s)	Mean	Median		
1	905	6,145	5,481		
2	690	7,187	6,072		
3	453	8,505	6,910		
4	331	10,070	8,812		
5	224	13,698	9,980		

Table 3.5. Average annual electricity consumption by income quintile in non-metered	fuel-heated
households	

Disposable		NON-METERED FUELS-HEATED HO	OUSEHOLDS ONLY
income		Elec. kWh	
quintile	Count	Mean	Median
1	234	3,016	2,738
2	316	3,652	3,300
3	312	4,073	4,166
4	359	4,678	4,689
5	416	5,490	5,213



Figure 3.2. Average annual electricity and gas consumption by income decile and heating fuel





3.3 Characterising consumer groups: CHAID analysis

The results and analysis of energy consumption by different socio-demographic variables (as presented in brief in section 3.2 and in detail in the accompanying spreadsheet), provide some indication of the distribution of energy consumption by different household types. The process of Chi-squared Automatic Interaction Detector (CHAID) can be used to further explore and identify defining characteristics associated with different energy consumption levels. This approach was used in developing the archetypes.

Two different CHAID models have been applied to two different subsets of the dataset to model: gas consumption in gas-heated households; and electricity consumption in non-gas heated households. In addition to creating the Archetypes, two further CHAID models were run to develop a more detailed set of groups which may be useful for Ofgem in its own analysis. These detailed CHAID models were run using the new, updated dataset.

3.3.1 Electricity consumption in non-gas heated households

This CHAID model was run on the subset of the dataset containing all non-gas heated properties (i.e. electrically heated and non-metered fuels (which include LPG)). Predictor variables used in the model (i.e. variables which the model identified as having a statistically significant difference with respect to the dependent variable – in this case annual electricity consumption) are shown below.

Box 1. Variables selected as predictors in the CHAID model of electricity consumption in non-gas heated households

٠	Household composition	•	Category of Dwelling
٠	Tenure	•	Income quintiles*
٠	Age of HRP ⁴		

* Newly selected in updated dataset. Previous model used heating fuel.

Within the parameters of the model criteria (e.g. adhering to the minimum group size rule), the CHAID model resulted in 14 distinct groups, with between around 200,000 and 450,000 households in each, as shown below. Cross-tabulating the nodes created in the CHAID analysis with sociodemographic variables in the LCF dataset helps to identify the key defining characteristics of each group. Full details of the nodes are shown in the accompanying spreadsheet (tab: 'Elec BIG CHAID'), which includes a count of households in each group, the estimated annual electricity consumption of the group, and counts and percentages of households in each node by different socio-demographic variables (income, tenure etc). For reference, and to facilitate identification of the key defining characteristics (i.e. how does each node differ from the model population as a whole) the same information is shown for: all non-gas heated households; all electricity-only households; all non-metered fuel households only; and all GB households.

Table 3.6. Nodes resulting from the CHAID model of electricity consumption in non-gas heated households

Node ID	Predicted value (Mean annual elec. kWh)	Count	Table N %
6	3,150	363,925	9%
25	3,437	390,118	9%

⁴ HRP stands for Household Reference Person and is defined as the householder with the highest income (or the oldest of two or more householders with the same income).

3,878	214,542	5%
4,274	359,436	8%
4,916	217,879	5%
5,063	256,517	6%
5,286	268,438	6%
5,339	287,464	7%
5,386	430,909	10%
6,353	244,579	6%
6,717	386,758	9%
6,811	230,040	5%
7,391	281,210	7%
10,017	306,800	7%
	3,878 4,274 4,916 5,063 5,286 5,339 5,386 6,353 6,717 6,811 7,391 10,017	3,878214,5424,274359,4364,916217,8795,063256,5175,286268,4385,339287,4645,386430,9096,353244,5796,717386,7586,811230,0407,391281,21010,017306,800

3.3.2 Gas consumption in gas-heated heated households

This CHAID model was run on the subset of the dataset containing all mains gas heated properties. The dependent variable in the model was annual gas consumption, such that the resulting nodes (or groups of households) would be defined according to the relationship between socio-demographic descriptors and annual household gas consumption. An estimate of annual electricity consumption is then assigned to each group using the raw data.

Predictor variables used in the model (i.e. variables which the model identified as having a statistically significant difference with respect to the dependent variable – in this case annual gas consumption) are shown below.

Box 2. Variables selected as predictors in the CHAID model of gas consumption in mains gas heated households

•

•

Tenure
Catagony of dwalling

•

- Category of dwelling
- Household composition
- Government Office Region
- Income quintiles Age of HRP
- Economic position of HRP
- Age of fill

This resulted in 33 distinct groups, with between around 400,000 and 1.1m households in each, as shown in Table 3.7 below. As with the CHAID on non-gas households, the nodes created for gas heated properties have been cross-tabulated with socio-demographic variables and the resulting tables included in the accompanying spreadsheet (tab: Gas BIG CHAID) to provide full details of the characteristics of each group. The spreadsheet includes a count of households in each group, the estimated annual gas consumption (assigned by CHAID) and electricity consumption (derived from the survey data), and counts and percentages of households in each node by different socio-demographic variables (income, tenure etc). For reference, and to facilitate identification of the key defining characteristics (i.e. how does each node differ from the model population as a whole) the same information is shown for all GB gas-heated households.

Table 3.7. Nodes resulting from the CHAID model of gas consumption in mains gas heated households

Node ID	Predicted value (Mean annual gas. kWh)	Count	Table N %	Estimated elec. kWh
10	7,203	603,890	2.9%	1,862

32	8,702	462,497	2.2%	2,103
9	9,720	428,694	2.1%	2,288
41	10,097	436,842	2.1%	2,452
31	10,480	467,016	2.2%	2,469
22	10,738	517,183	2.5%	2,441
42	11,643	436,930	2.1%	2,414
44	11,791	707,942	3.4%	2,897
15	11,972	553,172	2.6%	3,111
51	12,315	766,739	3.7%	2,827
62	13,074	470,362	2.3%	2,743
36	13,198	738,507	3.5%	3,264
27	13,233	463,224	2.2%	3,857
43	13,352	563,713	2.7%	3,034
61	13,966	469,666	2.2%	2,689
63	14,532	537,306	2.6%	3,386
38	14,664	620,793	3.0%	2,844
28	15,408	774,378	3.7%	3,951
64	15,427	484,148	2.3%	3,763
56	15,777	684,521	3.3%	3,958
58	16,369	1,056,870	5.1%	3,573
60	16,653	773,938	3.7%	3,920
55	17,502	788,168	3.8%	4,513
23	17,797	952,556	4.6%	3,563
59	18,493	495,255	2.4%	4,120
46	18,672	902,793	4.3%	4,780
39	19,193	709,510	3.4%	4,328
47	19,366	765,572	3.7%	5,217
53	20,016	438,352	2.1%	4,150
54	21,262	521,851	2.5%	4,838
25	21,834	686,668	3.3%	5,405
48	21,848	675,697	3.2%	5,381
26	25,274	924,760	4.4%	5,766

The Archetypes 4

bed semi's owned with mortgage

detached houses in less urban areas

detached houses in less urban areas

Archetype 11: Asset-rich, "empty-nesters" in

Archetype 12: Wealthy working families in larger

4.1 Introduction

The Archetypes identified in the original analysis for Ofgem were recreated in the new (LCF 2006-11) dataset. The sociodemographic descriptions of the Archetypes therefore remain the same (although counts/proportions may be slightly different, reflecting the newer data). New, updated energy consumption estimates have been allocated to the Archetypes using the latest data. Figures shown in grey italics are the original values to show where numbers have changed slightly.

Count of Mean Archetype N % Mean annual HHs electricity annual kWh gas kWh Archetype 1: Low-income electrically-heated 909,902 4% 6,130 HHS Archetype 2: All other electrically-heated 1,717,198 7% 8,912 Non-mains gas Archetype 3: Low-income non-metered fuel-541,473 2% 3,383 heated Archetype 4: All other non-metered fuel-heated 1,070,042 4% 4,814 Archetype 5 : Low-income, out-of-work single 937,111 4% 2,158 8,495 adults in small 1-bed social rented flats (London) Archetype 6: Young working adults in rented flats 1,142,581 5% 2,853 10,372 Mains gas heated households (London) Archetype 7: Low-income single adults (lone 1,265,857 5% 2,640 10,592 parents or elderly) in social rented houses Archetype 8: Younger working families in 2,777,321 11% 3,491 13,595 medium-sized rented houses Archetype 9: "Average mains gas-heated 8,242,283 33% 3,585 15,280 households" Archetype 10: Wealthy working families in 3-4 9% 4,588

2,331,870

2,580,421

1,602,071

25,118,129

10%

6%

100%

4,098

5,306

4,217

Table 4.1. Summary	v of the Energy	Consumer	Archetypes	with u	ndated val	ues (I Cl	F Survey	data	2006-11	۱
Tubic 4.1. Summary	y of the Energy	consumer	Archetypes		puatea vai		Juivey	uutu	2000 11	1

18,784

19,226

23,832

15,911

4.2 Non-mains gas heated household archetypes



Archetype 2: All other Electrically-heated Households Couples or younger single adults, in small, owner-occupied or private rented houses or flats, in fulltime employment Count of HHs: 1,717,000 (1,694,000) Mean annual electricity consumption: 8,910 kWh (7,700 kWh)

Mean annual household disposable income: £27,361 (£25,800)

Key characteristics:

Disposable income quintile 2 and above (mainly middle-income, quintile 2 and 3, annual disposable household income >£11,500 (>£11,000))

Mainly couples; one fifth of households have children at home.

Mixed age range, but over one quarter under 35 (29%) (27%).

Over half (51%) are in full-time employment and one quarter (26% (27%)) retired.

Mixed tenure but a high proportion owner occupied (51%) (55%) and one quarter (28%) private rented

Small (67% (64%) 2 or fewer bedrooms), purpose-built flats (42%) (38%) or terraced houses (21%) (23%)

Pay mainly by direct debit (45%) or standard credit (37%) (41% representation for each) Some propensity for switch (13%)

71% (70%) in Urban areas

Distribution across English regions, Scotland and Wales:



Archetype 3: Low-income Non-metered Fuel-heated households Older people in detached houses in rural areas who own their home outright (low income but assetrich)

Count of HHs: 541,500 (548,000)

Mean annual electricity consumption: 3,380 kWh (3,600 kWh)

Mean annual household disposable income: £11,9200 (£11,000)

Key characteristics:

Disposable income quintiles 1 & 2 (annual disposable household income $< \pm 19,000$ ($< \pm 18,100$)) Mix of single adults and couples, but mainly over 60 (67%) (65%) and retired.

Medium-size (2-3 bed), detached (45%) (40%) and semi-detached (24%) (25%) houses Over half own outright (57%) (54%)

'Sticky' customers paying by standard credit (46%) (51%)

Rural (71% (65%) in villages and hamlets)

Distribution across English regions, Scotland and Wales:



Archetype 4: All other non-metered fuel-heated households
Wealthy, market-savvy families in rural detached properties
Count of HHs: 1,070,000 (1,100,000)
Mean annual electricity consumption: 4,810 kWh (5,600 kWh)
Mean annual household disposable income: £45,000 (£43,000)
Key characteristics:
High income (income quintiles 3 & above, annual disposable household income >£19,000
(>£18,100))
Oil central heating (76%) (74%)
Couples, mainly working age, full-time or self-employed (18%) (16%)
With dependent or adult off-spring still living at home (32% (31%) with dependent children and 17%
(18%) multi-person households)
Larger (42% 4 or more bedrooms), detached (59%) (57%) houses
Owner-occupiers, 41% (40%) own outright
Higher propensity to switch (21%) (19%) and pay by direct debit 57% (49%)
Rural (82% (80%) in villages and hamlets)
Distribution across English regions Scotland and Wales:



4.3 Main gas heated household archetypes

Archetype 5 : Low-income, out-of-work single adults in small 1-bed social rented flats (London)Count of HHs: 937,000 (950,000)Mean annual gas consumption: 8,280 kWh (8,550 kWh)Mean annual electricity consumption: 2,160 kWh (2,000 kWh)Mean annual household disposable income: £6,950 (£6,500)Key characteristics:Disposable income quintile 1 (annual household income <£11,500 <£11,000)</td>Mainly single, young adults (10% 11% < 25) without children (though 13% lone parents), not working</td>(41% + 14% unemployed) (42%) though one third (32%) (34%) retired being over 65.Small (54% 55% 1 bed) flats (100%)Mainly social rented (82%) and high proportion are in London (25%) (28%)Higher proportion have prepayment meters (46% 45% for electricity and 41% 39% for gas)'Sticky' customers

Distribution across English regions, Scotland and Wales:



Archetype 6: Young working adults in rented flats (London)

Count of HHs: 1,143,000 (1,100,000)

Mean annual gas consumption: 10,400 kWH (11,300 kWh)

Mean annual electricity consumption: 2,850 kWh (2,700 kWh)

Mean annual household disposable income: £25,900 (£24,300)

Key characteristics:

Middle income (69% 62% quintiles 2 and 3)

Mainly young (43% 41% under 35) couples without children (39%) or single adults without children (29%) (28%), working fulltime (55%) (54%)

In rented (51% 55% social, 47% 43% private) flats (23% converted houses, 77% purpose-built) A high proportion is in London (37%) (38%)

'Sticky' customers

Higher proportion have prepayment meters (28% *31%* for electricity and 23% *24%* for gas) Distribution across English regions, Scotland and Wales:



Archetype 7: Low-income single adults (lone parents or elderly) in social rented houses

Count of HHs: 1,266,000 (1,220,00)

Mean annual gas consumption: 10,600 (11,500 kWh)

Mean annual electricity consumption: 2,600 (2,500 kWh)

Mean annual household disposable income: £7,700 (£7,200)

Key characteristics:

Disposable income quintile 1 (annual household income <£11,500 <£11,000)

Mainly single adults (76% 77%; 65% are women), some with children (hence 24% 25% lone parents) but 39% (one third) over 60

Either not working (39%) (42%) or retired (35%) (36%)

Small-medium sized (83% 82% 2-3 bed) terraced houses (57%)

All renting, mainly social rented (70%) (73%)

Higher proportion have prepayment meters (45% for electricity and 43% for gas) 'Sticky' customers



Distribution across English regions, Scotland and Wales:

Archetype 8: Younger working families in medium-sized rented houses

Count of HHs: 2,780,000 (2,530,000)

Mean annual gas consumption: 14,000 kWh (14,500 kWh)

Mean annual electricity consumption: 3,500 kWh

Mean annual household disposable income: £28,000 (£27,000)

Key characteristics:

Middle-income (69% 68% income quintiles 2 and 3)

Younger couples (33% 32% under 35) with children (though some lone parents) working full (45%) or part-time (15%)

In 3 bed (53%), rented (51% 54% social, 45% 42% private), terraced houses (54%)

Higher than average use of prepayment meters (35% 34% for electricity and 31% 29% for gas)



Archetype 9: "Average mains gas-heated households"

Count of HHs: 8,242,000 (8,230,000)

Mean annual gas consumption: 15,570 kWh (16,400 kWh)

Mean annual electricity consumption: 3,600 kWh

Mean annual household disposable income: £22,500 (£21,500)

Key characteristics:

Mix of incomes though none in the top quintile (annual disposable household income <£42,000 < \pm 40,000)

Mix of household types (couples and single adults, mainly without children), either working age and in fulltime employment (45%) (47%) or retired (30%) (29%)

Owner-occupiers (54% 55% with mortgage, 46% 45% owned outright)

In 3-bed (58%) (59%) semi-detached (50%) houses

Pay by direct debit (61%) (55%) or standard credit (31%) (36%); some propensity to switch Distribution across English regions, Scotland and Wales:



Archetype 10: Wealthy working families in 3-4 bed semi's owned with mortgage
Count of HHs: 2,332,000 (2,340,000)
Mean annual gas consumption: 19,100 kWh (20,200 kWh)
Mean annual electricity consumption: 4,600 kWh (4,800 kWh)
Mean annual household disposable income: £62,200 (£59,000)
Key characteristics:
High income (100% income quintile 10, annual disposable income >£42,000 (>£40,000))
Couples, some with dependent children (41%) (40%) or adult offspring (hence 30% 32% multi-adult ⁵
households)
Working age (60% 35-55) and working fulltime (78%)
In 3-4 bed (75%) semi-detached (55%) (54%) and terraced houses
Owned with mortgage (81%)
High proportion in London (26%) (27%)
Pay by direct debit and market savvy
Distribution across English regions, Scotland and Wales:

⁵ Multi-adult households have 3 or more adults.



Archetype 11: Asset-rich, "empty-nesters" in detached houses in less urban areas

Count of HHs: 2,580,000 (2,500,000)

Mean annual gas consumption: 19,400 kWh (20,600 kWh)

Mean annual electricity consumption: 4,100 kWh (4,200 kWh)

Mean annual household disposable income: £23,700 (£23,000)

Key characteristics:

Average income (64% 66% income quintiles 3 and 4)

Mainly retired (46%) (43%) and couples (62%) (64%), without children at home

In 3-4 bed (77%) (76%) detached (100%) houses

All are owner occupiers and the majority own outright (67%) (64%)

Pay by direct debit (71%) (64%) but less likely to switch

Urban with town and fringe areas (17%) (18%)

Distribution across English regions, Scotland and Wales:



Archetype 12: Wealthy working families in larger detached houses in less urban areas

Count of HHs: 1,602,000 (1,500,000)

Mean annual gas consumption: 23,140 kWh (25,200 kWh)

Mean annual electricity consumption: 5,300 kWh (5,600 kWh)

Mean annual household disposable income: £69,200 (£65,600)

Key characteristics:

High income (100% income quintile 10, annual disposable income >£42,000 (>£40,000)) Couples (69%) with dependent children (45%) or adult offspring (hence 28% multi-adult⁶ households)

Working age (62% 63% aged 35-55) and working fulltime (69%) (71%) or self-employed (14%) In larger (69% 70% 4 or more bedrooms), detached (100%) houses

Owned with mortgage (70%) (73%) or outright (30%) (27%)

High proportion in the south east (20%) and less urban areas (27% 25% town & fringe or villages) Pay by direct debit (75%) (68%) and market savvy (61% 56% likely to have switched more than once) Distribution across English regions, Scotland and Wales:



⁶ Multi-adult households have 3 or more adults.