
The Daylesford Trust

Energy & Sustainability Assessment

Proposed refurbishment of existing building and extension for 4no apartments
@ 84-86 Oldham Street, Manchester

07 May 2020

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CIBSE Accreditation Nos:

LCCSIM084077

LCCD084077

LCEA084077

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Issue Status

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First Issue Date	Revision Issue Date	Issue Revision	Issued By
May 7, 2020			DW



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1. Executive Summary

This document is in response to the Manchester City Council's Development Framework Core Strategy July 2012. It specifically addresses the following relevant planning policies:

- **EN 4 Reducing CO2 Emissions by Enabling Low and Zero Carbon Development.**
- **EN 6 Target Framework for CO2 reductions from low or zero carbon energy supplies.**

The report details how the development will incorporate Sustainable Design and resource efficiency measures in accordance with the Energy Hierarchy, so to meet the policy requirements and reduce its overall environmental impact. The methodology and calculations are consistent with the MCC Appendix A EN6 Energy Target Explanation.

In relation to policy EN 6, the development is required to achieve a 15% Carbon Reduction over Part L 2010 Compliancy of the Building Regulations. This equates to a 9% Carbon Reduction over Part L 2013 Compliancy.

In order to demonstrate this 9% reduction in carbon emissions, resource efficiency measures and the application of Low / Zero Carbon technologies have been considered and implemented.

The figures used within this report have been based on the most recent issue of drawings (May 2019) and modelled using SAP 2012 (domestic) and to accurately predict Energy Usage and CO₂ reductions.

All dwellings will utilise electric heating and hot water and the U Values and design targets specified exceed Part L 2013 compliance.

Following the LZC feasibility assessment, it is proposed that the development will not benefit from any additional technologies.

As a result of the above, the predicted site wide reduction in CO₂ over Part L 2013 of the Building Regulations is **10.0%**.

Therefore, the development complies with the CO₂ reduction target outlined in EN 6.



2. Planning Statement

The following report relates to the proposed development at 84-86 Oldham Street, Manchester.

2.1 The Development

The development includes the conversion, refurbishment and extension of the existing building to create 4No new flats.



Proposed Site Block Plan (not to scale)

2.2 Relevant Policies

This report is written in response to the Manchester City Council's Development Framework Core Strategy July 2012 specifically addressing the following relevant planning policies:

EN 4 Reducing CO₂ Emissions by Enabling Low and Zero Carbon Development.

Policy EN 4

Reducing CO₂ Emissions by Enabling Low and Zero Carbon Development

The Council will seek to reduce fuel poverty and decouple growth in the economy, growth in CO₂ emissions, and rising fossil fuel prices, through the following actions:

- All development must follow the principle of the Energy Hierarchy, being designed:
 - to reduce the need for energy through design features that provide passive heating, natural lighting and cooling
 - to reduce the need for energy through energy efficient features such as improved insulation and glazing
 - to meet residual energy requirements through the use of low or zero carbon energy generating technologies
- Wherever possible new development and retrofit projects, including energy generation plant, must be located and designed in a manner that allows advantage to be taken of opportunities for low and zero carbon energy supplies.
- Where possible new development and retrofit projects will be used as a mechanism to help improve energy efficiency and provide low and zero carbon energy supplies to existing buildings.
- Where appropriate new development and retrofit projects will be required to connect to and/or make contributions to low or zero carbon energy schemes and/or to incorporate provision to enable future connection to any existing / potential decentralised energy schemes.
- The use of building materials with low embodied carbon in new development and refurbishment schemes.



Policy EN 6

Target Framework for CO₂ reductions from low or zero carbon energy supplies

Applications for residential development of 10 or more units and all other development over 1,000 sq m will be expected as a minimum to meet the target shown in Tables 12.1 or 12.2, unless this can be shown not to be viable. This should be demonstrated through an energy statement, submitted as part of the Design and Access Statement. Such a statement will be expected to set out the projected regulated energy demand and associated CO₂ emissions for all phases of the development.

Developments smaller than the above threshold, but involving the erection of a building or substantial improvement to an existing building will also be expected to meet the minimum target, where viable, but will not be expected to submit an energy statement.

The target framework relates to three broad development locations and their potential for low and zero carbon, decentralised energy. The areas are defined as follows

- Target 1 Network development areas: Locations where the proximity of new and existing buildings, the mix of uses and density of development provide the right conditions to support district heating (and cooling).
- Target 2 Electricity intense areas: Locations where the predominant building type has an all electric fit-out such as retail units and leisure complexes.
- Target 3 Micro-generation areas: Locations where lower densities and a fragmented mix of uses tend to mean that only building scale solutions are practical.

Domestic CO₂ emissions reduction targets

Table 12.1

Target	% Minimum requirement
Target 1: Network development area	CHP/district heating anchor or connection or where not feasible a 15% increase on Part L 2010
Target 2: Electricity intense buildings	+15% increase on Part L 2010
Target 3: Micro generation area	+15% increase on Part L 2010

Non-domestic CO₂ emissions reduction targets

Table 12.2

Target	% Minimum requirement
Target 1: Network development area	CHP/district heating anchor or connection or where not feasible, a 15% increase on Part L 2010
Target 2: Electricity intense buildings (Applies to commercial uses with a high proportion of emissions from electricity use (>45 kg CO ₂ /m ²)	+10% increase on Part L 2010
Target 3: Micro generation area	+15% increase on Part L 2010



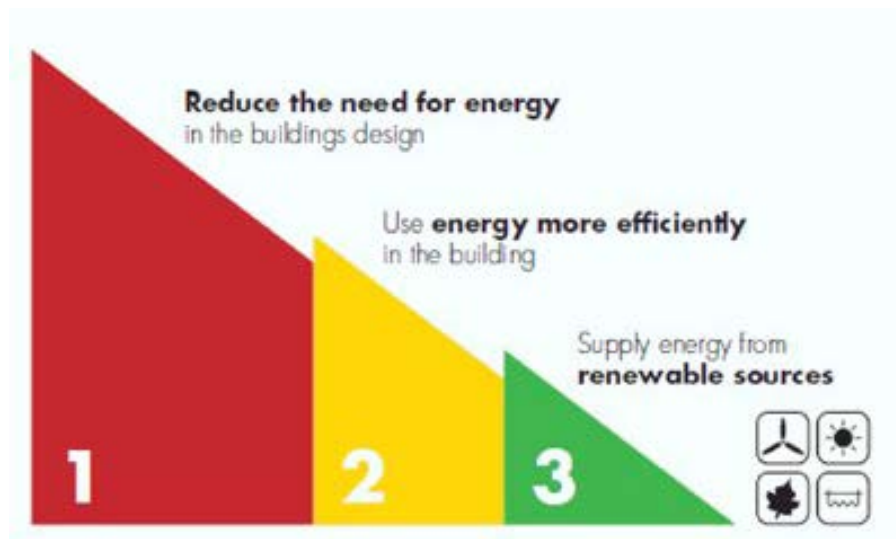
2.3 Sustainable Design Strategy

In response to the policy requirements set out in section 2.2, the development aims to achieve the following design targets:

1. The Site as a whole will achieve a minimum of 9% CO₂ reduction over the Part L 2013 Target Emission Rate (TER).

To achieve the most accurate calculations and estimates, sample units have been modelled using *SAP 2012* the governments Standard Assessment Procedure for residential dwellings.

A Part L compliant baseline has been established and then further improvements have been made to the building fabric and specification prior to the addition of LZC technologies. This complies with the Energy Hierarchy:



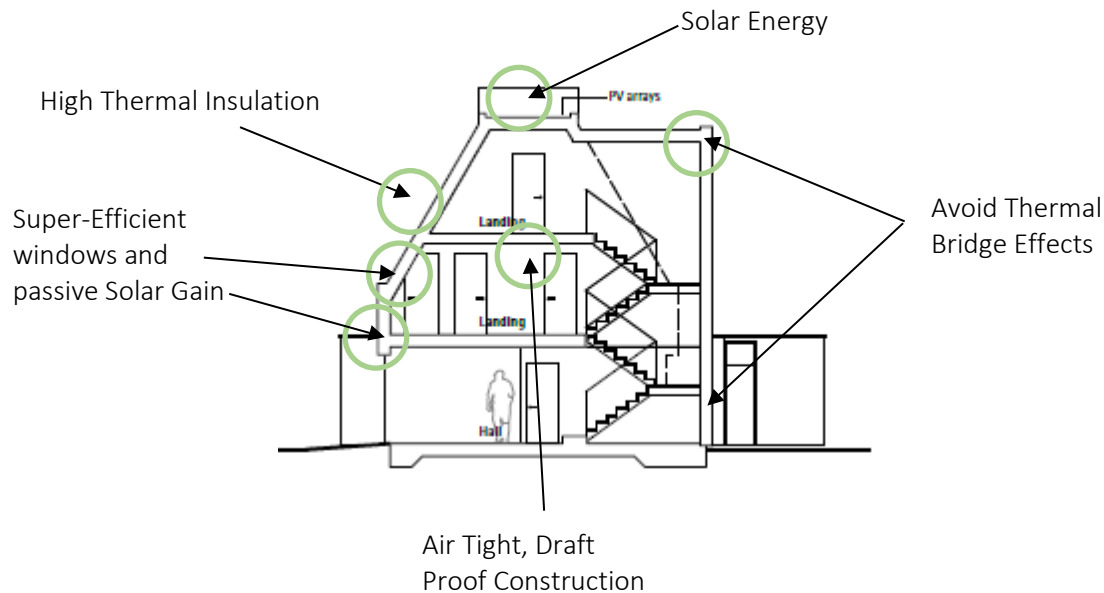
In accordance with the above methodology, the design will utilise Passivhaus principles and will be designed with a fabric first approach, all fabric U Values, air permeability and ventilation targets are beyond Building Regulations Compliancy.

Further efficiency measures to both the building fabric and building services will be incorporated to reduce the energy demand further and associated carbon emissions. This approach demonstrates a holistic low energy design concept, involving very low limiting values and thus leads to high-energy performance targets.

2.4 Energy Efficient Design and Specification

In line with the above Sustainable Design Strategy, the following Energy Efficient design measures are specified.

- High levels of insulation throughout with minimal thermal bridges.
- Passive solar gains and internal heat sources.
- Excellent level of airtightness.
- Good indoor air quality by openable windows



The Proposed specifications and key energy efficient design measures are as follows:

Residential Units:

- Upgraded wall U-values of $0.30 \text{ W/m}^2\text{K}$
- New External Wall U-values of $0.28 \text{ W/m}^2\text{K}$
- New Dormer and Mansard Wall U-values of $0.28 \text{ W/m}^2\text{K}$
- Upgraded Roof U-values of $0.18 \text{ W/m}^2\text{K}$
- New Flat Roof U-values of $0.18 \text{ W/m}^2\text{K}$
- New Dormer Roof U-values of $0.18 \text{ W/m}^2\text{K}$
- New Window U-values of $1.6 \text{ W/m}^2\text{K}$
- 100% low energy lighting throughout.
- 100% efficient non-fossil fuel Electric Heating and hot water

Operational usage will be improved further by ensuring better occupant management through the following:

- Energy Display devices showing electricity and primary fuel consumption.
- Efficient White Goods where supplied (A+ or A rated).
- Low Water Use fittings on Sanitary Ware
- A Home User Guide to explain how to use the dwelling, fittings and appliances efficiently.



2.5 Sustainable Development

In addition to the primary building design and fabric there are many other issues that will impact on creating a Sustainable Development. Sustainability should be taken into consideration from the start of the development and promoted throughout the building construction on site. Features which enable more efficient usage should also be specified to encourage the building users to maintain efficient use throughout occupation.

Materials

- Any new materials will have an A+ or A rating under BRE's Green Guide.
- Where possible, materials will be chosen that are responsibly sourced (such as FSC timber), recycled or reclaimed.
- All insulation materials will have a GWP (Global Warming Potential) of 5 or less.

Water Use

- Indoor water use will be restricted by use of fittings with lower flow rates, baths with smaller capacity, dual-flush toilets, and (where applicable) washing machines and dishwashers with low water usage.

Waste

- The contractor will be obligated to register with and achieve certification under Considerate Constructors.
- The contractor will be obligated to produce a Site Waste Management Plan (SWMP) to set targets and monitor to reduce waste and divert from landfill.
- The development will incorporate dedicated internal and external general waste and recyclable storage in accordance with the LA collection.

Health, Wellbeing & pollution

- Key rooms have good levels of day lighting and so the need for artificial lighting is reduced.
- Materials with low VOC emissions will be used.
- Improved acoustic performance between dwellings and units.



2.6 Choice and Impact of Renewable Technology

All technologies were investigated for their suitability to the site and development, please refer to section 3 for details.

In addition to energy efficiency measures, it is proposed that the development will not feature any additional technologies due to the required carbon emission reduction being achieved through efficient design measures.



2.7 Energy & CO2 Reduction Summary

A summary of all stages of the energy demand assessment from baseline figures to final carbon reduction are shown in Figures 1 & 2 below:

Summary of CO2 Emission Reductions	Total CO2 emissions (kgCO2/year)
Baseline emissions	27026.1
Improved emissions (after application of energy efficiency measures)	24312.0
Improved emissions (after incorporation of efficient energy supply)	24312.0
Improved emissions (after incorporation of renewable energy technology) % CO2 displaced in total	24312.0
% CO2 displaced in total	10.0%
% CO2 displaced by energy efficiency measures	10.0%
% CO2 displaced by efficient supply of energy	0.00%
% CO2 displaced by renewable energy	0.0%

Fig 1. Summary of CO2 Reductions



	Energy demand (kWh pa)	Energy saving achieved (%)	Regulated CO ₂ emissions (kg pa)	Saving achieved on residual CO ₂ emissions (%)
Building Regulations Part L compliance ("Baseline" energy demand & emissions)	52073.5		27026.1	
Proposed scheme after energy efficiency measures and CHP ("Residual" energy demand & emissions)	46843.9	10.0%	24312.0	10.0%
Proposed scheme after on-site renewables	46843.9	0.0%	24312.0	0.0%
Proposed scheme offset for financial contribution or other "allowable solution"			0	0
Total savings on carbon emissions				10.0%

Fig 2. Savings on residual emissions



For a full Breakdown of the figures and calculations please see Appendix A – Energy Demand Assessment Spreadsheet.

Baseline energy demand

‘Standard Assessment Procedure - SAP 2012’ was used to produce example SAP reports to generate the figures used within the calculations.

Baseline energy demand (kWh pa)	52073.5
Regulated emissions (kg pa)	27026.1

Heating

The heating and cooling hierarchy has been applied to the design process of the development. It has resulted in large focus on energy efficiency measures and as can be seen in Figure 1.

Energy savings from the use of CHP systems (kWh pa)	-
Emission savings from the use of CHP systems (kg pa)	-
Total regulated emissions after CHP savings (kg pa)	27026.1

Energy efficiency

The following table demonstrates how the development achieves the reduction in carbon dioxide emissions from energy efficiency measures.

Energy savings from energy efficiency measures (kWh pa)	5229.6
Emission savings from energy efficiency measures (kg pa)	2714.1
Total regulated emissions after CHP savings and energy efficiency measures (kg pa) (“residual emissions”)	24312.0

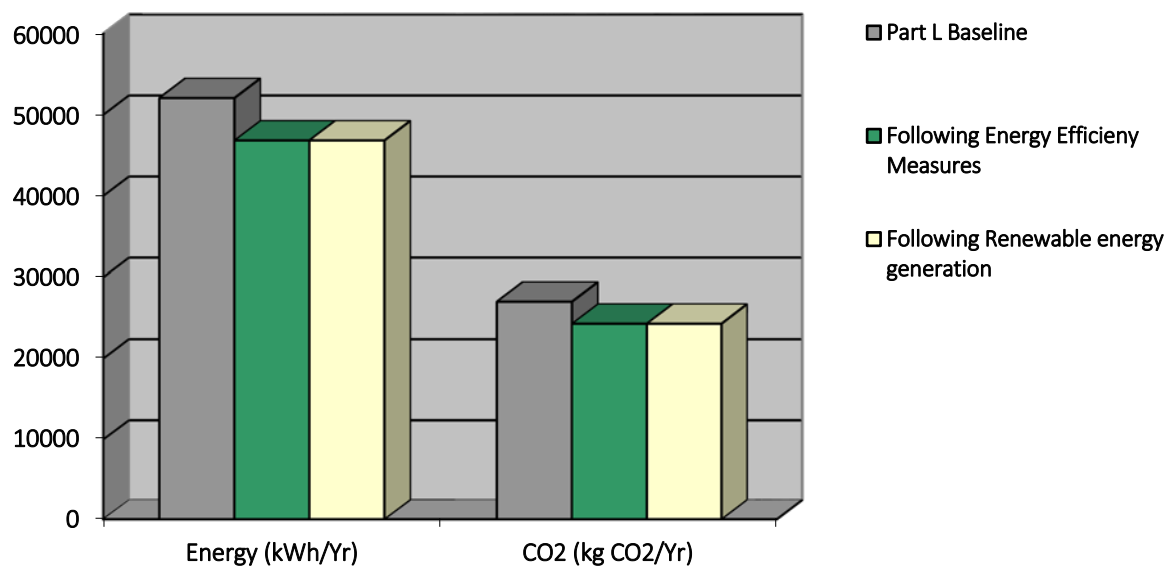


On-site renewables

The following table demonstrates how the development achieves the reduction in carbon dioxide emissions from LZC technologies.

Energy saving from the use of renewables (kWh)	-
Saving on residual emissions from the use of renewables (kg)	-
Saving on residual emissions from the use of renewables (%)	-

The chart below illustrates the improvements over the Part L Compliant Baseline:



3. Feasibility assessment of renewable energy technologies

Solar Hot Water (Thermal)

Solar water heating systems are one of the more familiar renewable technologies used at the moment. They use the energy from the sun to heat water, most commonly for hot water needs. Solar heating systems use a heat collector that is usually mounted on a roof in which the sun heats a fluid. This fluid is used to heat water that is stored in either a separate hot water cylinder or in a twin-coil hot water cylinder (the second coil is used to provide additional heating from a boiler or other heat source).

Solar hot water panels could be used however, PV will provide slightly better savings and avoid the need for water storage cylinders when compared.

Renewable Technology Not Chosen.

Wind

Wind turbines convert the kinetic energy in wind into mechanical energy that is then converted to electricity. Turbines are available in a range of sizes and designs and can either be free-standing, mounted on a building or integrated into a building structure.

The windspeed in the area is under the advised minimum and the built up area means that a wind turbine wouldn't be feasible.

Renewable Technology Not Viable



Photovoltaic Panels (PV)

Photovoltaic modules convert sunlight directly to DC electricity. The solar cells consist of a thin piece of semiconductor material, in most cases of silicon. Through a process called doping, very small amounts of impurities are added to the semiconductor, which creates two different layers called n-type and p-type layers.

Certain wavelengths of light are able to ionize the silicon atoms, which separates some of the positive charges (holes) from the negative charges (electrons). The holes move into the positive or p-layer and the electrons into the negative or n-layer. These opposite charges are attracted to each other, but most of them can only re-combine by the electrons passing through an external circuit, due to an internal potential energy barrier. This flow of electrons produces a DC current.

A PV array can be mounted on the suitable roof space however none is proposed at this stage due to the required carbon emission reduction being achieved through efficient design measures.

Renewable Technology Not Chosen.



Biomass Heating

Biomass is any plant-derived organic material that renews itself over a short period.

Biomass energy systems are based on either the direct or indirect combustion of fuels derived from those plant sources. The most common form of biomass is the direct combustion of wood in treated or untreated forms. The use of biomass is becoming increasingly common in some European countries (some countries such as Austria are heavily dependent on biomass).

The environmental benefits relate to the significantly lower amounts of energy used in biomass production and processing compared to the energy released when they are burnt. This can range from a four-fold return for biodiesel to an approximate 20-fold energy return for woody biomass. Biomass-fuels can be used to produce energy on a continuous basis (unlike renewables such as wind or solar energy) and it can be an economic alternative to fossil fuels as it is a potential source of both heat and electricity.

However, Biomass systems have particular design management and maintenance requirements associated with sourcing, transportation and storage and are therefore more commonly used in commercial developments rather than domestic installations. It can be less convenient to operate than mains-supplied fuels such as natural gas and are more management intensive and require expertise in facilities management. Sources of biomass can also fluctuate, so boilers should be specified to operate on a variety of fuels without risk of overheating or tripping out.

A communal biomass system would not be feasible for this development due to use, space and maintenance issues. The system would be extremely large and there is very little space around the properties to locate the boilers, hoppers and fuel stores that is suitable for deliveries, but also appropriate for feeding the boiler.

Renewable Technology Not Viable



Ground Source Heat pumps

A heat pump is a device that takes up heat at a certain temperature and releases it at a higher temperature. The essential components of a heat pump are heat exchangers (through which energy is extracted and emitted) and a means of pumping heat between the exchangers. The effectiveness of the heat pump is measured by the ratio of the heating capacity to the effective power input, usually known as the coefficient of performance (COP). Ground-source heat pumps (GSHP) extract heat from the ground. They are classified as either water-to-air or water-to-water units depending on whether the heat distribution system in the building uses air or water. Ground source heat pumps either use long shallow trenches or deep vertical boreholes to take low grade heat from the ground and then compress it to create higher temperatures.

Ground source heat pumps would not be suitable due to the lack of land space around the properties and the associated costs.

Renewable Technology Not Viable



Air Source Heat pumps

Air source heat pumps absorb heat from the outside air. This is usually used to heat radiators, underfloor heating systems, or warm air convectors and hot water in your home. An air source heat pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside.

The system performs down to air temperatures of -20°C which means that they are more than suitable for installations within the UK. Hot water and Heating can be provided 365 days a year. The hot water is produced without the aid of electrical immersions and at 55°C is more than hot enough for baths and showers.

There are two main types of air source heat pump system:

- An air-to-water system distributes heat via your wet central heating system. Heat pumps work much more efficiently at a lower temperature than a standard boiler system would. So they are more suitable for under-floor heating systems or larger radiators, which give out heat at lower temperatures over longer periods of time.
- An air-to-air system produces warm air which is circulated by fans to heat your home. They are unlikely to provide you with hot water as well.

Air Source heat pumps are a good option to provide heating and cooling for commercial units.

Renewable Technology Not Chosen



Appendix A – 9% Energy Demand Assessment – 84-86 Oldham Street, Manchester

House Type	Flat A E J	Flat B F	Flat C G	Flat D H K	Flat L
Frequency	3	2	2	3	1
BASELINE Dwelling Emission Rate (DER)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)
Main Heating Fuel Requirement (DER)	2265.85	2863.93	3643.2	2670.65	1753.06
Secondary Main Heating Fuel Requirement (DER)	0	0	0	0	0
Secondary Heating Fuel Requirement (DER)	0	0	0	0	0
Water Fuel Requirement (DER)	1356.28	1370.85	1385.68	1334.99	1304.2
Electricity Pumps Fans Requirement (DER)	0	0	0	0	0
Electricity Lighting Requirement (DER)	208.15	235.21	211.42	191.75	198.51
TOTAL PER DEVELOPMENT					
AFTER ENERGY SAVING MEASURES Dwelling Emission Rate (DER)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)
Main Heating Fuel Requirement (DER)	2288.63	2856.96	3643.31	2744.54	1758.24
Secondary Main Heating Fuel Requirement (DER)	0	0	0	0	0
Secondary Heating Fuel Requirement (DER)	0	0	0	0	0
Water Fuel Requirement (DER)	923.01	935.4	948.01	904.92	878.75
Electricity Pumps Fans Requirement (DER)	0	0	0	0	0
Electricity Lighting Requirement (DER)	208.15	235.21	211.42	191.75	198.51
TOTAL PER DEVELOPMENT					
FINAL Dwelling Emission Rate (DER)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)
Main Heating Fuel Requirement (DER)	2288.63	2856.96	3643.31	2744.54	1758.24
Secondary Main Heating Fuel Requirement (DER)	0	0	0	0	0
Secondary Heating Fuel Requirement (DER)	0	0	0	0	0
Water Fuel Requirement (DER)	923.01	935.4	948.01	904.92	878.75
Electricity Pumps Fans Requirement (DER)	0	0	0	0	0
Electricity Lighting Requirement (DER)	208.15	235.21	211.42	191.75	198.51
PV Energy Produced (DER)					
TOTAL PER DEVELOPMENT					



Appendix A – 9% Energy Demand Assessment – 84-86 Oldham Street, Manchester

Flat M	Flat N	Flat O	TOTAL (kWh/yr)		TOTAL (kgCO2/yr)
1	1	1	14		
Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)
1842.43	5930.41	5609	33974.2	0.519	17632.6
0	0	0	0.0	0.519	0.0
0	0	0	0.0	0.519	0.0
1317.4	1687.54	1707.21	15547.6	0.519	8069.2
0	0	0	0.0	0.519	0.0
206.24	319.38	329.6	2551.8	0.519	1324.4
			52073.5		27026.1
Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)
1847.16	5718.11	5387.36	33678.5	0.519	17479.2
0	0	0	0.0	0.519	0.0
0	0	0	0.0	0.519	0.0
889.97	1167.72	1184.44	10613.6	0.519	5508.5
0	0	0	0.0	0.519	0.0
206.24	319.38	329.6	2551.8	0.519	1324.4
			46843.9		24312.0
Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Total Energy Demand (kWh/yr)	Carbon Emission Factor	Associated Total CO2 (kgCO2/yr)
1847.16	5718.11	5387.36	33678.5	0.519	17479.2
0	0	0	0.0	0.519	0.0
0	0	0	0.0	0.519	0.0
889.97	1167.72	1184.44	10613.6	0.519	5508.5
0	0	0	0.0	0.519	0.0
206.24	319.38	329.6	2551.8	0.519	1324.4
			0.0	0.519	0.0
			46843.9		24312.0



Predicted Energy Assessment

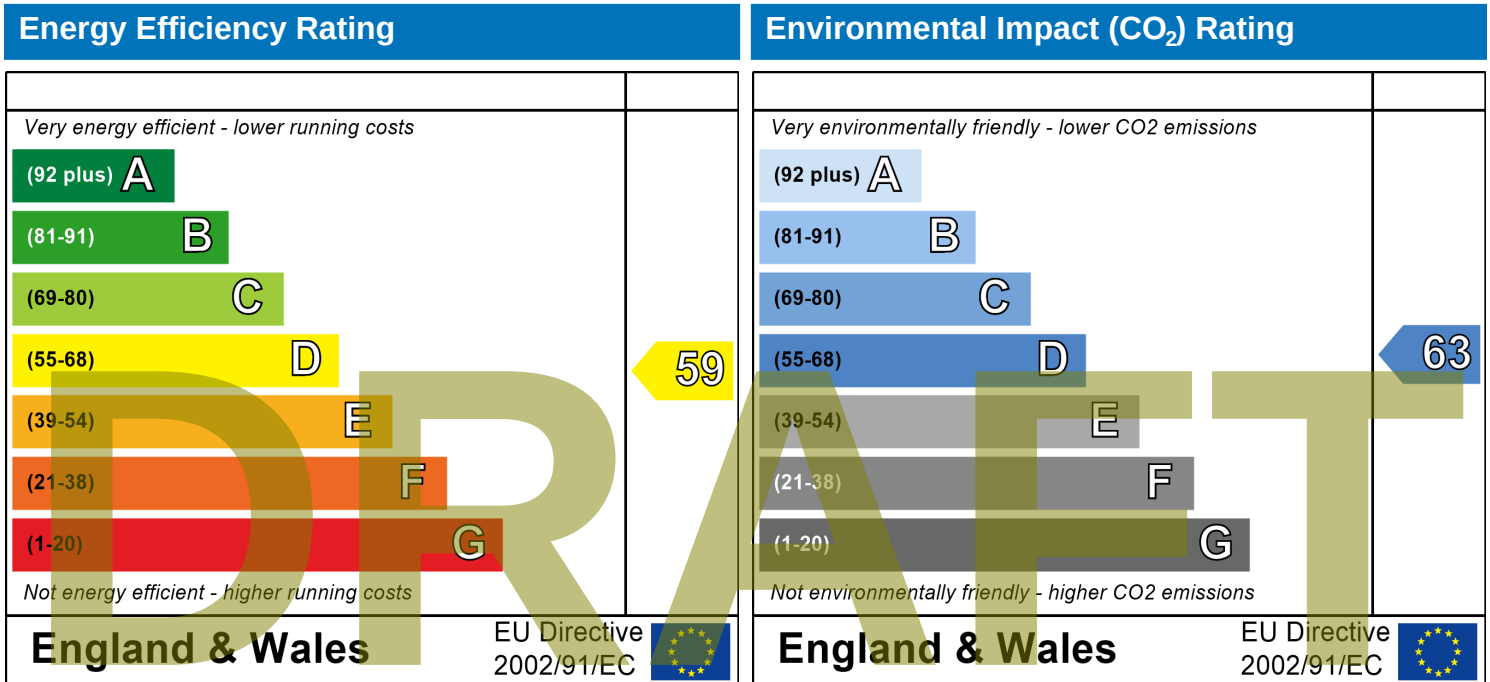
84-86 Oldham Street
Manchester
M4 1LF

Dwelling type:
Date of assessment:
Produced by:
Total floor area:

Top floor Flat
28 April 2020
Stroma Certification
71.8 m²

This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about the energy performance of the completed property.

Energy performance has been assessed using the SAP 2012 methodology and is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO₂) emissions.



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO₂) emissions. The higher the rating the less impact it has on the environment.

SAP Input

Property Details: Flat O - Be Lean

Address: 84-86 Oldham Street, Manchester, M4 1LF
 Located in: England
 Region: North West England
 UPRN: tba
 Date of assessment: 28 April 2020
 Date of certificate: 29 April 2020
 Assessment type: New extension to existing dwelling
 Transaction type: Marketed sale
 Tenure type: Unknown
 Related party disclosure: Employed by the professional dealing with the property transaction
 Thermal Mass Parameter: Indicative Value Medium
 Water use <= 125 litres/person/day: True
 PCDF Version: 459

Property description:

Dwelling type: Flat
 Detachment:
 Year Completed: 2020
 Floor Location: Floor area:
 Storey height:
 Floor 0 71.8 m² 2.55 m

Living area: 35 m² (fraction 0.487)
 Front of dwelling faces: North West

Opening types:

Name:	Source:	Type:	Glazing:	Argon:	Frame:
Front glazing	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Metal, thermal break
Rear glazing	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Metal, thermal break

Name:	Gap:	Frame Factor:	g-value:	U-value:	Area:	No. of Openings:
Front glazing	16mm or more	0.8	0.72	1.6	4.36	1
Rear glazing	16mm or more	0.8	0.72	1.6	5.9	1

Name:	Type-Name:	Location:	Orient:	Width:	Height:
Front glazing		Dormer Walls	North West	0	0
Rear glazing		New external walls	South East	0	0

Overshading: Average or unknown

Opaque Elements:

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
<u>External Elements</u>							
New external walls	49.317	5.9	43.42	0.28	0	False	N/A
Dormer Walls	10.2	4.36	5.84	0.28	0	False	N/A
New mansard walls	9.92	0	9.92	0.28	0	False	N/A
Main flat roof	69.74	0	69.74	0.18	0		N/A
Dormer flat roof	2.06	0	2.06	0.18	0		N/A
<u>Internal Elements</u>							
<u>Party Elements</u>							
Party Wall	20						N/A
Party Floor	75						N/A

Thermal bridges:

Thermal bridges: No information on thermal bridging (y=0.15) (y =0.15)

SAP Input

Ventilation:

Pressure test: No (Assumed)
 Ventilation: Natural ventilation (extract fans)
 Number of chimneys: 0
 Number of open flues: 0
 Number of fans: 3
 Number of passive stacks: 0
 Number of sides sheltered: 1
 Pressure test: 15

Main heating system:

Main heating system: Room heaters
 Electric (direct acting) room heaters
 Fuel: Electricity
 Info Source: SAP Tables
 SAP Table: 691
 Panel, convector or radiant heaters

 Central heating pump : 2013 or later
 Design flow temperature: Design flow temperature >45°C
 Room-sealed
 Boiler interlock: Yes

Main heating Control:

Main heating Control: Programmer and appliance thermostats
 Control code: 2603

Secondary heating system:

Secondary heating system: None

Water heating:

Water heating: Electric instantaneous at point of use
 Water code: 909
 Fuel :Electricity
 No hot water cylinder
 Solar panel: False

Others:

Electricity tariff: Standard Tariff
 In Smoke Control Area: Unknown
 Conservatory: No conservatory
 Low energy lights: 100%
 Terrain type: Dense urban
 EPC language: English
 Wind turbine: No
 Photovoltaics: None
 Assess Zero Carbon Home: No

SAP WorkSheet: New extension to existing dwelling

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.25

Property Address: Flat O - Be Lean

Address : 84-86 Oldham Street, Manchester, M4 1LF

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	71.8 (1a)	2.55 (2a)	183.09 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	71.8 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	183.09 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				3	30 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

	Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.16 (8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Number of storeys in the dwelling (ns) 0 (9)

Additional infiltration [(9)-1]x0.1 = 0 (10)

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction 0 (11)

if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 0 (12)

If no draught lobby, enter 0.05, else enter 0 0 (13)

Percentage of windows and doors draught stripped 0 (14)

Window infiltration 0.25 - [0.2 x (14) ÷ 100] = 0 (15)

Infiltration rate (8) + (10) + (11) + (12) + (13) + (15) = 0 (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area 15 (17)

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) 0.91 (18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

Number of sides sheltered 1 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 0.92 (20)

Infiltration rate incorporating shelter factor (21) = (18) x (20) = 0.85 (21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
--------	-----	---	-----	-----	-----	-----	-----	-----	---	-----	-----	-----

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
---------	------	------	------	-----	------	------	------	------	---	------	------	------

SAP WorkSheet: New extension to existing dwelling

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

1.08	1.06	1.04	0.93	0.91	0.8	0.8	0.78	0.85	0.91	0.95	0.99
------	------	------	------	------	-----	-----	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)) , otherwise (23b) = (23a)

0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) x [1 - (23c) ÷ 100]

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 1.08 1.06 1.04 0.93 0.91 0.82 0.82 0.81 0.86 0.91 0.95 0.99 (24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m= 1.08 1.06 1.04 0.93 0.91 0.82 0.82 0.81 0.86 0.91 0.95 0.99 (25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Windows Type 1			4.36	$\times 1/[1/(1.6) + 0.04] =$	6.56		(27)
Windows Type 2			5.9	$\times 1/[1/(1.6) + 0.04] =$	8.87		(27)
Walls Type1	49.32	5.9	43.42	$\times 0.28 =$	12.16		(29)
Walls Type2	10.2	4.36	5.84	$\times 0.28 =$	1.64		(29)
Walls Type3	9.92	0	9.92	$\times 0.28 =$	2.78		(29)
Roof Type1	69.74	0	69.74	$\times 0.18 =$	12.55		(30)
Roof Type2	2.06	0	2.06	$\times 0.18 =$	0.37		(30)
Total area of elements, m²			141.24				(31)
Party wall			20	$\times 0 =$	0		(32)
Party floor			75				(32a)

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 44.92 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 12350.59 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K 21.19 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 66.11 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

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(38)m=

65.12	63.84	62.57	56.33	55.16	49.69	49.69	48.68	51.8	55.16	57.53	60.01
-------	-------	-------	-------	-------	-------	-------	-------	------	-------	-------	-------

 (38)

Heat transfer coefficient, W/K

(39)m = (37) + (38)m

(39)m=

131.23	129.95	128.67	122.44	121.26	115.8	115.8	114.79	117.9	121.26	123.64	126.12
--------	--------	--------	--------	--------	-------	-------	--------	-------	--------	--------	--------

Average = Sum(39)_{1...12} /12=

122.41 (39)

Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=

1.83	1.81	1.79	1.71	1.69	1.61	1.61	1.6	1.64	1.69	1.72	1.76
------	------	------	------	------	------	------	-----	------	------	------	------

Average = Sum(40)_{1...12} /12=

1.7 (40)

Number of days in month (Table 1a)

(41)m=

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	28	31	30	31	30	31	31	30	31	30	31

 (41)

4. Water heating energy requirement:

kWh/year:

Assumed occupancy, N

2.29 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)²)] + 0.0013 x (TFA -13.9)

if TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36

88.56 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=

97.42	93.88	90.34	86.79	83.25	79.71	79.71	83.25	86.79	90.34	93.88	97.42
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Total = Sum(44)_{1...12} =

1062.77 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=

144.47	126.36	130.39	113.68	109.07	94.12	87.22	100.08	101.28	118.03	128.84	139.91
--------	--------	--------	--------	--------	-------	-------	--------	--------	--------	--------	--------

Total = Sum(45)_{1...12} =

1393.46 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

 (46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel

0 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

0 (48)

Temperature factor from Table 2b

0 (49)

Energy lost from water storage, kWh/year

(48) x (49) =

0 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day)

0 (51)

If community heating see section 4.3

Volume factor from Table 2a

0 (52)

Temperature factor from Table 2b

0 (53)

Energy lost from water storage, kWh/year

(47) x (51) x (52) x (53) =

0 (54)

Enter (50) or (54) in (55)

0 (55)

Water storage loss calculated for each month

((56)m = (55) x (41)m

(56)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

 (56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) - (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

 (57)

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Primary circuit loss (annual) from Table 3

0

(58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=

122.8	107.4	110.83	96.62	92.71	80	74.14	85.07	86.09	100.33	109.52	118.93
-------	-------	--------	-------	-------	----	-------	-------	-------	--------	--------	--------

(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)

(63)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

(63)

Output from water heater

(64)m=

122.8	107.4	110.83	96.62	92.71	80	74.14	85.07	86.09	100.33	109.52	118.93
-------	-------	--------	-------	-------	----	-------	-------	-------	--------	--------	--------

Output from water heater (annual)_{1...12}

1184.44

(64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=

30.7	26.85	27.71	24.16	23.18	20	18.53	21.27	21.52	25.08	27.38	29.73
------	-------	-------	-------	-------	----	-------	-------	-------	-------	-------	-------

(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a):

Metabolic gains (Table 5), Watts

(66)m=

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34

(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=

46.66	41.44	33.7	25.51	19.07	16.1	17.4	22.62	30.35	38.54	44.98	47.95
-------	-------	------	-------	-------	------	------	-------	-------	-------	-------	-------

(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=

300.69	303.81	295.95	279.21	258.08	238.22	224.95	221.83	229.69	246.43	267.56	287.42
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=

51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(69)

Pumps and fans gains (Table 5a)

(70)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=

-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(71)

Water heating gains (Table 5)

(72)m=

41.26	39.96	37.24	33.55	31.15	27.78	24.91	28.59	29.89	33.71	38.03	39.96
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(72)

Total internal gains =

(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=

485.41	482.01	463.69	435.07	405.11	378.9	364.06	369.84	386.74	415.49	447.38	472.14
--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	--------

(73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Orientation:	Access Factor Table 6d		Area m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)							
Southeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>5.9</td></tr></table>	5.9	x	<table><tr><td>36.79</td></tr></table>	36.79	x	<table><tr><td>0.72</td></tr></table>	0.72	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>86.65</td></tr></table>	86.65	(77)
0.77																		
5.9																		
36.79																		
0.72																		
0.8																		
86.65																		
Southeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>5.9</td></tr></table>	5.9	x	<table><tr><td>62.67</td></tr></table>	62.67	x	<table><tr><td>0.72</td></tr></table>	0.72	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>147.6</td></tr></table>	147.6	(77)
0.77																		
5.9																		
62.67																		
0.72																		
0.8																		
147.6																		

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Southeast 0.9x	0.77	x	5.9	x	85.75	x	0.72	x	0.8	=	201.96	(77)
Southeast 0.9x	0.77	x	5.9	x	106.25	x	0.72	x	0.8	=	250.23	(77)
Southeast 0.9x	0.77	x	5.9	x	119.01	x	0.72	x	0.8	=	280.28	(77)
Southeast 0.9x	0.77	x	5.9	x	118.15	x	0.72	x	0.8	=	278.25	(77)
Southeast 0.9x	0.77	x	5.9	x	113.91	x	0.72	x	0.8	=	268.27	(77)
Southeast 0.9x	0.77	x	5.9	x	104.39	x	0.72	x	0.8	=	245.85	(77)
Southeast 0.9x	0.77	x	5.9	x	92.85	x	0.72	x	0.8	=	218.67	(77)
Southeast 0.9x	0.77	x	5.9	x	69.27	x	0.72	x	0.8	=	163.13	(77)
Southeast 0.9x	0.77	x	5.9	x	44.07	x	0.72	x	0.8	=	103.79	(77)
Southeast 0.9x	0.77	x	5.9	x	31.49	x	0.72	x	0.8	=	74.16	(77)
Northwest 0.9x	0.77	x	4.36	x	11.28	x	0.72	x	0.8	=	19.64	(81)
Northwest 0.9x	0.77	x	4.36	x	22.97	x	0.72	x	0.8	=	39.97	(81)
Northwest 0.9x	0.77	x	4.36	x	41.38	x	0.72	x	0.8	=	72.01	(81)
Northwest 0.9x	0.77	x	4.36	x	67.96	x	0.72	x	0.8	=	118.27	(81)
Northwest 0.9x	0.77	x	4.36	x	91.35	x	0.72	x	0.8	=	158.98	(81)
Northwest 0.9x	0.77	x	4.36	x	97.38	x	0.72	x	0.8	=	169.49	(81)
Northwest 0.9x	0.77	x	4.36	x	91.1	x	0.72	x	0.8	=	158.55	(81)
Northwest 0.9x	0.77	x	4.36	x	72.63	x	0.72	x	0.8	=	126.4	(81)
Northwest 0.9x	0.77	x	4.36	x	50.42	x	0.72	x	0.8	=	87.75	(81)
Northwest 0.9x	0.77	x	4.36	x	28.07	x	0.72	x	0.8	=	48.85	(81)
Northwest 0.9x	0.77	x	4.36	x	14.2	x	0.72	x	0.8	=	24.71	(81)
Northwest 0.9x	0.77	x	4.36	x	9.21	x	0.72	x	0.8	=	16.04	(81)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	106.29	187.57	273.97	368.5	439.26	447.74	426.82	372.25	306.43	211.98	128.5	90.19	(83)
--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	-------	-------	------

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	591.7	669.58	737.66	803.58	844.36	826.64	790.88	742.08	693.17	627.47	575.87	562.33	(84)
--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)

21

(85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

(86)m=	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(86)
	0.99	0.99	0.98	0.95	0.89	0.75	0.6	0.64	0.85	0.96	0.99	0.99	

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.13	19.33	19.66	20.15	20.55	20.85	20.95	20.94	20.73	20.22	19.64	19.16	(87)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	19.45	19.46	19.48	19.54	19.55	19.6	19.6	19.61	19.58	19.55	19.53	19.5	(88)
--------	-------	-------	-------	-------	-------	------	------	-------	-------	-------	-------	------	------

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.98	0.97	0.93	0.83	0.64	0.43	0.48	0.76	0.94	0.98	0.99	(89)
--------	------	------	------	------	------	------	------	------	------	------	------	------	------

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.06	17.35	17.84	18.57	19.12	19.51	19.59	19.59	19.38	18.69	17.84	17.13	(90)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

fLA = Living area ÷ (4) =

0.49

(91)

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Mean internal temperature (for the whole dwelling) = $fLA \times T1 + (1 - fLA) \times T2$

(92)m=	18.07	18.32	18.73	19.34	19.81	20.16	20.25	20.25	20.04	19.43	18.72	18.12	(92)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.07	18.32	18.73	19.34	19.81	20.16	20.25	20.25	20.04	19.43	18.72	18.12	(93)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

Set T_i to the mean internal temperature obtained at step 11 of Table 9b, so that $T_{i,m}=(76)m$ and re-calculate the utilisation factor for gains using Table 9a

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Utilisation factor for gains, hm :

(94)m=	0.99	0.98	0.96	0.93	0.84	0.69	0.51	0.56	0.8	0.94	0.98	0.99	(94)
--------	------	------	------	------	------	------	------	------	-----	------	------	------	------

Useful gains, hmG_m , $W = (94)m \times (84)m$

(95)m=	583.95	655.71	710.86	743.64	713.35	567.29	404.87	416.07	552.03	589.28	563.86	556.21	(95)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
--------	-----	-----	-----	-----	------	------	------	------	------	------	-----	-----	------

Heat loss rate for mean internal temperature, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	1806.98	1743.48	1573.19	1278.09	983.94	644.38	423.24	441.81	700.03	1071.02	1436.38	1755.95	(97)
--------	---------	---------	---------	---------	--------	--------	--------	--------	--------	---------	---------	---------	------

Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	909.94	730.98	641.57	384.81	201.32	0	0	0	0	358.41	628.21	892.6	
Total per year ($kWh/year$) = $Sum(98)_{1...5,9...12} =$												4747.85	(98)

Space heating requirement in $kWh/m^2/year$

66.13	(99)
-------	------

9a. Energy requirements – Individual heating systems including micro-CHP

Space heating:

Fraction of space heat from secondary/supplementary system

0	(201)
---	-------

Fraction of space heat from main system(s)

$$(202) = 1 - (201) =$$

1	(202)
---	-------

Fraction of total heating from main system 1

$$(204) = (202) \times [1 - (203)] =$$

1	(204)
---	-------

Efficiency of main space heating system 1

100	(206)
-----	-------

Efficiency of secondary/supplementary heating system, %

0	(208)
---	-------

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$kWh/year$
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------------

Space heating requirement (calculated above)

909.94	730.98	641.57	384.81	201.32	0	0	0	0	358.41	628.21	892.6
--------	--------	--------	--------	--------	---	---	---	---	--------	--------	-------

$$(211)m = \{[(98)m \times (204)]\} \times 100 \div (206) \quad (211)$$

909.94	730.98	641.57	384.81	201.32	0	0	0	0	358.41	628.21	892.6
--------	--------	--------	--------	--------	---	---	---	---	--------	--------	-------

$$Total (kWh/year) = Sum(211)_{1...5,10...12} = 4747.85 \quad (211)$$

Space heating fuel (secondary), $kWh/month$

$$= \{[(98)m \times (201)]\} \times 100 \div (208)$$

(215)m=	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215) _{1...5,10...12} =												0	(215)

Water heating

Output from water heater (calculated above)

122.8	107.4	110.83	96.62	92.71	80	74.14	85.07	86.09	100.33	109.52	118.93
-------	-------	--------	-------	-------	----	-------	-------	-------	--------	--------	--------

$$Efficiency of water heater \quad 100 \quad (216)$$

(217)m=	100	100	100	100	100	100	100	100	100	100	100	(217)
---------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-------

Fuel for water heating, $kWh/month$

$$(219)m = (64)m \times 100 \div (217)m$$

(219)m=	122.8	107.4	110.83	96.62	92.71	80	74.14	85.07	86.09	100.33	109.52	118.93	
Total = $Sum(219a)_{1...12} =$												1184.44	(219)

SAP WorkSheet: New extension to existing dwelling

Annual totals

	kWh/year	kWh/year
Space heating fuel used, main system 1		4747.85
Water heating fuel used		1184.44
Electricity for pumps, fans and electric keep-hot		
Total electricity for the above, kWh/year	sum of (230a)...(230g) =	0 (231)
Electricity for lighting		329.6 (232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	Fuel Price (Table 12)	Fuel Cost £/year
Space heating - main system 1	(211) x	13.19	x 0.01 = 626.24 (240)
Space heating - main system 2	(213) x	0	x 0.01 = 0 (241)
Space heating - secondary	(215) x	13.19	x 0.01 = 0 (242)
Water heating cost (other fuel)	(219)	13.19	x 0.01 = 156.23 (247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 = 0 (249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a			
Energy for lighting	(232)	13.19	x 0.01 = 43.47 (250)
Additional standing charges (Table 12)			0 (251)
Appendix Q items: repeat lines (253) and (254) as needed			
Total energy cost	(245)...(247) + (250)...(254) =		825.94 (255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42 (256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	2.97 (257)
SAP rating (Section 12)		58.57 (258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating (main system 1)	(211) x	0.519	= 2464.13 (261)
Space heating (secondary)	(215) x	0.519	= 0 (263)
Water heating	(219) x	0.519	= 614.72 (264)
Space and water heating	(261) + (262) + (263) + (264) =		3078.86 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	= 0 (267)
Electricity for lighting	(232) x	0.519	= 171.06 (268)
Total CO2, kg/year		sum of (265)...(271) =	3249.92 (272)
CO2 emissions per m²		(272) ÷ (4) =	45.26 (273)
EI rating (section 14)			63 (274)

13a. Primary Energy

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	Energy kWh/year	Primary factor		P. Energy kWh/year
Space heating (main system 1)	(211) x	3.07	=	14575.89 (261)
Space heating (secondary)	(215) x	3.07	=	0 (263)
Energy for water heating	(219) x	3.07	=	3636.23 (264)
Space and water heating	(261) + (262) + (263) + (264) =			18212.12 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	3.07	=	0 (267)
Electricity for lighting	(232) x	0	=	1011.86 (268)
'Total Primary Energy		sum of (265)...(271) =		19223.98 (272)
Primary energy kWh/m ² /year		(272) ÷ (4) =		267.74 (273)

DRAFT

SAP WorkSheet: New extension to existing dwelling

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.25

Property Address: Flat O - Baseline

Address : 84-86 Oldham Street, Manchester, M4 1LF

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	71.8 (1a)	2.55 (2a)	183.09 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	71.8 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	183.09 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				3	30 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

	Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.16 (8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Number of storeys in the dwelling (ns) 0 (9)

Additional infiltration [(9)-1]x0.1 = 0 (10)

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction 0 (11)

if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 0 (12)

If no draught lobby, enter 0.05, else enter 0 0 (13)

Percentage of windows and doors draught stripped 0 (14)

Window infiltration 0.25 - [0.2 x (14) ÷ 100] = 0 (15)

Infiltration rate (8) + (10) + (11) + (12) + (13) + (15) = 0 (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area 15 (17)

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) 0.91 (18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

Number of sides sheltered 1 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 0.92 (20)

Infiltration rate incorporating shelter factor (21) = (18) x (20) = 0.85 (21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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SAP WorkSheet: New extension to existing dwelling

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

1.08	1.06	1.04	0.93	0.91	0.8	0.8	0.78	0.85	0.91	0.95	0.99
------	------	------	------	------	-----	-----	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)) , otherwise (23b) = (23a)

0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) x [1 - (23c) ÷ 100]

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 1.08 1.06 1.04 0.93 0.91 0.82 0.82 0.81 0.86 0.91 0.95 0.99 (24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m= 1.08 1.06 1.04 0.93 0.91 0.82 0.82 0.81 0.86 0.91 0.95 0.99 (25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Windows Type 1			4.36	x 1/[1/(2) + 0.04] =	8.07		(27)
Windows Type 2			5.9	x 1/[1/(2) + 0.04] =	10.93		(27)
Walls Type1	49.32	5.9	43.42	x 0.3 =	13.03		(29)
Walls Type2	10.2	4.36	5.84	x 0.3 =	1.75		(29)
Walls Type3	9.92	0	9.92	x 0.3 =	2.98		(29)
Roof Type1	69.74	0	69.74	x 0.2 =	13.95		(30)
Roof Type2	2.06	0	2.06	x 0.2 =	0.41		(30)
Total area of elements, m²			141.24				(31)
Party wall			20	x 0 =	0		(32)
Party floor			75				(32a)

* for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 51.11 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 12350.59 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K 21.19 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 72.3 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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SAP WorkSheet: New extension to existing dwelling

(38)m=

65.12	63.84	62.57	56.33	55.16	49.69	49.69	48.68	51.8	55.16	57.53	60.01
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 (38)

Heat transfer coefficient, W/K

(39)m = (37) + (38)m

(39)m=

137.42	136.14	134.86	128.63	127.45	121.99	121.99	120.98	124.1	127.45	129.83	132.31
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Average = Sum(39)_{1...12} /12=

128.6

 (39)

Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=

1.91	1.9	1.88	1.79	1.78	1.7	1.7	1.68	1.73	1.78	1.81	1.84
------	-----	------	------	------	-----	-----	------	------	------	------	------

Average = Sum(40)_{1...12} /12=

1.79

 (40)

Number of days in month (Table 1a)

(41)m=

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	28	31	30	31	30	31	31	30	31	30	31

 (41)

4. Water heating energy requirement:

kWh/year:

Assumed occupancy, N

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)²)] + 0.0013 x (TFA -13.9)

if TFA ≤ 13.9, N = 1

2.29

(42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36

88.56

(43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
97.42	93.88	90.34	86.79	83.25	79.71	79.71	83.25	86.79	90.34	93.88	97.42

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)
(44)m=

97.42	93.88	90.34	86.79	83.25	79.71	79.71	83.25	86.79	90.34	93.88	97.42
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Total = Sum(44)_{1...12} =

1062.77

 (44)
Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)
(45)m=

144.47	126.36	130.39	113.68	109.07	94.12	87.22	100.08	101.28	118.03	128.84	139.91
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Total = Sum(45)_{1...12} =

1393.46

 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=

21.67	18.95	19.56	17.05	16.36	14.12	13.08	15.01	15.19	17.7	19.33	20.99
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 (46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel

150

(47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

0

(48)

Temperature factor from Table 2b

0

(49)

Energy lost from water storage, kWh/year

(48) x (49) =

150

(50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day)

0.01

(51)

If community heating see section 4.3

Volume factor from Table 2a

0.93

(52)

Temperature factor from Table 2b

0.6

(53)

Energy lost from water storage, kWh/year

(47) x (51) x (52) x (53) =

0.86

(54)

Enter (50) or (54) in (55)

0.86

(55)

Water storage loss calculated for each month

((56)m = (55) x (41)m

(56)m=

26.65	24.07	26.65	25.79	26.65	25.79	26.65	26.65	25.79	26.65	25.79	26.65
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) - (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=

26.65	24.07	26.65	25.79	26.65	25.79	26.65	26.65	25.79	26.65	25.79	26.65
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 (57)

SAP WorkSheet: New extension to existing dwelling

Primary circuit loss (annual) from Table 3

0

(58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=

171.12	150.42	157.04	139.46	135.72	119.91	113.87	126.73	127.07	144.68	154.63	166.56
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)

(63)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

(63)

Output from water heater

(64)m=

171.12	150.42	157.04	139.46	135.72	119.91	113.87	126.73	127.07	144.68	154.63	166.56
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Output from water heater (annual)_{1...12}

1707.21

(64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=

69.35	61.27	64.67	58.43	57.58	51.93	50.32	54.6	54.31	60.56	63.47	67.84
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(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a):

Metabolic gains (Table 5), Watts

(66)m=

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34	137.34

(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=

46.66	41.44	33.7	25.51	19.07	16.1	17.4	22.62	30.35	38.54	44.98	47.95
-------	-------	------	-------	-------	------	------	-------	-------	-------	-------	-------

(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=

300.69	303.81	295.95	279.21	258.08	238.22	224.95	221.83	229.69	246.43	267.56	287.42
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=

51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02	51.02
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(69)

Pumps and fans gains (Table 5a)

(70)m=

0	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=

-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56	-91.56
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(71)

Water heating gains (Table 5)

(72)m=

93.22	91.17	86.92	81.15	77.4	72.12	67.63	73.38	75.42	81.4	88.15	91.18
-------	-------	-------	-------	------	-------	-------	-------	-------	------	-------	-------

(72)

Total internal gains =

(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=

537.37	533.23	513.38	482.67	451.35	423.24	406.78	414.63	432.28	463.18	497.5	523.36
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(73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Orientation:	Access Factor Table 6d		Area m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)						
Southeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>5.9</td></tr></table>	5.9	x	<table><tr><td>36.79</td></tr></table>	36.79	x	<table><tr><td>0.63</td></tr></table>	0.63	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>75.82</td></tr></table> (77)	75.82
0.77																	
5.9																	
36.79																	
0.63																	
0.8																	
75.82																	
Southeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>5.9</td></tr></table>	5.9	x	<table><tr><td>62.67</td></tr></table>	62.67	x	<table><tr><td>0.63</td></tr></table>	0.63	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>129.15</td></tr></table> (77)	129.15
0.77																	
5.9																	
62.67																	
0.63																	
0.8																	
129.15																	

(77)

(77)

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Southeast 0.9x	0.77	x	5.9	x	85.75	x	0.63	x	0.8	=	176.71	(77)
Southeast 0.9x	0.77	x	5.9	x	106.25	x	0.63	x	0.8	=	218.95	(77)
Southeast 0.9x	0.77	x	5.9	x	119.01	x	0.63	x	0.8	=	245.25	(77)
Southeast 0.9x	0.77	x	5.9	x	118.15	x	0.63	x	0.8	=	243.47	(77)
Southeast 0.9x	0.77	x	5.9	x	113.91	x	0.63	x	0.8	=	234.73	(77)
Southeast 0.9x	0.77	x	5.9	x	104.39	x	0.63	x	0.8	=	215.12	(77)
Southeast 0.9x	0.77	x	5.9	x	92.85	x	0.63	x	0.8	=	191.34	(77)
Southeast 0.9x	0.77	x	5.9	x	69.27	x	0.63	x	0.8	=	142.74	(77)
Southeast 0.9x	0.77	x	5.9	x	44.07	x	0.63	x	0.8	=	90.82	(77)
Southeast 0.9x	0.77	x	5.9	x	31.49	x	0.63	x	0.8	=	64.89	(77)
Northwest 0.9x	0.77	x	4.36	x	11.28	x	0.63	x	0.8	=	17.18	(81)
Northwest 0.9x	0.77	x	4.36	x	22.97	x	0.63	x	0.8	=	34.97	(81)
Northwest 0.9x	0.77	x	4.36	x	41.38	x	0.63	x	0.8	=	63.01	(81)
Northwest 0.9x	0.77	x	4.36	x	67.96	x	0.63	x	0.8	=	103.48	(81)
Northwest 0.9x	0.77	x	4.36	x	91.35	x	0.63	x	0.8	=	139.1	(81)
Northwest 0.9x	0.77	x	4.36	x	97.38	x	0.63	x	0.8	=	148.3	(81)
Northwest 0.9x	0.77	x	4.36	x	91.1	x	0.63	x	0.8	=	138.73	(81)
Northwest 0.9x	0.77	x	4.36	x	72.63	x	0.63	x	0.8	=	110.6	(81)
Northwest 0.9x	0.77	x	4.36	x	50.42	x	0.63	x	0.8	=	76.78	(81)
Northwest 0.9x	0.77	x	4.36	x	28.07	x	0.63	x	0.8	=	42.74	(81)
Northwest 0.9x	0.77	x	4.36	x	14.2	x	0.63	x	0.8	=	21.62	(81)
Northwest 0.9x	0.77	x	4.36	x	9.21	x	0.63	x	0.8	=	14.03	(81)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	93	164.13	239.72	322.44	384.35	391.77	373.46	325.72	268.12	185.48	112.44	78.92	(83)
--------	----	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	------

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	630.37	697.35	753.1	805.11	835.7	815.01	780.25	740.35	700.4	648.66	609.94	602.28	(84)
--------	--------	--------	-------	--------	-------	--------	--------	--------	-------	--------	--------	--------	------

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.99	0.98	0.95	0.9	0.77	0.62	0.67	0.86	0.96	0.99	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.08	19.27	19.59	20.08	20.49	20.82	20.94	20.92	20.7	20.17	19.59	19.11	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	19.39	19.4	19.42	19.48	19.49	19.54	19.54	19.55	19.52	19.49	19.46	19.44	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.98	0.97	0.93	0.84	0.66	0.45	0.49	0.77	0.94	0.98	0.99	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	16.95	17.23	17.7	18.43	18.99	19.42	19.52	19.52	19.29	18.59	17.74	17.02	(90)
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fLA = Living area ÷ (4) = 0.49 (91)

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Mean internal temperature (for the whole dwelling) = $fLA \times T1 + (1 - fLA) \times T2$

(92)m=	17.99	18.22	18.62	19.23	19.72	20.1	20.21	20.21	19.98	19.36	18.64	18.04	(92)
--------	-------	-------	-------	-------	-------	------	-------	-------	-------	-------	-------	-------	------

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	17.99	18.22	18.62	19.23	19.72	20.1	20.21	20.21	19.98	19.36	18.64	18.04	(93)
--------	-------	-------	-------	-------	-------	------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

Set T_i to the mean internal temperature obtained at step 11 of Table 9b, so that $T_{i,m}=(76)m$ and re-calculate the utilisation factor for gains using Table 9a

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Utilisation factor for gains, hm :

(94)m=	0.98	0.98	0.96	0.93	0.85	0.71	0.53	0.58	0.8	0.94	0.98	0.99	(94)
--------	------	------	------	------	------	------	------	------	-----	------	------	------	------

Useful gains, hmG_m , $W = (94)m \times (84)m$

(95)m=	620.32	681.12	724.51	746.57	713.88	575.62	416.31	427.66	561.57	606.94	594.96	594.09	(95)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
--------	-----	-----	-----	-----	------	------	------	------	------	------	-----	-----	------

Heat loss rate for mean internal temperature, L_m , $W = [(39)m \times [(93)m - (96)m]$

(97)m=	1881.25	1813.75	1635.02	1328.91	1022.45	671.46	440.82	460.47	729.16	1116.53	1498.8	1831.48	(97)
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Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	938.13	761.13	677.41	419.28	229.58	0	0	0	0	379.14	650.77	920.62	
Total per year ($kWh/year$) = $Sum(98)_{1...5,9...12} =$												4976.05	(98)

Space heating requirement in $kWh/m^2/year$

												69.3	(99)
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9a. Energy requirements – Individual heating systems including micro-CHP

Space heating:

Fraction of space heat from secondary/supplementary system

0	(201)
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Fraction of space heat from main system(s)

$$(202) = 1 - (201) =$$

1	(202)
---	-------

Fraction of total heating from main system 1

$$(204) = (202) \times [1 - (203)] =$$

1	(204)
---	-------

Efficiency of main space heating system 1

100	(206)
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Efficiency of secondary/supplementary heating system, %

0	(208)
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$kWh/year$
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------------

Space heating requirement (calculated above)

938.13	761.13	677.41	419.28	229.58	0	0	0	0	379.14	650.77	920.62	
--------	--------	--------	--------	--------	---	---	---	---	--------	--------	--------	--

$$(211)m = \{[(98)m \times (204)]\} \times 100 \div (206) \quad (211)$$

938.13	761.13	677.41	419.28	229.58	0	0	0	0	379.14	650.77	920.62	
--------	--------	--------	--------	--------	---	---	---	---	--------	--------	--------	--

$$Total (kWh/year) = Sum(211)_{1...5,10...12} = 4976.05 \quad (211)$$

Space heating fuel (secondary), $kWh/month$

$$= \{[(98)m \times (201)]\} \times 100 \div (208)$$

(215)m=	0	0	0	0	0	0	0	0	0	0	0		
Total ($kWh/year$) = $Sum(215)_{1...5,10...12} =$												0	(215)

Water heating

Output from water heater (calculated above)

171.12	150.42	157.04	139.46	135.72	119.91	113.87	126.73	127.07	144.68	154.63	166.56	
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Efficiency of water heater

100	(216)
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(217)m=	100	100	100	100	100	100	100	100	100	100	100		(217)
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Fuel for water heating, $kWh/month$

$$(219)m = (64)m \times 100 \div (217)m$$

(219)m=	171.12	150.42	157.04	139.46	135.72	119.91	113.87	126.73	127.07	144.68	154.63	166.56	
Total = $Sum(219a)_{1...12} =$												1707.21	(219)

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Annual totals

Space heating fuel used, main system 1	kWh/year	4976.05	
Water heating fuel used	kWh/year	1707.21	
Electricity for pumps, fans and electric keep-hot			
Total electricity for the above, kWh/year	sum of (230a)...(230g) =	0	(231)
Electricity for lighting		329.6	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	Fuel Price (Table 12)	Fuel Cost £/year	
Space heating - main system 1	(211) x	13.19	x 0.01 =	656.34 (240)
Space heating - main system 2	(213) x	0	x 0.01 =	0 (241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0 (242)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 13, or Appendix F for electric CPSU)			1	(243)
Low-rate fraction	1.0 - (243) =		0	(244)
High-rate cost	(219) x (243) x	13.19	x 0.01 =	225.18 (245)
Low-rate cost	(219) x (244) x	13.19	x 0.01 =	0 (246)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	0 (249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a				
Energy for lighting	(232)	13.19	x 0.01 =	43.47 (250)
Additional standing charges (Table 12)				0 (251)
Appendix Q items: repeat lines (253) and (254) as needed				
Total energy cost	(245)...(247) + (250)...(254) =			925 (255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	3.33	(257)
SAP rating (Section 12)		53.6	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating (main system 1)	(211) x	0.519	=	2582.57 (261)
Space heating (secondary)	(215) x	0.519	=	0 (263)
Water heating	(219) x	0.519	=	886.04 (264)
Space and water heating	(261) + (262) + (263) + (264) =			3468.61 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	0 (267)
Electricity for lighting	(232) x	0.519	=	171.06 (268)
Total CO2, kg/year	sum of (265)...(271) =			3639.67 (272)

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CO2 emissions per m²

(272) ÷ (4) =

50.69

(273)

EI rating (section 14)

58

(274)

13a. Primary Energy

	Energy kWh/year	Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211) x	3.07	=	15276.48	(261)
Space heating (secondary)	(215) x	3.07	=	0	(263)
Energy for water heating	(219) x	3.07	=	5241.13	(264)
Space and water heating	(261) + (262) + (263) + (264) =			20517.62	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	3.07	=	0	(267)
Electricity for lighting	(232) x	0	=	1011.86	(268)
'Total Primary Energy		sum of (265)...(271) =		21529.48	(272)
Primary energy kWh/m ² /year		(272) ÷ (4) =		299.85	(273)

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