Energy Efficiency
Good Practice Guide
for Refurbishment of the Residential Sector (Low Rise) 2015

Housing Executive
HOME ENERGY CONSERVATION AUTHORITY
“This approach considers the house as an energy system with interdependent parts, each of which affects the performance of the entire system”
US Department of Energy

“A dwelling should be considered as an integrated set of systems rather than a set of separate components”
National Standards Authority of Ireland

“The whole-house systems approach looks at the house as an energy system with interdependent parts. Like a human body, when one part functions poorly it affects the performance of the entire system”
Florida Energy Systems Consortium

“What is perhaps less well understood is that in order for these benefit’s to be wholly realised an integrated, holistic and synergistic whole house approach is needed. This requires going beyond the conventional policy driven measure-by-measure piecemeal approach and the current trend of ‘cream-skimming’ whereby only the most cost-effective energy efficiency measures are applied to the worst performing homes. Instead whole house energy efficiency retrofit involves combining improvements to optimise the performance of the building as a whole”
National Energy Foundation UK and Energy Efficiency Partnership for Buildings
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Executive Summary

The Housing Executive, as the Home Energy Conservation Authority (HECA), has a key role under statute in Northern Ireland to identify, promote and monitor progress of energy efficiency throughout all tenures in the residential sector. It has been responsible for promotion, support and implementation of a wide range of energy efficiency measures across the social housing and private sector since 1996.

This good practice guide is produced by the Housing Executive within its regional strategic role as HECA across Northern Ireland to better inform and influence key decision makers within both the public and private sector housing providers. Today residential energy efficiency has plateaued with significant improvements in recent years addressing the ‘low hanging fruits’ of affordable warmth measures. Now a fresh approach is required to exploit the successes to date in thermal performance in order to reduce fuel poverty, CO₂ emissions while enhancing health and well-being.

The Housing Executive, as the HECA Authority, firmly believes the correct approach is an improvement to the thermal performance of the external envelope as a single entity (Envelope First Approach) and an upgrade to the heating system. An objective of energy efficiency is to get the most out of the fuel used within the dwelling and to keep that heat where it is needed for as long as possible. This requires a whole upgrade of the thermal envelope of the dwelling rather than the piecemeal approaches of the past which looked separately, at different stages, at wall insulation, loft insulation, windows, external doors and heating.

Below is a list of the main recommendations and how they can apply to the different residential tenures:

<table>
<thead>
<tr>
<th>SUMMARY OF MAIN RECOMMENDATIONS</th>
<th>OO</th>
<th>PR</th>
<th>NIHE (LS)</th>
<th>HA</th>
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<tbody>
<tr>
<td><strong>STRATEGIC CONTEXT</strong></td>
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<tr>
<td>1 Ensure policies follow the hierarchy of energy efficiency for future refurbishment works involving affordable warmth measures.</td>
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<td>2 Adopt ‘Decent Homes Standard Plus’ within ‘Thermal Comfort’ criteria only as a minimum benchmark across all tenures for future programmes/initiatives.</td>
<td>x</td>
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<td>3 Ensure landlords/policy makers consider the DETI commitment for renewable heat in the delivery of replacement heating programmes.</td>
<td>x</td>
<td>x</td>
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<tr>
<td><strong>KEY ENERGY ISSUES ACROSS ALL TENURES</strong></td>
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<tr>
<td>4 Create the conditions to encourage householders off oil reliance in areas where natural gas networks are established.</td>
<td>x</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>5 Wall insulation works and loft insulation ‘top up’ works made a priority across all residential tenures to comply with present Building Regulations.</td>
<td>x</td>
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### FABRIC FIRST APPROACH

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<td>6</td>
<td>Within policies adopt an Envelope First Approach and upgrade heating system as the most logical methodology to reduce fuel poverty and CO₂ emissions, while enhancing health and well-being.</td>
<td>x</td>
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### ENERGY IMPROVEMENT MEASURES

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<tr>
<td>7</td>
<td>Existing walls require an intrusive pre works survey to establish the existing thermal performance in order to provide remedies, which may include complete insulation replacement.</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>8</td>
<td>Triple glazing, correctly fitted in line with Passive Home Standards in preference to double glazing in future refurbishment schemes. (only when the useful life of energy efficient double glazing is complete).</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>9</td>
<td>Consider the use of wood pellet boilers outside the natural gas network.</td>
<td>x</td>
<td>x</td>
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<tr>
<td>10</td>
<td>Promote air tightness measures and ventilation to all future energy efficient refurbishment programmes, with the additional benefit of enhancing health and well-being.</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>11</td>
<td>Develop an energy efficient refurbishment programme (Affordable Warmth Programme), based on a 20 year life cycle, using the Envelope First Approach and upgraded heating system.</td>
<td>x</td>
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<tr>
<td>12</td>
<td>Based on availability of capital finance, consider Solar PV (and wood pellet outside the natural gas network), with the additional benefit to the landlord of availing of government incentives which can be re-invested in future fuel poverty projects.</td>
<td>x</td>
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<tr>
<td>14</td>
<td>Behavioural Change: Any initiative must be supported by an advice element to explain the operation of new systems and benefits, resulting in behavioural change of the householder/landlord.</td>
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### IMPLEMENTING FINANCE

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<tr>
<td>15</td>
<td>That Government encourage a system of energy efficient loans for householders/landlords who can’t avail of the present initiatives to refurbish housing stock to a minimum energy efficiency standard.</td>
<td>x</td>
<td>x</td>
<td></td>
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</tbody>
</table>

OO = Owner occupier  
PR = Private Rented  
NIHE (LS) = Housing Executive Landlord Services  
HA = Housing Associations
Introduction

The Home Energy Conservation Act (1995) designated the Housing Executive as Northern Ireland's sole Home Energy Conservation Authority (HECA), a role granted to the 408 local authorities in Great Britain. The Act required the Housing Executive to develop a strategy to significantly improve the energy efficiency of the entire housing stock and to submit annual progress reports thereafter.

The Act stated that, as HECA Authority for Northern Ireland, the Housing Executive had to identify measures that it considered practicable, cost-effective and likely to result in a significant improvement in the energy efficiency of the residential accommodation. “Significant improvement” is defined in Northern Ireland as 34% (30% in GB) as there is greater scope for converting to natural gas here. The measures identified did not necessarily have to be implemented or financed by the Housing Executive although we are required to report annually on progress, irrespective of who carries out or finances the work. No deadline was set for the achievement of the target which is measured as a reduction in fuel consumption within the housing stock.

Within this document any reference to the Housing Executive refers to its HECA role, and any reference to the Housing Executive as the principal social housing provider will have the caveat of Landlord Services (LS) included eg. NIHE (LS).

The Housing Executive measures progress on the energy efficiency target through the House Condition Survey (HCS). The last major HCS was carried out in 2011 and recorded a 22.5% improvement in the energy efficiency of the occupied housing stock between 1996 and 2011. The Standard Assessment Procedure (SAP 12, termed as SAP within remainder of document. Note: HCS used SAP 09) measures the energy efficiency of individual dwellings on a scale of 1 to 100 (1 being extremely poor and 100 being excellent). On this scale the average SAP for Northern Ireland’s housing had risen from 35 in 1996 to 60 by 2011. This compares favourably to the average SAP score of 55 for England in 2010. This improvement represents recurrent savings of some 2.5 million tonnes of carbon dioxide per annum over 1996 levels.

However, fuel poverty remains a major issue in Northern Ireland with 42% of households recorded as fuel poor in 2011. Energy efficiency measures are helping to mitigate its impact but rising fuel prices and income issues ensure the problem remains a serious issue in Northern Ireland. Since 1996, improvements in energy efficiency have become a cross-cutting factor in helping to deliver objectives and targets for a range of other Government Departments or agencies as set out in the table below;

<table>
<thead>
<tr>
<th>Government Department/Agency</th>
<th>Strategy/ Objective</th>
</tr>
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<tbody>
<tr>
<td>Dept for Social Development</td>
<td>Housing Fuel Poverty</td>
</tr>
<tr>
<td>Dept for Enterprise, Trade &amp; Investment</td>
<td>Energy Strategies Job Creation</td>
</tr>
<tr>
<td>Dept for Health, Social Services &amp; Public Safety</td>
<td>Health &amp; Wellbeing (includes fuel poverty)</td>
</tr>
<tr>
<td>Dept of Environment</td>
<td>Air Quality Climate Change</td>
</tr>
<tr>
<td>Dept of Agriculture</td>
<td>Rural Poverty</td>
</tr>
<tr>
<td>Office of First Minister &amp; Deputy First Minister</td>
<td>Anti-poverty Strategies Sustainable Development</td>
</tr>
<tr>
<td>Dept of Finance &amp; Personnel</td>
<td>Building Regulations Energy Performance Certificates</td>
</tr>
</tbody>
</table>

This document sets out the state of energy efficiency in each residential tenure and suggests a way forward for the future refurbishment of low rise dwellings across all tenures.
Considerable progress has been made to date upgrading the energy efficiency of all housing stock across all tenures both private and social. Whilst progress to date is good, there is room for further improvement and fuel poverty remains an issue due to long term high fuel prices and low household incomes. Energy efficiency remains a key component in alleviating fuel poverty.

At present both social and private landlords do not take account of a whole house approach (which considers a dwelling as an interdependent energy model, not unlike a human body) when delivering planned maintenance programmes. The failure to do this is not the most optimum approach for the occupants of dwellings and is driven more by budget and other considerations. This phased approach to energy efficiency often leads to scenarios like the following:

- **Year One**: Dwelling gets increased loft insulation
- **Year Five**: Upgrade the heating system
- **Year Seven**: Replace the single glazed windows or doors

This piecemeal approach affects the dwellings ability to maximise the various improvements as the reduced heat loss through lofts and walls would intensify the heat losses experienced from old or defective windows. The partial investment in insulation does not relieve tenants’ feelings of discomfort if the rest of the thermal fabric of the dwelling is not simultaneously upgraded.

There has been a variety of reasons for the current approach:

1. Different DSD and Ministerial priorities, over consecutive administrations, have influenced the Housing Executive’s business plan and targets and the direction of social landlord programmes over the years.

2. Removal of Multi-Element Improvements (MEI) as a vehicle to deliver major refurbishment to existing Housing Executive stock. The rationale for this action was the promotion of single element improvements to allow a greater spread of expenditure across more Districts at a time of restricted budgets. Restrictions resulted from the reduction in capital receipts as a consequence of reduced house sales, therefore putting a greater strain on the revenue stream funding. Although more dwellings were getting the complete refurbishment of the thermal envelope that is required to alleviate fuel poverty.

3. During the period of removal of MEI, fuel poverty was not as big a problem as it is today.

4. In previous years the cost of solid wall insulation was prohibitive, however with technological advances and political support the requirement to insulate the complete external envelope as one integrated component is a realistic objective.

5. There is no requirement for private rented accommodation in Northern Ireland to meet minimum standards of energy efficiency.

6. For owner occupiers, grants have only been available for some energy efficiency measures for those that are eligible, whilst for others, there are competing priorities for what they invest their money in.
The residential sector was responsible for around 25% of UK greenhouse gas end-user emissions in 2012, with carbon dioxide being the most prominent gas for this sector.\(^1\)

The guiding principle of energy efficiency for the refurbishment of residential dwellings requires a three tiered approach, called the Hierarchy of Energy Efficiency.\(^2\) Firstly reduce the energy demand, improve efficiency of the dwelling by using more energy efficient products and finally provide renewables, where appropriate, to generate heat or power.

\[ \text{ON-SITE LOW CARBON & RENEWABLES (FINAL)} \]

\[ \text{IMPROVE EFFICIENCY (SECONDARY)} \]

\[ \text{REDUCE ENERGY DEMAND (PRIORITY)} \]

A number of Government Departments also have strategies or targets that either influence or rely upon improving the energy efficiency of the housing stock.

Climate Change and Carbon Dioxide Emissions: (DECC and DoE Northern Ireland)

The UK Government has signed up to various international commitments to reduce CO\(_2\) emissions. It has an interim target to cut carbon emissions by 20% by 2020 as part of its programme to achieve the UK Climate Change Act target of 80% reduction by 2050.

Based on 2010 figures Northern Ireland has contributed a 14.7% reduction in CO\(_2\) emissions compared with the 1990 baseline, which is a poor comparison to the 23.9% reduction achieved in England.\(^3\)

With the significance of the emissions from the residential sector, making homes more energy efficient will make an important contribution to reducing the UK’s overall CO\(_2\) emissions. In 2011 the Sustainable Development Commission argued that existing dwellings need to be properly refurbished as they represent 70% of homes that will be occupied dwellings in 2050.

The UK Government, Scottish and Welsh Assemblies all have Climate Change Bills and associated targets. Although Northern Ireland does not have a Climate Change Bill it is required to contribute towards the UK’s national climate change targets. The DOE (NI) is presently developing a climate change strategy to reduce the effect of CO\(_2\) emissions. Existing dwellings will be expected to make a contribution to this.

Building Regulations (Department of Finance and Personnel, DFP):

In line with UK wide targets, building regulations have been amended in recent years to improve energy efficiency within new builds and refurbishment of dwellings. Within Northern Ireland the current CO\(_2\) reduction of 25% on the 2006 building regulations has been superseded in 2014 for England and Wales by a further 6% reduction. Based on previous amendments this legislation should be considered for NI in further years. Higher standards of energy efficiency in retrofit projects will, therefore, in time become mandatory.


\(^{2}\)DECC, The hierarchy of energy efficiency was conceived as part of the Local Government. Position Statement on Energy, 1998

\(^{3}\)McNally Griffiths Hyde, Energy efficiency of dwellings and their impact on CO\(_2\) reduction targets in NI, 2013
Good Practice in the European Context:

Energy efficiency has been a concept adopted by many European countries for decades driven by local climates and the 1970s energy crisis in the Middle East.

Germany: The concept of Passivhaus housing which involves low energy building science was developed in the 1990s in south west Germany. Today these or similar low carbon principles are becoming the benchmark for optimum energy efficient housing in some European countries.

Their federal government’s housing department has appreciated the climate change targets of 2050 and the impact housing has on these (up to 40% of energy use in Germany). Their latest initiative aims to refurbish all pre 1984 dwellings (30million) by 2020 with the objective to achieve 80% reduction in energy use.

U Values and Air Tightness: After studying analysis by the Sustainable Building Centre, sponsored by the International Energy Agency, the following western European countries have a higher building regulation standard for retrofitting of existing buildings than current Northern Ireland standards: Austria, Denmark, Finland, France, Germany and Sweden.

Admittedly some of these countries have a colder climate but their actions have effectively tackled fuel poverty. It is apparent that our present building regulations need to be upgraded further to keep in line with other developed countries in Europe.

Fuel Poverty (Department of Social Development, DSD):

A key driver to deliver energy efficiency within refurbishment of housing in Northern Ireland is the need to tackle fuel poverty. Presently Northern Ireland has the highest recorded fuel poverty level of 42% within the UK. DSD recognises the extent of the problem and the reduction of fuel poverty is a commitment within the Programme for Government. Although the improvement of energy efficiency is only one of the three factors that cause fuel poverty it is considered the most significant to deliver improvements.

Renewable Heat (Department of Enterprise, Trade and Investment - DETI):

DETI has a responsibility for implementing policy to support the delivery of 10% renewable heat within Northern Ireland by 2020. To aid in the delivery of this target, DETI has introduced the Renewable Heat Incentive (RHI) which social housing providers may be able to avail of. It is expected the RHI will involve receipt of an annual payment for seven years from commissioning of the biomass boiler.

DETI branding initiative to promote energy efficiency across sector.

Health and Well Being (Department of Health, Social Services and Public Safety, DHSSPS):

The Public Health Agency and individual health trusts in Northern Ireland have recognised the adverse impact that fuel poverty has on health and well-being. A number of health organisations contribute to initiatives aimed at reducing fuel poverty. In a recent pilot project with National Energy Action, Public Health Agency and local residents from Whiterock and Westrock in Belfast, energy efficiency measures were completed to dwellings in a targeted approach to fulfil the vision of the Northern Ireland Fuel Poverty Strategy which is for “a society in which people live in a warm, comfortable home and need not worry about the effect of the cold on their health”.

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5 NEA & PHA, Achieving Warmth in Whiterock and Westrock, 2014
Decent Homes Standard

All social housing landlords have a requirement to ensure that all of their housing stock meet the Decent Homes standard. A key component of this standard is providing a reasonable degree of thermal comfort which requires efficient heating and effective insulation. Within the Savills Report 2009 into the Housing Executive (LS) they commented Decent Homes Standard delivered, ‘a very low standard indeed.’

Decent Homes Standard Plus is considered an enhanced version and more acceptable as a minimum standard. Presently not considered as a benchmark in NI, however, its inclusion would enhance living conditions/health and well-being of householders. This guide is only concerned with the Thermal Comfort criteria within Decent Homes Standard Plus.

Air Quality (Department of Environment):

The DOE has Air Quality targets to meet. Any Council area where air quality is a problem must produce Air Quality Management Plans. Certain types of fuel, such as coal, contribute to poor air quality. Going forward, all social landlords or government bodies sponsoring grant aid to owner occupiers need to be conscious of the effects of its energy policies on this issue and make the case for why open fires are not an option in future schemes.

Best Value for Money:

This guide is considered within the context of a whole house approach. The level of heat loss and CO₂ emissions in relation to energy improvement options must be evaluated to establish a best value for money assessment of the various measures to deliver energy efficiency.

The NI Procurement Board definition of Best Value for Money is ‘Most advantageous combination of cost, quality and sustainability to meet customer requirements.’ In this context sustainability means economic, social and environmental benefits. Within a whole house approach the sustainability context can be delivered through all of these benefits.

**Recommendation:** Ensure policies follow the hierarchy of energy efficiency for future refurbishment works involving affordable warmth measures.

**Recommendation:** Adopt Decent Homes Standard Plus within Thermal Comfort criteria only as a minimum benchmark across all tenures for future programmes/initiatives.

**Recommendation:** Ensure landlords/policy makers consider the DETI commitment for renewable heat in the delivery of heating programmes.

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7 DFP, Best Value for Money definition from NI Executive (based on advice from NI Procurement Board), 2013

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Clonmore Green, Newtownabbey by Housing Executive.

This major refurbishment included integrated solar roof tiles providing solar PV and solar water heating. This scheme resulted in reduced annual energy bills for tenants.
Analysis of Key Factors Across All Tenures

Within this section we will assess fuel poverty, energy efficiency (via SAP) and the components parts, namely heating, insulation and double glazing across all tenures.

The most recent data across all tenures is taken from the Northern Ireland House Condition Survey 2011 published by the Housing Executive.

Breakdown of Tenures within Northern Ireland

<table>
<thead>
<tr>
<th>Tenure</th>
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<tbody>
<tr>
<td>Owner Occupier</td>
<td>469,000</td>
</tr>
<tr>
<td>Private Rented</td>
<td>125,000</td>
</tr>
<tr>
<td>Social Housing</td>
<td>111,000</td>
</tr>
<tr>
<td>Vacant</td>
<td>55,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>760,000</td>
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Source: House Condition Survey NIHE 2011

Analysis of SAP09 ratings relative to EPC Bandings A-G

Comment: With social housing benefiting from energy efficient programmes, delivering the ‘low hanging fruits’ the SAP has made initial gains but now plateaued out. The recent new build of social housing delivering to Code for Sustainable Homes at minimum of Level 3 (approx. SAP 85) and recently updated NI Building Regulations has improved the average SAP across the social housing sector.

SAP09 Bands by tenure:

Comment: The majority of Band E & F/G (considered very inefficient) are in the owner occupier and private rented sector. At present incentives in these tenures are based on means testing and a targeted approach, but not addressing the majority of the tenure mix.
Fuel Poverty as % across tenures:

Comment: Fuel Poverty is dominant across all sectors, with NI the highest Fuel Poverty region in the UK.

Central Heating as % across tenures:

Comment: Central heating is now fitted in 99% (749,500) of dwellings throughout Northern Ireland. The challenge is to utilize the natural gas as an interim solution and remove the reliance on oil where natural gas is available, especially in the owner occupier and private rented sectors.

Wall Insulation as % across tenures:

Comment: There are 173,650 dwellings in NI with no wall insulation. This equates to 23% across all occupied tenures. With the issue mainly in owner occupier and private rented sectors; further evidence to warrant continued intervention.

Loft Insulation as % across tenures:

Comment: 94% of dwellings (603,500) have loft insulation however only 35% have insulation over 150mm (Present new build specification is 300mm). The priority now will be to bring all the housing stock up to modern standard of 300mm, via ‘top up’ works.
Double Glazing as % across tenures:

Comment: 81% of dwellings have full double glazing with 148,320 dwellings with partial or no double glazing. Identifying the dwellings without double glazing should now be a priority.

Recommendation: Create the conditions to encourage households off oil reliance in areas where gas networks are established.

Recommendation: Investigate how to provide solid wall insulation preferably by external treatment (based on cost) is a priority.

Recommendation: Carry out a programme of top up loft insulation to present building regulation standard of 300mm across all residential tenures.

Recommendation: A targeted approach within owner occupier and private rented sector for intervention works to reduce fuel poverty by improving thermal improvement measures. (This good practice guide acknowledges the DSD Affordable Warmth Scheme encompasses an Area Based Approach for owner occupiers, with application based on a targeted approach/means tested benefits).
Heat loss from a typical dwelling:

To examine the fabric first approach we must appreciate the level of heat loss through the different elements of a home.

It is widely acknowledged the amount of heat loss from a building is:

- a. 35% - Walls
- b. 25% - Roof
- c. 15% - Draughts/unwanted ventilation
- d. 15% - Floor
- e. 10% - Windows

Immediately we can establish that 85% of the heat loss can be equated to fabric heat loss through the external envelope.

With the Climate Change Act 2008\(^8\) requiring an 80% reduction in CO\(_2\) emissions by 2050 and households accounting for over 25% of the total within the UK it is imperative refurbishment considers reducing fabric heat loss at the conceptual stage.

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\(^6\) UK Govt, Climate Change Act, 2008
\(^8\) Fuel poverty and human health: Our view of recent evidence Christine Liddell and Chris Morris, 2010
**Recommendation:** After assessment of heat loss and CO₂ emissions it is evident that the Fabric First Approach and dealing with the external envelope as a single entity, termed Envelope First with an upgraded heating system is a logical approach to effectively reduce fuel poverty and CO₂ emissions, while enhancing health and well-being.

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**Benefits of Increased Thermal Efficiency within a Fabric First Approach:**

1. Beneficial impact to the fabric, householder and reduction in CO₂.
2. Reduction in fuel bills – increases disposable income to spend on other essentials such as food, clothes, etc.
3. Reduced fuel debt and fuel poverty.
4. Reduced maintenance costs for landlord and owner occupiers.
5. Greater tenant satisfaction with improvement being carried out in holistic manner.
6. Increased value of home.
7. Improved health and wellbeing. The health impacts of tackling fuel poverty are reviewed, drawing primarily on large-scale studies completed in the last 10 years. Although physical health effects on adults appear to be modest, caregivers and children perceive significant impacts on children’s respiratory health.

Given the proven evidence that fuel poverty affects both physical and mental health it is believed that measures will go some way to improve health and wellbeing levels in households.

8. Reduced cost to NHS. Better health and well-being reduces the cost on NHS with typical A/E admission costing £2,500.
9. Energy programmes create jobs, delivering economic development for SME.
10. Minimises cost of damage to environment. With the UK targets for climate change and various interim targets a whole house approach will deliver significant reductions in household CO₂ emissions.

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**Priority of Refurbishment, with Insulation or Renewables:**

Another measure to demonstrate the need for fabric first is to assess the CO₂ reduction from the various insulation or renewable options. Each improvement has a beneficial effect by reducing the CO₂ emissions (kg/m²/yr) on the existing levels of the dwelling as outlined below.

a. External Envelope, Enhanced Wall and Loft Insulation - 27%
b. External Envelope, Triple glazed windows - 6%
c. External Envelope/Ventilation (via MVHR), Air Tightness -15%
d. Heating Systems, High efficiency boiler - 21%
e. Renewables, Solar Thermal - 8%
f. Renewables, Solar PV - 7%
g. Miscellaneous, Low Energy Lighting - 1%

With the external envelope and heating system accounting for nearly 70%, this clearly demonstrates the effectiveness of fabric first principles and efficient heating systems before installation of renewables for energy efficiency based on CO₂ Reduction.

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**References:**

10 NEA & PHA, Achieving Warmth in Whiterock and Westrock, 2014
11 North East based social enterprise Gentoo Group pilot scheme, Boiler on Prescription, 2014
12 The Hyde Group, Retrofit & Replicate Project briefing, 2009
This section concentrates on investigating the various measures available for refurbishment in relation to the external envelope, heating system and renewables.

Reference is made to the main elements of refurbishment specification as an indicator of current good practice by a large landlord in delivering planned refurbishment, across all tenures for low rise properties (Annex A).

1. External Envelope – Wall Insulation:

Within the residential sector the private rented tenure, at 30%, has the highest level of dwellings with no wall insulation. Although social housing has the highest level of dwellings with some form of wall insulation (91%), the Housing Executive appreciates the priority of wall insulation for those dwellings without it and has either commissioned or is in partnership with others to address this issue. The Housing Executive has 5000 units built from ‘No Fines’ construction. A research project to evaluate the best options to improve the thermal performance of ‘No Fines’ is presently being carried out in Antrim. Another house type, the ‘Rural Cottage’ has been considered with a pilot project of external wall insulation outside Coleraine. This involved the installation of external wall insulation, new windows/doors and replacement fascia, barge and soffit. The project completed in autumn 2013 and is presently being assessed for variances of annual energy bills. Initial findings suggest up to 25% of savings on fuel costs with this pilot scheme.

The options for improvement of wall insulation are dictated by the wall type, namely cavity or solid.

a) Cavity Wall with No Insulation:

With the majority of housing stock of cavity construction having insulation, the thermal performance of the cavity wall is a key factor. Cavity wall insulation can significantly reduce heat loss, and is just above loft insulation in the priority of insulating dwellings. The thermal performance is based on the type and thickness of insulation. With cavity wall width in 1970 at 50mm and only moving to 100mm in 1990 potentially a third of the social landlord stocks have cavities below 100mm. However, it must also be recognised that some dwellings may be unsuitable for cavity wall insulation due geography, poor mortar joints, etc. A proper survey of the building at the outset will determine suitability.

Using a modern silver/grey bead with thermal conductivity of 0.033 W/Mk, the following results are typical for an upgraded cavity wall with filled cavity insulation:

<table>
<thead>
<tr>
<th>Existing Cavity</th>
<th>U Value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>50mm</td>
<td>0.52</td>
<td>May require internal insulation in addition</td>
</tr>
<tr>
<td>75mm</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>100mm</td>
<td>0.29</td>
<td></td>
</tr>
</tbody>
</table>

Based on Block 2000kg/m3, rendered/block 2000kg/m3 plastered and Thermal Conductivity of bonded bead 0.033 W/mK

Indicative Cost: Up to £800 per dwelling for insulating only

b) Internal Wall Insulation:

If there is already partial fill with rigid board insulation or there is only a 50mm cavity, or if it’s a solid wall, additional performance can be achieved with fitting internal wall insulation.

<table>
<thead>
<tr>
<th>Year Built</th>
<th>Existing U Value</th>
<th>Revised U Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988-1994</td>
<td>0.60</td>
<td>0.33</td>
</tr>
<tr>
<td>1994-2000</td>
<td>0.45</td>
<td>0.28</td>
</tr>
<tr>
<td>+2006</td>
<td>0.35</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Thermal Conductivity of 40mm internal wall insulation 0.025 W/mK

However it is widely accepted with the complexities and expense of internal wall insulation it hasn’t been as successful as external wall insulation. In summary this is not an option considered for main stream refurbishment.

Indicative Cost: £5,500 - £8,500 depending on house size.

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13 TSB, Solid Wall Innovative Insulation and Monitoring Processes using Lean Energy Efficient Retrofit (S IMPLER), 2013
14 NIHE, NIHE External Wall Insulation Pilot Scheme – Draft Report, 2014
15 BRE Good Practice Guide 44 Parts 1 & 2
c) Extraction of Existing Cavity Wall Insulation:

Based on current research, all refurbishment schemes should consider the age and condition of the existing cavity wall insulation. This will require a thermal camera assessment and/or borescope survey to ascertain the existing condition and performance. If it is confirmed that existing insulation (fibre or bead) is inadequate or no longer fit for purpose, it may have to be extracted and, subject to a proper survey, re-insulated with bonded bead, which is now used extensively in preference to blown fibre.

Indicative Cost: £2000 for a two three bedroom townhouse for extraction and re-insulating. Costs vary depending on house size and elevations and include new insulation.

d) Solid Wall Insulation:

As highlighted 9% of Housing Executive (LS) and over 30% of private rented stock has no cavity and research into external wall insulation is currently on-going to improve the thermal performance of dwellings.

Heat loss through an un-insulated solid wall is typically over 50% greater than through an insulated cavity wall. The options to insulate solid walls are either external or internal and the following factors must be considered when landlords or homeowners are deciding on the best option:

i. Is there a future external cyclical maintenance (ECM) scheme planned, as external insulation has a rendered finish.

ii. External insulation will require the gutters, downpipes, fascia and soffit boards to be altered, therefore completing during an ECM is preferable. Where electrical wiring is removed from existing walls, it is not recommended that it is re-attached to the external wall insulation. Undergrounding of cables is required, which will need co-operation with NIE.

iii. External insulation is most effective when the whole external envelope is being upgraded simultaneously, which requires upgrading the windows, doors, fascia/soffit and loft insulation also.

iv. If decanting is an issue, external insulation is preferable.

v. If the internal floor area is critical external insulation should be considered.

vi. External insulation may not be acceptable if the vernacular architecture of the external façade is a feature.

vii. As discussed above internal insulation can complement cavity insulation to improve thermal performance.

viii. Thermal bridging where the internal walls/floors meet the external walls can be magnified with internal insulation.

ix. Interface with neighbouring dwellings (private/social), in some cases may be an issue.

x. Terraced dwellings where front door opens onto a public footpath (eg. no garden areas) are an issue. As Roads Service own footpaths they are unlikely to agree to encroachment for external insulation. In such cases, internal wall insulation should be considered.

External Wall Insulation (EWI): This can either be applied as render or cladding; with render being the cheaper option. Cladding can either be wooden, clay or aluminium panels. The render system uses fixed insulation (expanded polystyrene, mineral fibre lamella and phenolic) over coated with weather protective and breathable render finish.

<table>
<thead>
<tr>
<th>EWI thk &amp; type</th>
<th>U Value W/m²K (attached 215mm bwk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100mm Grey EPS</td>
<td>0.28</td>
</tr>
<tr>
<td>160mm Grey EPS</td>
<td>0.19</td>
</tr>
<tr>
<td>80mm Phenolic</td>
<td>0.22</td>
</tr>
<tr>
<td>120mm Phenolic</td>
<td>0.15</td>
</tr>
</tbody>
</table>

External wall insulation will reduce the effect of thermal bridging and the need for additional rendering costs.

Indicative Costs: £12,000 for 3 bedroom semi-detached house including replacement windows, doors, fascia/barge and adequate loft insulation to provide complete thermal envelope (£6,500 for EWI only).

16NIHE, NIHE Cavity Wall Insulation – Inspection Report, 2014
Internal Solid Wall Insulation: Internal insulation is used in particular circumstances as discussed above. It can either be insulated studwork or thermal laminate plasterboard (dry lining). Condensation can be an issue; therefore a vapour control layer is employed with the studwork.

One important consideration when using internal insulation, it can introduce numerous thermal bridges. Internal insulation involves the replacement of all internal surfaces, ceilings, architraves, skirting’s, light switches and sockets etc.

Recommendation: Wall insulation, either for cavity or solid should be a consideration when planning a refurbishment. The condition of existing wall insulation should be assessed based on thorough intrusive investigation. A real ‘U’ value could be calculated from the pre works investigation in order to specify the insulation to achieve an improved design ‘U’ value to deliver thermal comfort. No insulation or poorly performing wall insulation will be counterproductive to any other measures being carried out.

2. External Envelope – Roof Insulation:

Roof insulation considers insulation at above the ceiling level offset the heat loss up to 25% from a typical building.

a. Loft Insulation: is sited above the ceiling level between the joists and the thickness is determined by the depth of the joists. Good practice dictates the loft insulation should be no more than 25mm either above or below the top of the ceiling joists. If additional insulation is required it should then be laid across the joists.

<table>
<thead>
<tr>
<th>Loft Insulation Over Joists</th>
<th>U Value W/m²K</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional 150mm (300mm total)</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Additional 200mm (350mm total)</td>
<td>0.12</td>
<td></td>
</tr>
</tbody>
</table>

Based on loft insulation with thermal conductivity of 0.040 W/mK, with 150mm loft insulation already laid between joists.

Indicative Cost: £500 for 150mm Loft Insulation Top Up
Three considerations when laying loft insulation:

i. **Condensation in Loft/Roof Space:** With increased air tightness and greater levels of insulation the possibility of condensation increases. Draught proofing the hatches and insulating around the cold water storage tank not only avoids freezing but reduces the moisture in the attic and consequently the possibility of condensation in the attic.

Maintaining roof void ventilation also reduces condensation but the loft insulation should be placed as far as practical to avoid the thermal bridging at the eaves level. In summary vents in the soffit, roof ridge vents or breathable felt must be considered to avoid condensation.

ii. **Wiring:** The existing cables in the attic/roof create the possibility of dissipating heat if tied together. To offset this risk the cables should be located above the proposed loft insulation and separated out.

iii. **Storage:** If a dedicated storage space is designed into a refurbishment, laminated rigid insulation board should be used to offset the reduced thickness of insulation at the storage location.

b. **Rafter Insulation:** This is only a requirement if the loft/attic space is designed as a habitable space, otherwise insulating above ceiling height is preferable in order to efficiently heat only the space being used.

As with loft insulation the possibility of condensation must be a consideration.

c. **Flat Roof Insulation:** When refurbishing an existing flat roof, the preferred option is to keep the insulation on the upper side of the decking to minimise the possibility of condensation. This is known as a warm deck construction. Typically flat roof insulation is made from rigid board, namely rigid thermoset polyisocyanurate (PIR).

3. **External Envelope – Windows:**

Windows are a significant source of heat loss at 10%, under normal conditions. However, if the wall is satisfactorily insulated the heat loss through these openings will be magnified, particularly if the existing windows have dilapidated frames and broken seals as heat loss will follow the line of least resistance.

**Double Glazing v Triple Glazing:**

At present, good practice among social landlords, is the installation of windows with a thermal transmittance whole window “U Value” of 1.4 W/m²K (or better) and British Fenestration Rating Council (BFRC) ‘A’ rated.

The argument for triple glazing concentrates on increased thermal comfort and reduced heat loss through the windows. Existing double glazing that is still performing well should be retained until it reaches the end of its useful life. At that point, householders/landlords should consider replacing it with triple glazing. With greater evidence of householders not always needing to use their primary heating source, triple glazing is another good example to maximise insulation as it reduces the heat loss. Admittedly there is a 30% increase in cost but, as more households opt for triple glazing, the cost differential will reduce. This is much the same as the costs of double glazing reducing in the 1990s to the point that it became the industry standard and no-one considered single glazing anymore.

Good practice for the insulation of triple glazing must include the following:

a. Insulation of the frame, therefore requesting the frame U Value is preferable.

b. Low e coatings on the inside of the inner pane to reflect radiant heat back into the room.

c. Fill the gap between panes with argon or xenon to reduce heat loss from conduction.

d. Consider triple glazing to achieve a U Value of 0.8 W/m²K.

e. Consider air tightness of the window fitting with the use of air tape over a good quality sealant.

**Recommendation:** During refurbishment always ensure loft insulation is topped up to 300mm depth. Based on investigation, if there is any evidence of the existing loft insulation not having the original integrity it should all be replaced.
In summary energy efficient triple glazed windows with insulated frames, fitted to maximise air tightness can enable the external envelope to reduce heat loss in conjunction with the other measures discussed.

Indicative Costs: 30% e/o cost of existing double glazed window/frame.

(It must be remembered modern double glazing installed delivering a thermal performance of 1.4 W/m²K U value should be retained until the end of its useful life, and only then should households/landlords consider replacement).

**Recommendation:** Triple glazing should be considered over double glazing in refurbishment projects, ensuring the windows are fitted correctly in line with fitting to Passive Home standard for air tightness. (only when the useful life of energy efficient double glazing is reached).

4. External Envelope – Floor:

Within a refurbishment scenario the likelihood of replacing insulation within the ground floor is prohibitive based on cost. However where external insulation is considered, this can be extended down to foundation level externally. This presents additional costs in relation to paths, drainage, other services, therefore the benefits need to be assessed and set against the increased costs and disruption.

5. Heating System:

After the external envelope has been addressed with regard to energy efficiency, the next component to deliver significant improvement is the installation of an efficient heating system.

As the single biggest heating replacement programme within Northern Ireland, the Housing Executive (LS) Heating Policy is a good example of current practice. The Housing Executive (LS) Heating Policy recognises natural gas as the most efficient system. Where natural gas is not available the Housing Executive offers ‘A’ rated condensing domestic oil boiler or wood pellet boilers.

Existing heating systems are now being upgraded with zoning for heat/water and a 2nd heating zone if the house type can justify it, room thermostats and thermostatic radiator valves on each radiator.

Within the natural gas network this policy will help reduce fuel poverty and increase thermal comfort. Outside the natural gas network there is a poor uptake in wood pellet boilers, and the fitting of A rated oil boilers results in householders paying high energy prices (although now saving typically £200 on existing oil boiler). Oil boilers do not address CO₂ reduction targets.

As this good practice guide concentrates on low rise residential, the research currently ongoing with medium and high rise dwellings by the Housing Executive (LS) is outside the scope of this paper.

**Recommendation:** Outside the natural gas network, consider the use of wood pellet boilers to deliver comparable energy costs to natural gas. Within the natural gas network fitting of oil boilers should be considered by exception only.

6. Airtightness and Ventilation:

Within all the options to consider, airtightness and unwanted ventilation are inextricably linked, and must be carried out in concert.

**Airtightness:** Airtightness prevents the heat loss of air which has been warmed by the existing heating system. The heat loss escapes via the gaps within the structure, and is replaced by cold air, which requires continued heating. The net result is increased use of the heating system adding to household running costs.

To understand air tightness a thorough understanding of how air leakages occur within the structure must be appreciated. As per air leakage pathways below there are many possible combinations which hamper airtightness.
Reducing air leakage must be based on the practicalities of the existing structure. It is not financially feasible to install a vapour barrier throughout the internal envelope without major refurbishment; however, measures which complement air tightness at the known leakage locations are desirable.

**Good Practice examples of Airtightness in Refurbishment:**

**Windows/Doors:**
- Ensure all replacement windows/doors are sealed with approved mastic and further covered with air tape.
- Ensure there are no draughts caused by gaps within existing casement.
- All doors fitted with integral draught seals and better box seals.

**Walls:**
- Remove the skirting on the first floor to seal a layer of air tape around all first floor rooms, with particular attention at external walls to act against the cold bridge with the first floor joist butting on to the external skin. This will not eradicate the effects of the cold bridge, but will provide a level of resistance.
- Ensure any sockets are sealed eg. Light fittings on a dry lined external wall or suspended ceiling.
- Make good damage to mortar joints and fill holes in external walls.

**Floor:**
- Lay hardboard sheeting over the first floor timber floors, after the air tape has sealed around the floor edge of each room. Take care to make good gaps and seal around service pipes.

**Roof:**
- Ensure loft hatch fits snugly and apply draught-stripping between the hatch and frame.

**Services:**
- Seal gaps around any service pipes and cables passing through the external wall.
- Ensure the mechanical extract fans fitted for wet rooms

Realistic expectations of air tightness results must be considered against the measures taken. It is not value for money to seal the living areas with a vapour barrier but, using air tape with new windows can however deliver a measurable net benefit. Air tightness leads to reduced CO₂ emissions, reduced heat loss, greater thermal comfort and improved health and well-being.

Current building regulations for new build dwellings require an air pressure test to gauge the leakage of heated or conditioned air, which indicates the air tightness performance of the dwelling. It would be good practice to carry out this air test on existing dwellings to establish their air permeability with the view of setting air tightness standards as an objective in any further refurbishment programme.

**Ventilation:** With airtightness addressed (as far as practically possible within a refurbishment), the question of ventilation has to be considered. The options are mechanical ventilation, heat recovery (MVHR) or Positive Input Ventilation (PIV). The ability of existing extract fans must be considered against the functionality of mechanical ventilation, heat recovery systems or positive ventilation systems depending on cost and existing structural suitability for ducting.

Within new build low energy dwellings the MVHR is the most applicable to recycle warm air from the wet rooms. Within a refurbishment example the inclusion of MVHR
would necessitate severe internal disruption and after, commissioning, continual maintenance of replacement filters. With these two factors the inclusion of MVHR is discounted.

Positive Input Ventilation with the heat option can provide fresh ventilated and heated air into the dwelling from a central fan fixed on the first floor. This system doesn’t require a series of ducting, but requires a small gap under all internal doors, but an issue with fire doors. The fan will draw air directly from the roof space, which will depressurise the roof space. To stop air recirculating the loft hatch must be sealed airtight. The system provides positive ventilation throughout the dwelling which offsets the likelihood of condensation and mould growth, a modern day issue with more air tight dwellings.

To aid the extraction of stale air from the wet rooms/kitchens a modern low energy extract fan should be fitted with reduced air changes of 15/l/s to run intermittently. Modern fans have front grille covers and anti-back drafts to stop cold air entering the fan, which is a constant issue with householders.

Education of householders is an essential element when installing these devices. Traditionally householders believed the PIV systems produced cold air and were noisy. The modern upgrades use additional heat at source and are suspended in the roof, therefore eliminating noise pollution.

PIV with low energy extract fans may not be an ideal solution compared to MVHR. However, it is a workable compromise for a refurbishment situation to deliver the airtightness/ventilation balance within a realistic budget and minimal input by the householder.

Many social landlords have successfully used PIV systems to remove the likelihood of condensation occurring in existing homes to date and it is considered a proven technology and value for money. Improved ventilation enhances the internal air quality resulting in better health and well-being for householders.

**Recommendation:** Promote air tightness good practice measures during refurbishment and allocate costs as an integral refurbishment element to reduce energy bills and deliver improved health and well-being. Consider using air tightness standards as a performance target in further refurbishment programmes.

**Recommendation:** Within modern refurbishment ventilation is now a necessary consideration. Based on minimal disruption a Positive Input Ventilation system with heat option is preferable to reduce condensation and enhance health and well-being.

7. Thermal Bridging:

Thermal bridging occurs when materials with a higher thermal conductivity allow heat flow where elements meet, sometimes called cold bridging. When designing a refurbishment scheme this needs to be considered. However, as this good practice guide advocates a non-intrusive refurbishment, existing thermal bridging will be difficult to eradicate. Installation of new elements eg. windows and doors, will require consideration to minimise thermal bridging.

8. Renewables:

Systems for energy generation must consider cost, ability of use by the householders, and delivery of energy efficiency. Systems within an individual dwelling are preferable to communal projects to alleviate possible housing management issues. Proven systems with a creditable track record for social housing are solar photovoltaic panels, solar thermal panels and biomass boiler (discussed above). At present it is considered that ground source and air source heat pumps are only suitable for new build. In refurbishment situation, air source heat pumps are less favourable due to the high capital outlay and the non-availability of Economy 10 tariff used in GB. However the merits and issues around air source heat pumps are currently being explored and may be included in further revisions of this good practice guide.
Wind turbines, hydroelectricity and heat pumps have been discounted for this good practice guide based on value for money and/or functionality within refurbishment of typical residential properties.

Within the array of established renewables the options for refurbishment of one to two storey dwellings concentrate on:

a. Biomass boilers (wood pellet)
b. Solar Photovoltaic (PV) panels
c. Solar Thermal panels

**a. Biomass Boilers:** The heating system is a key component in any dwelling, and after good insulation of the envelope this is the next factor for consideration. As discussed previously natural gas is the preferable option, where available, followed by high efficiency oil or biomass boilers. Another consideration is the UK Government incentive schemes for biomass boilers namely Renewable Heat Incentive.

These boilers are carbon neutral and typically reduce the household emissions by 9 tonnes per year.

**Typical Example:**
Replacement wood pellet boiler for dwelling under 1500ft² including installation costs & VAT £6000

RHI Upfront Grant £2500

Net Cost £3500 of installation.

RHI Ongoing Grant £600-1000 pa x 7 years
b. Solar PV Panels: Solar PV panels convert sunlight into electricity for importing into the grid or home use. Typical panel sizes use 2-3.5 kWp. The current maximum of 3.68 kWp due to the intensity of renewables being imported into the network grid.

The panels are fitted on a south facing elevation of an existing structurally sound roof and connected into the home wiring via an inverter. At present the UK Government has a NI Renewable Obligation Certificate scheme which, along with export tariffs, provides an annual income for investors in PV, as well as reducing household electricity bills. The carbon reduction from a 3.5kWp solar PV panel is 1.4 tonnes pa.

**Typical Example:**

Install Solar PV panel 3.0 kWp, costs £5500
NI Renewable Obligation Certificate/Export tariff = £490 pa x 20 years (To be reduced annually in Oct 2015 and Oct 2016).
Reduced Electric Bill = up to £200 pa x 20 years (source EST)

Typical Example:

Install Solar Thermal panel and replacement solar storage tank £3000 inc VAT
RHI one off payment £320
Net Cost approx. £2680
Typical savings per year £90
The solar thermal panel is preferable for a tenant due to the increased convenience of hot water, typically seven months pa. However with the high capital outlay and a probable limited space in a south facing roof, the installation of Solar PV based on the current incentives for 20 years is preferable for landlords/homeowners.

c. Solar Thermal Panels: Solar thermal panels use the sun’s energy to heat hot water. Panels can either be flat plate or evacuated tube collectors, with options now for drain back to prevent damage during severe frost, without relying on anti-freeze solutions.

The panels again have to be south facing and are incentivised under the RHI scheme with a capital payment of £320 towards installation. When grants were more advantageous in previous years the economic case for solar thermal panels was enhanced. There are minimal CO₂ reductions but coupled with natural gas reduces household emissions by 0.23 tonnes pa.

**Recommendation:** Develop an energy efficient refurbishment programme, with a 20 year life cycle to the external envelope as a single entity (Envelope First Approach) and heating replacement within one scheme eg. ‘Affordable Warmth Programme’ to reduce fuel poverty and CO₂ emissions. It is acknowledged with insulation and heating as two separate professions, this may be delivered as two projects, with minimal time delay between them.

**Recommendation:** During refurbishment works proper consideration of established renewable options of Solar PV and Biomass to reduce fuel poverty, reduce CO₂ emissions and allow the landlord to gain government incentives to develop further fuel poverty projects.

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Sunderland Road Flats, Castlereagh, Belfast by Housing Executive.
This is the 1st Solar PV scheme in social housing in Northern Ireland.

Within the local administration our sponsoring department (DSD) acknowledges NI has the highest UK level of fuel poverty at 42%, therefore fuel poverty reduction is a key priority in the current programme for government.

The Housing Executive, in its HECA role, strongly recommends an Envelope First via Fabric First plus heating upgrade so that occupants immediately get the maximum benefits from energy efficiency improvements. However, the Housing Executive recognises that not all landlords or home owners may be in a position to finance improvements in this manner and, for financial reasons may still need to phase in such works. Therefore, where funding remains a barrier to the Envelope First approach, the Housing Executive would recommend a priority order in which improvements take place.

Based on the case study in section I, after analysis of the Energy Performance Certificate (EPC) calculations, the % reduction per measure is considered against current household annual energy costs: (April 2015)

a. High Efficiency boiler, with zoned areas and loft insulation – 14% reduction
b. Cavity Wall Insulation, to current building regulations – 10% reduction
c. Triple Glazing – 3% reduction

Note, EPC calculations do not cater for air tightness and ventilation, but as noted above it can deliver substantial reduction.

It is evident a ‘fabric first’ approach before renewables can make a significant impact on improving the reduction in CO₂ emissions. In recent years there has been a greater recognition of the interdependency of various measures in achieving CO₂ reductions, reducing fuel poverty and providing greater thermal comfort.

Outline below are works required in priority of importance based on reducing fuel poverty to deliver an energy efficient housing refurbishment:

1. High efficiency condensing boiler (inc zoned system) and loft insulation
2. Cavity insulation to current building regulations
3. Ventilation and air tightness
4. Triple glazed windows, fitted to Passive Home Standards
5. Solar PV connected to HWC

James Court, Antrim Road, Belfast by Choice Housing. This scheme had both loft and cavity wall insulation upgraded in the past 3-4 years and then had 50kWp of Solar PV installed in 2014. So far over 80% of generated electricity has been used at the scheme.

Recommendation: Priority of Works; Based on greatest effect on reduction of annual energy costs the priority of works in delivering this variant of Envelope First and Efficient Heating System should follow:

Priority One: High efficiency condensing boiler (inc zoned system) and loft insulation

Priority Two: Cavity insulation to current building regulation

Priority Three: Ventilation and air tightness

Priority Four: Triple glazed windows, fitted to Passive Home Standards

Priority Five: Solar PV system connected to Hot Water Cylinder
Mill Cottages, Glenhull, Greencastle, Co Tyrone by Rural HA.
During a recent major refurbishment scheme the dwellings the energy efficient works included replacement upvc ‘A’ rated double glazing and external doors to current building regulations; 300mm loft insulation, energy efficient light bulbs and zoned heating with modern condenser oil boilers, providing estimated savings to tenant’s annual energy bills of approx. £200.

10. Energy Efficiency Measures: Advice
This section covers low energy lighting, appliances and monitoring energy use. These are not items provided by landlords, but tenants and owner occupiers can be provided with advice on these and other energy saving activities/behaviours.

a. Low Energy Lighting and Usage: Compact Fluorescent Lamps (CFLs) and Light Emitting Diodes (LEDs) are now commonplace in many homes. However, some households still use the old style incandescent bulbs. If these lights are replaced with low energy lighting, savings up to 7% of the household electricity costs can be achieved annually. The usage of the lighting is also important eg. Turn off lights when not using rooms, only use background lighting and sensors for external lighting.

b. Appliances: Usage is an important factor as seen below:

![Average Household Energy Use UK (DECC)](image)

17 Most homes now have Compact Fluorescent Lamps (CFL) and Light Emitting Diodes (LED), however some households still have the old style incandescent bulbs.
The household behaviour with regard to leaving devices/systems on stand-by is worth consideration. Typically a family will use £45-80 per year for items on stand-by or not in use. Apart from the behavioural change required to turn off devices at night, the use of stand by savers is one option to reduce energy waste.

The type and age of appliance is another important factor. Using appliances with Energy Saving Trust (EST) recommended certification mark is preferable as these achieve the highest efficiency possible, eg. only fridges which are A+ and washing machines with AAA are recommended.

c. Energy Monitoring: Energy monitoring devices highlight consumption data, therefore empowering householders to manage their energy use.

The monitors comprise of sensors fitted to the incoming mains supply which transmit electricity consumption data to a monitor unit, with the following data for display:

i. Time
ii. Current tariff
iii. Current cost (either real time for pre-paid customers or monthly/quarterly costs for credit customers)
iv. Visual presentation of data to demonstrate high/low usage
v. Comparable data with previous year

Although seemingly functional, with the assumption of using proven technologies, there is no necessity to use energy monitors. Lessons learned from previous projects demonstrate the householder’s see monitors initially as a checking tool but soon become accustomed to their new technologies without the need to cross reference to energy monitors.

**Recommendation:** Behavioural Change:
Any initiative must be supported by an advice element to explain the operation of new systems and benefits, resulting in behavioural change of the householder. This should be integral to the refurbishment and only carried out by competent energy advisors.
Mill Cottages, Drumquin, Co Tyrone by Rural HA. During a recent major refurbishment scheme the energy efficient works included replacement upvc ‘A’ rated double glazing and external doors to current building regulations; 300mm loft insulation, energy efficient bulbs and zoned heating with modern condenser oil boilers, increasing the dwellings energy efficiency rating to RdSAP C74, (2014 NI average is D60).

Strand Court, Holywood Road, Belfast by Choice Housing. Retrofit including 11KWp of Solar PV.
Implementation/Financing:

In this section we will analyse the various funding mechanisms currently available to deliver energy efficient refurbishment including self-financing.

When considering financing the views and wishes of the householder is crucial and refurbishment must address their views and aspirations.

1. Social Housing:

The current model for refurbishment within the Housing Executive (LS) is external cyclical maintenance (ECM) and single element replacements eg. heating system replacements whereas the housing associations use a mix of single and multi-element refurbishment based on their particular stock profile. As per a previous recommendation, an energy efficient refurbishment programme (Affordable Warmth Programme) based on a 20 year life cycle to deliver thermal improvements of the external envelope and heating system within one project could be established to help reduce fuel poverty and CO₂ emissions. It is acknowledged the insulation and heating works could be delivered in two projects, as discussed earlier.

The only option for grant funding Housing Associations is via the NI Sustainable Energy Programme, ‘Cosy Homes’ for heating and insulation works. The funding is only considered a top up and the majority of costs must be met by their reserves.

Refurbishment Scenario:

This is based on a 1963 mid terrace with natural gas boiler recently updated (but no upgrade in heating system with zones, room stats etc). The revised specification accounts for the measures discussed in the previous section. All the works will have to be self-funded by the respective social landlords.

<table>
<thead>
<tr>
<th>Replacement Element</th>
<th>Typical Existing Spec £</th>
<th>Revised Spec £</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cavity Wall extraction &amp; installation, if required</td>
<td>NA</td>
<td>2000</td>
<td>e/o spec</td>
</tr>
<tr>
<td>Loft Insulation up to 300mm (under completed heating scheme)</td>
<td>500</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Replace Windows &amp; Doors</td>
<td>3000 (Double G)</td>
<td>4000 (Triple G)</td>
<td>e/o spec</td>
</tr>
<tr>
<td>Airtightness Measures</td>
<td>NA</td>
<td>1500</td>
<td>e/o spec</td>
</tr>
<tr>
<td>Positive Ventilation System</td>
<td>500</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Upgrade heating system for zoning</td>
<td>1000</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td><strong>5000</strong></td>
<td><strong>9500</strong></td>
<td></td>
</tr>
</tbody>
</table>

During the case study in the next section we will consider the cost of refurbishment against the carbon reduction and heating load and resultant reduction in energy bills.

18 Only when recently fitted modern double glazing units have reached the end of their useful life of thermal performance.
Renewable Scenario:

Only after the delivery of improvements to the thermal envelope and upgrading the heating system should the installation of renewables be considered. Renewables have evolved, however, this good practice guide considered functionality, Solar PV and Biomass boilers were the shortlisted options.

Roof mounted solar PV was the preferred option for housing (with limited garden space) delivering the best financial return. Biomass boilers have high capital costs but are an option where the natural gas network is not available.

<table>
<thead>
<tr>
<th>Element</th>
<th>Capital Costs £</th>
<th>Grants</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV (3Kw)</td>
<td>5,500</td>
<td>NIROC only, no capital</td>
<td>Grant x 20years</td>
</tr>
<tr>
<td>Biomass (12Kw)</td>
<td>6000</td>
<td>RHI</td>
<td>600 (x 7years)</td>
</tr>
</tbody>
</table>

Renewables will be considered in the case study with the associated benefits to the householder and the landlord.

2. Owner Occupier:

Owner occupiers can avail of various grant aid for energy efficiency and renewables. However some of these grants are time limited and may not be available in the longer term.

a. Affordable Warmth Scheme: This is the DSD scheme to address fuel poverty within the private sector. It uses an area based approach to target the highest levels of fuel poverty, but self-referrals are permitted. The eligibility is based on the applicant's income levels. Work is ranked with insulation/ventilation as the top priority, followed by heating, windows and solid wall measures as priority 4. (Annex B).

b. Boiler Replacement Scheme: This scheme is for home owners only and is based on income qualification and the age of the existing boiler. It is for both oil and natural gas.

c. DETI Renewable Grants: This scheme, supported by UK Government is to incentivise the domestic and commercial sectors to utilise renewable heat technologies with a target of 10% of heating coming from renewable sources by 2020. The Renewable Heat Incentive (RHI) is available to home owners and tenants of private landlords to avail of capital funding after installation of biomass boilers, air/ground source heat pumps and solar thermal panels. The grant has an upfront payment followed by ongoing annual payments for seven years.

RHI Upfront Payment: This is a one off payment; currently £2500 for a biomass boiler is dependent on an approval system which requires the use of a system and installer from an approved list. These one off payments are also available for the following technologies (which are not considered technically feasible and/or not best value for money (BVFM) for refurbishment works):

- Air source heat pump £1,700
- Ground/water source heat pump £3,500
- Solar thermal hot water £320

Wood pellet boiler fitted into residential dwelling.
**RHI Ongoing Payment:** The ongoing payment follows on from the upfront payment and is another incentive, operational from April 2015. The concept is regular annual payments for the first seven years of the life of the renewable heating system. Probable payments are believed to be £600-£1000 per annum for biomass boilers. (dependent on potential energy use noted in the EPC certificate).

**d. NI Sustainable Energy Programme:**
This programme is administrated by the Energy Savings Trust on behalf of the Utility Regulator. The priority within the scheme is for vulnerable domestic both social and private occupiers deemed to be in or at risk of fuel poverty. This scheme is presently continuing until March 2016.

**e. Future Initiatives:** The NI Executive are currently looking at initiatives to provide a fully comprehensive approach with grants and loans system for energy efficiency and renewables eg. HEAT (Householder Energy and Thermal Efficiency).

**f. Self-Funding:** Increasingly the net benefits of energy efficiency and incentives from renewables are now a consideration in the business case for self-funding.

For simplicity the generic model of 1963 mid terrace with natural gas boiler recently updated will be used.

<table>
<thead>
<tr>
<th>Replacement Element</th>
<th>Revised Spec £</th>
<th>Grant</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cavity Wall extraction &amp; installation</td>
<td>2000</td>
<td>AWS</td>
<td>Income based</td>
</tr>
<tr>
<td>Loft Insulation top up from existing 100mm</td>
<td>500</td>
<td>AWS NISEP</td>
<td>Income based</td>
</tr>
<tr>
<td>Replace Windows &amp; Doors</td>
<td>4000 (Triple G)</td>
<td>AWS only offer Double G</td>
<td>Based on strict criteria</td>
</tr>
<tr>
<td>Airtightness Measures</td>
<td>1000</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Positive Ventilation System</td>
<td>500</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Upgrade heating system for zoning</td>
<td>1000</td>
<td>AWS NISEP</td>
<td>Income based</td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td><strong>9000</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AWS = Affordable Warmth Scheme    
NISEP = NI Sustainable Energy Programme:

<table>
<thead>
<tr>
<th>Element</th>
<th>Capital Costs £</th>
<th>Grants</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV (3Kw)</td>
<td>5500</td>
<td>NIROC only, no capital</td>
<td>Grant x 20years</td>
</tr>
<tr>
<td>Biomass (12kw)</td>
<td>6000</td>
<td>RHI</td>
<td>RHI £2500 &amp; £600 (x 7years)</td>
</tr>
</tbody>
</table>
3. Private Landlord:

The generic model noted in the Owner Occupier section will allow for grant aid/incentives from AWP, DETI renewable grants and NISEP. As there is no current regulatory framework for private landlords all measures are based on acceptance by the respective landlord.

4. Energy Efficient Mortgages/Loans:

Within this best practice guide we advocate fabric first concentrating on the external envelope with an upgraded heating system and only then consider renewables. In Germany their central strategy for achieving carbon reduction in existing buildings is through continuation of successful low interest loan programmes from their Government.19 Their current programme supports deep, comprehensive retrofits as opposed to individual measures. Indeed in Germany the effectiveness of their deep retrofit solutions is evident as tenants will pay additional rent (cold rent20) for a refurbished property with lower energy bills. This is not a direct substitution as tenant/occupier’s ‘buyin’ must be driven by reduced energy bills and supports the view of all parties sharing in the benefits of reduced energy bills.

To ensure a fully comprehensive approach to achieve the climate change targets and reduce fuel poverty, low interest loans for whole house approach need to be considered for appropriate home owners/private landlords.

**Recommendation:** That Government encourage a system of loans to incentivise householders and landlords who are outside the income threshold of Affordable Warmth and require energy efficient works. Similar to the ‘cold rent’ system in Germany the repayment could be based on the savings in energy costs. This would effectively mean householders divert from high energy bills to paying for energy efficient refurbishment instead. With the grants available via Affordable Warmth catering for the fuel poor and DETI renewable capital grants only benefiting those on decent disposable incomes, any proposed loan system would address the majority of householders, sometimes addressed as the ‘squeezed middle’.

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19 B Hamilton, A Comparison of Energy Efficiency Programmes for Existing Homes in 11 Countries, 2010
Rinmore Area of Creggan Estate, Derry by Apex HA.
Housing Executive stock transfer to Apex HA, after consultation/voting from tenants: Major refurbishment works by Apex including the following energy efficiency works; New external wall insulation/render system, new upvc double glazed windows and doors to current building regulations and efficient gas fired central heating from natural gas network.

Sunderland Road Flats, Castlereagh, Belfast by Housing Executive.
This is the 1st Solar PV scheme in social housing in Northern Ireland providing reduced annual energy bills for tenants.
Case Study – Desk Top Analysis

Based on the agreed principles of Envelope First and efficient heating followed by renewables to reduce our energy demand and maximise energy efficiencies this section will concentrate on low rise scenario:

**Low Rise - Existing Mid terrace townhouse:**

This example will illustrate the bulk of the existing residential sector with a typical social housing two storey mid terrace dwelling built between 1956 - 1973, which has recent natural gas replacement and a refurbishment within 20 years.

<table>
<thead>
<tr>
<th>Data Input</th>
<th>Dwelling Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td></td>
</tr>
<tr>
<td>Property Type</td>
<td>Mid terrace house</td>
</tr>
<tr>
<td>Property Age</td>
<td>1963</td>
</tr>
<tr>
<td>No of storeys</td>
<td>2</td>
</tr>
<tr>
<td>Internal Floor area</td>
<td>76m²</td>
</tr>
<tr>
<td>Height (floor to ceiling)</td>
<td>2.4m</td>
</tr>
<tr>
<td>No of open fireplaces</td>
<td>1No</td>
</tr>
<tr>
<td>Electric meter type</td>
<td>Single tariff</td>
</tr>
<tr>
<td>Habitable Rooms</td>
<td>Kitchen/Dining, Living room, Bedr1, Bedr2, Bedr 3</td>
</tr>
<tr>
<td>Heated Habitable Rooms</td>
<td>5No</td>
</tr>
<tr>
<td>No of rooms with bath and/or shower</td>
<td>1No</td>
</tr>
<tr>
<td>Wall Construction</td>
<td>Cavity Wall as built</td>
</tr>
<tr>
<td>Floor Construction</td>
<td>Solid as built, no added insulation</td>
</tr>
<tr>
<td>Roof Construction</td>
<td>Pitched Roof with tiles</td>
</tr>
<tr>
<td>Loft Insulation</td>
<td>100mm</td>
</tr>
<tr>
<td>No of external doors/ type</td>
<td>2No</td>
</tr>
</tbody>
</table>

**Efficiency Energy Rating of Dwelling with No Change:**

<table>
<thead>
<tr>
<th>Glazing Type</th>
<th>Double glazed</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of house draught proofed</td>
<td>Nil</td>
</tr>
<tr>
<td>No of low energy lamps</td>
<td>Nil</td>
</tr>
<tr>
<td>Heating system</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Secondary Heating System</td>
<td>Open Fire</td>
</tr>
<tr>
<td>Ventilation System</td>
<td>2No mechanical extract fans</td>
</tr>
<tr>
<td>Water Heating</td>
<td>From existing natural gas system</td>
</tr>
</tbody>
</table>

RdSAP: Reduced Data SAP used when an EPC is assessed in existing dwelling eg. refurbishment

RdSAP = 57 (within variance of NI average of 60).
Annual household energy costs = £1424 (inc cooking/appliance costs of £400)
Energy use = 344 kWh/m² per year,
CO₂ emissions = 4.6 tonne.
a) Refurbishment Works:

1. If a thorough intrusive survey necessitates the need for replacement, extract/refill cavity wall insulation with silver/grey bead.
2. Replace windows/doors with triple glazing with air tightness a priority (assumes existing windows whether single or double glazed are at the end of their useful life).
3. Increase loft insulation to 300mm mineral wool.
4. Provide air tightness measures as discussed.
5. Provide positive ventilation system with heat option.
6. Upgrade heating system for zoning and three channel central heating programmer.
7. Advise tenant in energy efficiency, including new systems in house, (all items can be addressed within a householder pack, given after refurbishment is complete).

This work will require a refurbishment on the basis of an Envelope First and heating upgrade. This scenario assumes natural gas is already fitted, as the vast majority of all residential tenures have either natural gas or oil boiler heating system.

The works listed highlight a works cost of £9500, which is approx. £4500 extra than the typical existing social housing specification for similar works.

<table>
<thead>
<tr>
<th>Replacement Element</th>
<th>Revised Spec £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgrade heating system for zoning</td>
<td>1000</td>
</tr>
<tr>
<td>Loft Insulation existing 100mm</td>
<td>500</td>
</tr>
<tr>
<td>Cavity Wall extraction &amp; installation</td>
<td>2000</td>
</tr>
<tr>
<td>Airtightness &amp; Positive Ventilation System</td>
<td>2000</td>
</tr>
<tr>
<td>Replace Windows &amp; Doors to triple glazing</td>
<td>4000</td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td><strong>9500</strong></td>
</tr>
</tbody>
</table>

Efficiency Energy Rating of Dwelling with Refurbishment Works:

<table>
<thead>
<tr>
<th>Energy Efficiency Rating</th>
<th>Current</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 92 plus</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>B 81-91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C 69-80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D 55-68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E 39-54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F 21-38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G 1-20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RdSAP = 75
Annual household energy costs = £1007 (inc cooking/appliance costs of £400)
30% Reduction
Energy use = 185 kWh/m² per year, 46% Reduction
CO₂ emissions = 2.5 tonne. 46% Reduction

Additional Renewable Options:

With the progression from energy efficient measures to renewables, the addition of renewables will also be calculated to assess their benefits, namely:

- Install Solar Photovoltaic Panel to the roof.
- Install Biomass heating boiler.
b) Renewable Options – Solar PV Panel:

With the uncertain capacity of the existing grid network and the limited roof size within the social housing sector an assumption to install a 3kWp panel (12 x 250w panels) would be prudent. Other considerations include roof stability and orientation.

Typical cost of 3kWp solar PV panel for a roof is £5,500. It is estimated up to £200 savings annually per household, however this is dependent on usage and ROI of 5-7 years.

Efficiency Energy Rating of Dwelling with Refurbishment Works and Solar PV:

<table>
<thead>
<tr>
<th>Very energy efficient - lower running costs</th>
<th>Current</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 92 plus</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>B 81-91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C 69-80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D 55-68</td>
<td></td>
<td></td>
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<tr>
<td>F 21-38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G 1-20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Not energy efficient - higher running costs

RdSAP = 85
Annual household energy costs = £828
(inc cooking/appliance costs of £400 and assumed £200 savings to householder from Solar PV)
42% Reduction
Energy use = 119 kWh/m² per year,
65% Reduction
CO₂ emissions = 1.6 tonne.
65% Reduction
The use of Solar PV will allow the landlord to use the incentives for future fuel poverty works.

c) Renewable Options – Biomass Heating:

This is only included for illustrative purposes as this scenario has existing natural gas heating already fitted. Biomass boilers fitted in social housing use a 10kg bag of wood pellets which require manual filling and periodic cleaning by the householder.

Typically a new system will cost £6000, but with a capital grant of £2500 and annual payments for 7 years this option will have a payback under 4 years.

Efficiency Energy Rating of Dwelling with Refurbishment Works and Biomass:

<table>
<thead>
<tr>
<th>Very energy efficient - lower running costs</th>
<th>Current</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 92 plus</td>
<td>72</td>
<td>73</td>
</tr>
<tr>
<td>B 81-91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C 69-80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D 55-68</td>
<td></td>
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</tr>
<tr>
<td>E 39-54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F 21-38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G 1-20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Not energy efficient - higher running costs

RdSAP = 72
Annual household energy costs = £1088
(inc cooking/appliance costs of £400)
24% Reduction
Energy use = 200 kWh/m² per year,
42% Reduction
CO₂ emissions = 0.9 tonne.
80% Reduction
Outside the natural gas network the use of biomass should be the preferred option (based on householder assessment of suitability) for the private sector over an oil boiler based on running costs and the availability of the DETI RHI capital grant of £2500 upfront grant and ongoing incentive for 7 years.

This is only included for comparison, as the scenario is based on a recently fitted natural gas boiler. However biomass is relevant to areas outside the natural gas network.

Data summary of Refurbishment and Renewable Options at Annex C
Energy Efficiency Rating of Insulation Measures to establish Priority of Refurbishment (based on Reduction of Fuel Poverty):

This section addresses the issue of current financial constraints and measures the impact of various measures individually as discussed within the envelope first and efficient heating system model:

**Priority One. Upgraded Heating Controls (Zoned) and Loft Insulation (individual measure):**

<table>
<thead>
<tr>
<th>Very energy efficient - lower running costs</th>
<th>Current</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 92 plus</td>
<td>66</td>
<td>73</td>
</tr>
<tr>
<td>B 81-91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C 69-80</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>G 1-20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Not energy efficient - higher running costs

RdSAP = 66
Annual household energy costs = £1222
(inc cooking/appliance costs of £400)
14% Reduction
Energy use = 269 kWh/m² per year,
22% Reduction
CO₂ emissions = 3.6 tonne.
22% Reduction

**Priority Two. Cavity Wall Insulation to current Building Regulations (individual measure):**

<table>
<thead>
<tr>
<th>Very energy efficient - lower running costs</th>
<th>Current</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 92 plus</td>
<td>66</td>
<td>73</td>
</tr>
<tr>
<td>B 81-91</td>
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<td></td>
<td></td>
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<tr>
<td>G 1-20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RdSAP = 63
Annual household energy costs = £1284
(inc cooking/appliance costs of £400)
10% Reduction
Energy use = 290 kWh/m² per year,
16% Reduction
CO₂ emissions = 3.9 tonne.
15% Reduction

**Priority Three: Air tightness and ventilation (not assessed on EPC)**
Priority Four: Triple glazed windows
(individual measure):

<table>
<thead>
<tr>
<th>Current</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 92 plus</td>
<td>75</td>
</tr>
<tr>
<td>B 81-91</td>
<td>59</td>
</tr>
<tr>
<td>C 69-80</td>
<td>59</td>
</tr>
<tr>
<td>D 55-68</td>
<td>59</td>
</tr>
<tr>
<td>E 39-54</td>
<td>59</td>
</tr>
<tr>
<td>F 21-38</td>
<td>59</td>
</tr>
<tr>
<td>G 1-20</td>
<td>59</td>
</tr>
</tbody>
</table>

Very energy efficient - lower running costs
Not energy efficient - higher running costs

RdSAP = 59
Annual household energy costs = £1378 (inc cooking/appliance costs of £400)
3% Reduction
Energy use = 326 kWh/m² per year,
5% Reduction
CO₂ emissions = 4.4 tonne.
4% Reduction

Note: EPC calculations do not account for fitting windows to Passive Home Standard

Priority Five: Install Solar PV:

As discussed earlier, renewables should only be fitted after all refurbishment measures are completed.
Concluding Recommendations Across All Tenures

1. **Clear Goals and Targets:** Establish clear goals by all housing providers and legislators. Good examples are the Housing Executive Corporate Objective to ‘Deliver Better Homes’, DSD Fuel Poverty Strategy and Climate Change Act 2008. Our refurbishment example delivers 30% reduction in energy bills per household and 46% reduction in CO₂ per dwelling. These reductions can increase to 40%+ reduction in energy bills, 65% reduction in CO₂ and if Solar PV is introduced.

   The assumption has been made that the current government incentives will be claimed by the dwelling owner and the occupant receive reduced energy costs. The incentives can finance further energy efficient refurbishment.

2. **Envelope First and Heating System:** Based on an earlier recommendation propose an Affordable Warmth Programme for refurbishment within the social housing sectors to deliver an Envelope First Approach with an upgraded heating system. It is acknowledged the insulation and heating works may have to be within two projects, with minimal time delay between them.

3. **Funding:** Advocate a low interest system for private sector householders and landlords, with repayment cycles in line with incentive schemes for renewables. Ensure this low interest loan scheme follows the same principles of Fabric First and Envelope First Approach, eg. Only fit renewables when the dwelling reaches a C rating (RdSAP of 69-80).

4. **Householder Behaviour Change:** All initiatives must be introduced with a tangible energy advice to support behavioural change by the landlord, tenant or householder. This should be integral to the refurbishment and only carried out by competent energy advisors.

5. **Industry Training:** The industry needs to appreciate energy efficient principles, and carry out renovation works accordingly. This requires education and training from the apprentice on site to the manager. This report acknowledges the positive work by CITB in the education of some construction professionals in Germany. The next step is to roll out and educate our local construction industry of these energy efficient principles.

6. **Case Study and Live Monitoring:** A refurbishment example should be completed as a research project to assess the actual reduction in energy use, CO₂ reduction and actual air test results. Another key consideration will be to assess the improvement in thermal comfort allowing for better health and well-being for the householder.

   (At present the Housing Executive are carrying out preparatory works to refurbish four existing Housing Executive social dwellings in Newry to cover the spectrum of current low carbon/energy efficient standards and adapt them for refurbishment:

   - Full Passive House Standard
   - BREEAM Domestic Refurbishment Standard
   - Energy Performance Certificate (EPC) “A” Rating

---

21 Building Skills for Sustainable Construction II Leonardo Project
Summary Across All Tenures

After analysis of the House Condition Survey 2011 it is evident across all tenures the key elements of central heating, loft insulation and double glazing have been upgraded in over 80% of all residential dwellings in Northern Ireland. Wall insulation is present in 71% of dwellings. However the issues of quality of cavity wall insulation and cost effectiveness of solid wall insulation are being addressed by a range of research initiatives, with the largest supported by the Technology Strategy Board. In total all the measures have delivered an improvement in energy efficiency of 22.5% from 1996-2011, resulting in a SAP average across all tenures of 60 by 2011. It is a reasonable assumption that the greatest effect has been created by the single element programmes, but a more integrated approach is now required to further reduce fuel poverty and CO₂ emissions.

The whole house approach is advocated within the principle of the hierarchy of energy efficiency to provide a more integrated solution. Within this document the whole house approach has been simplified to only consider the external envelope, namely Envelope First approach, and heating upgrade. This can be delivered via a refurbishment and is dependent on the financial constraints of the homeowner/landlord. As per the case study the cost of an Envelope First with upgrade of an existing natural gas system for a typical three bedroom house is £9,500 (assume nil refurbishment since new build, which is worst case and would be very uncommon with historical grants/initiatives previously completed within public/private sector housing) with an overall 30% reduction in annual energy bills and an overall CO₂ reduction per year of 46%. (Based on an existing modern ‘A’ rated natural gas boiler already fitted). If a 3Kw Solar PV panel was fitted at an additional cost of £5,500 the percentage CO₂ reduction per year would be 65%.

With behaviour change essential to ensure a reduction in energy demand it is imperative all measures whether in the private or public sector allow for education and advice with any retrofit measures.

Within social housing refurbishment is delivered via single element and multi element works. A proposed Affordable Warmth Programme could deliver the Envelope First and heating upgrade solution to reduce fuel poverty and CO₂ emissions with enhanced health and well-being.

The DSD Affordable Warmth Scheme does offer combined heating and insulation grants. Self-financing is the only method to truly provide an integrated approach, for many home owners although there is research being carried out into low interest loans for householders to avail of energy efficiency measures and renewables.

In the Netherlands and Germany, Green Mortgages are offered up to 34,043 and 50,000 euros respectively for retrofit. These mortgages are more advantageous with reduced interest rates over comparable loans. If Green Mortgages were introduced in Northern Ireland, effectively providing a low interest loan it would open the accessibility of energy efficient retrofit to a greater audience.

Rinmore Area of Creggan Estate, Derry by Apex HA.
### APPENDIX A

**Construction/ House Types Across NI Residential Sector:**

<table>
<thead>
<tr>
<th>Type of Construction</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Wall</td>
<td>Pre 1919</td>
</tr>
<tr>
<td>Solid Wall/Cavity</td>
<td>1919-1944</td>
</tr>
<tr>
<td>Cavity Wall (Pre Housing Executive)</td>
<td>1945-1971</td>
</tr>
<tr>
<td>Aluminium Cottages</td>
<td>1947-1957</td>
</tr>
<tr>
<td>No Fines (patented systems)</td>
<td>1947-1965</td>
</tr>
<tr>
<td>Flats (5 storey &amp; over)</td>
<td>1960-1970</td>
</tr>
<tr>
<td>Cross wall construction</td>
<td>1960-1974</td>
</tr>
<tr>
<td>Masonry without cavity wall insulation</td>
<td>1971-1981</td>
</tr>
<tr>
<td>Timber framed</td>
<td>Post 1972</td>
</tr>
<tr>
<td>Masonry with cavity wall insulation</td>
<td>1981-1998</td>
</tr>
</tbody>
</table>

*Source: Distribution of housing types in social housing, Energy Efficiency Best Practice in Housing, EST*

### ANNEX A

**Typical Main Elements of Refurbishment Specification within Social Landlords:**

These are based on typical Heating, External Cyclical Maintenance and Revenue Replacement policies:

a. Install natural gas where available, and condensing oil boilers, wood pellet boiler where gas is not available.

b. Ensure the heating system includes zoning (where feasible), rooms stats and thermostatic radiator values (TRV).

c. Replace windows with double glazed units delivering 1.4 W/m²K U Value for both window and frame using double glazed low emissivity, soft coat with 16mm gap.

d. Provide 270mm of loft insulation.

e. Provide cavity wall insulation if none is present.

Some social landlords consider single element works have been the preferred refurbishment option over multi element improvements. This provides a greater footprint of refurbishment across the stock but of limited impact per dwelling.

Heat loss is always considered constant for each building element however when single building elements are upgraded the heat loss is concentrated through the remainder of the building, eg. Fitting new loft insulation will concentrate more heat loss through the remaining components.
ANNEX B

DSD Affordable Warmth Scheme Measures

1. Installation of a new gas or oil central heating system where no system currently exists, conversion of an existing bottled gas (LPG), solid fuel;
2. Conversion of Economy 7 heating system to natural gas where available or oil where natural gas is not available or to a high efficiency storage heating system;
3. Boiler replacement for eligible applicants with boilers over 15 years old;
4. Heating Controls;
5. Replacement of existing radiators, as needed;
6. Removal and replacement of ineffective cavity wall insulation;
7. Loft insulation;
8. Hot water tank jacket;
9. Cavity wall insulation;
10. Draught Proofing;
11. Insulation for Solid Wall constructed properties;
12. Replacement windows (subject to recommendation following a technical inspection by the Housing Executive.)

Note: Energy advice and benefit awareness do not constitute an Affordable Warmth measure.

Not in order of priority

Source: DSD Fuel Poverty Unit

ANNEX C

Data Summary of Refurbishment and Renewable Options:

<table>
<thead>
<tr>
<th></th>
<th>EPC</th>
<th>Energy KWh/m² pa</th>
<th>Approx CO₂ Kg/m² pa</th>
<th>CO₂ Per Tonne</th>
<th>Light £ pa</th>
<th>Heat £ pa</th>
<th>HotW £ pa</th>
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<tbody>
<tr>
<td>Existing Dwelling</td>
<td>D57</td>
<td>344</td>
<td>60</td>
<td>4.6</td>
<td>94</td>
<td>739</td>
<td>191</td>
</tr>
<tr>
<td>With Energy Efficient</td>
<td>C75</td>
<td>185</td>
<td>32</td>
<td>2.5</td>
<td>48</td>
<td>440</td>
<td>119</td>
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<tr>
<td>Refurbishment</td>
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<td>119</td>
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<td>1.6</td>
<td>53</td>
<td>456</td>
<td>119</td>
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<tr>
<td>&amp; PV</td>
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<td></td>
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<td>12</td>
<td>0.9</td>
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<tr>
<th>Option</th>
<th>KWh/m²</th>
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