



## Hub Controller: residential energy credits findings

Report prepared for SEAI by Fuinniv Independent Consulting

## Table of Contents

Table of Contents	2
1. Introduction	3
2. Data collection	4
2.1. Additional data from Hub Controls Ltd.	4
2.2. BER data from SEAI	5
3. Determine % main space heating savings	6
3.1. Average gas usage per dwelling for cooking	6
3.2. Share of gas fuelled main space heating	7
4. Applying the savings to the “Median D2 Dwelling”	9
4.1. Calculating average annual heating hours	9
4.2. Savings in the Median Dwelling	12

## 1. Introduction

This document outlines derivation of proposed energy credits for the Hub Controller, Automatic Energy Manager developed by Hub Controls Ltd. This document has been written on request by SEAI to aid understanding of and discussion around the proposed energy credits. The document gives an overview of the data already provided by SEAI and Hub Controls Ltd. and the calculations carried out on this data. **The figures outlined in this document are preliminary and are not to be taken as final figures.**

Extensive energy/system monitoring has been carried out on the Hub Controller to date, most notably detailed in the independently verified report “Evaluation of the Energy Saving Potential of an Automated Energy Management device in domestic dwellings in Ireland”. The text from the report is largely not repeated in this document other than to say that the findings therein related to energy savings achieved by the Hub Controller underpin this energy credits recommendation. Namely that the Hub Controller saves 25.1% on all gas usage on average and that savings are on main space heating. To quote from the above report:

*“The independent verifiers agreed on an average of 25.1% of total energy consumption per year in households using natural gas. Applying 25.1% to the average energy consumption of 14,671.2 kWh for 800 homes in Treatment and Control Group in the Base Year, results in 3,684.95 kWh saving (or 25.1% on all gas use) per dwelling per year.”*

*“As all other energy usage factors such as hot water, cooking etc., remain unchanged, the total energy saving is attributable to the introduction of time control, temperature control, remote access, and automatic energy reduction to the space heating system.”*

## 2. Data collection

The data outlined in this section was provided on request during summer 2021 by Hub Controls Ltd. and SEAI for the purposes of deriving the proposed energy credits.

### 2.1. Additional data from Hub Controls Ltd.

The supplier provided the following data in Excel format (data was also provided in PDFs but was not used as the Excel data is more accessible and suffices for the purpose of this study). All data is in the file “Hub Controls trial requested data.xlsx”, barring the information on item (5 – cooking) in file “Hub Controls additional data.xlsx”

item #	Item	Was this made available?	Hub controller comment
1	MPRN (electricity meter) numbers for the 400 dwellings and, where available, corresponding BER numbers. Includes info on data access consent	Yes	We don't have BER numbers
2	Gas usage data per dwelling. On a monthly basis, if possible, correlated to the above MPRN numbers. For the 12 months of the base year and 12 months of the test year.	Yes	Tab Gas consumption data from GNI
3	Heating system “run hours” (also called “heating on hours” per dwelling on a monthly basis if possible (or daily basis otherwise). Correlated to the above MPRN numbers. For the 12 months of the base year and 12 months of the test year.	Yes	Tab Heating hours TEST period and Heating hours BASE period
4	Mean internal temperatures (24*7) per dwelling on a monthly basis if possible (or daily basis otherwise). Correlated to the above MPRN numbers. For the 12 months of the base year and 12 months of the test year.	Yes, for the 12 months of the Test year. No for the 12 months of the Base year.	Tab Mean int temp TEST period
5	If possible, outline of which dwellings use gas for cooking (correlated to the above MPRN numbers).	Yes (provided subsequent to 1-4 above)	-

**Table 1: Overview of data provided by Hub Controls Ltd.**

## 2.2. BER data from SEAI

Once the dwelling MPRNs were made available by Hub Controls Ltd., a number of BER fields for 394 out of the 400 dwellings was requested from SEAI (6 of the dwellings “opted out” of data consent). SEAI sourced data for 255<sup>1</sup> of these from the BER database and anonymised the data by excluding MPRNs from the returned data. The data was provided in the file “Hub Controls trial BER data request v0.X.xlsx”, including the following data fields:

- Total Physical Area (this is the total floor area)
- Living Area Percent (percentage of the dwelling assumed at 21degC during heating hours)
- Heat System Control Cat (indicates level of controls identified on site by BER assessor)
- Main SH Fuel Description (main space heating fuel)
- Suppl SH Fuel Description (secondary space heating fuel)
- Main WH Fuel Description (main water heating fuel)
- Suppl WH Fuel Description (supplementary water heating fuel)
- Energy Value (total primary energy kWh/m<sup>2</sup>/yr)
- SHMainPrimaryEnergy (main space heating primary energy kWh/yr)
- SHSecPrimaryEnergy (secondary space heating primary energy kWh/yr)
- WHMainPrimaryEnergy (main water heating primary energy kWh/yr)
- WHSecPrimaryEnergy (secondary water heating primary energy kWh/yr)

Further definition of these fields is available in the DEAP Manual.

---

<sup>1</sup> For the purposes of this exercise, 255 dwellings are enough to estimate share of gas for space heating relative to other gas uses. Data does not appear to have been available for the remaining 139 dwellings.

### 3. Determine % main space heating savings

For the purposes of this analysis, the Hub Controller is only assumed to generate savings to main space heating in dwellings using Natural (mains) Gas. While it is accepted that the Hub Controller is responsible for 25.1% savings in total natural gas usage in the dwelling, it is necessary to determine what this translates to in terms of percentage main space heating saving for gas heated dwellings (it will clearly be a figure greater than 25.1% once there are other gas uses in the dwellings for secondary heating, water heating etc.). To do this, the proportion of gas usage for main space heating relative to total gas usage is determined based on the BER data for the 255 dwellings outlined above. Calculations are in "Share of space heating saved V0.X.xlsx"

The BER data is used to determine the average space heating final energy demand (gas delivered for space heating) and the average gas delivered for any other end uses per dwelling (i.e., main water heating, secondary space heating). These will be determined from the BER data.

As the BER data does not give an indication of gas usage for cooking, this analysis estimates the gas used for cooking per dwelling.

#### 3.1. Average gas usage per dwelling for cooking

Hub Controls Ltd. carried out a survey of the test dwellings to understand fuels used for cooking. Out of 357 responses to their survey, 168 use gas for cooking. The table below uses SEAI's residential Sector report to determine energy used per annum in cooking (gas and electricity). It then uses CSO data to determine the share of dwellings using gas for all cooking, and those using a combination of gas and electricity for cooking. Finally, the overall average of gas used per dwelling for cooking in the Hub Controls Ltd. sample is determined.

<b>Cooking: Calculate avg gas used for cooking per dwelling</b>			
<b>Parameter</b>	<b>Value</b>	<b>Units</b>	<b>Comment</b>
Total # Responded to call	357	#	From Hub Controls customer survey
Total # Gas cooking	168	#	
Likelihood of gas cooking	47.06%	%	# With gas cooking / # total responses
National avg deliv energy per dwelling	18,524	kWh	SEAI residential report 2018 <a href="https://www.seai.ie/publications/Energy-in-the-Residential-Sector-2018-Final.pdf">https://www.seai.ie/publications/Energy-in-the-Residential-Sector-2018-Final.pdf</a> (Table 6 and table 19)
Proportion used in cooking (gas and elec)	2.26%	%	
National avg cooking energy per dwelling (gas and elec)	418	kWh	% Used in cooking * national avg energy per house
Proportion all dwellings with nat gas as main cooking fuel	13%	%	CSO table 15 <a href="https://www.cso.ie/en/releasesandpublications/er/q-env/qnhsenvironmentmoduleq22014/">https://www.cso.ie/en/releasesandpublications/er/q-env/qnhsenvironmentmoduleq22014/</a>
Proportion dwellings with gas and elec cooking (gas hob, elec grill+oven)	12%	%	
Proportion gas in a combined cooker (gas hob, elec oven/grill)	60%	%	According to <a href="https://iea-etsap.org/E-TechDS/PDF/R06_Cooking_FINAL_GSOK.pdf">https://iea-etsap.org/E-TechDS/PDF/R06_Cooking_FINAL_GSOK.pdf</a> (page 3), the ratio of gas hob : electric oven (plus grill) is 333: (164+50) ≈ 1.5:1. So approximately 60% of cooking is from gas in a combined cooker
Weighted average gas used in dwelling with gas cooking	338	kWh	Dwelling with gas cooking uses either all gas or 60/40 gas/elec for cooking
Overall avg kWh gas used for cooking per dwelling in Hub Ctrl's sample	159	kWh	Weighted average gas in dwelling with gas cooking * % from survey

**Table 2: Average gas usage per dwelling for cooking in hub controls sample**

### 3.2. Share of gas fuelled main space heating

As outlined above, the BER data from SEAI shows the “primary energy” usage for each of main and secondary space and water heating and the fuel for each of these. These are termed the “end uses”. The savings generated by the Hub Controller and indeed energy credits, are based on delivered (or final) energy.

The primary energy factor is determined per end use per dwelling. Primary energy divided by primary energy factor gives the delivered or final energy per end use. The primary energy factors are sourced from DEAP Table

8:

Fuel	Total primary energy factor
Mains Gas	1.1
Heating Oil	1.1
Electricity	Depends on assessment date
House Coal	1.1
Solid Multi-Fuel	1.1
Manuf.Smokeless Fuel	1.2
None	0
Wood Logs	1.1
Peat Briquettes	1.1

**Table 3: Primary energy factors for all fuels used in the 255 dwellings from DEAP Table 8**

The BER data is filtered per end use to calculate only the mains gas used (based on BER data). From this, the total gas usage (for all heating and cooking) and gas for main space heating alone are determined, and the share of total gas used for main space heating alone is determined (at 68.53%). As the percentage total gas saved by the Hub Controller is 25.1%, and all savings are assumed to be in main space heating, then the percentage main space heating savings by the Hub Controller =  $25.1/68.53 = 36.63\%$ .<sup>2</sup>

---

<sup>2</sup> Note that on review of preliminary findings with SEAI and Hub Controls Ltd., the question was raised WRT the share of heat demand met by secondary heating and the possibility that secondary heating meets less heat demand than the 10% assumed in DEAP. Data has not been provided to counteract the share of secondary vs main space heating assumed in DEAP and data is not available to demonstrate that the Hub Controller reduces energy used in secondary space heating. Therefore, the approach of determining the share of main space heating savings and following DEAP assumption on secondary heating meeting 10% of space heat demand is followed.

<b>Calculate % savings in space heating</b>			
<b>Parameter</b>	<b>Value</b>	<b>Units</b>	<b>Comment</b>
Total delivered gas for all dwellings in BER sample for space/water heating	4,662,219	kWh	From SEAI BER data for dwellings listed by hub controls
Total # dwellings in BER sample	255	#	Number of hub controls dwellings for which SEAI had BER data
Assumed gas used in cooking across BER sample	40,518	kWh	Overall avg kWh gas used for cooking per dwelling in Hub Ctrl's sample * number of dwellings in BER sample
Total delivered gas for all dwellings in BER sample incl cooking	4,702,737	kWh	All gas usage (BER based gas usage plus cooking)
Total delivered gas for all dwellings in BER sample for main space heating	3,222,583	kWh	Main space heating gas only
% Gas used for main space heating only in sample	68.53%	%	Main space heating gas only / total gas usage
% Gas saving from hub controls (relative to entire gas usage)	25.10%	%	From hub controls report (total gas saving by hub controller)
% Gas saving from hub controls (relative to gas used for main space heating only)	<b><u>36.63%</u></b>	%	Percentage main space heating saving by hub controller

**Table 4: Percentage main space heating savings**

## 4. Applying the savings to the “Median D2 Dwelling”

SEAI have confirmed that the Median house they provided in April 2021, “d2 house.xml” is the median house for use in this project. It has a BER grade of D2 (275.41kWh/m2/year when calculated in DEAP v3.2.1 (the version of DEAP ordinarily used for residential Energy Credits calculations).

The analysis in this project emulates the savings that would be achieved if this median house were part of the dwelling stock in the Hub Controls test dwellings:

- a) The average base year heating hours are derived from survey data provided by Hub Controls Ltd. and applied to the median dwelling in DEAP.
- b) The main space heating savings shown in Table 4 are applied to the median dwelling (with surveyed heating hours from step (a).

### 4.1. Calculating average annual heating hours

Hub Controls provided heating “on hours” detail for the 400 test dwellings for the baseline period. For each dwelling, the number of heating on hour per month was provided for at least twelve months.

“Opt-outs” were excluded from this analysis, meaning that 394 dwellings were considered. For each dwelling, if more than 12 months data was available, then those months with more than one data point were averaged. For example, the following dwelling has no data for September 2017 and January – April 2019. It has data for the months in between. The data in red font is averaged for the months of October, November and December. For example, October = (28.43 + 89.06)/2 = 58.74.

Month start date	Month ID	raw on hours	12 months	1 year on hours (average "red" months where needed)
01/09/2017	9	-	September	50.17
01/10/2017	10	28.43	October	58.74
01/11/2017	11	128.28	November	114.29
01/12/2017	12	150.56	December	80.51
01/01/2018	1	150.80	January	150.80
01/02/2018	2	162.47	February	162.47
01/03/2018	3	164.46	March	164.46
01/04/2018	4	105.81	April	105.81
01/05/2018	5	59.27	May	59.27
01/06/2018	6	27.55	June	27.55
01/07/2018	7	15.69	July	15.69
01/08/2018	8	21.55	August	21.55
01/09/2018	9	50.17		
01/10/2018	10	89.06	<b>Total for 12 months -&gt;</b>	<b>1,011.31</b>
01/11/2018	11	100.29	<b>8 months heating season only -&gt;</b>	<b>896.35</b>
01/12/2018	12	10.46		
01/01/2019	1	-		
01/02/2019	2	-		
01/03/2019	3	-		
01/04/2019	4	-		

**Table 5: Sample run hours for one dwelling**

In some dwellings, it was found that some months had more than 730 on-hours. 730 is the maximum number of hours we would expect for any month (24\*365/12) meaning that the data for that dwelling is flawed and should not be used as they would skew the data. 20 dwellings had this issue and were excluded, leaving 374 dwellings worth of on-hours data with an average of 1603 hours heating in the heating season. Analysis was carried out in the file named “BasePeriod\_HeatingHours\_V0.X.xlsx”

As these on-hours are to be applied to the net space heat demand of the median dwelling in DEAP (i.e. space heating on-hours), they are converted to the “Length of one unheated period [h]” applied in DEAP to each of 14 “unheated periods” per week as per the table below (the standard DEAP on hours are included in this table for comparison purposes).

As discussed with SEAI and Hub Controller Ltd. the run hours in the 8 months of the heating season alone (Oct-May) are 1,603 (relative to 1,944 in DEAP’s standard heating season). As this difference may be at least in part due to some warmer than expected days during the heating season, conversely, heating may have been needed during some of the colder days in summer (which DEAP would ordinarily consider outside of the heating season). The monitored on-hours (average) in the **full** year is 1,812 hours, with 209 hours of those being in the four summer months (1,812-1,603 hrs). However, it is likely that in summer that the bulk of the gas usage is for hot water rather than space heating and this should be accounted for to give a better representation of “additional” on hours for space heating in the summer. It will be assumed for the purposes of this exercise that the 1,603 hours in the heating season is the minimum value that should be accounted for in the DEAP Net Space Heat Demand tab, with additional on-hours for space heating in summer to be calculated as shown below.

To approximate the share of the 209 hours to “allocate” to space heating:

- From the file referenced in Section 3 “Share of space heating saved V0.X”:

  - the annual average gas usage for main space heating is 13,100kWh in the 246 dwellings with gas main space heating.
  - the annual average gas usage for main water heating is 4,424kWh according to the file “Share of space heating saved V0.X”. This will be roughly the same each month, so for the four months of the summer, will be 1,475kWh.

- the D2 Median dwelling (with no adjustments: filename “D2 house DEAP 3.2 workbook.xlsx”) shows that the net space heat demand for the full year is 10,779 kWh and for the heating season is 10,161kWh. Based on this, if heating were to be used in the summer (as is being discussed here), it requires 5.74% of the total space heat demand.
- On this basis, it is estimated that  $752 / (752 + 1475) = 33.8\%$  of summer heating hours are for space heating.
- This equates to 71 out of the above 209 hours, meaning that on-hours is  $1,603 + 71 = 1673$  (the calculation figures shown here are rounded to the nearest integer).
- Full calculations are in the file “BasePeriod\_HeatingHours\_V0.X.xlsx”

	DEAP standard hours	Monitored hours in base year heating season	Monitored hours in base year Full season
Length of heating season (days)	243	243	243
# on hours in heating season	1944	1603	1673
Length of heating season (weeks)	34.7	34.7	34.7
#hrs per week heating on	56	46.17	48.20
#unheated periods per week (constant, based on DEAP)	14	14	14
DEAP#unheated periods per day (constant, based on DEAP)	2	2	2
Hours per day heating on	8	6.6	6.9
Hours per day heating off	16	17.4	17.1
Hours in each unheated period	8	8.702	8.557
Annual average gas usage (space)	13,100		
Annual average gas usage (water)	4,424		
Summer hot water gas usage	1,475		
On hours summer only	209		
D2 median heating season NSHD	10,161		
D2 median annual NSHD	10,779		
Share NSHD in summer only	5.74%		
Gas demand for space heating in summer	752		
Assumed share of on hours for summer space heating	34%		
On hours in summer for space heating only	71		
Assumed annual on hours	1,673		

**Table 6: Adapting average monitored run hours for DEAP**

Based on the above, the “hours in each unheated period” for use in DEAP is 8.557. As the number of summer on-hours for space heating in summer is likely to be very low, the heating season is still assumed to be Oct-May rather than the full 12 months of the year (assuming “length of heating season” to be 52 weeks would actually make the unheated periods above longer and likely skew the credits to a lower than expected value).

## 4.2. Savings in the Median Dwelling

The median dwelling was replicated in the Excel version of DEAP rather than the software version (v3.2.1) during this analysis because:

- a) The on hours cannot be adjusted in the DEAP software
- b) DEAP V3.2.1 is currently used for any deemed credits calculation. Therefore, determining savings for the purposes of energy credits needs to use this version of DEAP.

The “hours in each unheated period” are entered in the net space heat demand calculation in DEAP’s HtUse as highlighted in yellow below (see the file “D2 house hours adjusted DEAP 3.2 full season.xlsx”:

<b>For calculation of adjusted temperature due to intermittent heating</b>					
Time constant of dwelling [h]				10	
Mean external temperature for heating season [C]				7.6	
Length of one unheated period [h]				8.557	
Number of unheated periods per week				14	
				Unheated	Heated
Hours per week				119.797	48.2028
Heat loss from dwelling during one unheated period [MJ]				74.2	

**Table 7: on hours adjustments in DEAP**

DEAP’s “results” tab shows the main space heating delivered energy as shown in yellow below at 14,566kWh/yr:

<b>Results</b>	
	Delivered energy [kWh/yr]
Space heating - main	14,566
Space heating - secondary	2,956
Water heating - main	6,737
Water heating - supplementary	0
Pumps, fans, etc.	169
Energy for lighting	861
CHP input (individual heating systems only)	0
CHP electrical output (individual heating systems)	0
Type 1	0

**Table 8: main space heating demand in median dwelling (after on hours adjustment)**

For comparison purposes, the main space heating delivered energy with DEAP’s standard hours (1,944 rather than 1,673 per year) is 15,245kWh/yr. Note that the relationship between run hours in DEAP and energy usage is non-linear: largely due to the subtleties of DEAP’s net space heat demand calculation such as the impact of thermal mass, heat capacity and gains on energy usage as outlined in DEAP Manual Section 7.3. The approach DEAP uses is based on the EN standards underpinning the Energy Performance of Buildings Directive (EPBD).

The savings derived in Section 3.2 are then applied to the main space heating delivered energy shown in Table 8 as follows to give savings in the median dwelling per m<sup>2</sup> floor area. Finally, this is scaled to a 110m<sup>2</sup> floor area and 70m<sup>2</sup> floor area (apartment)

<b>SAVINGS</b>	
% main space heating	36.63%
Main space heat savings kWh	5,335
Total floor area of median dwelling	109.80
Main space heat savings kWh/m <sup>2</sup>	48.59
<b>Main space heat savings kWh in 110m<sup>2</sup> house</b>	<b>5,345</b>
<b>Main space heat savings kWh in 70m<sup>2</sup> apt</b>	<b>3,401</b>

**Table 9: Energy savings for 110m<sup>2</sup> house and 70m<sup>2</sup> apartment**