TUATH HOUSING ASSOCIATION

ENERGY MASTER PLAN REPORT

REPORT BY IHER ENERGY SERVICES, MARCH 2022, VERSION -05

Unit 25 DOCKLANDs INNOVATION PARK
Dublin 3

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1. Introduction

1.1. Background

Tuath Housing appointed IHER Energy Services in May 2019 to develop an Energy Masterplan and compile a Register of Opportunities.

This report summarises the work delivered by IHER Energy Services for Tuath Housing.

1.2. Deliverables

As outlined in Section 3 of the RFQ, the deliverables required can be broken into three broad categories:

Energy Audits, Review of BER & other data and the Register of Opportunities

1. Energy audits on 11 dwellings and its office buildings on Church Street, Dundalk and 33 Lower Leeson Street.
2. A review of 2,920 existing BER certificates along with available stock condition surveys and housing data.
3. Population of a Register of Opportunities (RoO) to advise Tuath Housing on options to improve the energy performance of their assets.
4. Identify numbers of homes using electricity, gas and oil as main fuel for heating.
5. Identify potential solutions for different typologies to be fed into the RoO.

Behavioural Measures

6. Identify behavioural measures to reduce energy consumption.

2. Tuath Housing - All Data Sources

Tuath manages 8,000 dwellings approximately. It should be noted that the total number of dwellings is fluid due to continuous property transactions so the figures listed should be considered accordingly.

Of the 8,000 dwellings, 7,050 are leased/managed whereas 950 are owned by Tuath. The Tuath team has advised that priority shall be given to the energy upgrades of the dwelling owned by Tuath.

Three key databases have been reviewed and analysed further to develop the energy masterplan.

a) **Tuath_All Properties below B2** of 2,546 dwellings with BERs in range B2 – G. (938 units are Tuath-owned).
b) Tuath's **Master Tracker** of owned dwellings, listing units on retrofit schedule for 2021 & 2022. (949 units)
c) **BER database** created by IHER containing BERs of 2,920 dwellings (B1-G), both leased and owned.

3. Tuath Housing Retrofit Objectives

Tuath's stated objective is to upgrade 50% of its owned dwelling to B2 by end 2024 and 100% to B2 or better by 2027.

Consideration will also be given to strategy for the leased dwellings.

4. Tuath Housing - BER Database

4.1. Gathering BER data files (xmls)

As outlined in Section 2, Tuath Housing manages over 8,000 social homes which are spread nationwide. There are approximately 2,546 properties with a BER rating lower than B2 and have been identified as requiring some form of energy upgrade (Tuath_All properties below B2).

The BER data available from SEAI is also a further source of data. Tuath Housing requested 2,920 xml data files for its current stock of dwellings with BER ratings of B1 and below from SEAI. Tuath Housing did not request xml files for A rated Dwellings.

The BER data records were then analysed using IHER's access-based Episcope BER Database tool that has the capacity to import thousands of BER xml files and to collate the data within into a Master Excel summary document.

The xmls data files were received from SEAI though the delivery process took about 4 months in total. The xmls were then forwarded to IHER for loading. Most of the xmls were DEAP 3 files and were imported into BER Database tool. For more recently published BERs in DEAP 4, a separate process was required to make this data available by SEAI to IHER and these records were manually loaded into BER Database tool.

It should be recognised that the report on the 2,920 xml files only reflects those properties with BERs.

4.2. Tuath Housing BER Database:

IHER loaded the 2,920 xml files into the BER database tool.

The Database tool then exports key variables selected by IHER to a Master Excel spreadsheet known as Scenario 1. Using Scenario 1, IHER then conducted further analysis on the data in Scenario 1 producing a range of tables and charts.

The BER dataset also includes a filter to separate leased dwelling and Tuath-owned dwellings.

Table 1 Summary of Key Aspects of Tuath Housing BER Database

Owned	617
Leased	2303
Total	**2920**

(So, of the 950 owned Tuath dwellings, 617 are listed in the BER database and 330 units approx. were not found).

A selection of key charts is shown in the following sections, which will include:

- BER rating
- Dwelling types

- Wall types
- Wall insulation levels
- Roof insulation levels
- Window U values
- Primary Fuel type
- Boiler efficiencies

5. Charts & Tables from BER Database of 2,920 Dwellings

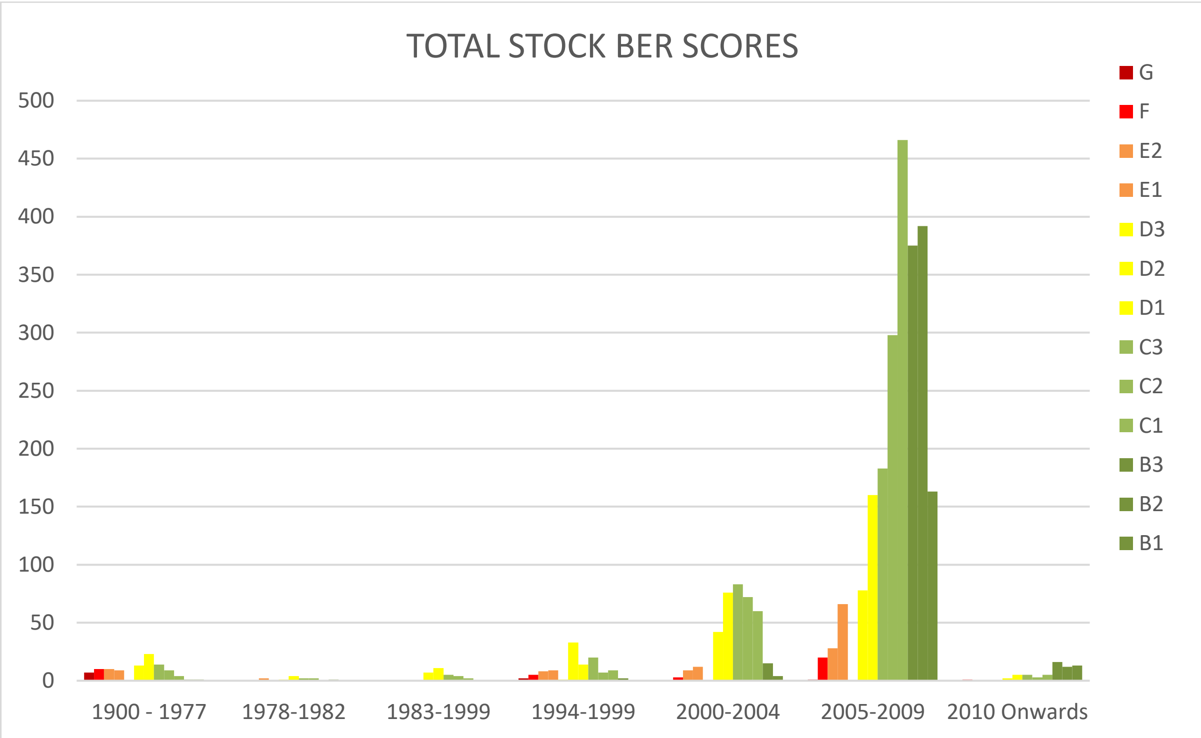
5.1. BER Ratings by Age band

The total number of BER certificates by energy rating band (B1, B2 etc) and construction age band is shown in figure 1. Note that A rating dwellings are not included in this analysis.

Within the stock of 2,920 dwellings with BERs, 78.5% were constructed from 2005 onwards, as can be seen in Table 2 below.

13% of the dwelling were built from 2000-2004, and thus 91.5% of the stock was built since 2000.

Figure 1: BER Ratings by Age Band



The corresponding table 2 gives the associated numbers for Figure 1.

Table 2: BER Ratings by Age Band - All

Count of CurrentBER	G	F	E2	E1	D3	D2	D1	C3	C2	C1	B3	B2	B1	Grand Total	Percentage
⊞1900 - 1977	7	10	10	9		13	23	14	9	4	1	1		101	3.5%
⊞1978-1982				2		1	4	2	2		1			12	0.4%
⊞1983-1999						7	11	5	4	2				29	1.0%
⊞1994-1999	2	5	8	9	1	33	14	20	7	9	2			110	3.8%
⊞2000-2004		3	9	12		42	76	83	72	60	15	4		376	12.9%
⊞2005-2009	1	20	28	66		78	160	183	298	466	375	392	163	2230	76.4%
⊞2010 Onwards		1				2	5	5	3	5	16	12	13	62	2.1%
Grand Total	10	39	55	98	1	176	293	312	395	546	410	409	176	2920	100%

Figure 2 shows that the poorer rated dwellings (D1 or worse) are mostly in Dublin, but this is best explained by the associated numbers in Table 3.

Figure 2: BER Ratings by Area

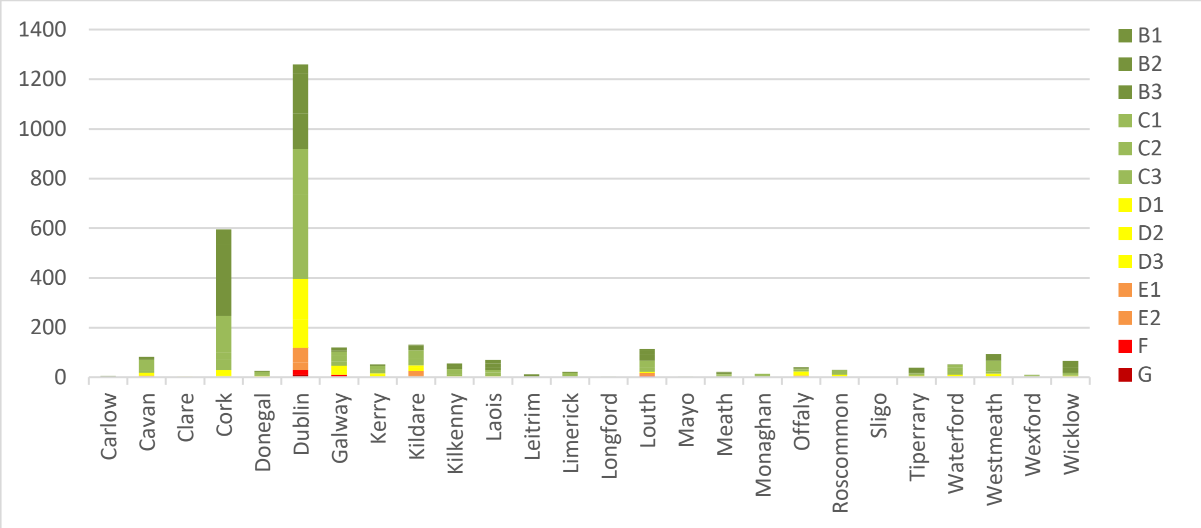


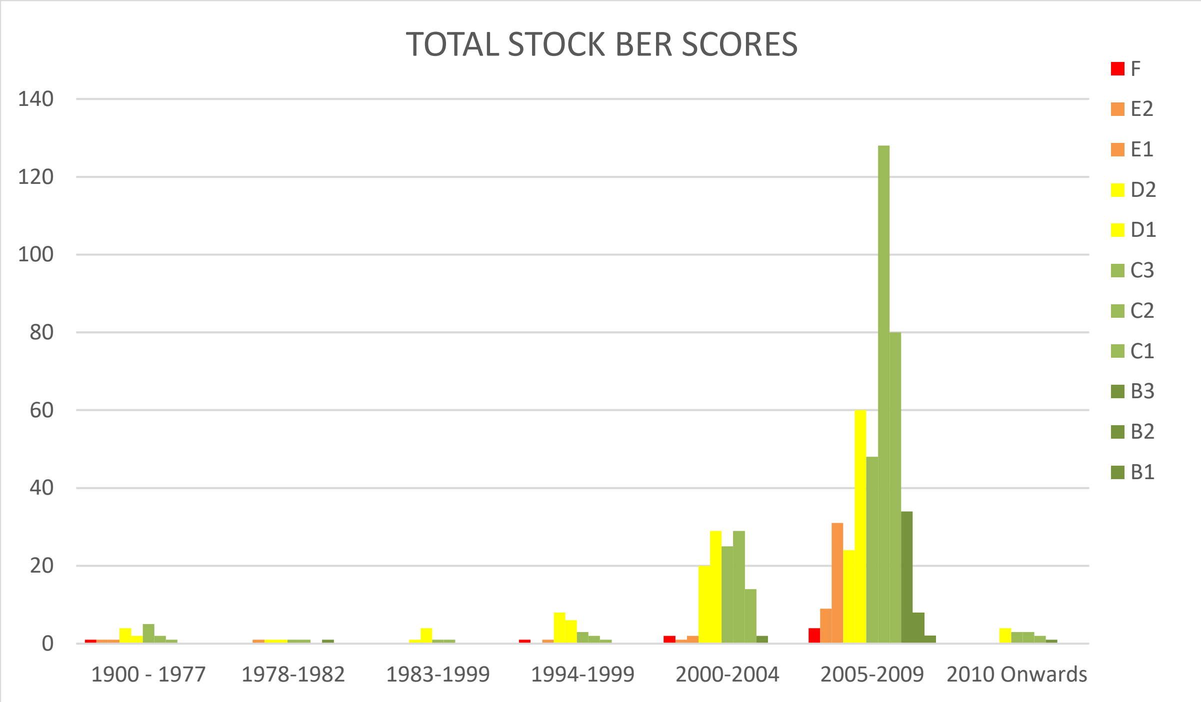
Table 3: BER Rating Count by Area

Row Labels	G	F	E2	E1	D3	D2	D1	C3	C2	C1	B3	B2	B1	Grand Total
⊞Carlow							2	1			3			6
⊞Cavan		1	4	2		4	7	8	45		4	8		83
⊞Clare						1	2							3
⊞Cork		3				4	21	42	31	147	131	157	59	595
⊞Donegal						6		3	6	7	3	1		26
⊞Dublin	9	19	31	60	1	112	164	165	177	182	141	164	34	1259
⊞Galway		9		1		11	26	16	23	17	6	2	9	120
⊞Kerry			1	1		7	7	13	4	12	7			52
⊞Kildare			5	20		12	11	9	18	33	20	1	2	131
⊞Kilkenny		1				2	1	5	1	22	11	13		56
⊞Laois							4	6	9	9	11	17	14	70
⊞Leitrim								1			11			12
⊞Limerick								1	3	14		4		22
⊞Longford									1	2				3
⊞Louth		5	6	6		1	4	3	14	28	24	16	7	114
⊞Mayo							1		1					2
⊞Meath						1		7	4	1	2	4	3	22
⊞Monaghan								5	9					14
⊞Offaly		1	1	5		1	16	1	6	3	1	5		40
⊞Roscommon			1	1		1	7	5	10	4	1			30
⊞Sligo							1							1
⊞Tiperrary			2			2	3	3	3	3	1	1	21	39
⊞Waterford			2	1			7	11	19	10	1			51
⊞Westmeath			2	1		6	5	2	8	43	24	2		93
⊞Wexford	1						2	3	1	2	1			10
⊞Wicklow						5	2	2	2	7	7	14	27	66
Grand Total	10	39	55	98	1	176	293	312	395	546	410	409	176	2920

5.2. Rating by Age Band- owned dwellings

The total number of BER certificates by energy rating band (B1, B2 etc) and construction age band for Tuath-owned dwellings is shown in figure 3.

Figure 3: BER Ratings by Age Band - Owned



The corresponding counts are shown in Table 4.

Table 4: BER Ratings by Age Band - Owned

Row Labels	F	E2	E1	D2	D1	C3	C2	C1	B3	B2	B1	Grand Total
1900 - 1977	1	1	1	4	2	5	2	1				17
1978-1982			1	1	1	1	1		1			6
1983-1999				1	4	1	1					7
1994-1999	1		1	8	6	3	2	1				22
2000-2004	2	1	2	20	29	25	29	14	2			124
2005-2009	4	9	31	24	60	48	128	80	34	8	2	428
2010 Onwards					4	3	3	2	1			13
Grand Total	8	11	36	58	106	86	166	98	38	8	2	617

Interestingly, 44 units in the 2005-2009 age band are E and F rated (see red number above) . By filtering the Master list, all of these units are electrically heated, and many are included in the Tuath Master Tracker for upgrade in 2022.

5.3. Dwelling Types

The split of dwellings by type is shown in Figure 4.

Figure 4: Dwelling Types

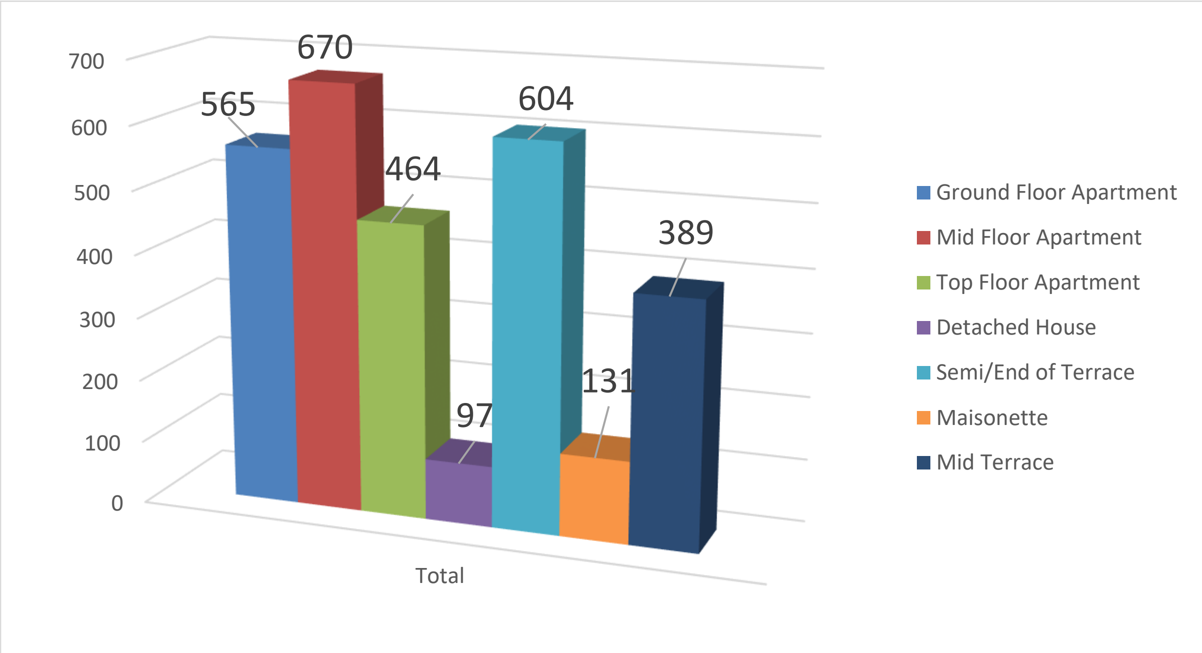


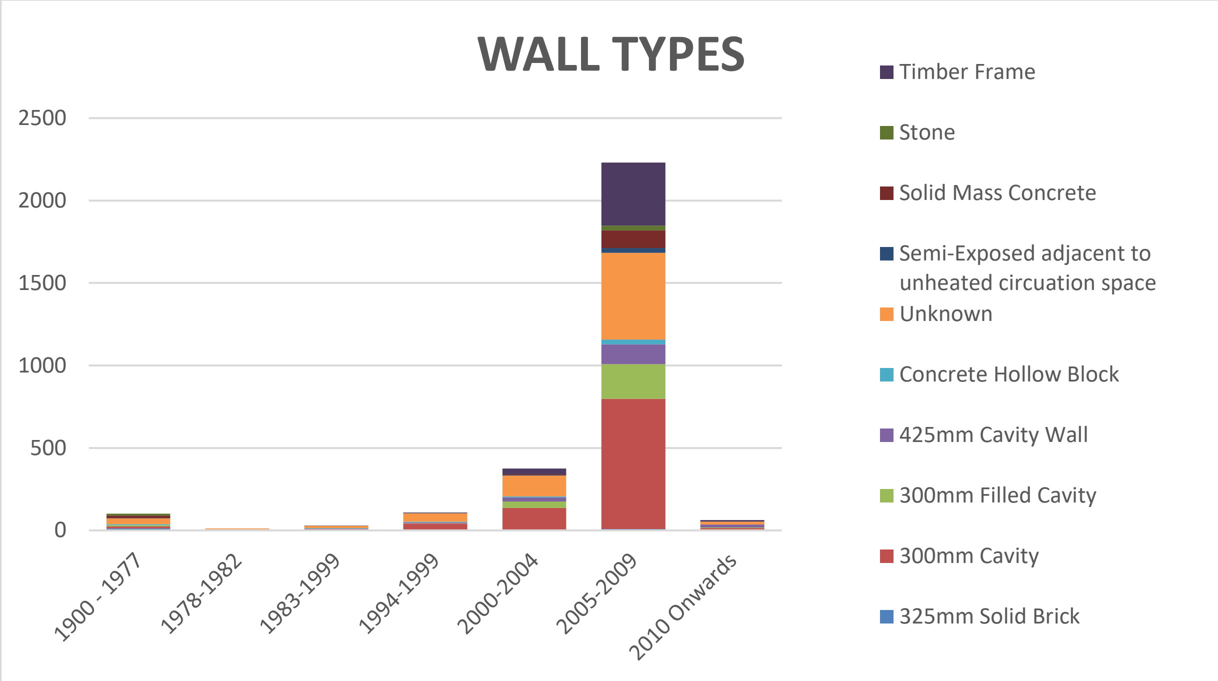
Figure 4 shows that 1,699 (58%) of the 2,920 BER stock are apartments. The balance of 42% are houses and maisonettes. This is a useful metric when getting a perspective on longer term retrofit decisions. The breakdown is expanded further in terms of heating systems and fuel types later in this section.

5.4. Wall Types

We already know that 91.5% of the stock dates from 2000 onwards.

Figure 5 shows predominant wall type post 2000 is cavity and timber frame. Where BER assessors are unsure they can enter the wall type as unknown. In the case of apartment blocks, it is often difficult for a BER Assessor to know the wall construction without access to drawings thus it is to be expected that unknown category will be chosen. Also, under an earlier instruction to BER assessors by SEAI, if the assessor did not know a wall type the assessor was required to enter the wall type as stone. The wall type counts are shown in the BER database master.

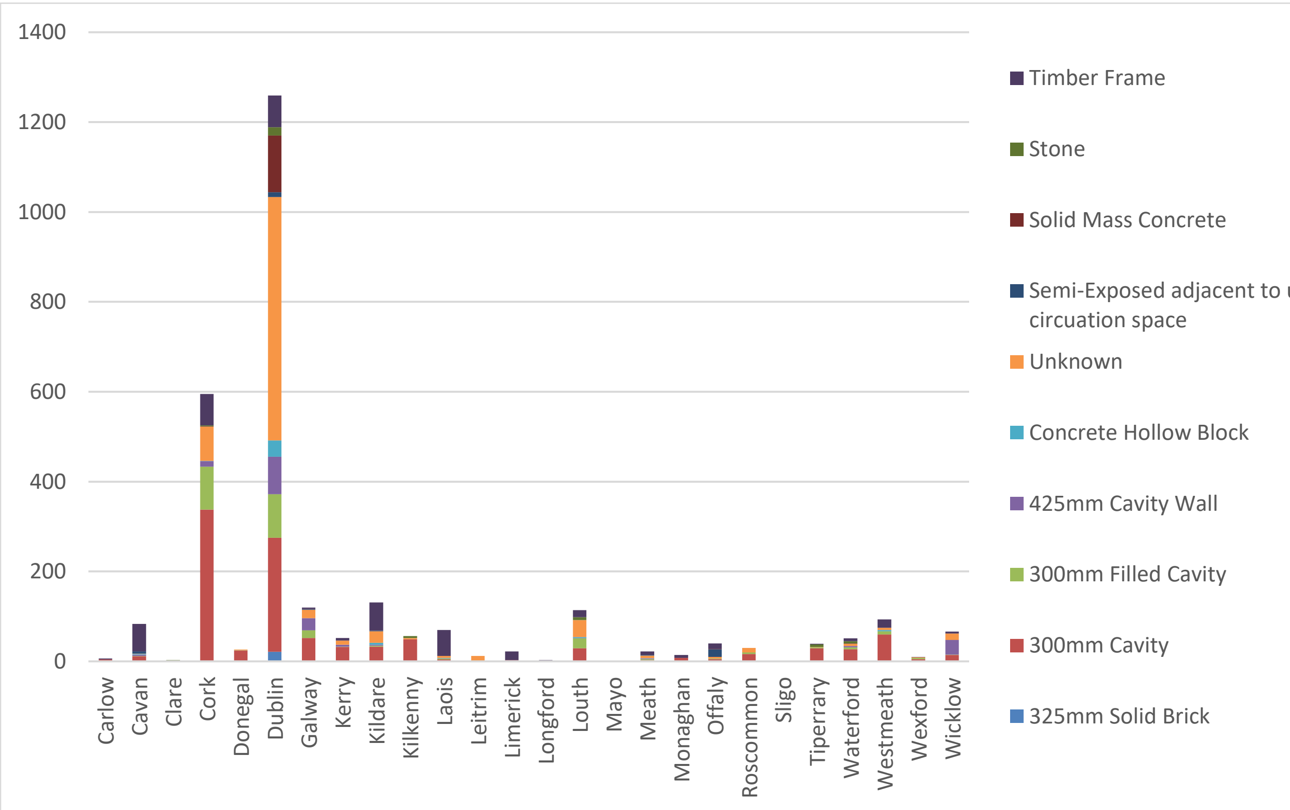
Figure 5: Stock by Wall Types



Wall types by County are shown in Figure 6.

When the corresponding chart, tables and excel lists are examined more closely, the locations of specific wall types like 325mm solid brick or mass concrete can be studied more closely.

Figure 6: Wall Types by County



5.5. Wall Insulation Levels

The BER xml file provides information on the levels of wall insulation by indicating the U value (in W/m^2K).

Draft Building Regulations were first introduced in Ireland in 1976 and there were revisions in 1981 (draft also), leading to full Building Regulations in 1991 with subsequent revisions in 1997, 2002, 2005, 2008 and 2011. Allowing for the transition interval between the commencement date for new regulations and the completion of the construction process, dwellings built two years after the introduction of the new regulations are considered to meet the new regulations.

Thus, it is assumed that all dwellings built before 1977 were not insulated. The default U values defined in Appendix S of the SEAI DEAP manual are shown in table 5.

Table 5: Exposed Wall U-values (Appendix S, DEAP v3.2.1)

Age Band	A	B	C	D	E	F	G	H	I	J
Wall type	Before 1900	1900-1929	1930-1949	1950-1966	1967-1977	1978-1982	1983-1993	1994-1999	2000-2004	2005 onwards
stone	2.1	2.1	2.1	2.1	2.1	1.1	0.6	0.55	0.55	0.37
225mm solid brick	2.1	2.1	2.1	2.1	2.1	1.1	0.6	0.55	0.55	0.37
325mm solid brick	1.64	1.64	1.64	1.64	1.64	1.1	0.6	0.55	0.55	0.37
300mm cavity	2.1	1.78	1.78	1.78	1.78	1.1	0.6	0.55	0.55	0.37
300mm filled cavity	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.55	0.55	0.37
solid mass concrete	2.2	2.2	2.2	2.2	2.2	1.1	0.6	0.55	0.55	0.37
concrete hollow block	2.4	2.4	2.4	2.4	2.4	1.1	0.6	0.55	0.55	0.37
timber frame	2.5	1.9	1.9	1.1	1.1	1.1	0.6	0.55	0.55	0.37

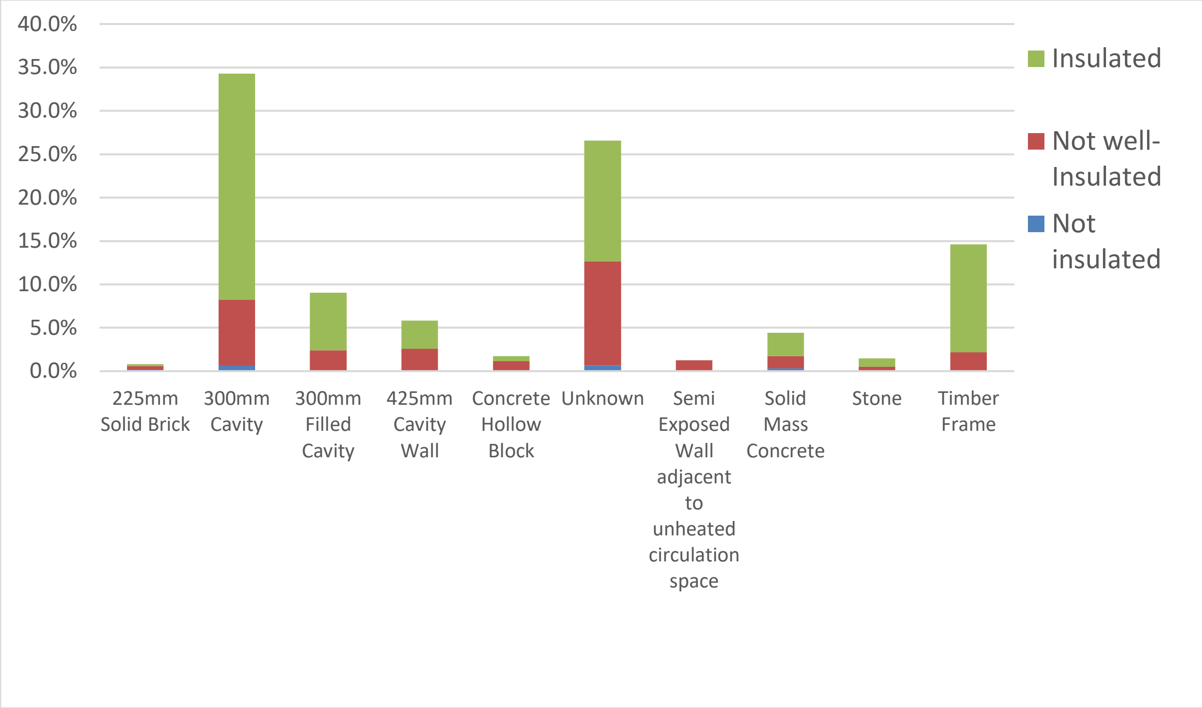
Both a cavity wall and an (insulation) filled cavity wall are shown in table 5.

In order to determine if walls are insulated to a reasonable standard, analysis was done on all dwellings to divide them into 3 categories:

- Insulated: wall U values of 0.37 W/m2K or less
- Not well insulated: wall U values >0.37W/m2K and < 1.64 W/m2K
- Uninsulated: wall U values > 1.64 W/m2K

The U value analysis of the Tuath stock walls is shown in Figure 7 and Table 6.

Figure 7: Wall U Value Analysis



As seen in Table 6, 67% of the stock is well insulated with a U value less than or equal to 0.37 W/m2K. 31% is deemed not well insulated and just 2% is uninsulated.

It is worth noting the "semi-exposed wall adjacent to unheated space" wall type. Per the rules of DEAP, if a corridor is unheated then the DEAP BER method assumes heat loss occurs through this wall from the apartment into the corridor. Such walls are typically not insulated so the heat loss can actually be quite significant. This semi-exposed wall type has come up as the main wall type in 1% of BERs where its heat loss areas is greater than the exposed wall.

In general, heat loss through semi-exposed walls adjacent to unheated spaces can be addressed by insulating this corridor wall or placing heaters in the corridor thus changing the wall type to a non-heat loss element.

Table 6: Wall Type by Insulation levels

Row Labels	Not insulated	Not well-Insulated	Insulated	Grand Total
225mm Solid Brick	0.2%	0%	0%	**1%**
300mm Cavity	0.6%	8%	26%	**34%**
300mm Filled Cavity	0.0%	2%	7%	**9%**
425mm Cavity Wall	0.0%	3%	3%	**6%**
Concrete Hollow Block	0.1%	1%	1%	**2%**
Unknown	0.7%	12%	14%	**27%**
Semi Exposed Wall adjacent to unheated circulation space	0.0%	1%	0%	**1%**
Solid Mass Concrete	0.3%	1%	3%	**4%**
Stone	0.1%	0%	1%	**1%**
Timber Frame	0.0%	2%	12%	**15%**
Grand Total	**2.0%**	**31%**	**67%**	**100%**

5.6. Windows

Windows were subdivided into those with U values =< 2.2 W/m2K (equivalent to 12mm gap air-filled double glazing with low e glass and the default values for windows installed from 2005 onwards) and those with U values > 2.2 W/m2K. The percentage by location as shown in Table 7.

Table 7: Window Analysis

Count of Windows U	Column Labels		
Row Labels	U<=2.2	U>2.2	Grand Total
Carlow	0.1%	0.1%	0.2%
Cavan	1.2%	1.7%	2.8%
Clare	0.0%	0.1%	0.1%
Cork	16.4%	3.9%	20.4%
Donegal	0.3%	0.5%	0.9%
Dublin	26.8%	16.3%	43.1%
Galway	2.8%	1.3%	4.1%
Kerry	0.8%	1.0%	1.8%
Kildare	2.7%	1.8%	4.5%
Kilkenny	1.5%	0.4%	1.9%
Laois	1.2%	1.2%	2.4%
Leitrim	0.4%	0.0%	0.4%
Limerick	0.3%	0.4%	0.8%
Longford	0.1%	0.0%	0.1%
Louth	2.1%	1.8%	3.9%
Mayo	0.0%	0.0%	0.1%
Meath	0.3%	0.4%	0.8%
Monaghan	0.0%	0.5%	0.5%
Offaly	1.1%	0.2%	1.4%
Roscommon	0.3%	0.8%	1.0%
Sligo	0.0%	0.0%	0.0%
Tiperrary	1.0%	0.3%	1.3%
Waterford	1.1%	0.7%	1.7%
Westmeath	0.8%	2.4%	3.2%
Wexford	0.2%	0.2%	0.3%
Wicklow	1.7%	0.5%	2.3%
Grand Total	63.4%	36.6%	100.0%

The table above indicates that window upgrades would be recommended for one third of the dwelling stock.

In the case of Tuath-owned dwelling, Table 8 shows 45% have a U value > 2.2 W/m2K (and thus recommended for upgrade).

Table 8: Window U values by Area – Tuath-owned dwellings

Count of Windows U	Column Labels		
Row Labels	U<=2.2	U>2.2	Grand Total
Carlow	0.0%	0.2%	0.2%
Cavan	2.8%	4.1%	6.8%
Clare	0.0%	0.2%	0.2%
Cork	1.6%	4.5%	6.2%
Donegal	0.0%	0.5%	0.5%
Dublin	25.8%	15.1%	40.9%
Galway	4.1%	2.3%	6.3%
Kerry	0.2%	0.0%	0.2%
Kildare	4.9%	3.6%	8.4%
Kilkenny	0.8%	0.6%	1.5%
Laois	1.1%	1.9%	3.1%
Limerick	0.3%	0.3%	0.6%
Longford	0.3%	0.0%	0.3%
Louth	3.2%	3.1%	6.3%
Mayo	0.0%	0.2%	0.2%
Meath	0.3%	1.1%	1.5%
Monaghan	0.0%	1.5%	1.5%
Offaly	4.2%	0.3%	4.5%
Roscommon	1.1%	0.5%	1.6%
Tipperary	0.2%	0.8%	1.0%
Waterford	0.8%	1.3%	2.1%
Westmeath	1.8%	1.5%	3.2%
Wexford	0.3%	0.5%	0.8%
Wicklow	1.3%	0.8%	2.1%
Grand Total	55.2%	44.8%	100.0%

5.7. Fuel Types

The analysis of fuel types will help inform retrofit strategy in the longer term, in the context of the Climate Action Plan goals.

Figure 8: Main Fuel Types

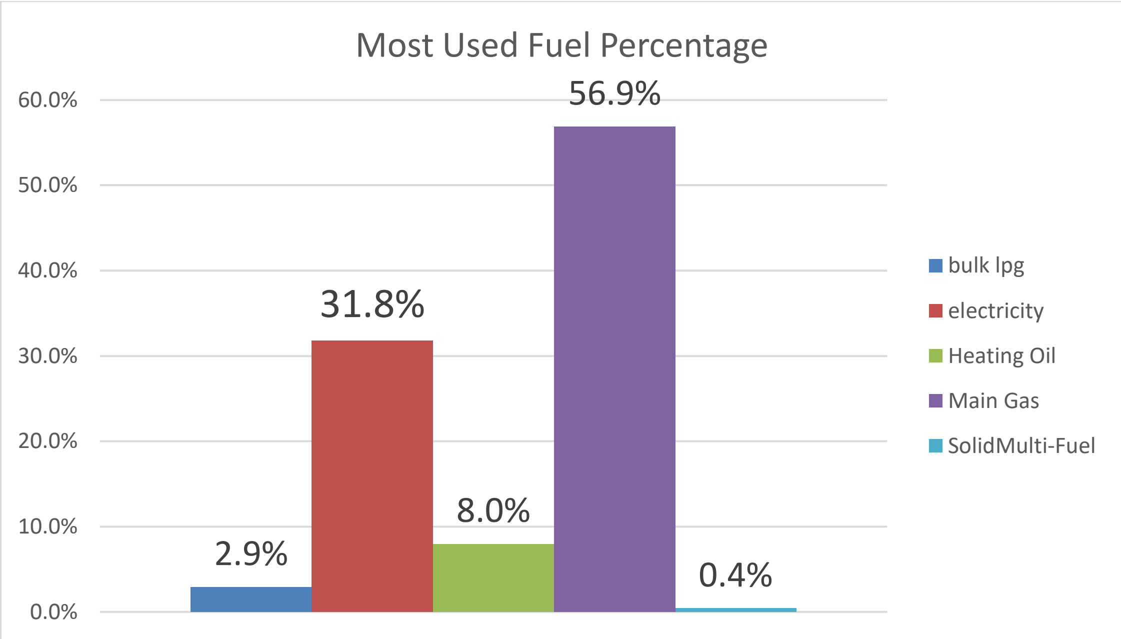


Figure 8 shows that 57% of the dwellings are heated by gas, 32% by electricity, 8% by oil, 3% by LPG and <1% by solid fuels.

Figure 9 show the fuel types used by houses and apartments.

Figure 9: Main Fuel Types in Houses

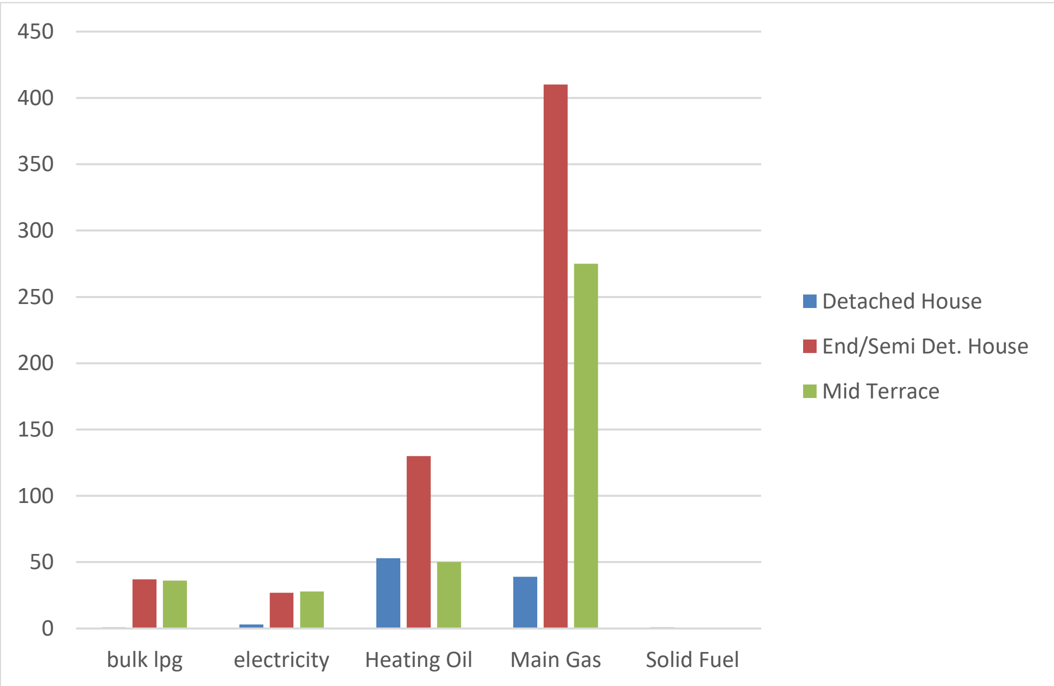


Figure 10 show the fuel types by apartments.

Figure 10: Main Fuel Types in Apartments

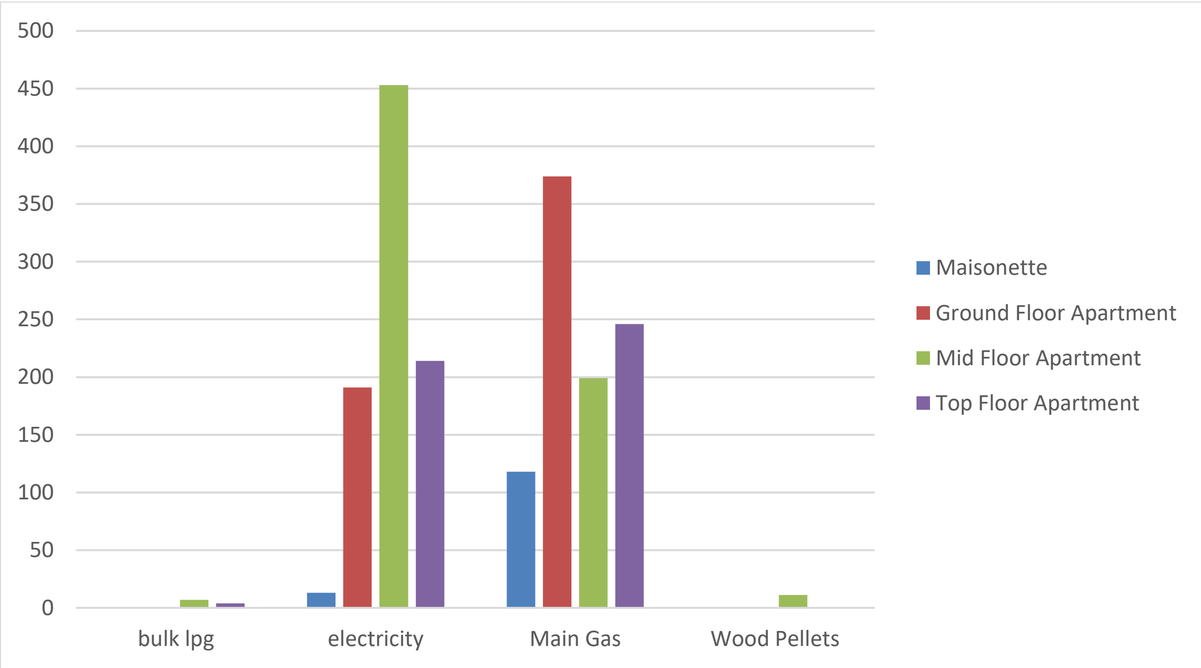


Figure 9 highlights that oil use applies exclusively applies to houses. Policy decisions on switching from oil boilers to heat pumps will need to focus on houses. All relevant addresses can be filtered from the BER Database.

Electricity use for space and water heating is primarily with apartments. DEAP does not distinguish easily between storage heating and direct electric heating, but they are mostly used in combination. So for the medium to long term, strategic decisions will need to be taken as to whether to continue with the systems, replace with newer electric heaters, switch over to heat pumps (either air to air, air to water or exhaust air) or possibly to condensing fossil fuel boiler systems.

5.8. Heating Types – All

Figure 11 shows heating types used in houses.

Figure 11: Heating Types for Houses

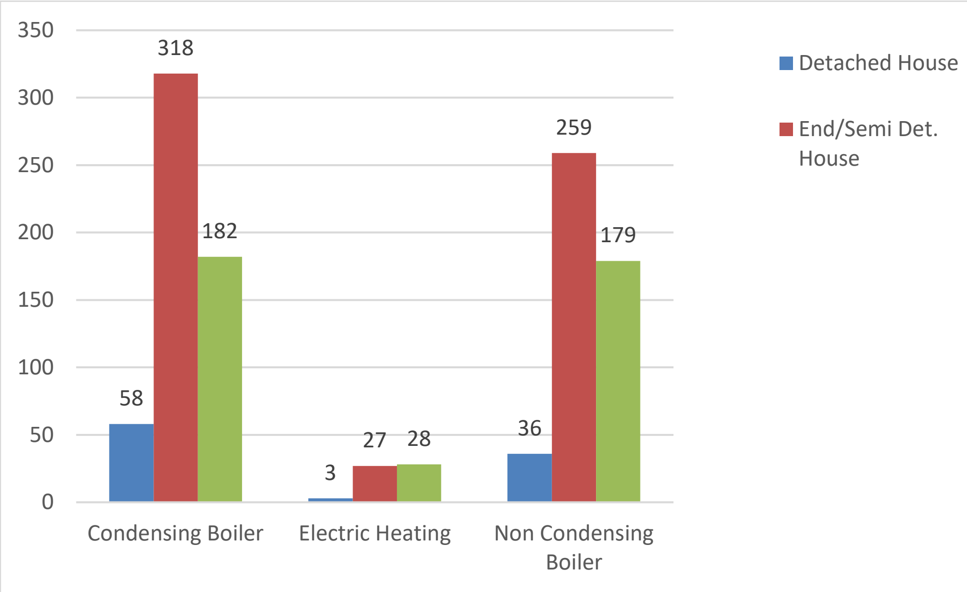
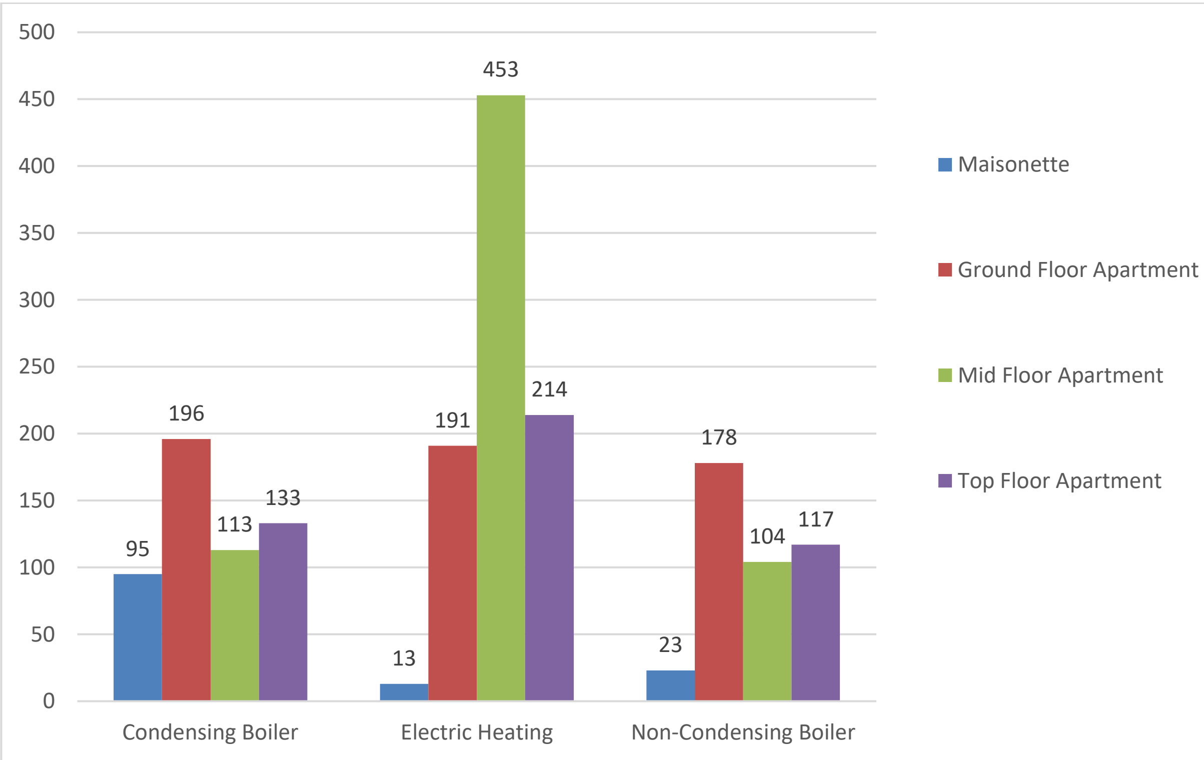


Figure 12 shows heating types used in apartments. There are approximately 420 non-condensing boilers in apartments.

Figure 12: Heating Types for Apartments



5.9. Heating Types - Owned

Figure 13 shows heating types used in houses owned by Tuath.

Figure 13: Heating Types for Houses – Owned

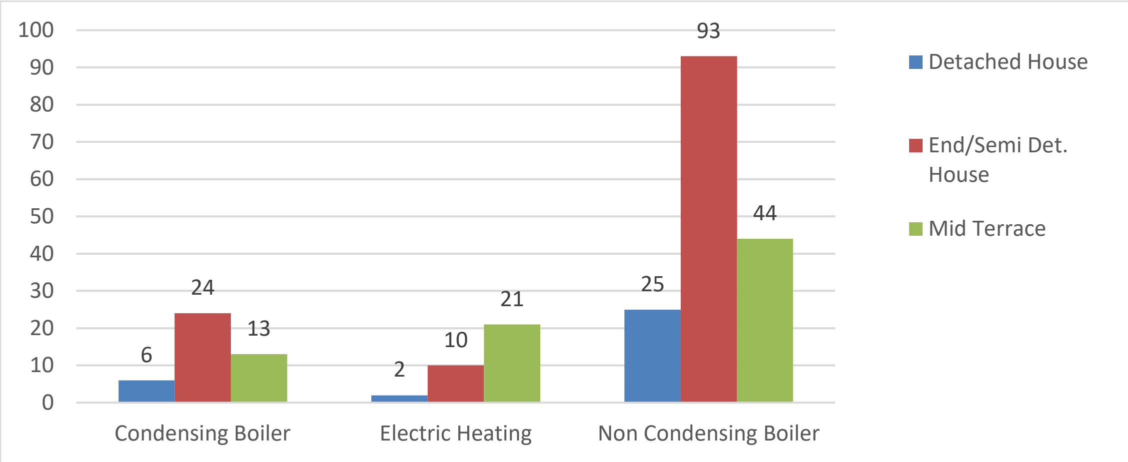


Table 9 shows that there are 162 non-condensing boilers in houses, which will include both gas and oil boilers.

Table 9: Heating Types for Houses: Tuath Owned

	Detached House	End/Semi Det. House	Mid Terrace	Grand Total
Condensing Boiler	**6**	**24**	**13**	**43**
Electric Heating	**2**	**10**	**21**	**33**
Non-Condensing Boiler	**25**	**93**	**44**	**162**
Grand Total	**33**	**127**	**78**	**238**

Figure 14 shows heating types used in apartments.

Figure 14: Heating Types for Apartments - Owned

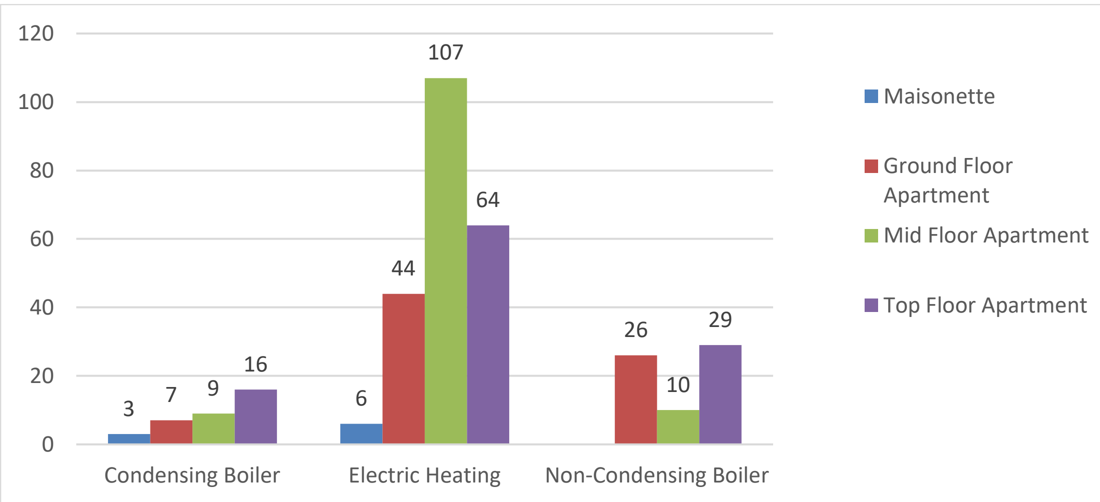


Table 10 shows that there are 65 non-condensing boilers in apartments. All are gas boilers. 221 units have electric heating.

Table 10: Heating Types for Apartments: Tuath-owned

	Maisonette	Ground Floor Apartment	Mid Floor Apartment	Top Floor Apartment	Grand Total
Condensing Boiler	3	7	9	16	35
Electric Heating	6	44	107	64	221
Non-Condensing Boiler		26	10	29	65
Grand Total	**9**	**77**	**126**	**109**	**321**

IHER Energy Services Ltd

6. Energy Surveys - 11 dwellings

6.1. Introduction

BER-based energy audits were carried out on 11 different dwellings. Upgrade recommendations were then developed for each of the dwellings.

Suitable Measures:

In line with the national Climate Action plan, the medium to longer term strategy is install heat pumps in 400,000 dwellings by 2030 and to upgrade 500,000 existing dwelling to B2 by 2030.

In relation to heat pumps, SEAI wants to ensure that heat pumps are only retrofitted in homes where heat loss is equivalent to a new home built in 2005, so that the heat pump will perform satisfactorily. Thus, all older homes will need to have significant insulation upgrades if applying for the grant.

The level of heat loss (fabric and ventilation losses) is specifically measured in the BER software and this value is called the Heat Loss Indicator (HLI). The HLI is required to be less than or equal to 2 W/Km2 in order to qualify for the heat pump grant.

SEAI does allow grant funding for HLI values up to a value of 2.3 if it can be demonstrated that the fabric and ventilation performance of the home is at a cost optimal level.

Cost optimal levels are set out by SEAI as follows:

Maximum exposed wall U-value	0.37 W/m^2K
Maximum roof U-value	0.16 W/m^2K or 0.25 W/m^2K where not accessible (flat roof or rafters)
Maximum window U-value	2.8 W/m^2K (and double glazed)
Maximum adjusted infiltration rate (measured in DEAP 4.2)	0.5 ac/hour

For all dwellings being considered for heat pump installations, a thorough examination of the existing heating system distribution systems (pipework and radiators) will be required in each dwelling as part of the heating design calculation. A heating design calculation must be conducted in accordance with SR50 when availing of SEAI grant funding (and this represents a common-sense approach). In some cases, radiators may have to be replaced or additional radiators will be required.

Note: A design flow temperature of 55°C is assumed in all analysis presented below. Following heating design work, it may be possible that lower design flow temperatures may be achieved giving higher heat pump efficiencies and better BER scores.

Heat Pump Options:

Three types of heat pump can be considered:

- Air-to-air for space heating only
- Air-to-water to provide both space and water heating: this will require installation of a radiator system
- Exhaust Air-to-water to provide both space and water heating and a heat recovery ventilation system: this will also require installation of a radiator system.

Recommended Measures:

An initial BER analysis was carried out on all 11 dwellings.

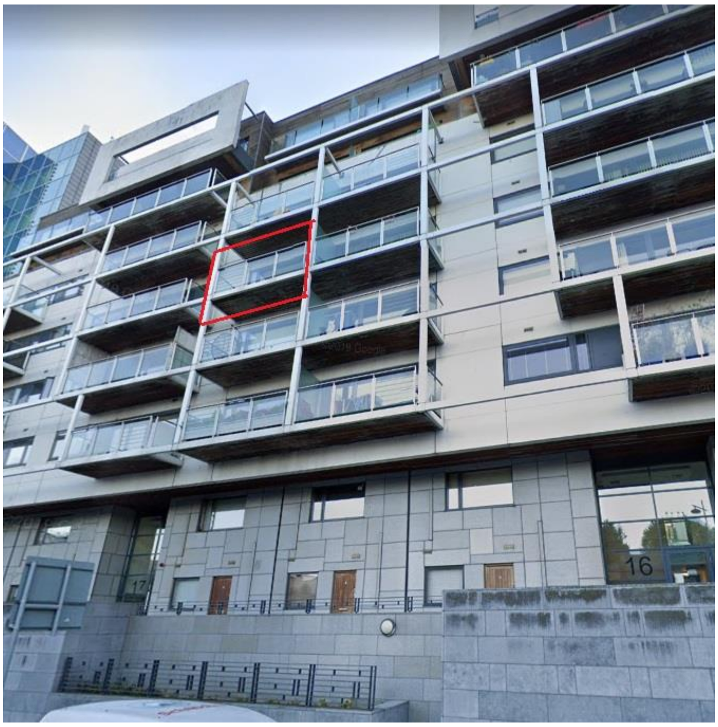
BER upgrade analysis was carried out in each case with the target of achieving a minimum B2 rating.

Where direct electric heating is currently in place, the preferred upgrade measure is to switch over to heat pumps.

The analysis is presented below for each dwelling which will help inform the wider retrofit strategy for the Tuath Housing stock.

6.2. Macken Street Apartments, Dublin 2

Apartment number 14 was surveyed (photo below).



Current Conditions	
Type	Mid floor apartment
Year built	2005
Walls	Cavity – default U value 0.37 W/m2K
Floor	Non heat losses
Roofs	Non heat losses
Windows	PVC, double-glazed, 12mm gap – default U value 2.2 W/m2K
Doors	Solid semi exposed door- default U value 1.36 W/m2K
Ventilation	Natural ventilation with 2 fans
Heating system	Electric direct acting heater
Heating Controls	Appliance thermostat
Secondary Heating	N/A
Hot water tank	Immersion 96 litre, 35mm spray foam

The key results from the site survey & BER analysis are as follows:

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
B3	139.65	27.46	1.26

Recommended Measures:

In the case of this Macken Street apartment, the HLI is 1.26 W/K/m2, so this apartment is ideally suited to a heat pump upgrade.

Two options are recommended for consideration:

Option 1: install air to air heat pump for space heating, water heating by immersion

Option 2: install exhaust air heat pump plus a radiator system for both space and water heating.

Upgrade Analysis Results – option 1

Step	Apt 14, Block 17 Macken Street	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step (kWh/m2/yr	BER Score	HLI
0	Current State (DEAP 4) with shower & bath. Main U- value wall = 0.37.	140		B3	1.26
1	Install Air to Air heat pump (default system)	105	34	B2	1.26
	Total Primary Energy Reduction		34	N.A.	

Upgrade Analysis Results – option 2

Step	Apt 14, Block 17 Macken Street	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step (kWh/m2/yr)	BER Score	HLI
0	Current State (DEAP 4) with shower & bath. Main U- value wall = 0.37.	140		B3	1.26
1	Install Exhaust Air heat pump (4kW, 45 °C design flow temperature) with new radiator system	64	75	A3	1.44
	Total Primary Energy Reduction		75	N.A.	

It should be noted that the exhaust air heat pump will increase the ventilation losses if default air tightness levels are entered in the DEAP BER application. However, the exhaust air heat pump is reliant on good air tightness. When the fan is running, make up air is drawn slowly through the building in a controlled fashion via special "fresh vents"

If the building is not so airtight, then you can have cold air from various locations and so you will use more energy.

Thus installation attention should also be paid to airtightness of apartments when designing the installation of exhaust air heat pumps. Ideally an air tightness test should also be conducted to verify that good air tightness levels are being achieved.

6.3. Apt 10, Corofin House, Dublin 17, D17 H763

2 houses were surveyed at Tyndall Avenue, number 3 and number 8.

Photo: Apt 10, Corofin house

• Current Conditions	
Type	Ground floor apartment
Year built	2007
Walls	Cavity – default U value 0.37 W/m2K
Floor	Above unheated basement – default U value 0.36 W/m2K
Roofs	Non heat losses
Windows	PVC, double-glazed, 12mm gap – default U value 2.2 W/m2K
Doors	Solid exposed door- default U value 3 W/m2K
Ventilation	Natural ventilation with 2 fans + 1 vent
Heating system	Electric direct acting heater
Heating Controls	Room thermostat
Secondary Heating	Integrated storage/direct acting heater
Hot water tank	Immersion 106 litre, 35mm spray foam

Key results – Apt 10, Corofin house

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
C2	183.08	36	1.62

Recommended Measures:

In this, the HLI is 1.26 W/K/m2, so this apartment is ideally suited to a heat pump upgrade.

Two options are recommended for consideration:

Option 1: install air to air heat pump for space heating, water heating by immersion

Option 1: install exhaust air heat pump plus a radiator system for both space and water heating.

Upgrade Analysis Results – option 1

Step	Apt 10, Corofin House	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step (kWh/m2/yr)	BER Score	HLI
0	Current State (DEAP 4) with shower & bath. Main U- value wall = 0.37.	183		C2	1.62
1	Install Air to Air heat pump (default system)	126	57	B3	1.62
2	Change all lights to LEDs	125	1	B2	1.62
	Total Primary Energy Reduction		58	N.A.	

Upgrade Analysis Results – option 2

Step	Apt 10, Corofin House	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step (kWh/m2/yr)	BER Score	HLI
0	Current State (DEAP 4) with shower & bath. Main U- value wall = 0.37.	183		C2	1.62
1	Install 4kW Exhaust Air heat pump (45 °C design flow temperature)	77	106	B1	1.8
	Total Primary Energy Reduction		106	N.A.	

6.4. 2 Clancy Court, Dublin 11, D11 Y018

Current Conditions	
Type	Semi-detached house
Year built	2006
Walls	Cavity – default U value 0.37 W/m2K
Floor	Solid floor with underfloor heating
Roofs	Ceiling floor default U value 0.25 W/m2k
Windows	PVC, double-glazed, 12mm gap – default U value 2.2 W/m2K
Doors	Solid door- default U value 3 W/m2K
Ventilation	Natural ventilation with 1 chimney + 3 fans
Heating system	Gas Boiler 91.1%
Heat emitter type	Underfloor pipes in concrete slab
Heating Controls	Programmer and room thermostat
Secondary Heating	Flush fitting live fuel effect 40%
Hot water tank	Indirect cylinder 72 litre, 35mm spray foam, heated by separate time control of DHW and NO cylinder thermostat

Current Results: 2 Clancy Court

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
C2	183.95	34.07	2.06

Recommended Measures:

The following measures have been evaluated.

Option 1: B2 target – gas boiler

- Adding TRVs to get to 50% of rads with TRVs
- Adding thermostat to the cylinder
- New gas stove with 60% and change chimney to flue
- Add PV array

Upgrade Analysis Results – option 1

Step	2 Clancy Court	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step	BER Score	HLI
0	Current State (DEAP 4) with shower & bath. U value wall = 0.37.	184		C2	2.06
1	Installing TRVs	175	9	C2	2.06
2	Installing Cylinder Thermostat	163	12	C1	2.06
3	Installing New stove 60%	152	11	C1	2.01
4	Installing PV panels of 2kWp	112	41	B2	2.01
	Total Primary Energy Reduction		**72**	N.A.	

Option 2: B2 target – heat pump

- Upgrade windows (to U=1.4)
- New gas stove with 60% and change chimney to flue
- Install an air-to-water heat pump

Upgrade Analysis Results – option 2

Step	2 Clancy Court		Reduction in Primary Energy per step	BER Score	HLI
0	Current State (DEAP 4) with shower & bath. U value wall = 0.37.	184		C2	2.06
1	New closed Stove 60%	174	10	C1	2.01
2	New windows (U=1.4, g=0.53)	170	4	C1	1.9
3	Installing 5kW Air to Water Heat Pump (55°C flow design)	103	67	B2	1.9
	Total Primary Energy Reduction		**81**	N.A.	

6.5. Apt 178, Timber Mills, Dublin 5, D05 XW84

Photo: 178 Timber Mills

Current Conditions - 178TM	
Type	Top floor apartment
Year built	2006
Walls	19 m2_Default U value 0.37W/m2K 23 m2_Exposed to unheated space
Floor	Non- heat loss
Roofs	Flat roof – default U value 0.25 W/m2k
Windows	Aluminium, double-glazed, 12mm gap – default U value 2.7 W/m2K
Doors	Solid semi-exposed- default U value 1.36 W/m2K
Ventilation	Natural ventilation with 2 fans + 3 vents
Heating system	Electric direct acting heater
Heating Controls	Thermostat only
Secondary heating	Integrated storage/direct acting heater
Hot water tank	Immersion 72 litre, 50mm spray foam, no cylinder thermostat

Current Results:

Current rating	**Primary energy Delivered (kWh/m2/yr)**	**CO2 Emissions (kgCO2/m2/yr)**	**HLI (W/K/m2)**
D1	225.46	44.33	2.02

Recommended Measures:

In the case of 178 Timber Mills, the logical upgrade is to switch from direct electric heating to heat pump. The current HLI is 2.02.

Two options are recommended for consideration:

Option 1: install air to air heat pump for space heating, water heating by immersion

Option 2: install exhaust air heat pump plus a radiator system for both space and water heating.

Upgrade Analysis Results – option 1

Step	178 Timber Mills	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step	BER Score	HLI
0	Current State (DEAP 4) with shower & bath. Main U value wall = 0.37.	225		D1	2.02
1	Change non-closable vents to closable vents	219	6	C3	1.96
2	Installing Air to Air Heat Pump (default system)	148	71	B3	1.96
3	Installing a radiator at the shared corridor	125.06	22	B3	1.41
4	Changing all the light to LEDs	124.67	0	B2	1.41
	Total Primary Energy Reduction		**101**	N.A.	

Note that this solution barely makes the B2 band.

Upgrade Analysis Results – option 2A

Step	178 Timber Mills	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step (kWh/m2/yr)	BER Score	HLI
0	Current State (DEAP 4) with shower & bath. Main U value wall = 0.37.	225		D1	2.02
1	Change non-closable vents to closable vents	219	6	C3	1.96
2	Installing 4kW Exhaust Air to Water Heat Pump (45°C design flow temperature)	97	122	B1	2.35*
3	Installing a radiator at the shared corridor	80	16	B1	1.74
	Total Primary Energy Reduction		**145**	N.A.	

The exhaust air heat pump easily achieves a B1 rating. However, it has the effect of increasing ventilation losses. This in turn so increases the HLI to 2.35, outside the permitted level for grant support.

An alternative approach is shown in Option 2B.

Upgrade Analysis Results – option 2B

Step	**178 Timber Mills**	**Primary Energy (kWh/m2/yr)**	**Reduction in Primary Energy per step (kWh/m2/yr)**	**BER Score**	**HLI**
0	Current State (DEAP 4) with shower & bath. Main U value wall = 0.37.	225		D1	2.02
1	Change non-closable vents to closable vents	219	6	C3	1.96
2	Installing 4kW Exhaust Air to Water Heat Pump (45°C design flow temperature)	97	122	B1	2.35*
3	ATT, 0.25 ac/h	94	3	B1	2.26*
	Total Primary Energy Reduction		**132**	N.A.	

In option 2B, an air tightness test is conducted and the assumed expected result is an air permeability of 5M3/hour/m2 (equivalent to 0.25 ACH). While we do not know if this is achievable, we have included this step to widen the scope of options.

6.6. 86 The Gallen, Dun Laoghaire, Co. Dublin

Photo: 86 The Gallen

Current Conditions – 86TG	
Type	Ground floor apartment
Year built	2003
Walls	External – cavity assumed. Default U= 0.55 W/m^{2}K. Area: 23m^2 Corridor – semi-exposed to unheated space. U=1.13 W/m^{2}K. Area = 32m^2
Floor	Semi-exposed over unheated car park
Roofs	Non-heat loss roof
Windows	PVC, double-glazed, 16mm gap – default U value 2.8 W/m^{2}K
Door	Default U value 1.36 W/m^{2}K
Ventilation	Natural ventilation with 3 fans / vents
Main Space Heating	Electric direct acting heaters
Secondary heating	Storage heater
Water Heating	Electric immersion, 135 litre cylinder, 35mm spray foam

Current Results:

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
D2	273.43	53.77	2.44

Recommended Measures:

Given this apartment was built in 2003 and has electric heating, the preferred option is to switch over to an air to water heat pump. The upgrade strategy involves taking measures to get the HLI value below 2.0.

Measures include:

- Adding additional insulation to exposed walls and heat loss wall to corridor
- Install new windows with U value of 1.4 of better
- Install an exhaust air heat pump

Upgrade Analysis Results

Step	86 The Gallen	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step (kWh/m2/yr)	BER Score	HLI	AIR (ac/h)
0	Current State (DEAP 4) with shower & bath. Uwall = 0.55.	273		D2	2.44	0.32
1	New windows (U=1.4), add internal insulation to exposed walls (U= 0.37)	250	23	D1	2.2	
2	New windows (U=1.4), insulate semi-exposed and exposed walls (U=0.37), new 4.5kW exhaust air heat pump	93	180	B1	1.98	
	Total Primary Energy Reduction		**180**	N.A.		

6.7. 21 Bremore Pastures Avenue, Flemington, Balbriggan, Co. Dublin K32YC52

Photo: 21 Bremore Pastures Avenue

Current Conditions – 21BPA	
Type	Mid-terrace house
Year built	2008
Walls	Assumed cavity wall – tbc. Default U= 0.37 W/m^{2}K. Area: 52m^2
Floor	Solid
Roofs	200mm attic insulation
Windows	PVC, double-glazed, 12mm gap, low-e – default U = 2.2 W/m^{2}K
Door	Solid, default U value = 3 W/m^{2}K
Ventilation	Natural ventilation with 3 fans / vents
Main Space Heating	Non-condensing gas boiler, Vokera Mynute, Efficiency = 80.1%. Programmer & room thermostat
Secondary Space Heating	Direct electric heater
Water Heating	Gas boiler (as above). 117 litre cylinder, 25mm spray foam thermostat with cylinder thermostat

Current Results:

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
C1	155.41	29.17	1.84

Recommended Measures:

The HLI is already less than 2 so the logical option is to change from a non-condensing gas boiler to an air-to-water heat pump, along with minor measures.

Upgrade Analysis Results

Step	21 Bremore Pastures Avenue	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step (kWh/m2/yr)	BER Score	HLI
0	Current State (DEAP 4) with electric shower & bath. Uwall = 0.37.	155		C1	1.84
1	Top up attic insulation to 300mm fibre, new 8kW heat pump, change all lights to LED/CFLs	88	67	B1	1.81
	Total primary Energy Reduction		**67**	N.A.	

6.8. 10 Bridge Apartments, McCurtain Street, Mullingar, Co. Westmeath, N91XR91

Photo: 10 Bridge Apartments

Current Conditions -10BA	
Type	Top-floor apartment
Year built	1996
Walls	Assumed cavity wall – to be confirmed. Default U= 0.55 W/m^2K. Area: $40m^2$
Floor	Non-heat loss floor
Roofs	100mm attic insulation
Windows	PVC, double-glazed, 16mm gap – default U value 2.8 W/m^2K
Door	Default U value 3 W/m^2K
Ventilation	Natural ventilation with 2 fans / vents
Main Space Heating	Electric direct acting heaters
Secondary Space Heating	Storage heater
Water Heating	Electric immersion, 96 litre cylinder, 35mm spray foam

Current Results:

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
C2	222.24	43.7	2.02

Recommended Measures:

In this case, fabric upgrades will get the HLI below 2. This will be possible also without the window upgrade, which can be reviewed should the upgrade project proceed.

These changes thus enable the switchover to exhaust air heat pump to be propose.

- Increase attic insulation to 300mm
- New windows & door (U = 1.4 W/m^2K)
- Exhaust air heat pump

Upgrade Analysis Results

Step	10 Bridge Apartments, Mullingar	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step	BER Score	HLI
0	Current State (DEAP 4) with shower. Uwall = 0.55.	222		C3	2.02
1	Top up attic insulation to 300mm, New windows & doors (U=1.4), all lighting to LED/CFL	170	52	C1	1.55
2	4.5 kW Exhaust Air Heat Pump	112	58	B2	1.93
	Total primary Energy Reduction		**52**	N.A.	

6.9. Apt. 1, Church Street, Dundalk

Photo: Apt 1, Church Street, Dundalk

Current Conditions -Apt 1, Church Street	
Type	Ground floor apartment
Year built	2004
Wall 1	Cavity wall. Default U= 0.55 W/m^2K. Area: $23m^2$
Wall 2	Semi-exposed wall to rear (not accessible). U= 1.13 W/m^2K. Area: $39m^2$
Floor	solid
Roofs	n/a
Windows	PVC, double-glazed, U= 3.1 W/m^2K
Door	Default U value 3 W/m^2K
Ventilation	Natural ventilation with 2 fans / vents
Main Space Heating	Electric direct acting heaters
Water Heating	Electric immersion, 160 litre cylinder, 50mm spray foam

Current Results:

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
D2	282.65	55.58	2.56

Recommended Measures:

It was unclear during the survey is the wall to the rear adjacent to the commercial space has been insulated. If any evidence can be provided on this, the calculation can be revised in due course. In the interim the recommended measures are as follows:

- Internal wall insulation (to exposed wall to front)
- New windows & door (U = 1.4 W/m^{2}K)
- Wet central heating system, heat pump and heating controls

Upgrade Analysis Results

Step	Apt. 1, Church Street, Dundalk	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step	BER Score	HLI
0	Current State	283		D2	2.56
1	internal wall insulation	224	59	C3	1.82
2	windows & door upgrade	209	15	C3	1.69
3	new central heating system with heat pump	100	109	B2	1.69
	Total primary Energy Reduction		**183**	N.A.	

6.10. Apt.2 , Church Street, Dundalk

Current Conditions -Apt 2, (above Tuath office) Church Street	
Type	Mid floor apartment
Year built	Pre 1900
Walls	Stone wall & 0mm insulation with plasterboard. Default U= 1.41 W/m^2K. Area: $74m^2$
Floor	Above office & apartment below
Roofs	n/a
Windows	Single glazing
Ventilation	Natural ventilation with 2 fans / vents
Main Space Heating	Electric direct acting heaters
Water Heating	Electric immersion, 96 litre cylinder, 50mm spray foam

Current Results:

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
F	383.82	75.47	4.11

Recommended Measures:

It was understood that walls have been dry-lined with insulation but we have no formal evidence of the depth and type of insulation product in situ. wall to the rear adjacent to the commercial space has been insulated. If any evidence can be provided on this, the calculation can be revised in due course. In the interim the recommended measures are as follows:

- Internal wall insulation
- New windows (U = 1.4 W/m^2K)
- Wet central heating system, heat pump and heating controls

As the apartment sits above an office, unless the office can be shown to have the same heating regime as defined for a dwelling by the DEAP method, (heated 8 hours per day, 7-9am, 5-11pm, October to May), then the floor is designed as partially heated below, with resultant heat losses.

Upgrade Analysis Results – v1

Step	Apt. 2, Church Street, Dundalk	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step	BER Score	HLI
0	Current State	384		F	4.11
1	internal wall insulation	283	101	D2	2.84
2	windows & door upgrade	239	44	D1	2.35
3	new central heating system with heat pump	102	138	B2	2.35
	Total primary Energy Reduction		**282**	N.A.	

Upgrade Analysis Results – v2

If confirmation is provided that the office has the same heating pattern as for the apartment above, then the floor would not be considered to be a heat loss floor.

Step	Apt. 2, Church Street, Dundalk	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step	BER Score	HLI
0	Current State	384		F	4.11
1	internal wall insulation	283	101	D2	2.84
2	windows & door upgrade	239	44	D1	2.35
3	new central heating system with heat pump - no heat loss floor	72	167	A3	1.3
	Total primary Energy Reduction		**312**	N.A.	

6.11. Apt. 3, Church Street, Dundalk

Current Conditions -Apt 3, (Rear of Tuath office) Church Street	
Type	Mid floor apartment
Year built	1900
Wall 1	Stone wall (1900) & 0mm insulation with p'board. Default U= 1.41 W/m^2K. Area: 65m^2
Wall 2	Cavity wall (2000) - Default U= 0.55 W/m^2K. Area: 22m^2
Floor	Solid – assumed all replaced in 2004
Roofs	Small flat roof section – 10m^2
Windows	PVC, double-glazed, U= 3.1 W/m^2K
Door	Default U value 3 W/m^2K
Ventilation	Natural ventilation with 2 fans / vents
Main Space Heating	Electric direct acting heaters
Water Heating	Electric immersion, 96 litre cylinder, 50mm spray foam

Current BER:

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
E2	347.72	68.37	3.31

Recommended Measures:

It was understood that walls have been dry-lined with insulation but we have no formal evidence of the depth and type of insulation product If any evidence can be provided on this, the calculation can be revised in due course. In the interim the recommended measures are as follows:

- Internal wall insulation
- Flat roof insulation
- New windows & door (U = 1.4 W/m^{2}K)
- Wet central heating system, heat pump and heating controls

Upgrade Analysis Results

Step	Apt. 3, Church Street, Dundalk	Primary Energy (kWh/m2/yr)	Reduction in Primary Energy per step	BER Score	HLI
0	Current State	348		E2	3.31
1	internal wall insulation	227	121	D1	1.99
2	Flat roof insulation	225	2	C3	1.97
3	windows & door upgrade	210	17	C3	1.82
4	new central heating system with heat pump	96	114	B1	1.82
	Total primary Energy Reduction		**252**	N.A.	

6.12. Apt. 7, Church Street, Dundalk

Current Conditions -Apt 7, (Rear of Tuath office) Church Street	
Type	Mid floor apartment
Year built	Pre 1900
Wall 1	Stone wall (1900) & 0mm insulation with p'board. Default U= 1.41 W/m^2K. Area: 68m^2
Wall 2	Cavity wall (2000) - Default U= 0.55 W/m^2K. Area: 22m^2
Floor	Non-heat loss
Roof 1: -ceiling level	100mm insulation - 25m^2
Roof 1: -sloped	Not accessible – so evidence of insulation – 15m2
Windows	PVC, double-glazed, U= 3.1 W/m^2K
Door	Default U value 3 W/m^2K
Ventilation	Natural ventilation with 2 fans / vents
Main Space Heating	Electric direct acting heaters
Water Heating	Electric immersion, 96 litre cylinder, 35mm spray foam

Current Results:

Current rating	Primary energy Delivered (kWh/m2/yr)	CO2 Emissions (kgCO2/m2/yr)	HLI (W/K/m2)
E1	313.93	61.73	3.11

Recommended Measures:

It was understood that walls have been dry-lined with insulation but we have no formal evidence of the depth and type of insulation product If any evidence can be provided on this, the calculation can be revised in due course. In the interim the recommended measures are as follows:

- Internal wall insulation
- Attic & sloped roof insulation
- New windows & door (U = 1.4 W/m^2K)
- Wet central heating system, heat pump and heating controls

Upgrade Analysis Results

Step	**Apt. 7, Church Street, Dundalk**	**Primary Energy (kWh/m2/yr)**	**Reduction in Primary Energy per step**	**BER Score**	**HLI**
0	Current State	314		E1	3.11
1	internal wall insulation	219	95	C3	2.07
2	attic insulation	211	9	C3	1.98
3	sloped roof insulation	168	42	C1	1.55
4	windows & door upgrade	148	71	B3	1.36
4	new central heating system with heat pump	83	66	B1	1.36
	Total primary Energy Reduction		**231**	N.A.	

7. Energy Audits of Non-Domestic Buildings

7.1. Methodology

Energy audits were conducted on two of Tuath Housing Office buildings:

- 33 Leeson Street Lower, Dublin 2
- 17 Church Street, Dundalk

Detailed energy audit reports were conducted and a separate report has been produced for each building.

7.2. Results

The content of the energy audit reports will not be repeated here but a range of improvements were recommended for each building, some with short to medium terms paybacks and others with very long-term paybacks.

As a minimum, each non-domestic building should record and track their own energy use and CO_2 footprint annually.

8. Register of Opportunities (ROO)

8.1. BER Database Stock Summary

From the BER database analysis in Section 3 for the 2,920 dwellings xmls with B ratings and below, key summary data to influence retrofit planning are as follows:

- 1,699 (58%) of the 2,920 stock is apartments.
- 91.5% of the stock dates from 2000 onwards.
- The predominant wall type post 2000 is cavity and timber frame
- 67% of the stock is well insulated with a U value less than or equal to 0.37 W/m2K. 31% is deemed not well insulated and just 2% is uninsulated.
- window upgrades would be recommended for one third of the dwelling stock.
- 57% of the dwellings are heated by gas, 32% by electricity, 8% by oil, 3% by LPG and <1% by solid fuels.
- oil use applies exclusively applies to houses whereas electric heating is predominantly in apartments
- there are approximately 470 non-condensing boilers in houses and 420 non-condensing boilers in apartments

Of course, it is important to remember that of the 2920 BER records in the database analysis, 617 are Tuath-owned and 2303 are leased.

The ROO will focus on the retrofit of Tuath's owned stock of 966 dwellings worse than B2 out to the end 2027.

8.2. Tuath Own Stock - Master Tracker Plans for 2022 & Beyond

Tuath's Master Tracker lists 966 Tuath-owned dwellings that are being considered for retrofit by end 2027.

96 units were upgraded in 2021 and 187 units are scheduled for B2 upgrades in 2022.

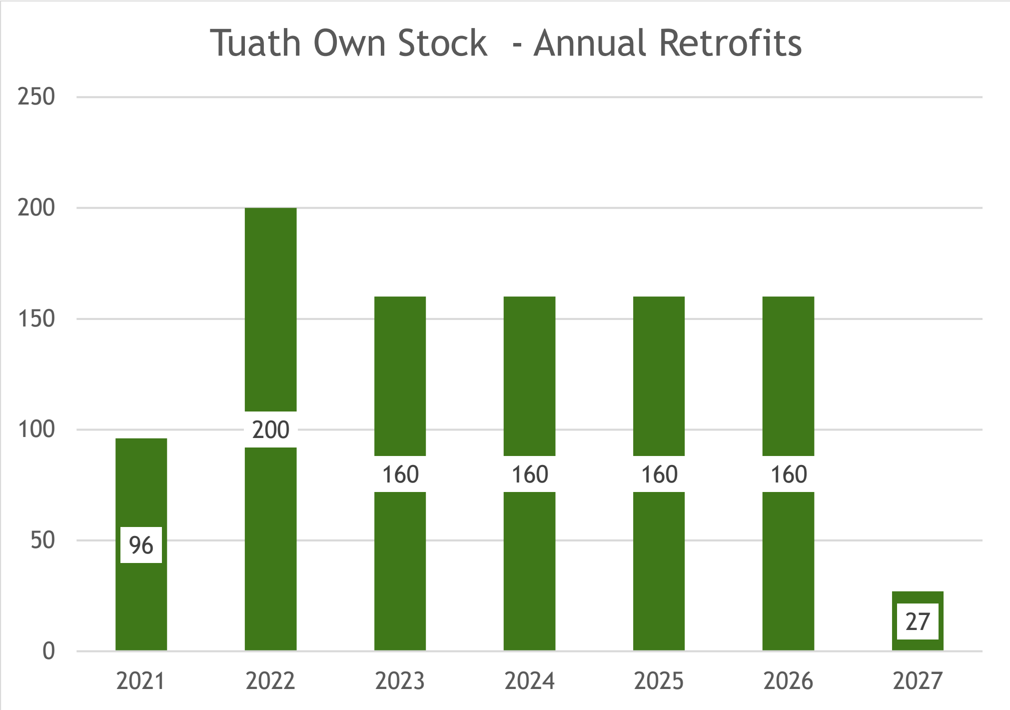
If a similar annual target was set out to 2027, all 966 Tuath owned dwellings would be upgraded to B2.

Table 11: Planned Retrofit of Tuath-owned Stock

	Annual	Cumulative	% Complete
2021	96		10%
2022	200	296	31%
2023	160	456	47%
2024	160	616	64%
2025	160	776	81%
2026	160	936	97%
2026	27	963	100%

IHER Energy Services Ltd

Figure 15: Planned Retrofit of Tuath-owned Stock



8.3. Tuath Leased & Managed Stock

As indicated in Section 2, Tuath List A comprises 2,546 dwellings with BERs in range B3 or worse. As 966 Tuath-owned, then the balance of 1580 would be deemed to be leased or managed units.

It is acknowledged that a retrofit strategy needs to be developed for the leased/ managed stock, as this tock must also be addressed in the context of the Climate Action Plan. However, this strategy needs to be developed in conjunction with the building owners. As this will require a longer planning timeframe, the retrofit strategy for this segment of the stock will not be addressed specifically in this EMP.

8.4. Retrofit Plan for Tuath-owned Houses

In order to create a register of opportunities, the overall retrofit strategy for the Tuath-owned stock was discussed with the Tuath Housing team.

The Tuath Master Tracker includes the following split of its 966 dwellings.

Table 12: Tuath-owned Stock

House	418
Apartment	528
Maisonette	12
Part of House	8
Total	966

Focussing on Tuath-owned houses, the range of measures completed in 2021 and planned for 2022 was analysed, and following discussion with the Tuath team, the same measures were then assumed pro-rata for the entire stock of 418 houses.

This projection is detailed in Table 13.

Table 13: Retrofit Measures for Tuath-owned Houses

House Types	Proportion	Count	type	Measures				
Type 1	10%	42	pre 1977	attic	heat pump		EWI	windows
Type 2	30%	125	1994-2004	attic	heat pump	CWI		windows
Type 3	50%	209	2005-2010	attic	heat pump			
Type 4	10%	42	1994-2004	attic	heat pump			windows
Total		**418**						

As the residential surveys did not cover all of types 1 to 4 above, house typology analysis from the BERWOW tool (developed by IHER) were used to produce the BER results and costs for the measures in Table 13. The results were then used to populate the ROO. BERWOW contains updated industry average cost for measures.

The BERWOW typologies used are shown below, and of course can be freely explored on BERWOW.

8.5. Retrofit Plan for Tuath-owned Apartments

For Tuath-owned apartments, following discussion with the Tuath team, it has been initially decided to assume exhaust air heat pumps will be fitted as the key heating system upgrade measure to apartments heated by electricity or gas.

This projection is detailed in Table 14.

Table 14: Retrofit Measures for Tuath-owned Apartments

Types	Proportion	Count	type	Measure
Type5	69%	377	electric	exhaust air HP
Type 6	11%	60	gas condensing	exhaust air HP
Type 7	20%	111	gas non-condensing	exhaust air HP
Total*		**548**	* include maisonettes & part of house	

The BER analysis for the Macken Street apartment (Section 6.2) was used to produce BER results for Type 5. Type 6 and 7 were combined and a sample gas non-condensing apartment BER from the main dataset was used to produce the BER upgrade results.

9. Populating the ROO

The upgrade analysis results for the 6 categories of dwelling types shown above have been entered in the Register of Opportunities master spreadsheet in order to summarise the metrics of the proposed energy upgrade programme.

The number of each dwelling type and all associated data from the upgrade analysis is also entered (e.g. pre & post BER scores, costs of measures, energy savings, energy credit values). This data is then combined to estimate the summary data for the Tuath-owned housing stock.

The first table (from the RoO) shows the projected energy, fuel costs and CO2 savings per annum arising from the proposed measures.

Ref	Opportunity	Number of units	Fuel Type	Estimated Annual Savings		
				[kWh]	[€]	[kgCO2]
001	House (Pre 1977) - solid wall need EWI	42	Natural Gas	483,210	€23,436	118,386
002	House (1994-2004 mid terrace)	125	Natural Gas	771,750	€18,750	189,079
003	House (2005-2010)	209	Natural Gas	1,711,710	€10,450	419,369
004	House (1994-2004 semi)	42	Natural Gas	65,057	€14,910	15,939
005	Mid floor apartment, 2005, electric	377	Electricity	2,529,957	€260,130	1,313,047
006	Ground floor apartment, 2005, gas non-condensing boiler and gas condensing	171	Natural Gas	995,904	€43,092	243,996
	Total	966		6,557,588	€370,768	2,299,817

The estimated annual savings would amount to 6.57GWh in energy ,€371,00 in running costs and 2,300 tonnes of CO2.

The second table (from the RoO) shows the capital costs, potential grant funding and possible energy credit values both of which are netted off to give the net capital costs. The simple payback is also shown.

The total capital cost for the programme up to 2027 is estimated at €17.7m. If 50% grant funding is available and energy credits continue at current levels, the net capital cost would be €7.9m.

Ref	Opportunity	Number of units	Capital Cost	Potential Grant Funding	Energy Credit Value	Net Capital Cost
001	House (Pre 1977) - solid wall need EWI	42	€1,390,200	€695,100	€58,338	€636,762
002	House (1994-2004 mid terrace)	125	€3,006,250	€1,503,125	€214,250	€1,288,875
003	House (2005-2010)	209	€4,692,050	€2,346,025	€244,321	€2,101,704
004	House (1994-2004 semi)	42	€1,071,000	€535,500	€51,408	€484,092
005	Mid floor apartment, 2005, electric	377	€4,147,000	€2,073,500	€250,328	€1,823,172
006	Ground floor apartment, 2005, gas non-condensing boiler and gas condensing	171	€3,369,726	€1,684,863	€113,544	€1,571,319
	Total	966	€17,676,226	€8,838,113	€932,189	€7,905,924

9.1. Funding

With regard to grant and other financial supports, there are SEAI grants and energy credits available from Energy Suppliers that can be factored into the investment analysis.

SEAI Grant Funding

SEAI's Energy Communities Grants Guidelines 2019 advise that grant funding up to 50% is available to Housing Associations.

https://www.seai.ie/resources/publications/Community-Grant-Guidelines-2019.pdf

The current Community Grant guidelines are not entirely clear but do state on page 23 that "Housing Associations and Local Authorities should contact SEAI directly to discuss options for participation in the Communities Energy Grant scheme in 2019 in relation to domestic works."

Energy Credits

An obligated party is a supplier or distributor selling more than 600 GWh of energy per year to final customers. The Energy Efficiency Obligation Scheme (EEOS) sets out a legal obligation for obligated parties to achieve energy efficiency savings each year from 1st January 2014 to 31st December 2020.

The Minister for Communications, Climate Action and Environment set an annual scheme target of 550 GWh in SI 131 of 2014. Following a consultation in 2016, this annual target increased to 625 GWh for 2017. It rose to 700 GWh from 2018-2020. Targets are allocated to each obligated party based on their share of the energy market. This is calculated in terms of sales volume to final customers. Each company's target is divided across three sectors: 75% non-residential, 20% residential and 5% energy poverty (residential).

From 2017 onwards, obligated parties were required to achieve at least 95% of their annual targets (cumulatively) each year. These targets will help Ireland meet the 2012 EU Energy Efficiency Directive.

Under the Energy Efficiency Obligations Scheme (EEOS), there are fixed energy credits (kWh) assigned to energy upgrade measures. The latest energy credit table is available at https://www.seai.ie/resources/publications/Energy_Saving_Credits_Table.pdf

Energy suppliers typically pay in the region of 8-12 cents per energy credit in order to acquire credits to meet the annual energy savings targets set for them under EEOS. For this Tuath Housing EMP study, the Register of Opportunities file was edited to include calculation of energy credits under a new "Savings" tab. A nominal value of 10c/kWh was set for demonstration purposes. However, it should be noted that energy credits have a higher value if the energy savings are achieved in fuel poor households.

9.2. Leased Managed Stock

My own preferences would be:

- develop clear strategy for dwellings pre 2000 (250 approx)
- make a firm decision on how to retrofit apartments with electric heating
- decide strategy for houses and apartments built from 2000-2004 with non-condensing and condensing boilers
- decide strategy for houses and apartments built after 2004 with non-condensing and condensing boilers

As stated in Section 2, 7,050 dwellings are leased/managed whereas 950 are owned by Tuath. The **Tuath_All properties below B2** List A contain 2,546 dwellings with BERs in the ratings range B2 down to G. 938 units on this list are Tuath-owned and thus the balance of 1608 units would be leased/ managed.

However, the BER database of 2920 records contains 1728 leased dwellings with ratings worse than B2. As the BER database only contained BER data on 63% of the units listed in the Master Tracker, if the same extrapolation is conducted, this would indicate approximately 2,750 leased dwellings below B2.

Thus the task to upgrades the leased dwellings is roughly 2.5 to 3 times the task to upgrade the Tuath-owned stock.

9.3. Follow up actions

In order to enable a more comprehensive database of all stock both owned and leased, it would be desirable to obtain BER certificates for all stock. Then, a regular annual refreshment of a BER database/ analysis tool could be developed to give a true picture of the entire stock.

While such as Database will never be 100% accurate due to the fluidity of the total stock, it would be sufficiently robust to be of considerable use for planning and reporting purposes.

The following steps would be recommended:

- Get a definitive list of MPRNs for all Tuath dwellings
- Send this list to SEAI and ask them to run a report advising which dwelling do or do not have BER certs
- Put a programme in place to get BER surveys done where no cert exists
- Then seek SEAI agreement to run a special report to list selected BER variables for all Tuath dwellings (using MPRN list)
- Produce a summary BER report on all owned and leased manged stock

10. Measures & Technologies

While many of the recommended measures are well known, general information is provided below on the main technologies proposed for adoption within the EMP (and others such as demand control ventilation and PV which are not included in the recommendations but may be considered for specific projects).

10.1. Heating Controls Package

To subdivide the home into independently controlled space heating and water heating zones, motorized controlled valves must be installed, along with at least one room thermostat and/ or thermostatic radiator valves (TRVs), a hot water cylinder thermostat (if required) and a 7-day programmable timer. The cylinder and room thermostats can then operate to create a boiler interlock to ensure your boiler only operates when required.

10.2. Air-to Water Heat Pump

In the last decade **air-to-water heat pumps** have become a popular renewable choice for heating and hot water systems, suitable for new and retrofit projects. As this is a relatively new technology, a lot of questions arise which give rise to many misconceptions.

What is a Heat Pump and what is an Air-to-water heat pump?

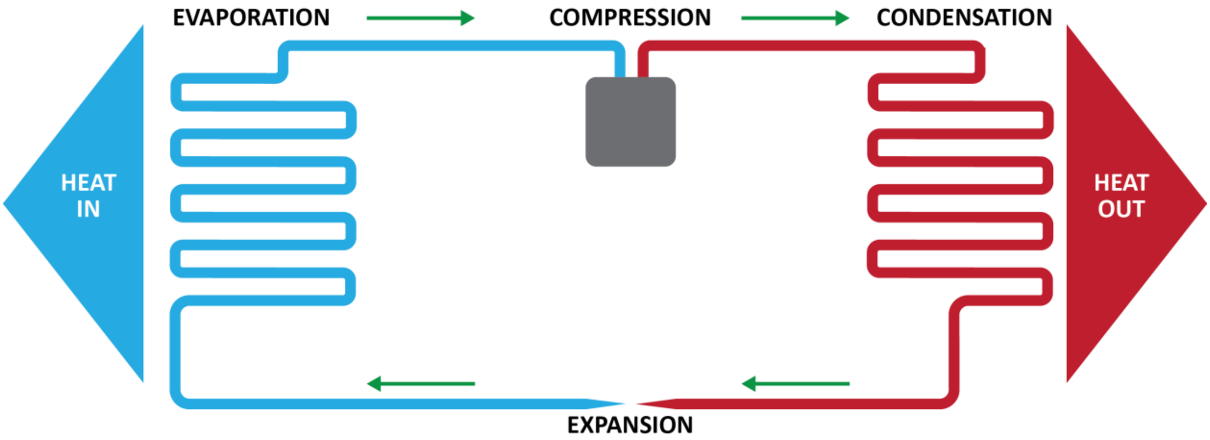
Heat Pump technology is being used in one of the most common appliances in our homes – the fridge. The principle of a heat pump is to move energy by the means of electricity, refrigerant gas and a compressor and in doing so, can provide both space heating, hot water and cooling.

To cool, the heat pump extracts heat from a warmer ambient e.g. the food in the fridge; and dumps it. To heat, the heat pump extracts heat from the air outside our homes and tranfers it inside our homes.

An AIR-TO-WATER heat pump transfers the heat obtained from the outside air to the water in our heating systems.

How does the Air-to-water heat pump work?

Air passes the heat exchanger outside called the EVAPORATOR and the refrigerant gas absorbs heat from outside air and evaporates. The vapour passes into the compressor and by compression increases its temperature and pressure. Hot vapour is condensed in the 2nd heat exchanger, the heat being passed via water to the space heating or domestic hot water system. The liquid refrigerant passes back through the expansion valve, reducing its pressure ready to start the cycle again.



What happens when outside temperature are very low?

Most air-to-water heat pumps are equipped with an electrical back-up heater, which can be programmed to provide heating when external temperatures fall below a specified point. This point is called equilibrium temperature and is usually set at -3 °C but in most cases the electrical back-up is not required for heating at all. Traditionally, manufacturers in the heat pump industry have their air-to-water heat pumps designed to suit the European climate working even at outdoor temperatures of -25 °C.

What is the efficiency of an the Air-to-water heat pump?

A heat pump's efficiency is often referred to as a **Coefficient of Performance (COP).** The COP describes the **ratio of electrical power used to heating power produced** under fixed input and output conditions by the heat pump unit only. A COP is used for examining the performance of a heat pump unit at ideal test conditions, usually in a laboratory.

A COP of 4 means for every 1kW of electrical energy used, 4kW of useful energy is produced – a net 3kW of useful energy will be 'free' generated by the heat pump. The COP decreases with falling ambient air temperatures and rising flow temperatures.

The Seasonal Performance Factor (SPF) or Seasonal Coefficient of Performance (SCOP) describes the ratio of the amount of electrical energy used by all components associated with the heat pump system, to the amount of heat energy delivered to the heating system, over a long period of time (e.g. season or year).

SPF is a better indicator of performance for the purposes of examining the "real-life" performance of a heat pump than COP and takes into account the full heating system installed.

Does the type of heat emitter have an affect on the SPF?

SPF values may vary depending on the type of heat emitters used and aiming for a low flow temperature will result in high SPF figures. Ideally with an Air-to-water heat pump we should use an UFH – underfloor heating system because this only requires flow temperatures up to 35°C, resulting in SPFs over 500%.

We can also use low temperature radiators, aluminium or steel panel or fan coils which require flow temperatures up to 55 °C, resulting in SPF's around 400%.

The hot water production efficiency though for any heat pump it is not that high due to the high flow temperature required to heat water. This figure is in around the 200% mark and takes into account that most air-to-water heat pumps require an electrical immersion to raise the temperature in the tank to 60 °C, as an anti-legionella protection.

Are there any specific requitrments when applying for a heat pump grant?

SEAI launched a new heat pump grant in April 2018. Before applying for the heat pump grant, a homeowner must be able to demonstrate their house has good levels of insulation and air tightness. The homeowner needs to engage the services of an SEAI registered Technical Advisor to perform an energy audit and BER calculation to prove that total heat loss is less than or equal to 2 Watts/m^2 as calculated in the BER software. More details are available on https://www.seai.ie/grants/home-energy-grants/heat-pump-systems/

10.3. Air-to -air heat pump

Air-to air heat pumps deliver warm air via fans to rooms within the dwelling. Typically an electric immersion would provide hot water.

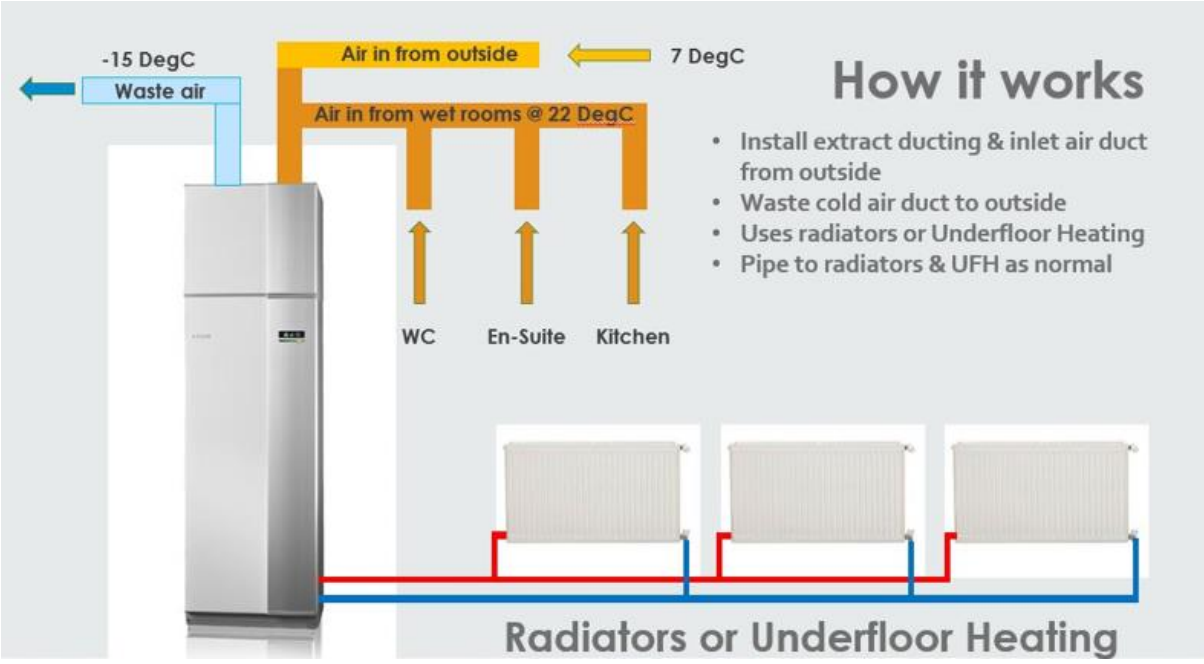
Homeowners and tenants are found to either like or dislike this form of room heating, so it does not suit everyone.

Air-to-air systems do not score as well as other heat pump systems in BER calculations and so may fail to enable to the target of B2c to be achieved.

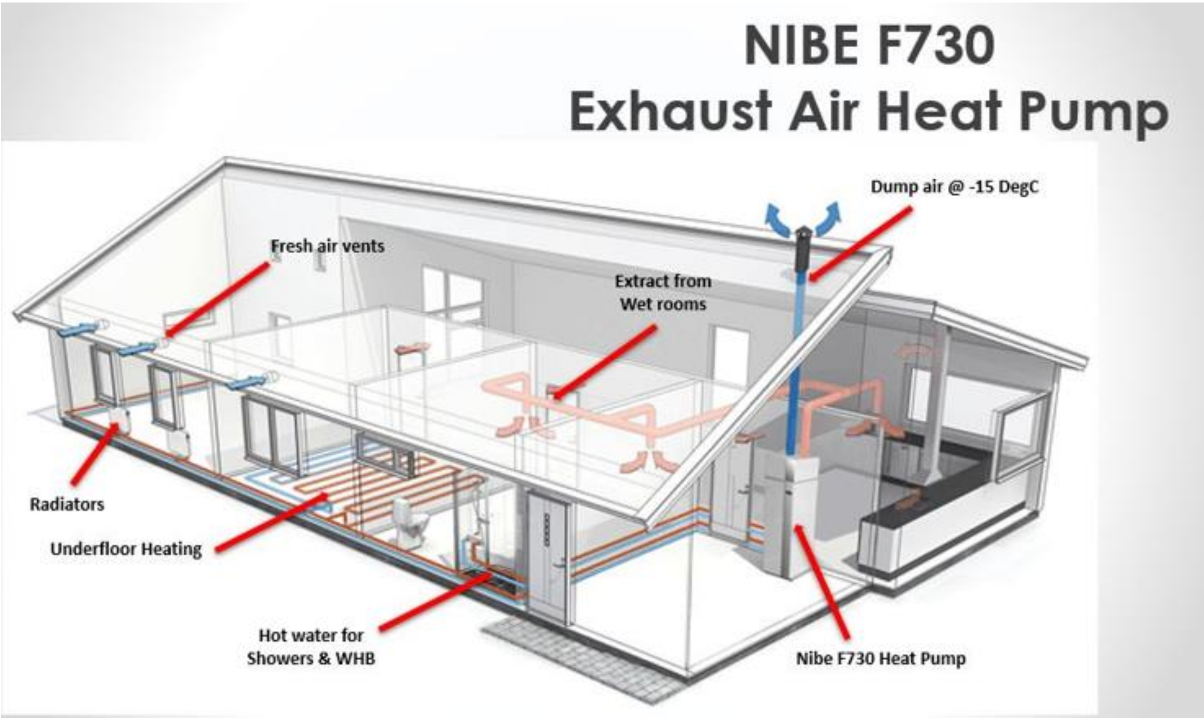
10.4. Exhaust air heat pump

An **Exhaust Air Heat Pump (EAHP)** extracts heat from the exhaust air of a building and transfers the heat to the supply hot tap water and space heating system via radiators or an underfloor heating network.

The graphic below *(included courtesy of Unipipe Ltd, NIBE suppliers in Ireland) illustrates how an exhaust air heat pump uses the warmed exhaust air to supply the heat pump which then feeds the heating network.



The schematic below (included courtesy of Unipipe Ltd, NIBE suppliers in Ireland) illustrates the location of the various components of an exhaust heating system including vents, extracts, ducting, the heat pump itself and the heating distribution system.



In the schematic above, there is a single fan that extracts from the wet rooms and one end of the kitchen area. This creates a negative pressure and fresh make up air is drawn through fresh air vents in other rooms. The vents are of a special design that diffuse the incoming air so that the occupants are unaware of the air movement.

During commissioning, ceiling grilles and the fan speed is adjusted to achieve the required ventilation rates using hot wire anemometers.

As well as providing both space heating and wate heating, the exhaust air heat pump also provides a regulated ventilation regime which is a significant extra feature. Many apartments have inadequate ventilation and ineffective air extraction, especially if bathrooms are located internally in the layout. This often leads to poor air quality and the build-up of damp and mould problems. The ventilation features of the exhaust air heat pump provides a solution to historic air quality issues in many cases.

Note: The authors of the report are not recommending any specific suppliers or models but are using available graphics for illustration purposes only.

10.5. Demand Control Ventilation

Demand control ventilation (DCV) provides a smart whole-house ventilation system. DCV is particularly appropriate in retrofit projects as it avoids the needs for extensive ductwork associated with mechanical heat recovery ventilation (MHRV) systems.

DCV works using humidistat-based vents in bedrooms and living rooms. These vents have a clever material strip that expands and opens the vents wider when humidity levels are higher and contracts and thus closes the vent again when humidity levels are returned to normal. These inlet vents have no mechanical or electrical parts.

DCV uses extract grilles to take air away from wet rooms like kitchens and bathrooms in ducts connected to a central point. A central fan exhausts unwanted air out of the building.

Both the inlets and the extract grilles react to indoor air quality (IAQ) and thus adjust the rate of airflow; the fan detects these changes in pressure, which means there are no cables or controls needed, and adjusts its running speed accordingly. The fan is typically very quiet (about the same as a PC) and uses minimal electricity (about the same as a low energy light bulb). It does not require filter changes or regular servicing.

10.6. Solar Photovoltaic (PV)

Solar PV panels generate electricity that is then fed via an inverter into the home's distribution board. It is important that the number of PV panels and thus the power generated in watts matches the base/ minimum electrical load of the house. At the moment, and it would appear for the foreseeable future, there is, and will be, no feed-in tariff for electricity generated in homes. Thus, if you don't use it, you'll lose it (to the ESB network).

As well as supplying electricity for normal household devices, PV-generated electricity can also be used to supply heat pumps, electric car batteries and also can be diverted to electric immersions in hot water tanks. New battery technologies will also enable some of the electricity generated to be stored.

11. Behavioural Measures

The following behavioural measures are recommended.

Behaviour 1. Implement an energy awareness campaign with all tenants to advise on how to use water heating and space heating systems most economically.
Behaviour 2. Engage with the relevant Local Authority to explore opportunities to work in partnership to achieve energy savings across all building stock.
Behaviour 3: Develop an Energy Booklet for Tuath Housing Tenants providing information and support.
Behaviour 4: Consider specific training in the area of storage heaters and how these should be operated in order to reduce energy consumption and cost.

12. Key Assumptions

In developing the EMP analysis, IHER made a number of important assumptions:

Source Data including Industry Average Cost of Works and Energy Costs

IHER normally uses a combination of the cost of works from a variety of sources to arrive at typical industry costs. Tuath Housing provided their most recent average costs of measures and these average costs are listed in Appendix A.

Final contractor prices will naturally vary from these industry average costs.

Calibration Factors and Payback Analysis

Care needs to be taken when using BER-based energy usage results to calculate annual energy costs. The BER methodology assumes a home is heated from October to May for 8 hours per day with the living room heated to 21°C and the rest of the habitable rooms heated to 18°C. This same assumption applies equally to a G-rated house or an A-Rated house. While there is no major study in Ireland exploring this topic, several EU studies have shown that a G-rated property might only use 50% of the energy predicted by the BER calculation as it would be too expensive to heat it to the assumed heating pattern.

Thus it makes sense that a calibration factor should be applied to the BER-calculated energy values to more accurately reflect running costs and savings arising from upgrade measures.

For the Tuath Housing analysis, IHER has introduced a calibration factor into the BER-based energy costs calculation.

Energy Costs

Energy costs are based on the SEAI domestic fuel price values (01 October 2021) listed in the table below. SEAI issues fuel price table every 6 months. The recent surge in fuel and energy costs will be reflected in the next issues on published data on 1st April 2022.

Note that as heat pumps often operate 24 hours per day, SEAI's fuel price data also provides calculated electricity costs for space heating and water heating via heat pumps.

Energy Prices (per kWh delivered including VAT, October 2021)

Gas	€0.06
Oil	€0.073
Electricity	€0.22
Smokeless	€0.063
Wood logs	€0.096
El.HP.water	€0.12
El.HP.space	€0.17

Appendix A

Industry Average Cost of Measures (2022)

Measure Pricing (Industry Average)	
Attic insulation (m^2)	€ 24
Sloping roof insulation (m^2)	€ 160
Flat roof insulation (m^2)	€ 160
Cavity fill insulation (m^2)	€ 20
Internal wall insulation (m^2)	€ 160
External wall insulation (m^2)	€ 240
Suspended floor insulation (m^2)	€ 45
2G Windows (m^2)	€ 430
3G Windows (m^2)	€ 500
Doors (m^2)	€ 850
Condensing boiler	€ 2,800
Heating controls package	€ 1,600
Wood stove	€ 4,000
Exhaust Air Heat Pump & new radiator system	€ 11,000
Demand Control Ventilation & Air tightness	€ 3,500
Photovoltaic panels (6 units)	€ 7,500
Solar thermal ($2m^2$)	€ 8,500
Low energy lights	€ 150