Arbed 1 Scheme
Evaluation of the Warm Wales Programme

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1.0 INTRODUCTION

The aim of this report is to evaluate what has been achieved as a result of the Warm Wales retrofit Programme funded under the Welsh Governments Arbed 1 Scheme. It will consider the environmental, social and economic impacts of the Programme and demonstrate the lessons learnt to help improve the implementation of the Arbed 2 Scheme and other retrofit projects.

The aim of the Arbed 1 Scheme, led by the Welsh Government, was to:

- increase the energy performance of existing homes in Wales, particularly the most energy inefficient homes;
- reduce the impact of fuel poverty on households in Wales;
- generate employment opportunities for Welsh residents and economic opportunities for Welsh businesses;
- promote the growth of local supply chains in the energy efficiency and renewable generation sectors.

The Arbed 1 Scheme intended to stimulate the installation of domestic energy efficiency and renewable energy measures which would improve the housing stock, increase economic investment in the low carbon market and assist in cutting carbon emissions. Funding was obtained by Registered Social Landlords (RSL) and Local Authorities (LA) in Wales in order to improve their own housing and private stock within specified areas.

Warm Wales, a Community Interest Company, was commissioned by five RSLs and two LAs, which had received funding from the Arbed 1 Scheme, to help deliver their projects. Warm Wales' role involved project design, project and contract management, and design advice working alongside contractors, RSLs/LAs and energy suppliers. Warm Wales actively sought private households to receive measures, create employment opportunities and educate residents on energy efficiency. Funds from the Carbon Emission Reduction Target (CERT) and Community Energy Savings Programme (CESP) were accessed, in addition to the Arbed funds and match funding by RSLs, to maximise the benefits for the communities involved.

The outcomes of this report will assist RSLs, LAs and other property owners to understand the barriers and drivers involved retrofitting dwellings and what the possible outcomes might be. This report has been produced by the Welsh School of Architecture at Cardiff University as a part of the Low Carbon Research Institute (LCRI) with information provided by Warm Wales and other sources.

2.0 BACKGROUND

2.1 Energy in UK housing and the need for urgent action

In 2007 the EU committed to transform Europe into a highly energy efficient, low carbon economy. EU Governments agreed that emissions would be cut by at least 20% of 1990 levels by 2020. Following this, the Climate Change Act was introduced in the UK in 2008 presenting a new approach to managing and responding to climate change in the UK (DECC, 2008). The Act set ambitious, legally binding targets, taking powers to help meet those targets and enhancing the UKs ability to adapt to the impact of climate change. Targets were set to reduce carbon emissions by 80% by 2050 with 1990 as the baseline year with interim targets of 26% by 2020.

Significant changes need to be made to all sectors of the built environment in order for these targets to be met, through increasing efficiency in energy demand and providing energy supply from low carbon sources. Figure 2.1 illustrates the importance of reducing energy consumed by households, with housing consuming 28% of total final energy consumption in the UK, the highest of all sectors. Traditional barriers for the necessary changes to be made include a lack of funds available to householders and government, knowledge regarding appropriate changes and the lack of appeal to householders to invest in something with little direct aesthetic or financial benefit. However, with energy costs increasing and greater investment by government in low carbon retrofitting schemes, important small steps are being made.

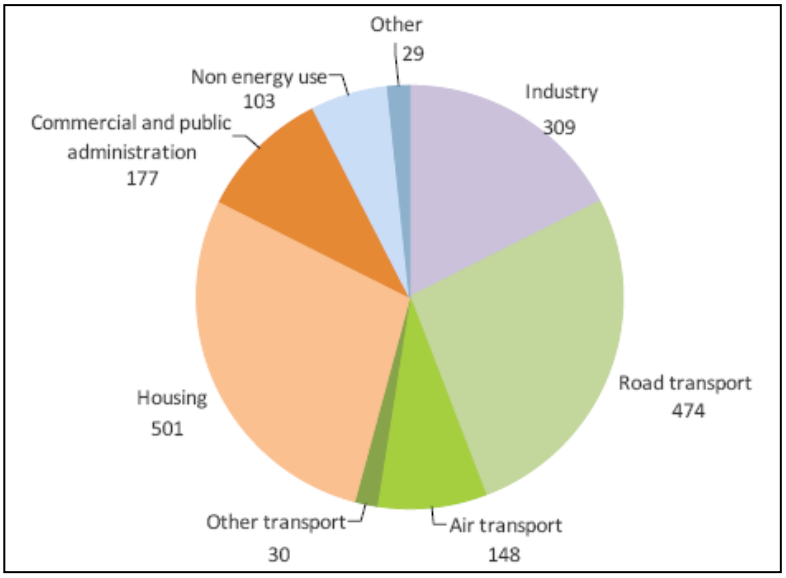


Figure 2.1 - Final energy consumption by sector in 2009 (UK, TWh) (Palmer J and Cooper I, 2011)

In 2010 UK greenhouse gas emissions were estimated to be 590.4 million tonnes CO_2 equivalent in ($MtCO_2e$) (DECC, 2012). This was 3.1% higher than in 2009. Between 2009 and 2010 the largest increases were experienced in the residential sector which had increased by 15%. This rise was due to an increase in gas use, mainly due to the very cold winter and fuel switching. This highlights the need for the implementation of low carbon technologies to improve the existing housing stock through more efficient properties and providing energy from low carbon sources.

Figure 2.2 illustrates that energy consumption in the home in the UK has changed significantly over the past 40 years. 90% of homes in Wales in 2008 had central heating (Welsh Assembly Government, 2009) compared with around 30% in 1970 (Palmer J and Cooper I, 2011). This, together with an increase in the number of homes in the UK, has seen an increase in energy used for heating homes by 40% since 1970.

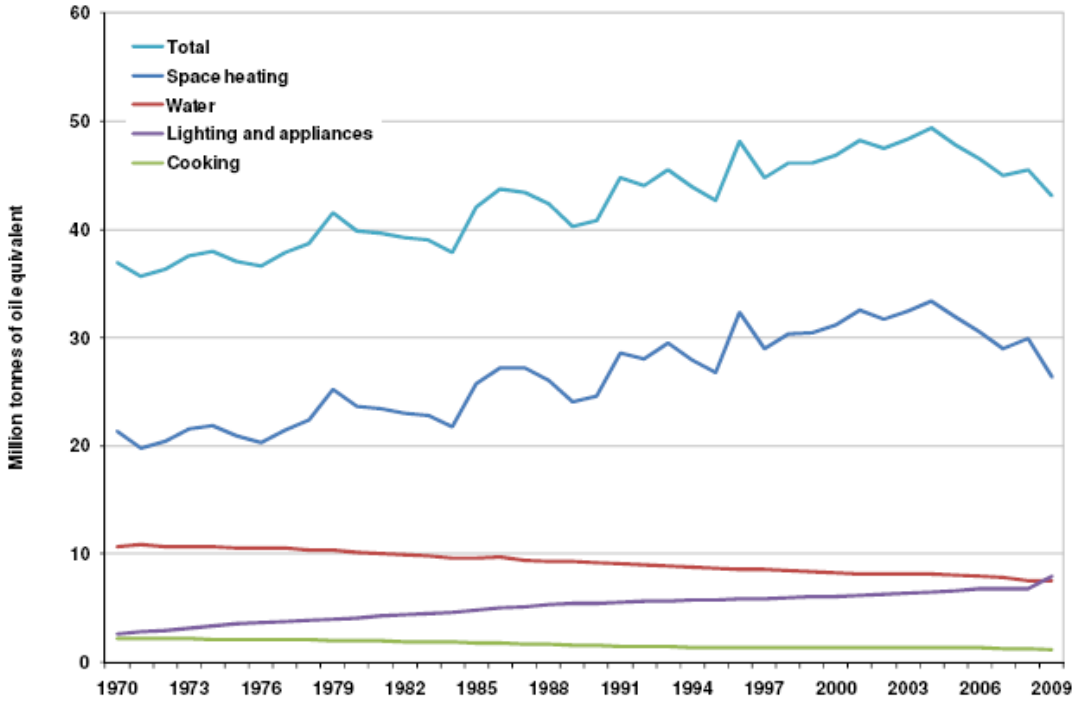


Figure 2.2 – Domestic energy consumption by end use (DECC, 2011b)

The use of unregulated electrical equipment has also increased significantly, with the low cost of time saving devices such as washing machines and dishwashers together with entertainment equipment including audio, visual and gaming. Less energy is used for heating water and cooking. Figure 2.3 summarises the energy consumption of a typical home in 2009 and highlights the opportunities to save energy through space and water heating. Changes are therefore required in both lifestyle and the current housing stock in order for these difficult targets to be met.

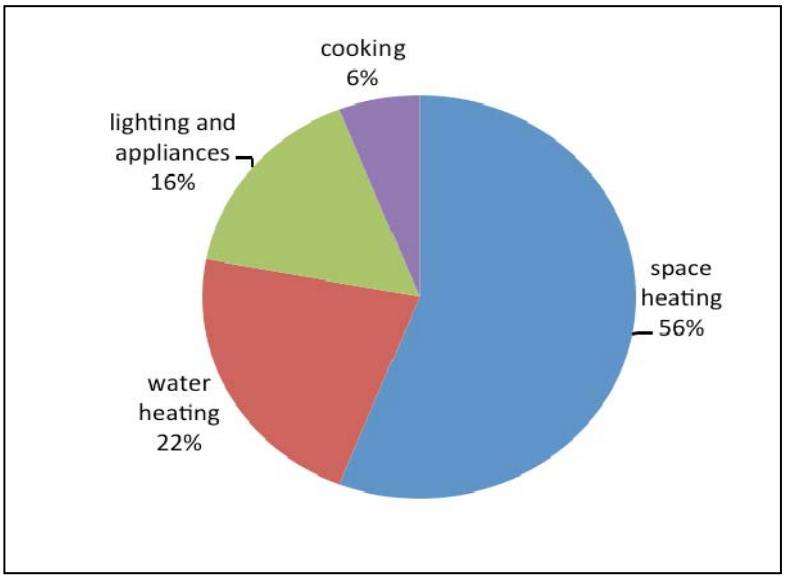


Figure 2.3 – Breakdown of energy consumption in the home (DTI, 2009)

There is also the serious social problem of fuel poverty in the UK. Over 5.5 million households in the UK are living in fuel poverty (spending more than 10% of their household income on heating) which is approximately 21% of all households (DECC, 2011a). In Wales it was estimated that 332,000 households were suffering from fuel poverty in 2008, an increase from 134,000 in 2004. 59,000 of these households were living in social housing (WG, 2012).

Fuel poverty has risen significantly since 2004 as a result of energy price increases, with electricity prices increasing by 75% and gas bills by over 122%. As household incomes have generally fallen or levelled off in the last four years, as a result of the economic downturn, the main way to reduce the impact of the price impacts is to increase energy efficiency of homes and provide energy from renewable energy sources.

2.2 Opportunities for low carbon dwellings

Buildings need to be designed to be low carbon. This includes the design of new housing and the retrofit of existing housing. Building Regulations in the UK control new build and aspirations by the Welsh Government is that all new homes in Wales will be zero carbon by 2016. However, with a replenishment rate of just 1% per annum (DCLG, 2006) and 20 million existing homes in the UK, good quality retrofitting is essential to reach targets. If the domestic building stock is to be made more sustainable and if CO_2 targets are to be realised, then the problem of how to improve the existing built environment must be addressed (European Union, 2002).

Figure 2.4 – Existing housing stock in the UK

Debate is underway as to whether older dwellings should be demolished and new homes built due to the cost to undertake the level of retrofit work required to achieve the level of carbon reductions necessary. However, other considerations need to be taken into account as well as carbon targets. There are a number of positive issues associated with retrofitting, including less waste generated during the retrofit process compared to new build, with 35% of waste currently going to landfill from the construction industry (DEFRA, 2011). It can be argued that maintenance, performance, construction and energy costs are lower for retrofitting. Important heritage aspects of an area can also be retained, together with existing community and social networks, with the resale value of older properties typically being higher (Plimmer et al, 2008).

The advantages associated replacing existing homes with new include certainties with costs during the construction process and lower risks with unknowns. Flexible procedures can be put in place and appropriate design and management standards can be assured, through more straightforward processes. Figure 2.5 demonstrates the differences in cost per m^2 between new build and refurbishment of different types of housing. Although new build costs are higher for all property types, the cost differential between new build and refurbishment is much less with terraced housing and flats which are the types of properties typical of the social housing stock.

Figure 2.5 - Comparison of costs between constructing new build housing and refurbishment (College of Estate Management Research, 2008)

The UK economy is dependent on a strong construction industry, with 2.3 million people employed in the industry in the UK in 2010, with half involved in repair, maintenance and improvement (Construction Skills, 2010). The importance of good quality, well designed and properly implemented retrofitting will become more important as the building stock ages. This will require a significant step change in training, skills and investment if carbon reduction targets are to be achieved. The construction industry will need to adapt to suit these needs.

There are a broad range of retrofit options available that need to be tailored to the contextual building stock considering its complexity and issues. Low carbon measures can address the following:

- Fabric - reduces energy demand, improves daylighting, and addresses lack of space;
- Form - reduces heat loss and draughts and improves occupant comfort;
- Appliances - reduces energy demand from white goods and lighting;
- Systems - provide energy from renewable sources.

The difficulty lies in choosing the most appropriate solution using the resources available. In the case of social landlords, owning 1,000s of different types of properties in different contexts with different types of tenant, this decision is extremely complex. There is the dilemma of taking the whole house approach on fewer dwellings or implementing one or two measures over a wider range of stock. This decision will be influenced by the type of funding available and the individual approach of the RSL.

The favourable long term view should be to aim for a whole house approach as this would provide a stock of properties that would perform as efficiently as possible, assuming the planning, design and construction of the works had been undertaken correctly and that maintenance procedures are put in place. By undertaking few measures to many properties, underlying problems may exist within properties that will prevent measures working efficiently. However, this approach would keep more householders satisfied with short term improved housing and may be dictated by funds available and political requirements.

2.3 Funding sources and drivers for retrofitting in the UK

With over 20 million existing homes in the UK there is a significant challenge for householders, local authorities, businesses and communities to target funding that is available on the homes most in need and also on a scale large enough to have long term impacts. Various funding streams have been made available to reduce emissions from the domestic housing stock in the UK. These are available to different groups of the population and frequently change name and eligibility criteria which can be confusing. Examples of funding streams available in the UK include:

- CERT – Carbon Emissions Reduction Target (CERT) was introduced in 2008 and requires that all domestic energy suppliers with more than 50,000 customers should assist in making savings in CO_2 emissions emitted by the householders. This is undertaken by the suppliers by promoting the uptake of low carbon energy solutions to householders. The overall target for the scheme is 293 $MtCO_2$ from 2008. The original target was 185$MtCO_2$ to end in 2011. Two thirds of the additional 108$MtCO_2$ must be delivered through professionally installed insulation measures. CERT expires at the end of 2012 and will be replaced by ECO.
- CESP – Community Energy Saving Programme targets households in *specific areas* of low income, namely Lower Social Output Areas (LSOAs), with priority given to those currently in the lowest 15 percentile, to improve energy efficiency and reduce fuel bills. CESP funding started in September 2009, and is provided by energy suppliers and electricity generators. Up to £350million is expected to be spent on energy efficiency measures. A whole house approach is promoted through the scheme which is suited to the property on a street by street basis, with special bonuses for achieving area intensity targets. Local authorities, community groups and energy companies work as a partnership to administer CESP.

In December 2011 the Energy Act 2011 was introduced which includes a number of new initiatives to encourage the uptake of energy efficiency measures and low carbon technologies:

- Green Deal - a new financing framework that will enable the provision of fixed improvements for the energy efficiency of households. Works are funded by a charge on energy bills over the long term which allows householders to purchase measures without a large upfront cost;
- Feed In Tariff – energy suppliers pay for energy generated from specific low carbon technologies;
- Renewable Heat Premium Payment – A UK government scheme designed for home owners to afford renewable technologies such as solar thermal panels, heat pumps and biomass boilers. Vouchers are provided depending on the technology applied for. Around £12million was available under this scheme. It ran until March 2012 following when it was superseded by RHI;
- Renewable Heat Incentive – Introduced in Autumn 2012, this scheme will provide financial support for households, communities and businesses to switch from fossil fuels for heating to renewable such as wood fuel;
- ECO – From October 2012 Energy Company Obligation will replace CERT and CESP and will help to target appropriate measures to households likely to need additional support, particularly people on low incomes and those living in hard-to-treat homes such as solid wall properties;
- Nest – Welsh Government programme offering energy efficiency improvements to householders in Wales launched in April 2011. Nest is available to householders who are in receipt of means tested benefits and who privately own or rent a domestic property. The energy rating of the home must be level F or G which indicates poor energy efficiency. This has replaced the Home Energy Efficiency Scheme (HEES). Measures included in Nest include a new central heating boiler, insulation for a hot water cylinder, loft, cavity wall and solid wall insulation, draught proofing for doors and windows and renewable energy technologies such as air source heat pumps,.
- The New Fuel Poverty Scheme set by the Welsh Assembly Government in 2010 (WAG, 2010) will seek to use all the levers available to it to reduce the number of households currently living in fuel poverty in Wales, and to take action that will help to achieve the target that, as far as is reasonably practicable, no household in Wales will be living in fuel poverty by 2018. This is a highly ambitious target given that 332,000 homes in Wales were suffering from fuel poverty in 2008 (WAG, 2008).

A key driver for social housing improvements in Wales is the Welsh Quality Housing Standard (WHQS) which requires that all ‘everyone in Wales should have the opportunity to live in a good quality home within a safe and secure community’. To help achieve this, the physical standard and condition of existing housing must be maintained and improved to the WHQS. The WHQS states that all social housing should reach a SAP of 65 as an indication of ‘adequate fuel efficiency and insulation’.

3.0 THE WORKS

3.1 The Arbed 1 Scheme

The Arbed 1 Scheme was set up to take a 'whole house' approach to install energy efficiency measures and renewables across Wales. It is the Welsh Governments (WG) Strategic Energy Performance Investment Programme.

£60 million of funding was invested in Arbed 1 from a range of sources. The scheme included properties owned by Registered Social Landlords (RSLs), Local Authorities (LAs) and owner occupied homes. The strategic objectives of the Arbed 1 Scheme were to:

- reduce fuel poverty;
- reduce carbon emissions;
- support the energy efficiency and renewables supply chain and encourage recruitment and training in the sector.

Properties were targeted in Strategic Regeneration Areas within Wales which were also believed to have low household incomes. The Arbed 1 Scheme was established in 2009 and 28 projects took place across Wales.

Funding for the Arbed 1 Scheme was provided from the following sources:

- £30 million from the Strategic Capital Investment Fund (SCIF) from the Welsh Assembly Government (WG) and the UK Department of Energy and Climate Change (DECC) under the Strategic Energy Performance Investment Programme;
- £10 million from energy suppliers through carbon saving obligations (Carbon Emission Reduction Target (CERT) and Community Energy Saving Programme (CESP);
- £20 million from RSLs and local authorities brought forward budgets for maintenance, housing renewal and neighbourhood support to take advantage of the cost savings and economies of scale.

More than 6,000 homes were included in the Arbed 1 Scheme in total. The Scheme aimed at a whole house approach, taking a street by street approach. Mixed tenure communities of public and private property ownership were preferable.

The Arbed 2 Scheme was due to start in 2012. Arbed 2 will have the same objectives as Arbed 1 targeting solid wall, off gas properties in low income areas with a more even split of public/private households. Over 4,000 properties will be improved over a 3 year period to 2015 in approximately

50 projects. £33 million ERDF funding will be available plus £12 million match funding from the Welsh Government. A minimum target reduction of 11.6KTCO_2 has been set.

3.2 The Warm Wales Arbed 1 Programme

Warm Wales, a Community Interest Company, based in Port Talbot in South Wales was commissioned by five RSLs and two LAs to help deliver their Arbed 1 projects. Warm Wales' role was to undertake scheme design, project management and provide design advice working alongside contractors, RSLs/LAs and energy suppliers. Warm Wales, as a Community Interest Company, are also able to access funds from the Carbon Emission Reduction Target (CERT) and Community Energy Savings Programme (CESP) together with gas fuel-switch grants via Wales & the West Utilities (W&WU) maximising the benefits for the communities involved. Figure 3.1 below illustrates the organisation of the Arbed 1 Scheme and Warm Wales role as described above. The 7 projects were part of the 28 projects funded by the WG. Each RSL/LA had made the decision as to what properties to improve and what measures to implement during the application process to WG. SPI were the main contractors on each of the 7 projects.

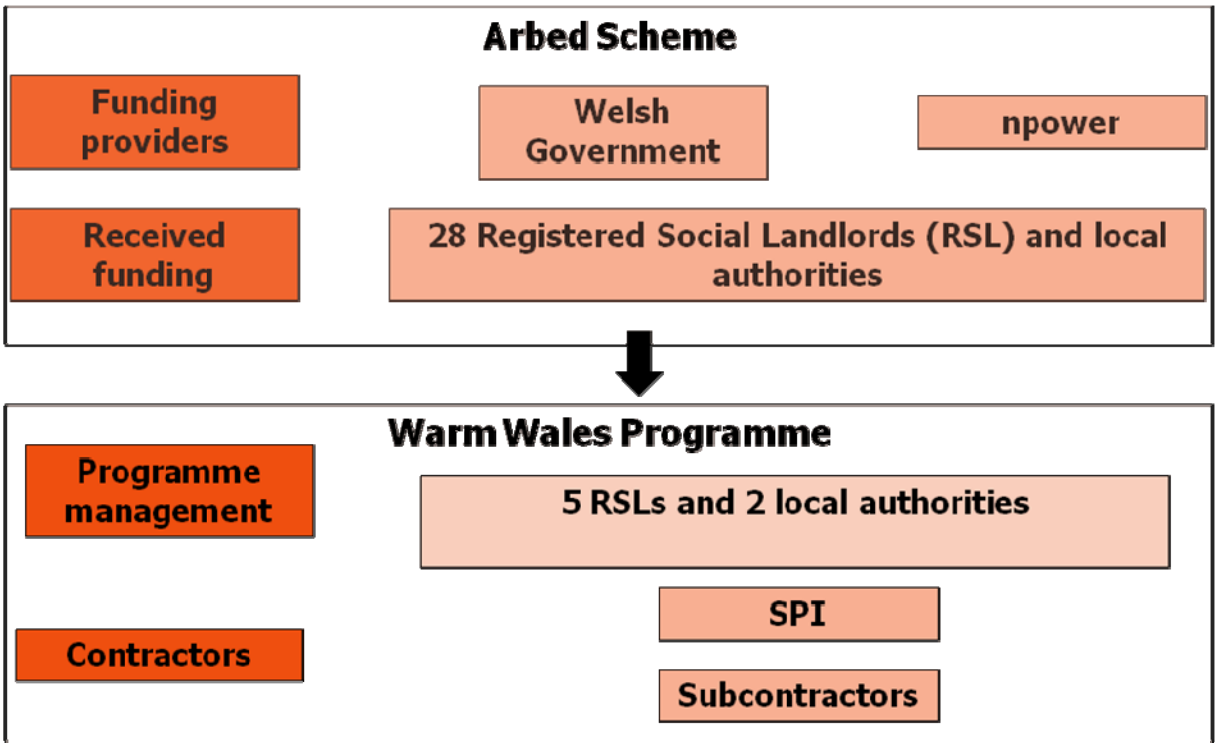


Figure 3.1 - The relationship between the Arbed 1 Scheme, the Warm Wales Programme and the 5 RSL and 2 LA projects

The organisation of Warm Wales staff involved in the Programme can be seen in Figure 3.2. The Chief Executive Officer and Board of Directors oversaw the overall programme. The two project managers, provided support to each other, and were involved in the scheme on a daily basis working with all stakeholders at all different levels and fed back to the Director of Operation. Advice was sought from experts associated with on-site operations including health and safety, quantity surveyors and for properties where fuel switching had been identified as a suitable option. Energy wardens were recruited to act as a direct link with householders.

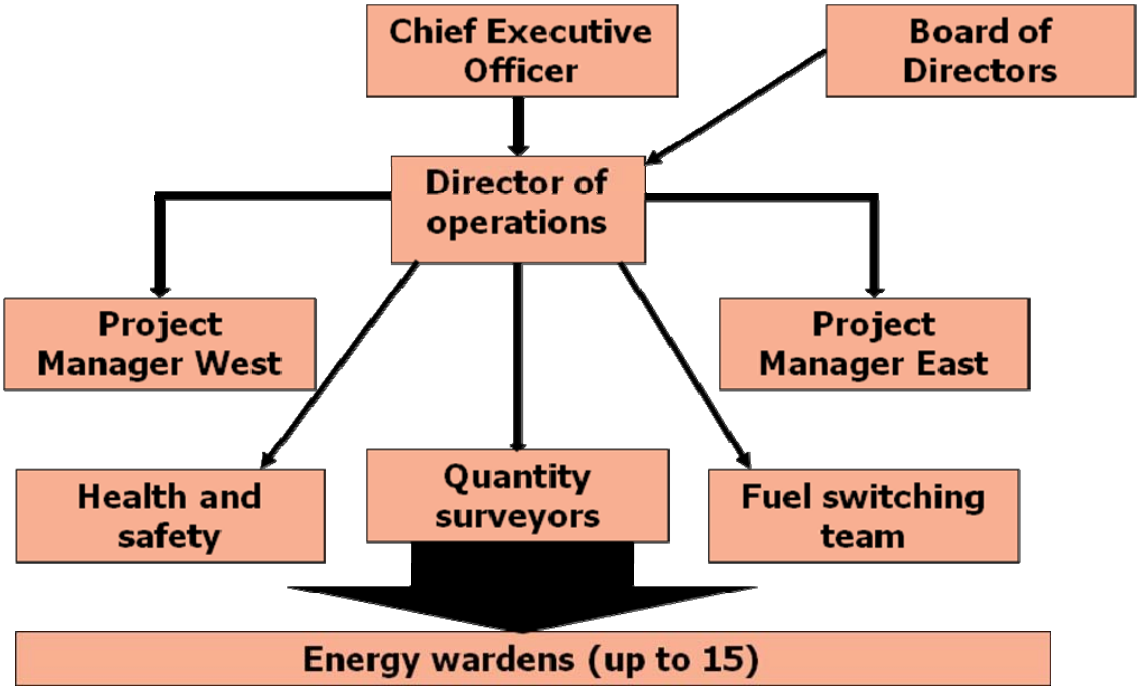


Figure 3.1 – Staff involved in the Programme at Warm Wales

3.3 Individual Warm Wales Arbed 1 projects

Warm Wales was commissioned by five separate RSLs and two LAs located across South and West Wales. These are summarised in Table 3.1 below which presents the area covered by the RSL, the total number of properties managed by each RSL, a summary of the types of properties included within the projects, the Arbed grant received and the main measures implemented. Around 20,000 properties are owned between the seven organisations, with a range of measures implemented on different aged and types of properties. The large range of housing across all seven projects provides an opportunity for the RSLs involved to share findings from the implementation of the Arbed 1 Scheme on different types and ages of properties in order to improve a broader range of their housing stock in the future.

RSLs/local authorities	Location	Total no. of units managed by RSL	Main type of properties included in Arbed	Arbed grant	Main measures
Charter Housing (incl part Caerphilly CBC homes)	South East Wales – Newport area	**5,500**	2 and 3 bed terrace built pre 1919 by National Coal Board	£1.6 million	EWI, Solar PV
Melin Homes	South East Wales – Pontypool area	**3,000**	1/3 pre 1919 solid wall, 2/3 post 1980 cavity wall houses	£1.0 million	EWI, Solar PV ASHP
Family Housing	South Wales area – Swansea area	**2,300**	Pre 1919 solid wall	£1.0 million	EWI, Solar PV
Coastal Housing	South Wales – Swansea area	**5,500**	½ pre1919 solid wall, ½ post 1980 cavity wall	£1.3 million	EWI, Solar PV
City and County of Swansea	South Wales – Swansea area	**Over 13,000**	Post war semi detached housing and some 1980s terraced	£2.5 million	EWI, Fuel switching, Solar PV Solar thermal
Tai Ceredigion	Mid West Wales – Aberystwyth area	**2,200**	Flats and semi det houses built between 1965-1980	£600,000	EWI, Fuel switching

Table 3.1 - Key characteristics of each of the Warm Wales Arbed 1 projects

The initial Scheme design for the seven projects started in April 2010, with site operations being underway before October and substantial completion by April 2011. Site works during the winter of 2010/2011 were difficult due to poor weather conditions with snow falling on numerous occasions and temperatures lower than average.

A total of £9.6million has been invested as a result of the Arbed 1 Scheme on properties within the Warm Wales programme.

3.4 Data Collection

In order to evaluate the impact of the Warm Wales Programme three different methods were used to collect information:

- Desk top data collection including information from provided by Warm Wales and energy calculations based on property types and ages;
- Questionnaire design and administration to householders;
- Interviews with staff involved in the Warm Wales Programme, both owners and WW staff.

4.0 OUTCOMES

This section of the report will present and evaluate what has been achieved through the Warm Wales Programme, investigating the positive and negative aspects of the Arbed 1 Scheme and identifying the problems that were experienced in order to assist future retrofit projects and programmes.

4.1 Properties and measures

The total number of properties included within the Warm Wales Programme was 1,147.

Properties constructed during different time periods pose different retrofit challenges due to the materials available, construction methods and needs of the population at the time of construction. 40% of properties improved within the Programme were built before 1919, therefore having solid wall construction, as shown in Figure 4.1. Almost a quarter of the properties improved were built during the period of rapid house building of 1945-1964. This group included properties of non-traditional construction which were built quickly following serious housing shortages after World War 2. A surplus of steel and aluminium production following the war drove construction to pre-cast and in-situ prefabrication (BRE, 2002). 20% of the properties were built between 1965-1980 and the same number were constructed after 1980.

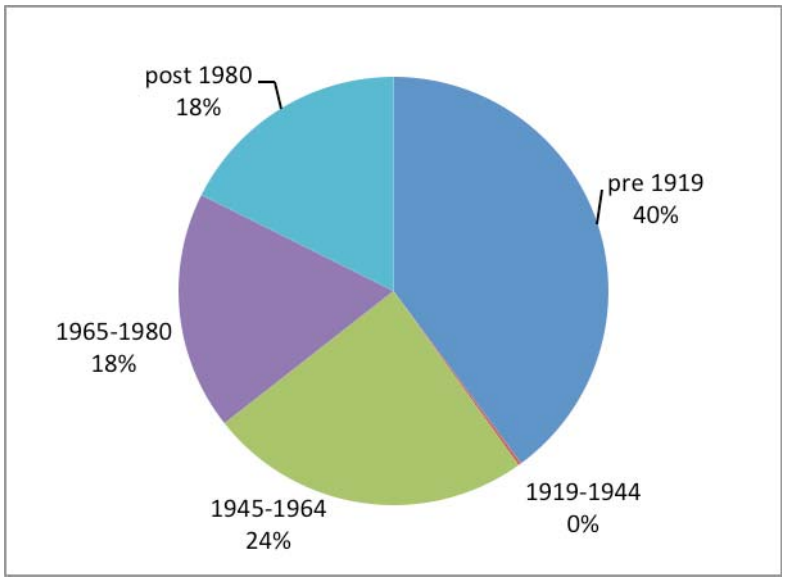


Figure 4.1 - Ages of properties improved within the Warm Wales Arbed 1 Programme

Figure 4.2 indicates that almost half the properties improved as part of the programme were either semi detached or end terraced properties. For this evaluation, these have been grouped together as they have three exposed walls and therefore similar heat loss characteristics. Almost 30% of the properties were mid terrace houses, 21% were flats. It was agreed that very few bungalows and detached properties would be treated as part of the programme in order to concentrate resources, and these property types are not well represented within the social housing sector.

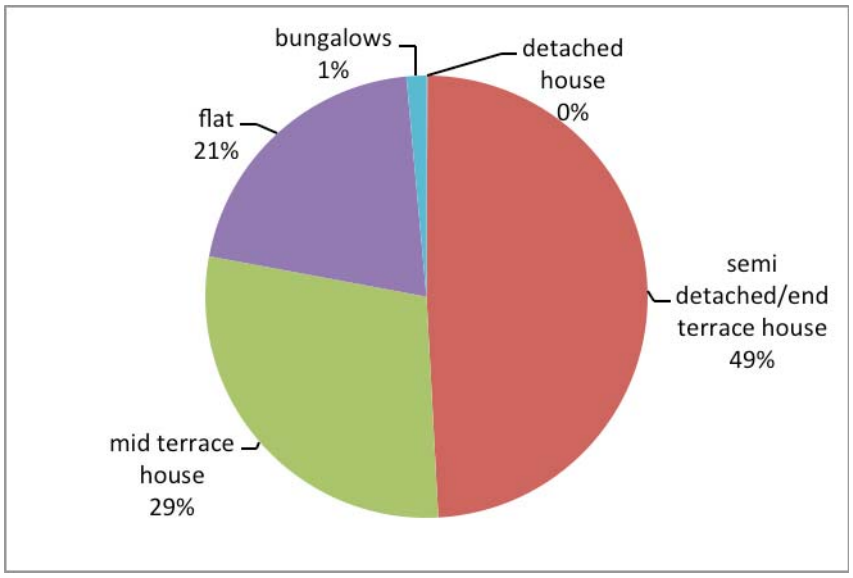


Figure 4.2 - Types of properties included within the Warm Wales Arbed 1 Programme

57% of the properties improved under the Warm Wales Programme were owned by RSLs as demonstrated in Figure 4.3. It was the RSLs that were the key drivers in securing the funding under the Arbed 1 Scheme. Almost a quarter of the properties were owned by LAs, with 20% being owner occupied.

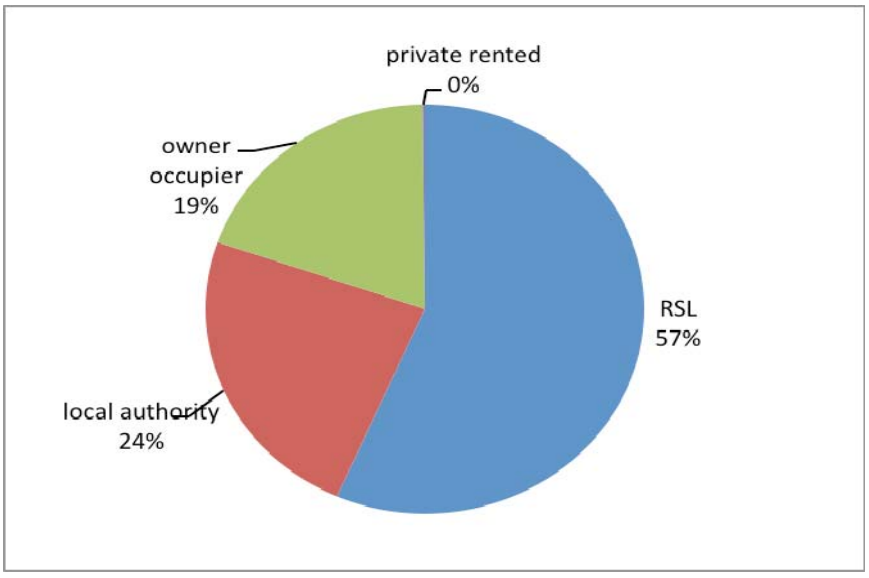


Figure 4.3 - Tenure of properties included within the Warm Wales Arbed 1 Programme

Due to the short turnaround time for the Programme, owner occupier recruitment proved difficult, due to the additional time required to reassure and support householders.

Fabric improvements made through the scheme involved the implementation of external wall insulation (EWI) to improve the internal thermal conditions. Solar PV, fuel switching, solar thermal and air source heat pumps were also installed where these could provide a more efficient energy supply system resulting in reduced energy costs and emissions.

Table 4.1 illustrates that a total of 1,391 measures have been installed as part of the Warm Wales Programme. 905 properties received 1 measure, 240 received two measures and 2 properties received three measures. This indicates that although the Arbed 1 Scheme was aiming to take a whole house approach, the projects within the Warm Wales Programme took more of a blanket approach improving a greater number of properties with fewer measures.

EWI was the most common measure installed, with 648 properties receiving this measure. 414 properties received solar PV, 46 solar thermal, 241 switched fuels and 42 had air source heat pumps installed, the proportions of which is shown in Figure 4.4.

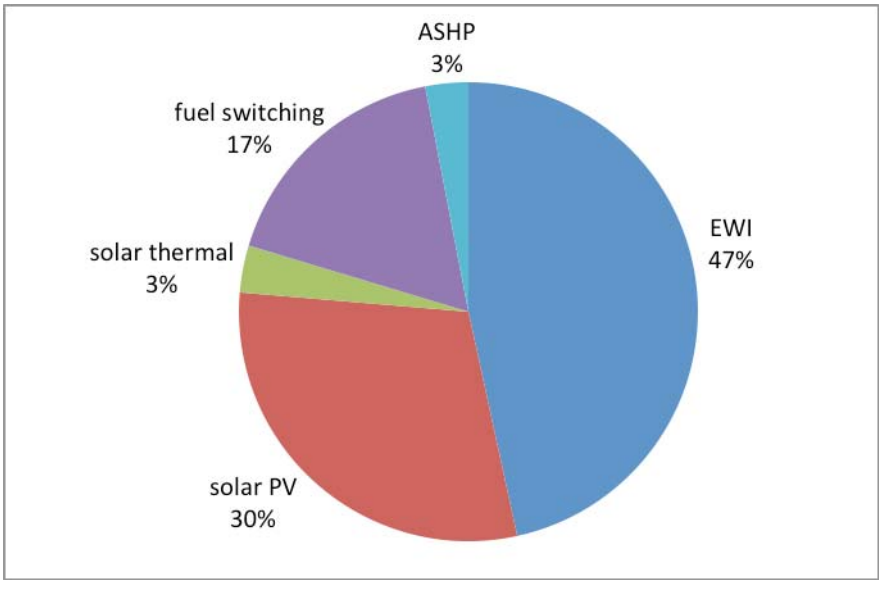


Figure 4.4 - Measures installed as part of the Warm Wales Programme

		Summary of measures													
	No. of measures	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	
	RLS/Local authority	**EWI**	**ASHP**	**Fuel switch**	**Solar PV**	**Solar thermal**	**EWI and fuel switch**	**EWI and Solar PV**	**EWI and Solar thermal**	**Fuel switch and solar PV**	**Fuel switch and solar thermal**	**Solar PV and solar thermal**	**EWI, solar thermal and solar PV**	**Fuel switch, solar PV and solar thermal**	**Total properties**
1	Charter Housing (including Caerphilly CBC)	127	0	0	3	2	0	62	5	0	0	0	1	0	200
2	Melin Homes	36	42	0	93	0	0	18	0	0	0	0	0	0	189
3	Family	105	0	0	26	3	0	11	2	0	0	0	0	0	147
4	Coastal	115	0	0	108	0	0	0	7	0	0	0	0	0	230
5	City and County of Swansea	22	0	114	45	10	29	2	0	37	8	7	0	1	275
6	Tai Ceredigion	54	0	0	0	0	52	0	0	0	0	0	0	0	106
	Total	**459**	**42**	**114**	**275**	**15**	**81**	**93**	**14**	**37**	**8**	**7**	**1**	**1**	**1147**

Table 4.1 - Measures installed with the Warm Wales Programme

Figure 4.5 illustrates the types of measures installed within the different aged properties. It is clear that EWI was targeted towards solid wall properties as this was believed to have the highest improvement in emissions and comfort in this type of housing. Fuel switching was predominant in both the 1945-1964 and 1965-1980 age bands. This is likely to be the case as these properties are remotely located and densely grouped in estates making fuel switching a relatively straightforward option with the funding available.

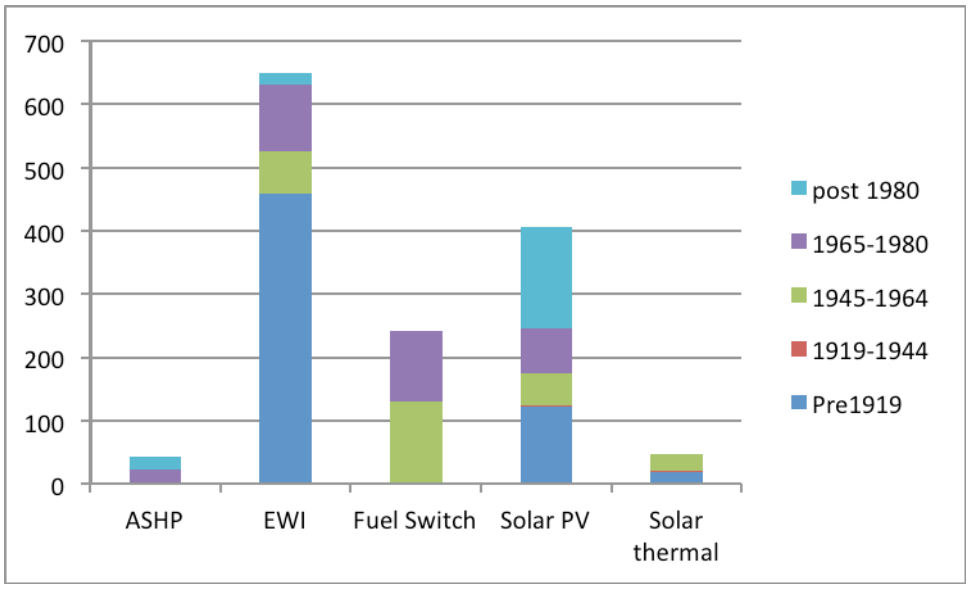


Figure 4.5 – Measures installed in different aged properties

Solar PV was the most common measure within the post 1980s properties. ASHP were only applied to properties in the 1965-1980 and post 1980 age groups, these were applied to flats on both occasions as illustrated in Figure 4.6.

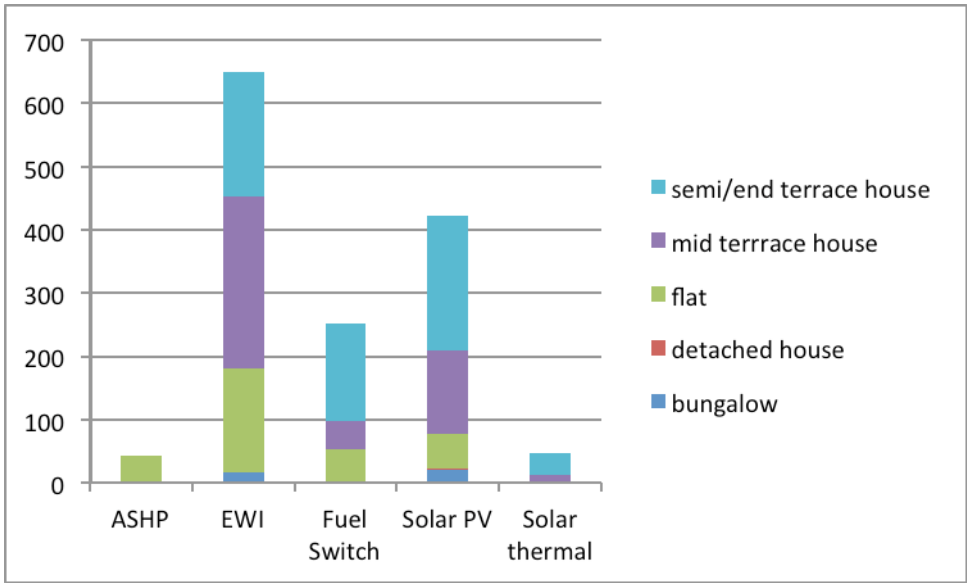


Figure 4.6 – Measures installed in different types of property

4.2 Technological issues

It is essential that low carbon measures are installed correctly for full benefits to be realised. Incorrect installation can lead to detrimental impacts rather than improved conditions for householders and reduced CO_2 emissions. Installation of low carbon technologies should involve a good quality, consistent pre-works survey to establish the standard and requirements of properties before site works commence, to ensure that technical problems can be overcome. An appropriate design then needs to be conveyed to those undertaking the works on site so that time taken to provide good quality design detail is not lost on site. Good quality workmanship is also essential to allow design to perform as planned.

With regards to fabric improvements, the benefits of EWI over internal wall insulation include no loss of internal space, less disruption to householders and less cost due to rewiring and removal of fittings and fixtures and allowances for redecoration and floor coverings. EWI also has the benefit of permitting total coverage if installation is undertaken correctly. Incorrect installation of EWI can result in thermal bridging when the external surface is not fully covered or gaps remain. This can create internal draughts and potential condensation issues. However, it is generally accepted by Ofgem that thermal bridging may exist around windows, doors and at roof and floor junctions when EWI is installed but this should be reduced if reasonably practical and cost-effective to do so. Problems were experienced with difficult detail issues that had to be solved on site. Some of these related to poor workmanship and difficulties experienced when dealing with too many properties being tackled simultaneously. Some examples of issues that arose during the installation of EWI within the programme are described below. Wherever possible the problems described have been rectified.

Figure 4.7 illustrates the difficulties when dealing with solid walled properties with intricate detailing. The front aspect of the building was to be retained due to planning issues to include the corner detail. This has resulted in a complicated detail at the edge of the EWI which requires careful installation to avoid water penetration and is time consuming to apply on site.

Figure 4.7 – Dealing with detailing when installing EWI

Complicated detailing is illustrated in Figure 4.8, which depicts the top verge trim at the corner of a roof. Issues such as this were not identified during the scheme design stage, so had to be dealt with on-site during works which took additional time. In this case the solution was to insert and fix a soffit board to the bottom of the trim to blank off the opening.

Although properties do vary, particularly older properties which have been extended over time, the provision of generic solutions for such issues from manufacturers and at the design stage would ensure that solutions provided are technically robust. None of the proprietary EWI systems have ready answers to awkward detailing and this therefore merits further special attention.

Figure 4.8 – Complex detailing around the roof line

Corners of properties are rarely exactly 90˚. In Figure 4.9 cutting of the top verge trim at the corner of the roof left a gap for potential water penetration onto the insulation. Pre-works detail design

and/or provision of a pre-formed capping system would help to alleviate this problem. The problem was rectified by the onsite manufacture of an upvc cover strip during installation.

Figure 4.9 – Roof corner detailing

Figure 4.10 demonstrates a further difficult to treat detail which had to be dealt with on site. An extension had previously been added to the property, resulting in the EWI having to be formed around the lead flashing on the extension. Figure 4.10 image illustrates the thickness of the insulation that has been added.

Figure 4.10 – Dealing with extensions

Detailing around the brackets supporting a balcony had to be dealt with on site to allow for the thickness of the EWI as illustrated in Figure 4.11. The insulation to the bottom of the ingress should have been chamfered to a 45° angle and protected by upvc to allow water run-off. There is the

opportunity, with the flat surface that has been included, for water pooling and potential for water penetration.

Figure 4.11 - Detailing around balcony support brackets

Shortcomings in workmanship can also create future water penetration problems. In Figure 4.12 the bottom track at floor level has not been terminated with a capping piece which prevents render adhering to the EWI. The problem is made worse as the vertical corner bead has not been continued down to the bottom track. This would be resolved by the introduction of a stop end or cutting a 45˚ cut into the end of the trim to enable the track to return into the door reveal.

Figure 4.12 – Detail at floor level

Another issue highlighted here is the need for the front nosing of the bottom track to be wiped clean prior to the receiver coat setting to ensure a clean front edge appearance. A similar problem has

been attempted to be solved with silicone in Figure 4.13, which again illustrates poor workmanship in trying to solve a problem quickly rather than properly created by tight schedules.

Figure 4.13 – 'Solving' the problem

Lack of care and attention during works is highlighted in Figure 4.14, where inconsistent gaps have been left on either side of the gas pipe, a frequent detailing issue that can arise where services enter a property. The base track should have been cut equally on either side of the pipe, and a trim should have been applied to allow for a key to be inserted into the top of the valve.

Figure 4.14 – Detailing around services entering a property

A commonly experienced problem is where guttering ends near an adjacent wall. In Figure 4.15 the guttering was covered by EWI. If a leak in the stop end of the guttering occurred, water from the gutter would run into the insulation. Furthermore, if the guttering was replaced in the future a hole

would remain in the render. This was subsequently rectified by cutting back the gutter and inserting insulation with a flashing to direct water into the gutter.

Figure 4.15 – Detailing around guttering

Window sills provide a challenge when installing EWI. It is common for upvc sills to be fitted over existing sills, which can leave opportunity for water penetration if not finished correctly with sealing by end caps (Figure 4.16).

Figure 4.16 - Fitting a new sill over existing sill

There are also difficulties when rendering up to the underside of the sill as illustrated in Figure 4.17 which again requires time and skill to complete correctly.

The need to maintain dwellings further than simply installing low carbon measures is demonstrated in Figure 4.18 where the addition of the EWI has resulted in damage to the head of the window.

Figure 4.17 - Rendering under the sill

Additional budgets should be incorporated into low carbon programmes to rectify direct problems that will reduce the benefit investments made.

Other problems, as illustrated in Figure 4.18, include a lack of ventilation in the window due to a lack of room above the opening window. Also the lack of a pre manufactured trim resulted in a upvc cover being made up on site which was reliant on the addition of silicon to prevent water penetration.

Figure 4.18 - Damage to window head during the installation of EWI

There is a need to provide a well prepared timetable for subcontractors to work to. Figure 4.19 illustrates problems that occur where programmes are poorly timed. In this example the heating system was installed after the EWI had been fitted. As a consequence the heating engineers cut a hole in the EWI for the flue which resulted in insulation being stuffed into the hole once the flue had

been installed. This resulted in the EWI installers having to return to the property to re-insulate and re-render the area around the flue, taking additional time and cost.

Figure 4.19 - Poor timetabling resulted in damaged EWI

Complexities also exist when adjacent properties have works undertaken. In many Welsh valley towns and villages solid wall terraced housing are constructed on hillsides with properties being stepped. As a result of this, detailing and junctions between properties, particularly in treating jointly owned 'party walls', are more difficult to overcome compared to those of properties on a flat site as illustrated in Figure 4.20.

Figure 4.20 – Junctions between properties on a steep road

When adjacent properties do not have works undertaken problems occur with the implementation of fixtures. In Figure 4.21 the differing profiles of guttering would lead to leaks during heavy rain. A

satisfactory conclusion was to provide the adjacent property with new matching guttering even though they were not involved in the Warm Wales Programme.

Figure 4.21 – Undertaking works on adjacent properties

All of the above examples illustrate the need for good planning and workmanship and the need for manufacturers to provide detailing solutions for the problems that might arise on site. There is a balance that needs to be met between specifying high quality design, completing works on time and cost.

In many of the situations described above it is the time aspect which provides a strong influence, with subcontractors wanting to get works completed as quickly as possible, therefore cutting corners at times. This demonstrates the necessity of quality control via agreed samples and site supervision. In that respect, reliance on manufacturer warranties is a poor substitute in comparison to insisting on appropriate design solutions and good quality workmanship during installation.

Generally, the necessary level of EWI product knowledge and experience is lacking, particularly locally, at sufficient scale for short term projects such as Arbed to take place through large scale programmes. EWI systems are generally material focussed and lack integrated installer warranties. The Arbed 1 Scheme has shown the need for up-skilling to ensure that sufficient levels of labour are available. It is also important that, where possible, schemes are well planned to enable consistency in employment rather than ad-hoc work dependent on funding streams. The 15 month gap between Arbed 1 and Arbed 2 demonstrates the problem in retaining skills.

4.3 Environmental outcomes

One of the main objectives of the Arbed 1 Scheme was to reduce carbon emissions to assist in meeting the targets set by Welsh and UK Government. As part of this evaluation CO_2 savings and SAP improvements have been calculated using information regarding the measures implemented and the types of properties that they have been made to on a property by property basis.

These calculations have been based on the database of property plans provided to Warm Wales by each of the RSLs/LAs which included data on property age, type and other property based information. There were however, inconsistencies and gaps in this dataset, particularly regarding age of properties. Where gaps were present, information has been obtained using digital maps including Google map.

In order to calculate changes in SAP ratings, CO_2 emissions and energy costs per property as a result of the measures installed, data from a previous study by the WSA have been utilised. In 2001, the WSA undertook a local authority wide survey of all properties in Neath Port Talbot County Borough Council as part of the development of the Energy and Environmental Prediction Model (Jones et al, 2000 and Jones et al, 2007) which was developed to predict energy use hotspots on a regional scale but based at a property level. This involved collecting information from the 56,000 domestic properties in the Borough through drive by surveys and desk top studies, and calculating SAP ratings based on the characteristics of properties that were present.

As it was not possible to collect detailed data for every house on a regional scale during the EEP model development, assumptions were made when calculating SAP values for different 'types' of housing. For example, Table 4.2 illustrates the 'as built' U-values of the different aged properties and fabric (BRE, 2009) used in the calculations. U- values are used to describe the energy performance of a building by providing a measure of heat loss through a material.

The higher the U-value, the greater the heat loss. Improvements in construction techniques over time have seen an improvement in U-values. As fabric improvements are made to properties, such as increasing EWI, the U-value improves from its as constructed value. U-values are used within this modelling process to calculate SAP ratings which can provide information about energy use and CO_2 emissions.

Age group	Wall U-value (W/m^2K)
Pre 1919	2.1
1919-1944	1.6
1945-1964	1.6
1965-1980	1.0
Post 1980	0.6
Property type	**Floor U-value (W/m2K)**
All	1.2
Property type	**Roof U-value (W/m^2K)**
All	0.4

Table 4.2 - Relationship between age group and U-value of different building components (BRE, 2009)

The outcome of the EEP model was to group 56,000 properties into 100 'clusters' based on characteristics collected from drive by surveys and desk top studies, a SAP rating was calculated for each cluster together with CO_2 emissions and energy cost for each property. Properties were clustered using property age, heated ground floor area (m^2), façade (m^2), window to wall ratio and exposed end area (m^2). The SAP ratings calculated have since been validated with actual SAP calculations and have been found to be representative.

The properties included within the Warm Wales Programme are typical of the Welsh Housing stock and similar to those in Neath Port Talbot, some are located in the Borough. Using the information provided from the project plans, namely property age and property type, properties have been allocated to one of the 100 clusters developed as part of the EEP model. This has enabled SAP ratings, CO_2 emissions and energy saving calculations to be made to demonstrate the improvements as a result of the Warm Wales programme. Gas has been assumed to the primary fuel apart from properties where fuel switching or ASHP have been installed where electrical heating was assumed to be the original heating fuel.

Table 4.3 illustrates the types and ages of the properties included within the Warm Wales Programme, together with the measures installed within these properties. For each of the types of property, SAP calculations before and after have been made together with CO_2 savings. All calculations have been made using the SAP calculator based on the BRE SAP Procedure 2009.

Properties with the highest CO_2 savings are those which have undergone fuel switching and are relatively large in area. Large CO_2 savings are associated with the change from electricity (Economy 7) to gas as the main heating fuel.

Type of property	Age band	Measures			No. of props	SAP before	SAP after	SAP change per property	CO_2 before (Kg/yr)	CO_2 after (kg/yr)	CO_2 saving per property (Kg/yr)	%CO2 saving	Total CO2 savings for prop type
no data	no data				11								
Flat	pre 1919	EWI	Solar pv		7	60	70	10	5147	3646	1500	29%	10503
Flat	pre 1919	EWI			94	60	70	10	5147	3646	1500	29%	141039
mid ter house	pre 1919	EWI	solar pv		62	58	75	17	8081	4768	3313	41%	205428
mid ter house	pre 1919	EWI	solar thermal		10	58	71	13	8081	5290	2791	35%	27913
mid ter house	pre 1919	EWI			190	58	69	11	8081	5689	2393	30%	454650
mid ter house	pre 1919	solar pv			23	58	64	6	8081	7161	920	11%	21171
mid ter house	pre 1919	solar thermal			2	58	60	2	8081	7683	398	5%	797
semi/end terrace	pre 1919	EWI	Solar pv	solar thermal	1	58	75	17	6765	3948	2817	42%	2817
semi/end terrace	pre 1919	EWI	Solar pv		22	58	73	15	6765	4343	2422	36%	53275
semi/end terrace	pre 1919	EWI	solar thermal		4	58	70	11	6765	4699	2065	31%	8261
semi/end terrace	pre 1919	EWI			69	58	68	9	6765	5094	1670	25%	115258
semi/end terrace	pre 1919	solar pv			6	58	64	6	6765	6013	751	11%	4507
semi/end terrace	pre 1919	solar thermal			2	58	61	2	6765	6370	395	6%	790
semi/end terrace	pre 1919	fuel switching			1	43	58	15	15704	6765	8939	57%	8939

semi/end terrace	1919-1944	solar pv			2	61	66	5	4292	3816	476	11%	952
semi/end terrace	1919-1944	solar thermal			1	61	64	3	4292	3919	373	9%	373
Flat	1945-1964	EWI			11	51	59	8	6030	4939	1091	18%	12000
semi/end terrace	1945-1964	EWI	Solar pv		2	62	75	13	4951	3180	1772	36%	3543
semi/end terrace	1945-1964	EWI			22	62	70	8	4951	3772	1179	24%	25939
semi/end terrace	1945-1964	EWI	Fuel switching		31	55	70	15	11415	3772	7643	67%	236930
semi/end terrace	1945-1964	fuel switching	solar thermal	solar pv	1	55	70	15	11415	3971	7444	65%	7444
semi/end terrace	1945-1964	solar thermal	solar pv		7	62	70	8	4951	3971	980	20%	6863
semi/end terrace	1945-1964	fuel switching	solar pv		2	55	68	13	11415	4359	7056	62%	14113
semi/end terrace	1945-1964	solar pv			40	62	68	5	4951	4359	592	12%	23699
semi/end terrace	1945-1964	fuel switching	solar thermal		8	55	65	10	11415	4563	6852	60%	54814
semi/end terrace	1945-1964	solar thermal			10	62	65	3	4951	4563	388	8%	3879
semi/end terrace	1945-1964	No measures			80	62	62	0	4951	4951	0	0%	0
semi/end terrace	1945-1964	fuel switching			88	55	62	7	11415	4951	6464	57%	568821
bungalow	1965-1980	EWI			17	59	62	3	4570	4131	439	10%	7465
Flat	1965-1980	ASHP			22	62	81	20	6419	3023	3396	53%	74719
Flat	1965-1980	EWI	Fuel switching		52	62	69	7	6419	2405	4014	63%	208718

mid ter house	1965-1980	EWI			4	65	70	5	7344	6209	1135	15%	4542
mid ter house	1965-1980	solar pv			4	65	71	6	7344	6318	1026	14%	4105
mid ter house	1965-1980	fuel switching	Solar pv		23	57	71	14	16717	6318	10399	62%	239179
mid ter house	1965-1980	fuel switching			13	57	65	8	16717	7344	9373	56%	121847
semi/end terrace	1965-1980	EWI			33	66	70	4	5266	4506	760	14%	25082
semi/end terrace	1965-1980	fuel switching	Solar pv		12	60	72	12	11982	4525	7457	62%	89480
semi/end terrace	1965-1980	solar pv			31	66	72	6	5266	4525	741	14%	22959
semi/end terrace	1965-1980	fuel switching			10	60	66	6	11982	5266	6716	56%	67161
bungalow	post 1980	solar pv			4	66	74	8	2332	1813	518	22%	2074
Det house	post 1980	solar pv			1	66	74	8	2332	1813	518	22%	518
Flat	post 1980	ASHP			20	60	82	22	6101	2662	3439	56%	68776
Flat	post 1980	solar pv			49	66	74	8	2352	1833	518	22%	25403
mid ter house	post 1980	EWI			5	66	67	1	2352	2262	90	4%	451
mid ter house	post 1980	solar pv			20	66	74	8	2352	1833	518	22%	10368
semi/end terrace	post 1980	EWI			14	66	67	1	2352	2262	90	4%	1261
semi/end terrace	post 1980	solar pv			87	66	74	8	2352	1833	518	22%	45103
semi/end terrace	post 1980	No measures			18	66	66	0	2352	2352	0	0%	0

Table 4.3 - CO_2 emissions per property type for different measures

The average SAP rating before works across the properties was 60. SAP ratings ranged from 43 to 66. Virtually all properties were therefore below the WHQS recommended SAP of 65. The target set by the WHQS is very ambitious as the average SAP rating for a British home is 51.6 (Palmer J and Cooper I, 2011). Figure 4.22 illustrates the improvement in SAP ratings before and after the measures were installed. The average SAP rating following the works was 69, with a range from 58 to 82 with only 231 properties falling below the WHQS of 65.

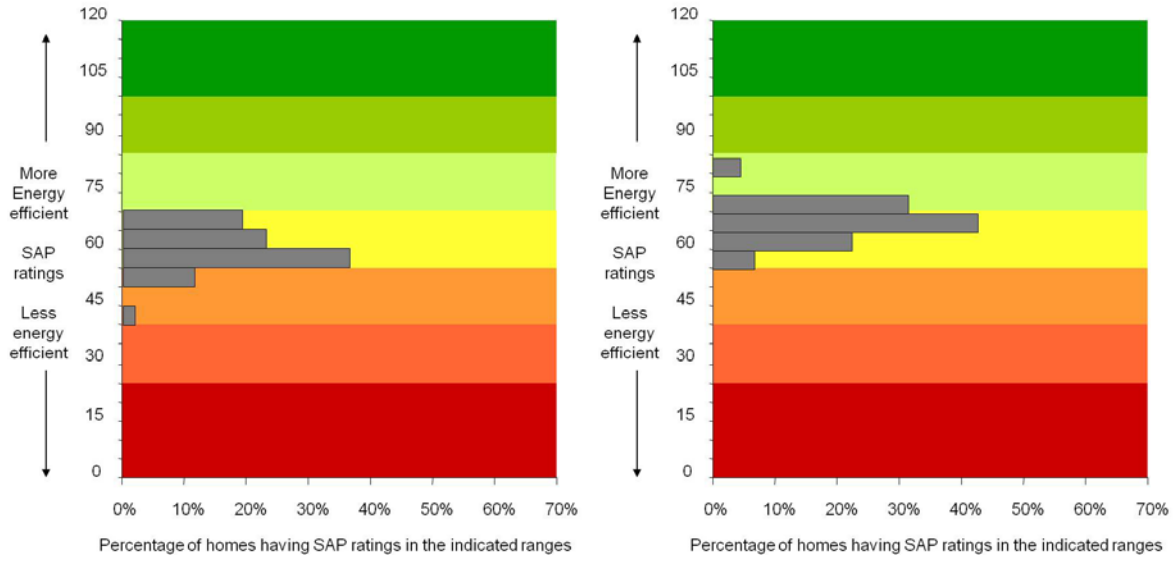


Figure 4.22 - SAP ratings of properties before and after measures were installed

Total CO_2 savings for the Programme have been calculated at 3,025 tonnes per year. The average UK household emits 10 tonnes of CO_2 per year. CO_2 savings per property ranged from 90 to 10,000 kg/yr which are illustrated in Figure 4.23. More than 30% of the properties saved more than 3,000 kg/yr CO_2.

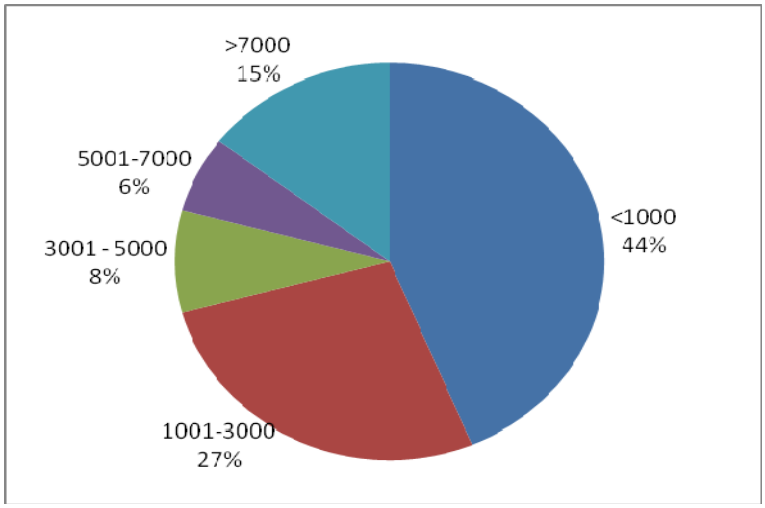


Figure 4.23 – CO_2 savings per property kg/year

Almost 1/3 of the properties save more than 40% of CO_2 emission when looking at the percentage of CO_2 saved compared to the CO_2 emissions before the work was undertaken.

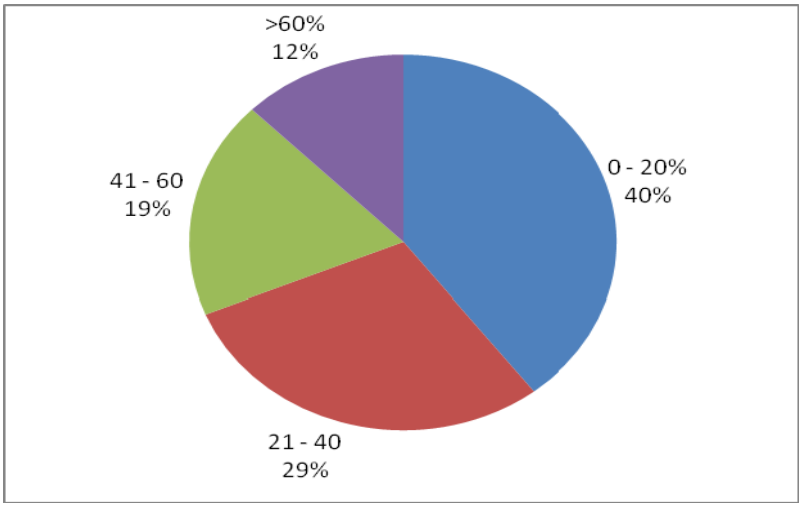


Figure 4.24 – Percentage of CO_2 savings per property

The greatest percentage of CO_2 savings are achieved when fuel switching is undertaken due to a lower emission factor associated with gas compared to other heating fuel sources as illustrated in Table 4.4.

Heating fuel source	Kg/CO_2/kWh
Gas	0.19
Coal	0.33
Oil	0.28
Electricity from grid	0.55

Table 4.4 – CO_2 emissions for different heating fuels (Carbon Trust, 2011)

The Programme has made a significant improvement to the aesthetics of communities, particularly those that have had EWI installed. Figures 4.25 to 4.29 provide evidence of visual improvements before and after works.

Figure 4.25 - Aesthetic improvement of solid wall terraced housing


Figure 4.26 - Aesthetic improvement of bungalows with EWI and solar PV installed


Figure 4.27 - Aesthetic improvement of flats with EWI installed


Figure 4.28 - Aesthetic improvement of flats with EWI installed, whilst retaining period features


Figure 4.29 - Aesthetic improvement of Non-traditional Cornish houses

4.4 Social outcomes

Training requirements were set as part of the funding criteria for the Arbed 1 Scheme. 156 training weeks were required to be attended per £1million investment.

Various training opportunities have been provided as a result of the Warm Wales Programme. Initiatives such as 'Job Match', a Welsh Government, Department for Work and Pensions and local authority backed initiative offering support to help people to overcome barriers to employment and 'Beyond Bricks and Mortar' were used to recruit appropriate staff.

The majority of trainee and apprenticeship opportunities were provided via the subcontractors involved in the Scheme and ranged from short term trainee positions to 3 and 4 year apprenticeships. Table 4.4 illustrates that the training weeks required was exceeded by over 25% of the required 1,308 weeks.

	Training weeks required	Training weeks undertaken	Nature of training
Charter Housing (and Caerphilly CBC)	314	386	NVQ2 Building treatments, NVQ2 Carpentry treatments NVW3/NVQ2 plumbing and heating
Melin	188	475	NVQ Electrical, Construction skills apprentice, NVQ plastering
Family	184	210	NVQ2 Electrical , NVQ2 plumbing, NEBOSH H&S, NVQ2 plastering
Coastal	190	199	NVQ2 Electrical, NVQ2 Plumbing and heating, NVQ2 plumbing
CCSwansea	304	304	NVQ2 plumbing, NVQ2 plumbing and heating C&G electrical
Tai Ceredigion	126	166	NVQ2 plasterers, NVQ3 plumbing, City and Guilds, NVQ3 Electrical installation.
Total	**1,308**	**1,704**	

Table 4.5 - Training undertaken under Warm Wales Programme

One of the key training opportunities provided through the Scheme was the recruitment of Community Energy Wardens who were involved during the implementation of the measures. Fifteen Energy Wardens were initially employed by Warm Wales during the implementation of the Scheme. The role of the Energy Warden was to work with Warm Wales and the main contractor to support community engagement, installation of measures and a provide an aftercare service to residents. This supporting role included being on hand to discuss and support residents in the understanding of information relating to the programme, benefits of individual measures and potential impacts throughout the installation process. The Energy Wardens were trained and supported to deliver Home Energy Assessments, basic energy advice and installation of Real Time Displays.

They also undertook home follow up visits ensuring installations were satisfactory and helping residents understand how to use any new equipment and or adjust lifestyle appropriately to make the most of it and were a first point of contact for residents who want further help or have any concerns. Specific training provided included:

- Health and Safety - working at height;
- Working safely in peoples homes;
- Loft insulation installation with insulation provider;
- RTD installation and operation;
- Home Energy Assessment process – internal and on the job training;
- Community engagement.

Two of the energy wardens employed during the Programme continue to be employed by Warm Wales. An additional two are employed on an ad-hoc basis when work is available. All fifteen received significant training and work experience to improve their long-term work prospects. The lack of continuity between Arbed 1 and Arbed 2 (over 15 months) has however prevented staff from being kept in continuous employment due to a lack of funding.

4.5 Economic outcomes

The Arbed 1 Scheme sought to stimulate economic regeneration, creating employment opportunities in local areas, selected as they were suffering from low household income, whilst also increasing capacity in the manufacture of low carbon technologies in Wales. The aim of the Warm Wales Programme was to target all grant assistance available to bring maximum benefit to low household income areas.

The total cost of the works implemented through the Warm Wales Programme as a whole was **£9,658,509** the breakdown of this is illustrated in Table 4.5.

Funding allocation	Contribution
Warm Wales Programme - RSL/LA properties	£6,372,155
Leveraged measures on RSL/LA properties	£2,141,104
Warm Wales Programme - privately owned properties	£1,145,250
TOTAL	**£9,658,509**

Table 4.5 – Funding allocation through Warm Wales Programme

The total cost of the measures implemented to *RSL/LA properties* utilising Arbed 1 Scheme funding through the Warm Wales Programme was £6,372,155.

£5,580,367 of this funding was provided from grant support mechanisms including Arbed/CESP/ CERT and LCBP. CESP (Community Energy Saving Programme) funding was only available to households in specific areas of low income in Wales to improve energy efficiency and reduce fuel bills, namely the areas covered by Charter Housing, Family Housing and Coastal Housing. CERT funding was provided by energy suppliers by promoting the uptake of low carbon energy solutions to all householders. The RSLs/LAs contributed £791,789 towards the direct cost of the Arbed 1 Scheme works undertaken to RSL/LA properties, which equates to 12.4% of the expenditure.

£2,141,104 additional funding was provided to undertake leverage measures by the RSLs/LAs on their properties. This included additional works such as replacement of eaves, electrical upgrades and general making good, together with making use of facilities such as scaffolding whilst on site to reduce future disruption.

£1,145,250 has been invested on EWI and new heating systems within *privately owned* dwellings.

Average actual costs per measure can be seen in Table 4.6. These are the average direct costs charged by the contractor to undertake the works including enabling works which varied according to the measure being installed.

Measure	Average cost	Note	No. of measure installed
EWI	£7,730	Inc enabling works and 5% VAT	648
Fuel switching	£3,126	Inc 20% VAT	241
Solar PV	£4,988	Inc enabling works	414
Solar thermal	£4,393	Inc enabling works	46
TOTAL			

Table 4.6 - Actual costs per measure installed during the Warm Wales projects

A comparison has been made of the CO_2 savings made per pound spent on the different measures for a semi detached/end terrace pre 1919 house, illustrated in Table 4.7. The highest CO_2 savings are made when fuel switching takes place, resulting in a CO_2 saving five times greater than the other measures for this type of property. This assumes that the original fuel source is economy 7 electrical heating which is the highest emitter of CO_2, as illustrated in Table 4.4.

Although CO_2 savings associated with fuel switching are in the magnitude of those required to achieve long term targets set, opportunities for fuel switching to gas are limited. The current fuel mix for domestic energy consumption in the UK is 1% coal, 21% electricity and 69% gas (DECC, 2011), which means that only around 22% have the opportunity to make this relatively cheap but significant change.

CO_2 savings are higher for EWI than for solar PV and solar thermal and prove to be better value for money with a lower £ per kg CO_2 per year.

Measure	CO_2 savings (kg/yr)	£ per measure	£ per kg CO_2 per yr	% CO_2 saving (kg/yr)
EWI	1,670	£7,730	£4.63	25
Fuel switching	8,939	£3,126	£0.35	57
Solar PV	751	£4,988	£6.64	11
Solar Thermal	395	£4,393	£11.12	6

Table 4.7 - Illustration of the CO_2 savings made per £ spent for a semi/end terraced house

Figure 4.30 demonstrates that fuel switching provides the best CO_2 savings per £ than any of the other measures (based on electricity being pre works heating fuel source).

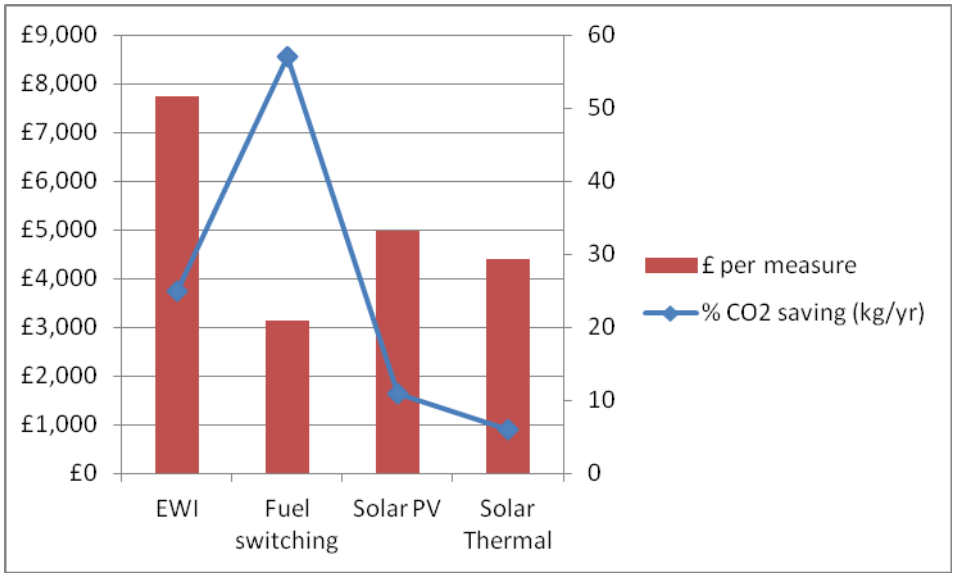


Figure 4.30 - Comparison of CO_2 savings and £ per measure for a pre 1919 semi/end terrace house

The overall annual energy bill financial savings as a result of the Warm Wales Programme can be seen in Table 4.8. The average annual energy bill before the works were undertaken was approximately £990. This corresponds to the estimated UK domestic fuel bill of £1,032 per year as calculated by OFGEM (2011) based on a typical consumption of 16,500 kWh per year of gas and 3,300 kWh per year of electricity.

Assuming the behaviour of the tenants remained similar, the average household energy cost after the works has been calculated to be £774. The average householder involved in the Programme could be saving £216 per year on their energy bills. It has to be acknowledged that an element of this saving could be used for increased temperatures for increased comfort rather than the householder benefitting financially.

The greatest energy bill savings have been calculated for a 1980s flat that has received ASHP with a saving of over 50%. 40% energy cost savings were calculated for a mid terrace pre 1919 house that had EWI and solar PV installed, with annual energy bills potentially being reduced by over £550.

Type of property	Age band	Measures			No. of props	cost of measures per property	Energy cost before (£)	Energy cost after (£)	Financial saving (£) per property per yr	% of energy cost saved	Total financial saving for house type (£)
no data	no data	No measures			11						
Flat	pre 1919	EWI	Solar pv		7	£12,718	£932	£697	£235	25%	£1,644
Flat	pre 1919	EWI			94	£7,730	£932	£697	£235	25%	£22,082
mid terrace house	pre 1919	EWI	solar pv		62	£12,718	£1,395	£821	£574	41%	£35,591
mid terrace house	pre 1919	EWI	solar thermal		10	£12,123	£1,395	£958	£437	31%	£4,370
mid terrace house	pre 1919	EWI			190	£7,730	£1,395	£1,021	£375	27%	£71,183
mid terrace house	pre 1919	solar pv			23	£4,988	£1,395	£1,196	£199	14%	£4,586
mid terrace house	pre 1919	solar thermal			2	£4,393	£1,395	£1,333	£62	4%	£125
semi/end terrace	pre 1919	EWI	Solar pv	solar thermal	1	£17,111	£1,188	£701	£486	41%	£486
semi/end terrace	pre 1919	EWI	Solar pv		22	£12,718	£1,188	£763	£424	36%	£9,334
semi/end terrace	pre 1919	EWI	solar thermal		4	£12,123	£1,188	£864	£323	27%	£1,293
semi/end terrace	pre 1919	EWI			69	£7,730	£1,188	£926	£262	22%	£18,045
semi/end terrace	pre 1919	solar pv			6	£4,988	£1,188	£1,025	£163	14%	£976

semi/end terrace	pre 1919	solar thermal			2	£4,393	£1,188	£1,126	£62	5%	£124
semi/end terrace	pre 1919	fuel switching			1	£3,125	£1,618	£1,188	£430	27%	£430
semi/end terrace	1919-1944	solar pv			2	£4,988	£796	£693	£103	13%	£206
semi/end terrace	1919-1944	solar thermal			1	£4,393	£796	£738	£58	7%	£58
Flat	1945-1964	EWI			11	£7,730	£1,069	£899	£171	16%	£1,879
semi/end terrace	1945-1964	EWI	Solar pv		2	£12,718	£902	£589	£313	35%	£626
semi/end terrace	1945-1964	EWI			22	£7,730	£902	£717	£185	20%	£4,061
semi/end terrace	1945-1964	EWI	Fuel switching		31	£11,000	£1,084	£717	£367	34%	£11,377
semi/end terrace	1945-1964	fuel switching	solar thermal	solar pv	1	£12,500	£1,084	£713	£371	34%	£371
semi/end terrace	1945-1964	solar thermal	solar pv		7	£9,380	£902	£713	£189	21%	£1,324
semi/end terrace	1945-1964	fuel switching	solar pv		2	£8,110	£1,084	£773	£311	29%	£621
semi/end terrace	1945-1964	solar pv			40	£4,988	£902	£773	£128	14%	£5,134
semi/end terrace	1945-1964	fuel switching	solar thermal		8	£7,520	£1,084	£841	£243	22%	£1,945
semi/end terrace	1945-1964	solar thermal			10	£4,393	£902	£841	£61	7%	£607

semi/end terrace	1945-1964	No measures			80	£0	£902	£902	£0	0%	£0
semi/end terrace	1945-1964	fuel switching			88	£3,125	£1,084	£902	£182	17%	£16,051
bungalow	1965-1980	EWI			17	£7,730	£840	£771	£69	8%	£1,169
Flat	1965-1980	ASHP			22		£612	£298	£314	51%	£6,908
Flat	1965-1980	EWI	Fuel switching		52	£11,000	£612	£498	£114	19%	£5,947
mid terrace house	1965-1980	EWI			4	£7,730	£1,281	£1,103	£178	14%	£711
mid terrace house	1965-1980	solar pv			4	£4,988	£1,281	£1,059	£222	17%	£889
mid terrace house	1965-1980	fuel switching	Solar pv		23	£8,110	£1,584	£1,059	£525	33%	£12,080
mid terrace house	1965-1980	fuel switching			13	£3,125	£1,584	£1,281	£303	19%	£3,938
semi/end terrace	1965-1980	EWI			33	£7,730	£953	£834	£119	12%	£3,927
semi/end terrace	1965-1980	fuel switching	Solar pv		12	£8,110	£1,150	£792	£358	31%	£4,292
semi/end terrace	1965-1980	solar pv			31	£4,988	£953	£792	£160	17%	£4,974

semi/end terrace	1965-1980	fuel switching			10	£3,125	£1,140	£953	£187	16%	£1,873
bungalow	post 1980	solar pv			4	£4,988	£485	£372	£112	23%	£449
detached house	post 1980	solar pv			1	£4,988	£485	£372	£112	23%	£112
Flat	post 1980	ASHP			20		£579	£261	£318	55%	£6,359
Flat	post 1980	solar pv			49	£4,988	£488	£375	£112	23%	£5,503
mid terrace house	post 1980	EWI			5	£7,730	£488	£474	£14	3%	£71
mid terrace house	post 1980	solar pv			20	£4,988	£488	£375	£112	23%	£2,246
semi/end terrace	post 1980	EWI			14	£7,730	£488	£474	£14	3%	£198
semi/end terrace	post 1980	solar pv			87	£4,988	£488	£375	£112	23%	£9,771
semi/end terrace	post 1980	No measures			18	£0	£488	£488	£0	0%	£0
Total							£47,541	£37,133	£10,408		£285,948

Table 4.8 - Energy costs and financial savings as a result of the Arbed projects

Figure 4.31 demonstrates the percentage savings to householders' energy bills as a result of the works undertaken. This graph illustrates that 50% of the households could be making more than a 20% financial saving assuming behaviour has remained the same following the work.

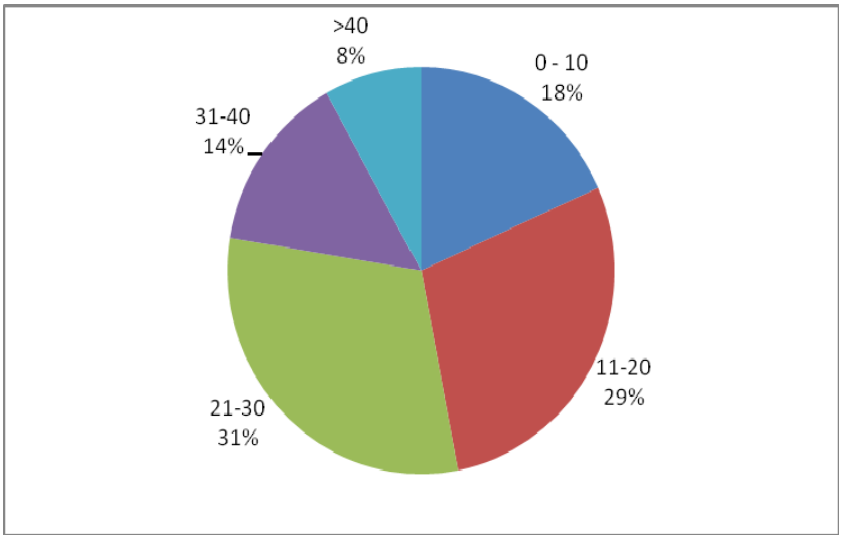


Figure 4.31- Percentage of energy bill reduction as a result of the Warm Wales Programme measures installed

The combined potential financial savings for all households involved in the Warm Wales Programme is £285,000 per year.

The investment involved in the Warm Wales Programme of £9,658,509 equates to a payback period of 33 years for the programme. This does not take into account the added value to the properties including the energy saving measures and associated maintenance works, the improved comfort for householders, improved aesthetic value of the communities and likely increased energy costs over time.

4.6 Supply Chains

When considering the supply chains involved in the Programme, four of the seven manufacturers are located in Wales including Envirowall, Rockwool, Sharp and Wetherby.

Twenty contractors/subcontractors were involved in the programme. Of these 16 were based in South Wales which strongly supports the aim of the scheme to increase local employment. The lead contractor that was recruited was predominantly based in Cardiff and supported in part from Birmingham.

5.0 STAKEHOLDER FEEDBACK

In order to provide qualitative feedback about the Warm Wales Programme, two methods of data collection have been used to obtain stakeholder feedback. An eight page questionnaire was administered to all households involved in the Programme. Interviews have also taken place with the RSLs involved.

5.1 Householder questionnaire

Residents were asked, via questionnaire, about their experience of the Programme and whether the work has helped to improve their home and living conditions. One questionnaire was sent to every household included within the Warm Wales Programme (1,147). The questionnaire and a freepost envelope was hand delivered by the Energy Wardens. Each door was knocked on two occasions. The energy wardens were asked to explain why the questionnaire was being given out and to encourage the householder to fill it in. The freepost envelope was used to return the form. If the householder preferred, the energy warden returned to collect the form at an agreed date and time and then return the questionnaires to the WSA, either by the freepost address or by contacting the WSA by telephone so that they could be collected. If the householder did not answer the door questionnaire and freepost envelope were posted through the letterbox.

Figure 5.1 - Administration of questionnaire at the door

183 questionnaires were returned. Of the questionnaires returned 19 were either incomplete or did not include an address and therefore could not be analysed.

Table 5.1 indicates that the average response rate from the RSLs for the questionnaire was 14%. The highest response was from the CCS project at 25% of the total of properties within the CCS project,

with the lowest response rate at 9% with Tai Ceredigion. A higher overall response rate was expected, however during the distribution of the questionnaires the energy wardens described the householders as feeling 'fed up' with the works and wanting to move on. In hindsight it was also felt that the questionnaire was too long and complicated for tenants to complete without more assistance.

RSL/local authority	Number of responses	Total number of properties	% response
Charter Housing Association/Caerphilly CBC	31	200	16
Melin Homes	11	189	6
Family	19	147	13
Coastal	23	230	10
CCSwansea	70	275	25
Tai Ceredigion	10	106	9
Total	**164**	**1147**	**14**

Table 5.1 - Questionnaire responses from RSLs

5.2 Questionnaire results

56% of the respondents lived in terraced housing, 33% were from semi-detached, 8% resided in flats with the remainder in bungalows and detached housing. 75% were renting from the local authority, housing association or housing trust with 22% owning the property or are buying with the help of a mortgage or loan and 3% rent from private landlords. This is representative of the Warm Wales Programme Arbed 1 portfolio with 80% renting from the local authority, housing association or housing trust and almost 20% owning the property outright.

Figure 5.2 illustrates the length of time that the householders have lived at the address.

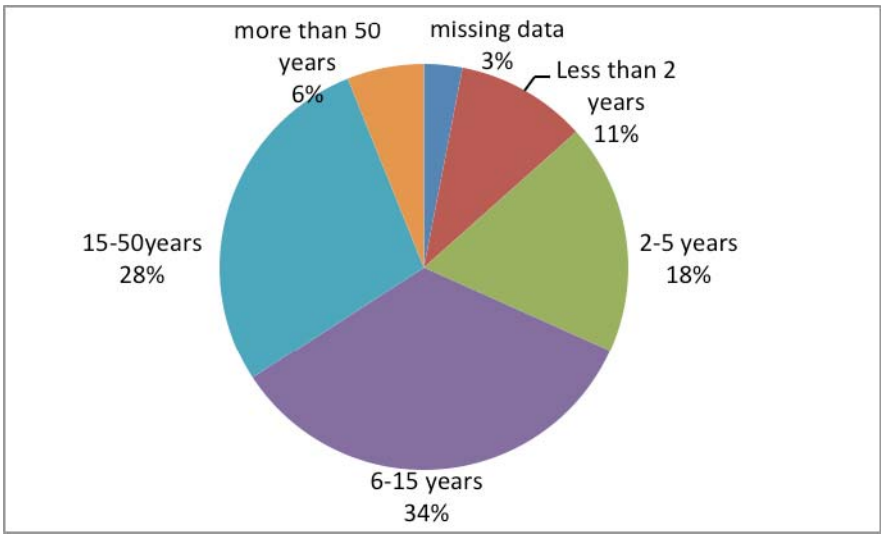


Figure 5.2 - Duration of residence at current address

It is interesting to note that almost 1/3 of the respondents have lived at the same property for over 15 years, with 6% having lived at the same address for more than 50 years. This indicates that householders have a strong sense of belonging and that community relationships will be well established.

Overall the response from householders with regards to the installation of measures has been positive. Specific responses are presented. Figure 5.3 shows that 35% of the respondents tend to agree or strongly agree that their home is more comfortable since the measures have been installed.

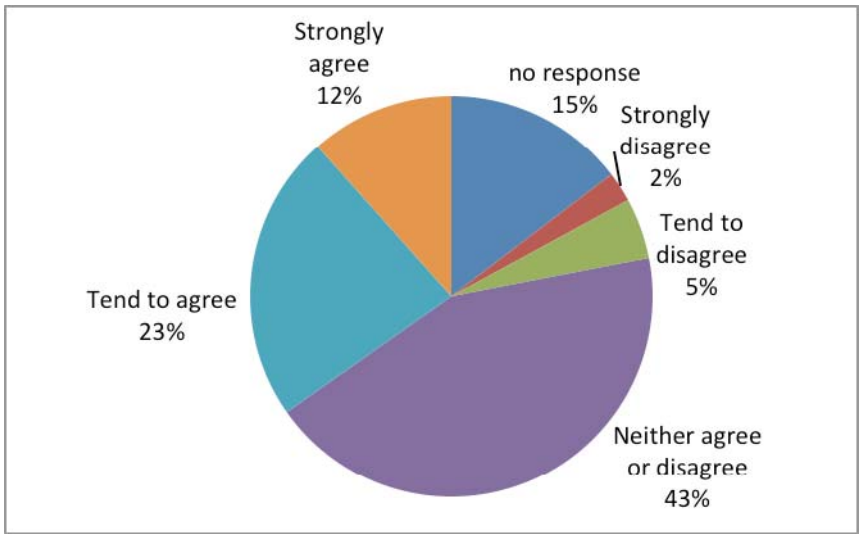


Figure 5.3 - Household comfort levels since measures were installed

Almost 60% respondents agree that they feel warmer in their homes since work was undertaken, as illustrated in Figure 5.4.

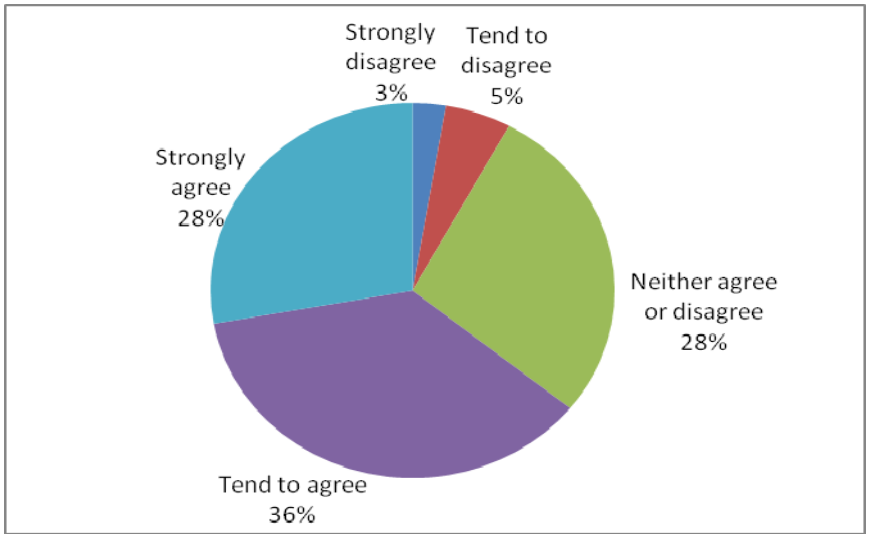


Figure 5.4 – House feels warmer since the measures were installed

50% of respondents agree that there home looks much better since the work was undertaken (Figure 5.5), and this extends to the area where they live which 50% also agree looks better.

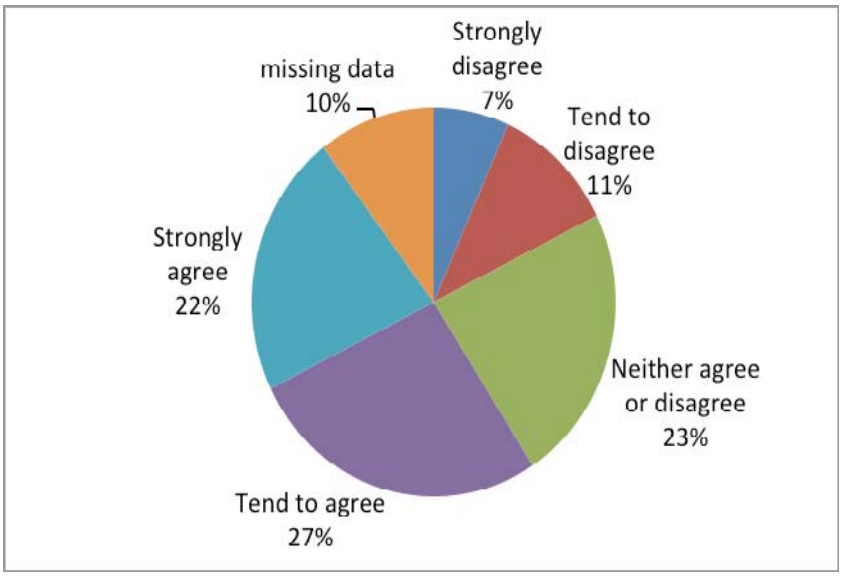


Figure 5.5 – House looks better since the measures have been installed

Figure 5.6 illustrates that 27% of respondents feel better since the measures were installed. However, 14% feel worse. There are many confounding factors that could impact on these results.

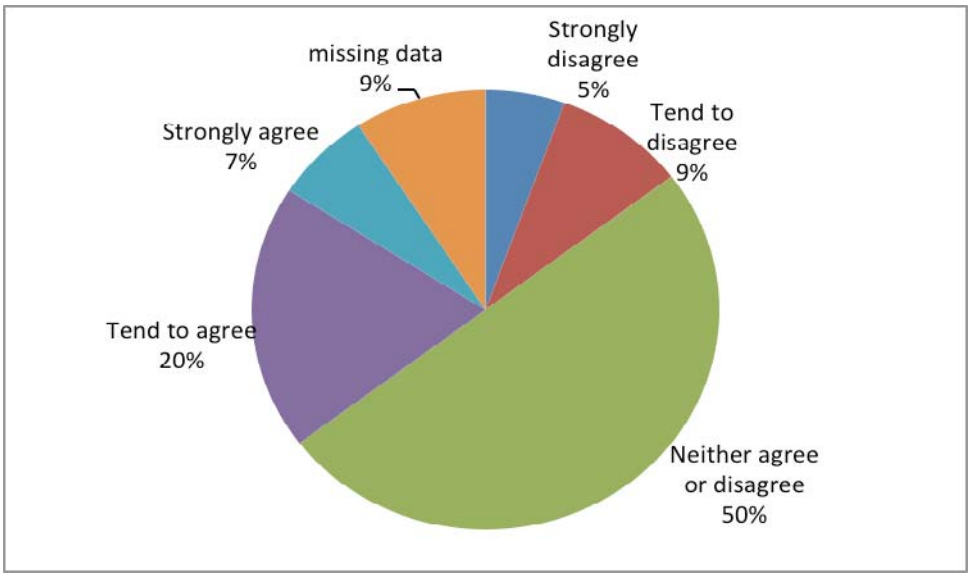


Figure 5.6 – Feel better since the measures were installed

With regards to awareness of energy use and savings, Figure 5.7 illustrates that 1/3 of respondents feel that they are more aware of carbon emissions and the need to reduce them since being involved in the Programme. Over half of the respondents agree that they are more aware of the amount of energy that their household uses since having the work done. However, over three

quarters find that it is too expensive to heat their home as warm as they would like in winter, accepting that at the time of survey , respondents would not have had the benefit of a full winter period to assess the savings .

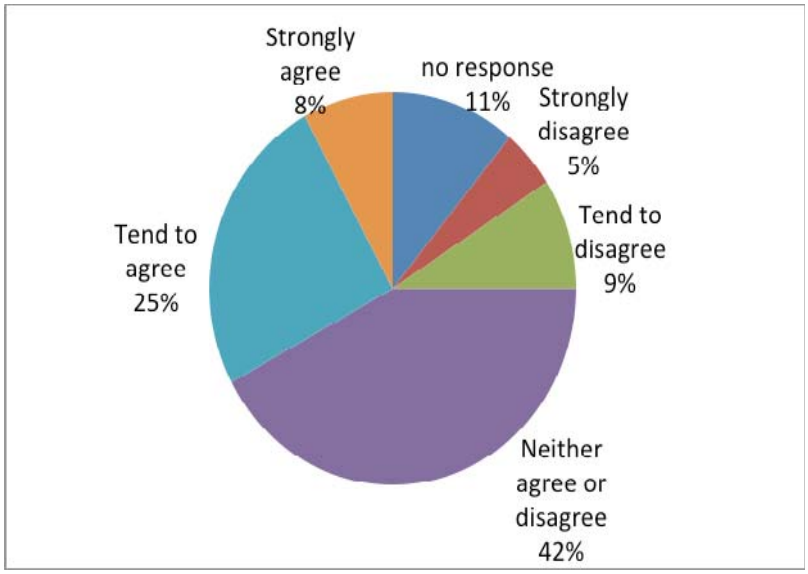


Figure 5.7- Household awareness of carbon emissions and the need to reduce them

When analysing the responses regarding the installation of measures, over 70% of respondents are either fairly or very satisfied with the quality of work undertaken by the contractor/subcontractor. These responses have been analysed according to the measures that have been installed, as shown in Figure 5.8. This illustrates that most dissatisfaction was experienced by those households that have EWI installed.

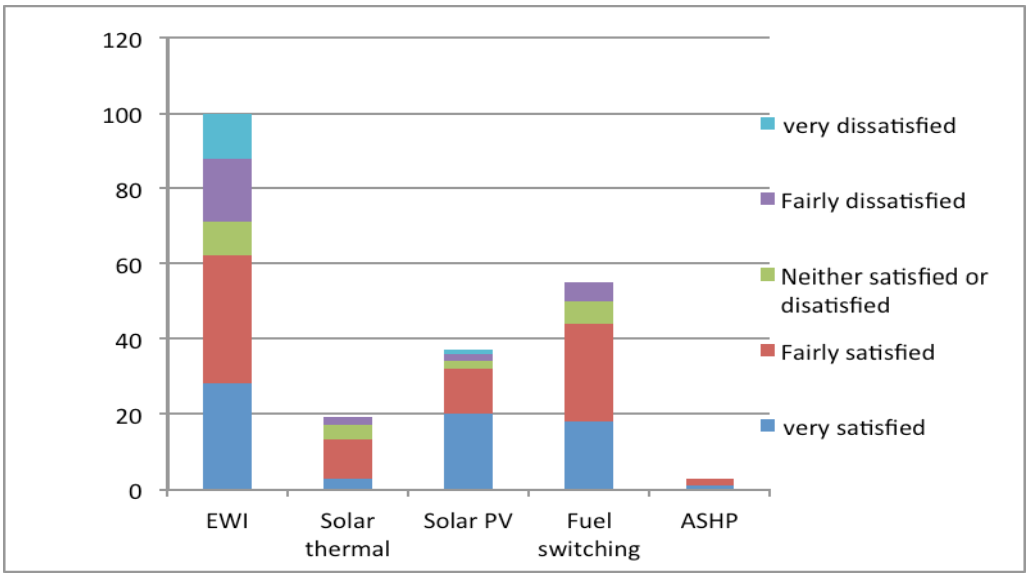


Figure 5.8 - Satisfaction with the quality of work according to the measures installed

Almost half the respondents have had to contact someone to report an issue since the measures have been installed. Most of the complaints were made to the RSL/LA or the subcontractor. Very few people reported that they contacted Warm Wales or the main contractor regarding any problems.

Comments regarding problems on site indicate that there was initially a lack of clarity on who the householder could contact if a problem did arise. This was a result of the compressed timescale and mobilisation period to commence works. The identification of this problem did however result in a comprehensive 'fault reporting system' being put in place by Warm Wales. 23% of respondents feel that a problem has not been rectified but work is on-going during the defects liability period to address the outstanding issues.

General positive comments received within the open questions regarding the programme include:

- The site workers were very polite;
- Properties look much nicer from the outside;
- The house feels much warmer.

Some general negative feedback that was received included:

- Poor completion of works on site;
- Lack of care and attention on site – workers were messy and displayed a lack of respect for property;
- Work undertaken was of poor quality;
- The length of time taken to do the work was too long. In some situations scaffolding was erected and left of site for many weeks before any further work was undertaken;
- There was a lack of communication about what work was going to be carried out and when.

5.3 Case studies

A sample of householders have been interviewed to provide feedback of the Warm Wales Programme to illustrate some positive impacts. These are presented on the following pages.

Mrs Williams

Mrs Williams is an owner occupier in Swansea who received EWI under the Arbed 1 Scheme.

Quote: "I'm very pleased with the appearance of my home, it looks much more attractive. My bills are now less than half of what I was previously paying and my house is a lot warmer. The house seems to retain the heat for longer periods of time also meaning that I haven't the need for my heating to be on for as long as before. Previously, I was in arrears with my gas provider and now I am actually in credit."

Mrs Toth

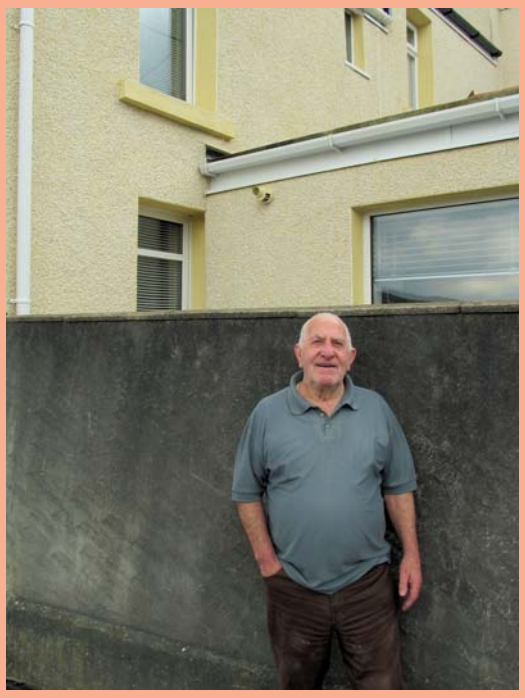
Mrs Toth was one of the original council tenants living on an estate and has had both a coal boiler and replacement oil boiler installed in her home.

Quote "My house feels much warmer in all the rooms and now the old oil boiler has been removed, I have more space in my kitchen. I won't have to worry about the increases in the price of oil any more. It was just going up and up. The gas supply will make things much easier as well. It was an awful job for both the coal and the oil delivery men to reach my back garden to deliver. They had to squeeze past both my neighbours back gardens to get to my house. I've had solar electric panels fitted to the back roof of the house as well so I should be making quite a saving on my bills"

Mr Durran

Mr Durran is an owner occupier who received EWI under the Arbed 1 Scheme.

Quote: "Even though fuel prices have risen our fuel bills are now a lot cheaper than they were in 2009. I notice that the house is a lot warmer and I am not so reliant on my heating being on all the time."



Miss Angharad Evans, Mr Jonathan Hire and Ronan

Miss Evans has lived in Bryniago for 5 years and was using a coal back boiler to heat her home.

Quote: "The gas heating has made a big difference. It feels much warmer in the house now and the new heating is much cleaner and less trouble than the old coal heating."

Miss Kelly Babb, Mrs Jackie Maccarinelli & Miss Sharon Davies

Miss Babb and Miss Davies are Swansea council tenants and Mrs Maccarinelli owns her home.

The Arbed 1 Scheme gave all three ladies the opportunity to benefit from new, energy efficient gas heating by bringing together a mix of grant schemes to maximise funding available to receive measures. The cost of having a new gas supply to their homes was covered by a grant from the Wales & West Utilities Ltd Warm Homes Assistance Scheme. They qualified for grants from the

Carbon Energy Reduction Target scheme towards the new heating, provided by npower under the terms of their regulatory obligations. This was topped up with Arbed 1 funding so that any the remaining balance to pay was minimal.

Quote: "I've lived here for 14 years. We have been paying about £30 per week to buy coal for heating so I'm expecting to make a saving now that we have gas heating. The house has been much warmer in fact; it's too warm at times! Now we have really hot water whenever we need it. Before, the water was only lukewarm and we had to use the immersion heater for hot water. Otherwise, we would lose heating from half the rooms in the house while the old system heated up the water. "

5.4 Interviews with stakeholders

Interviews have been held with key stakeholders in order to obtain feedback regarding the implementation of the scheme. The interviews involved questions regarding the management of scheme, lessons learnt from the process and data collection where appropriate. Representatives from RSLs and LAs involved in the Warm Wales Programme were interviewed during December 2011 and January 2012. Interviewees included:

- Mark Wade, Housing , renewal and adaptation manager for the private and public sectors, City and County Swansea;
- Megan Smith, Planned Maintenance Surveyor, Charter Housing;
- Darrin Davies, Head of Property Services, Family Housing Association (Wales) Ltd.;
- Andrew Thomas, Maintenance Manager, Coastal Housing.

Findings from the interviews have been combined under common themes and are presented below.

a Planning

The reasons given for applying for Arbed funding included improving affordable warmth, reducing fuel poverty, improving social inclusion and improving the physical built environment.

Key requirements included the need to deliver the works on time, in budget and to an acceptable quality, with a good level of householder liaison to ensure appropriate use and care of measures.

An appropriate time period should be available for planning permission to be obtained where necessary and a greater awareness of where planning permission is likely to be necessary should be known. Discussions should be carried out with planners as early as possible to ensure that necessary issues are dealt with as quickly as possible, as soon as possible.

Careful consideration should be given to the time of year that works are to be undertaken during the planning stage. Some flexibility should be given with regards to funding timescales when coinciding with winter weather conditions. Contractors had extra negative issues to deal with and householders more uncomfortable conditions to endure due the Arbed 1 Scheme schedule coinciding with a harsh winter period.

b Data collection and surveying

Desk top surveys, including existing knowledge of properties, available maps and additional data sets such as gas main information were used by RSLs and local authorities to prepare the initial bids to WG for Arbed funding. Extra surveying work was not undertaken during the bid preparation phase.

A lack of detailed information was provided by gas suppliers during the planning stage. Properties initially identified as 'off gas' were found to have gas available when work was due to start. Therefore the planned fuel switching was not required. This resulted in a change in approach from to the planned programme or works. This was a recurring theme through many of the projects, with the availability and accuracy of survey data provided often being poor or inadequate. Whilst there were exceptions, this was a common theme.

An appropriate detailed survey of the all properties should have been undertaken prior to the works by the main contractor. This was not undertaken in all cases, as a result of the compressed time-scale and in certain project areas, surveys were undertaken too late in the programme. This lack of information resulted in a number of issues including:

- Some properties that were identified as 2 storeys houses from the front aspect were found to have 3 storeys at the rear (due to steep landscape) when approached to undertake works. For private properties this made the cost of EWI not possible within the Arbed scheme due to the extra expense of the 3rd storey.
- Properties that were understood to be some distance off gas from an initial desk-top study were actually located very near to a gas main and therefore the fuel switching cost was far less than anticipated. More accurate information regarding the location of gas mains would result in better planning.
- Information regarding boiler types had, in some instances not been collected by the main contractor. This resulted in extra cost and time needed to replace boilers in some properties, as flue extensions were required as a result of the EWI. Where such properties had not been correctly surveyed, by the contractor, the additional costs were met by the contractor.
- The surface areas of the facades of some properties had not been accurately collected. This resulted in considerable delay and confusion regarding final costs for the works particularly when calculating EWI areas.

Costing of the projects has been very unclear due to a lack of survey information that should have been available.

There was, at times, uncertainty regarding who should have undertaken a survey of the properties. Some RSLs/LAs thought the Energy Wardens should have carryied them out, others believed that it was the responsibility of Warm Wales and others thought it was the responsibility of the main contractors. One RSL believed that Warm Wales undertook a full survey. The reality was that WW undertook the initial 'door step' surveys based on information provided by RSLs prior to entering into the contract with the main contractor, who were then responsible for undertaking the detailed pre-works surveys. It is clear that on Arbed 2 comprehensive pre-works surveys would greatly help improve this situation.

c Properties and measures

The properties included within the projects were selected for a number of reasons. These include:

- WG call specified the types of properties that should be chosen;
- Properties with a low SAP rating;
- Solid wall properties that were suitable for EWI;
- Off gas properties suitable for fuel switching;

- Properties of a ‘non-traditional’ construction;
- Areas outlying to main centres that sometimes get overlooked;
- Properties that are believed to be expensive to deal with;
- Properties grouped within areas that were similar to keep installation simple;
- Street by street basis to avoid ‘neighbour’ envy.

Warm Wales assisted in selecting appropriate properties, frequently based on achievability/access and client expectations of match funding. Some measures were not considered by one RSL as additional training would be required for long term maintenance which could be costly.

One respondent had previously undertaken a comprehensive survey of its stock that was used to identify properties most in need. Properties with a SAP less than 65 were used as the baseline.

More private sector properties would have been desirable, however, it was felt that the short time scales available limited the ability to readily recruit private sector households. More public engagement would have assisted with private sector uptake but this would have taken time. It was also felt that the contribution required by the private sector for EWI was too high. Additional costs, although real, were off putting to private households. For example, an additional charge of £150 to remove and replace an existing satellite dish during EWI installation.

Some respondents favoured the ‘little and many’ approach (Figure 5.9) and would prefer to undertake one or two measures to a lot of properties within an area.

Figure 5.9 - Area based approach

This approach removes the opportunity for disharmony within neighbourhoods and if an aesthetic fabric improvement such as EWI, is implemented, it can significantly improve the appeal of the area receiving it. Fewer measures also reduce the amount of things that can 'go wrong' and also reduces the need for in-depth training for efficient use.

Other RSLs/LAs feel that the 'whole house approach' is better, as all issues such as thermal bridging arising from EWI can be solved at once. This allows for energy efficiency measures and supply systems to be installed and maintenance issues to be dealt together, reducing overall costs. This also allows for more comprehensive tenant education, which should result in better performance of the measures.

In some cases the properties originally selected for improvements were exchanged during the programme as works were not progressing at the speed necessary for completion on time. For example, in one instance, more flats were included as this allowed for greater number of properties to be improved at a faster rate.

d On-site technical issues

A small minority of householders have, subsequent to treatment, raised some concern regarding internal damp patches where EWI has been installed. Respondents believe that the EWI may have created an impermeable barrier to moisture which has then become partially trapped within the solid walls. As this moisture cannot escape to the external atmosphere, it is penetrating through the plaster inside and could be the cause of its deterioration which then requires patching up. This problem is creating poor relations with some householders. It is however felt that once the moisture trapped inside the wall has evaporated, the problem should resolve itself. This may take a while and poor internal surface conditions will be experienced in the meantime which will require monitoring.

In contrast to this other concerns are that solid walls may become very dry due to no/little moisture penetration and that the 'fines' within the wall could 'move in' and cause a degree of structural movement or cracking. These technical issues may need further monitoring or investigation.

It is also felt that the EWI may not be treated in the appropriate manner by householders. Concern was expressed that the insulation layer may be damaged during DIY work such during the installation of satellite dishes etc.. The guidance note included in handover packs could help to avoid this issue.

e Detail

It was agreed that the quickest solution should not be chosen and that time should be taken to evaluate options. With tight deadlines this is not always possible and some flexibility in timescales should be given. There were instances where the quality of work was compromised due to tight deadlines, and in one case EWI had to be refitted for an entire road due to poor quality workmanship. Whilst this was at the contractors expense it did not help public relations. In many cases, particularly with older properties, detailing was complex (figure 5.10).

Figure 5.10- Complexities of detailing when installing EWI

Problems were experienced when identifying appropriate detailing for sills when installing EWI. Quick turnaround times and cost issues resulted in UPVC profile covers being used to cover sills rather than form colour coded aluminium replicas or recasts of the originals which could have reduced thermal bridging problems and would have been more aesthetically pleasing.

Following EWI installation, it was discovered in some homes that the sequence of work had been inadequately planned and the flue for the boiler needed to be extended to fully penetrate the additional wall thickness. This was undertaken with additional cost being met by the contractor. In some cases where the flue extension was not available, the complete boiler was replaced, again, at the contractors cost.

Phenolic foam was the most favoured option for EWI. One respondent believed it to be a more robust treatment rather than the equivalent glass wool insulation batts which were also a bit thicker.

Generally it was felt that detail provided by EWI system suppliers for site workers was not good enough. As a result, there have been instances of thermal bridging and poor finishing at fascias, casement, eaves and detail at the flat roof level. It was felt that unnecessary time was spent rectifying problems that should not have occurred due to a lack of information.

f Collaboration

The main reason Warm Wales was chosen/selected to manage the projects was that the necessary skills or time was not available in-house. Warm Wales was also chosen due to previous experience working with certain staff members, their CESP/CERT experience and knowledge of the technologies to be implemented.

In most cases there was limited experience within RSLs/local authorities in installing the specified measures. EWI had been installed previously in few cases, although it had not been considered an energy efficiency measure before but more as protection for buildings against wind and adverse weather.

g Costs and emissions

There was a degree of confusion regarding the actual financial cost of works and what was undertaken. It is felt that an appropriate survey at the outset would have significantly assisted with the success of the programme in avoiding re-measurements and scope for 'extras'. It was generally felt that not enough information was available for the respondents to review costs and as a result there has been considerable uncertainty regarding the final contributions required. This is a result of the tight timescales in commencing works, using a schedule of rates, and the need to redesign schemes on site due to the inaccuracy of some of the initial data provided. The re-measurement of works has also been necessary as a result of lack of accurate final account data from the contractor.

Additional works were undertaken to take advantage of the facilities available on site, including utilising scaffolding to fix eaves, fascias and gutters. Non-traditional Cornish properties were reroofed whilst EWI was installed. Electrical upgrades were also undertaken. These improvements would not have taken place at this time if the Arbed scheme had not been taking place.

It is strongly believed that if RSLs/local authorities had been able to use their own 'framework' main contractors on site, work could have progressed more smoothly and, ultimately, money would have been saved/more properties could have been dealt with. This was not however possible, as a pre-

condition of the CESP and CERT funding from the Energy Company was that they used their own main contractor to undertake management of the works. Any of the RSLs own contractors would have in any event, also been faced with the combination of time constraints, extremely adverse weather conditions, the inaccuracy of much of the original stock data (with exceptions) and access issues, in the case of many of the properties.

Only one respondent had any knowledge of the CO_2 savings that would have been made as a result of the works, with more attention being given to the overall financial and comfort benefit to residents.

h Stakeholders

A range of staff within the organisations were involved in the project depending on the scale of the scheme and the organisation structure. The main role of the staff was to oversee the project to ensure appropriate management and to provide an informal 'clerk of works' on site to ensure quality control.

Staff involved included surveyors, maintenance managers, costs and contracts, legal representatives, financial control and customer liaison. The commitment by RSLs/local authorities was significant. RSLs/local authorities also had time involved in dealing directly with queries from Welsh Government.

The vast amount of stakeholders involved in the scheme was considered to overcomplicate the programme significantly and it was felt resulted in unnecessarily high costs. It was also felt that there were too many 'chiefs' involved and that project management could be confusing for those involved.

On a positive front, it was generally felt that the energy wardens played an important role in the Programme and that their involvement worked well.

Consistency with on-site staff involved assisted the construction process. This was particularly true with 'on-site' contractors. Where a high turnover of site managers among both the main contractor and the specialist subcontractors was reported, more problems were experienced. It was also felt that when subcontractors were not 'local', more problems arose on site and works took longer.

A number of problems were highlighted with regards to the contractors. It was felt that:

- the main contractor generally, did not have the right experience to undertake the works as they specialised in plumbing and were not based in the area;
- some work was subcontracted to companies unfamiliar to both the contractor and the RSL. There were a number of times when the subcontractors selected seemed to have a lack of experience, or insufficient staff, to undertake the work to an appropriate standard; and it was acknowledged that capacity issues to meet the overall Arbed programme were largely the main cause.
- there did not appear to be sufficient staff within the main contractors company to deal with the work, particularly in the initial setting up period;
- lack of consistency with site managers/staff was a recurring problem;
- lack of information regarding the costs associated with the work was a particular concern.

Most respondents dealt with complaints informally on site by dealing with the sub-contractors or energy wardens directly wherever possible to reduce delay. There was no awareness of a complaints procedure to follow that involved the main contractor or Warm Wales even though this had been agreed at the regular progress meetings. It tended to be the case that formalised complaints were made to RSLs/LAs as householders were more familiar with that procedure rather than the contractor or Warm Wales.

In some cases it is understood that the householders have been provided directly with information packs regarding solar PV and solar thermal, and respondents understood that this was driven by the installer. This was, in any case, required by Warm Wales as a part of the contract completion requirements.

It is understood that the main contractor has provided information regarding the do's and don'ts for EWI. Follow up training would be useful for the maintenance teams and tenants. It was felt that a completion meeting summarising the outcomes of the works would be beneficial as well as the practical completion /snagging meeting.

More occupant education is required for all building projects to ensure measures are utilised effectively and fabric is not affected. Respondents felt that they would use most of the subcontractors involved within the scheme again. It was stressed that are very few experts involved in the installation of energy efficiency measures and renewable energy systems, and when a scheme

such as Arbed takes place the industry is stretched beyond its limits resulting in, at times, poor quality work from labour sources that are not sufficiently qualified or adequately experienced.

The lack of continuity between Arbed 1 and 2 has meant that staff taken on for Arbed 1 are no longer retained. If Arbed had been a rolling scheme the lessons learnt in stage 1, could have been taken through to stage 2. Many of the staff trained as part of stage 1 have moved on. Subcontractors were unable to offer apprenticeships to staff taken on due to the short timescale of the Scheme.

It is understood that the role of the RSLs/local authorities will be reduced in the Arbed 2. Some concern was expressed that householders will continue to think that RSLs/local authorities are responsible and that they could still tend to be viewed as the first point of contact if problems arise.

6.0 CONCLUSIONS

This evaluation of the Warm Wales component of the Arbed 1 Scheme was undertaken to provide evidence of the impacts of a large scale retrofit programme. Environmental, social and economic impacts of the Programme have been evaluated to demonstrate the positive and negative aspects of the programme in order to assist with improving the implementation of both Arbed 2 and other large scale retrofit programmes/projects, such as the current CESP programme, that are necessary for the deep carbon reductions required in the near future.

The following key points have been identified that could be **undertaken differently** to improve the implementation of low carbon solutions in the retrofit of housing in large scale programme:

1. Survey and model properties - by undertaking an accurate survey of properties to be included, as soon as possible, appropriate measures can be identified. Responsibility for this should be clearly allocated so that it is actually undertaken in advance, and in sufficient detail;
2. Consistent methods of data collection and storage would simplify the surveying process and aid the collation of evidence that improvements are making a difference and lessons can be learnt for future experiences. Data collection is usually very variable in quality and accuracy;
3. Monitoring of works before and after would allow for a better evaluation of success to provide evidence that the measures are performing as expected, even on a sampling basis. The potential social impacts of the scheme such as householders behaviour during and after works and impact on broader community also needs to be better understood in order to optimise the benefits that can flow from such schemes;
4. The improvement measures to be delivered and the approach to be taken should be confirmed, with a clear rationale of either 'whole house' or 'blanket'? – the Warm Wales Programme was not whole house but responded to the practicalities of being able to deliver a 'blanket' range of appropriate improvements in a confined timescale;
5. Adopt the most appropriate combination of measures for the building, the locality and the tenants, within the funds available, considering the long term maintenance; Consider fabric, form, systems, appliances. Fabric improvements are favoured. Homes are warmer and appearance is improved, however detail needs to be specified correctly. Solar thermal is generally only favourable on larger properties, in this case properties were often too small to benefit fully. Generally little difficulty was experienced during the installation of supply systems– provided that work sequencing was addressed.

6. Understand the funding sources available and utilise them fully. Be aware of possible barriers for example, households who received solar PV were not eligible to receive FIT because of ARBED funding;
7. Costs of work need to be carefully planned to reduce levels of uncertainty. Cost evaluation should include more emphasis on fixed and measured capital costs at the outset together with due allowance for expected operational costs including enabling works, maintenance and the cost of project management;
8. The supply chain should be carefully considered. Local subcontractors on existing frameworks can often provide the benefit of continuity and experience of the types of properties involved and local manufacturers can be worked with to adapt measures as required;
9. Product warrantees should be fit for purpose. Experience has shown that, especially in the case of EWI, they are not and should be improved by negotiation with suppliers and installers through improved contract specification requirements. Main contractors should underwrite compliance with product specifications to provide those assurances.

During the evaluation process a number of **barriers to large scale roll out** have been identified:

1. Cost evaluation should include a much better control of capital costs together with operational costs including enabling works, maintenance and project management;
2. Rectifying detailing due to small variations in properties took time and additional funding on site which was inefficient. Detailing solutions provided by manufacturers , agreed with their approved installers at the outset, would assist with this;
3. Different products require different detail, which involves a lot of new information to take on and to trust. In this respect, there is a need to share information at all levels;
4. Due to the quick turnaround time specified by the programme there were instances of a lack of time for appropriate planning, particularly at the initial site set up stages and for selection of appropriate measures. Additional planning time could have allowed more appropriate solutions to be have been identified;
5. Lack of experience and available local skills caused problems in implementation , frequently preventing works of a satisfactory standard being delivered that would last.

Key **drivers** of a large scale retrofit programme have been identified to include:

1. A good contractor who is efficient, organised, and resourced to take ‘well-planned’ risks;

2. Large scale funding, such as Arbed, which at an average rate in excess of 80% grant, enabled work to go ahead. This presented employment opportunities and allowed risks to be taken using technologies that had not been used in the past by RSL's /LAs.

Undertaking the Arbed 1 Scheme has provided RSLs and LAs with confidence to try out new technologies and establish new relationships with local suppliers and installers, which will continue to be used. There is a need for good scheme design and contract planning and workmanship. There is also a need for the supply chain to provide flexible and adaptable solutions for the problems that might arise. A balance needs to be met between high quality design, meeting tight deadlines and cost in order to complete works that will deliver the CO_2 targets necessary.

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GLOSSARY OF TERMS

CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CO_2	Carbon dioxide
DECC	UK Government Department for Energy and Climate Change
FIT	Feed in tariff
LA	Local Authority
OFGEM	Electricity and gas regulator in the UK
RSL	Registered Social Landlord
SAP	Standard Assessment Procedure
SPI	Main contractor involved in the Arbed Scheme
WAG	Welsh Assembly Government
WHQS	Welsh Housing Quality Standard
WSA	Welsh School of Architecture, Cardiff University

Appendix 1

Householder questionnaire

ARBED – Warm Wales home improvement study

A study is being conducted by the Welsh School of Architecture at Cardiff University to look at the impact of the ARBED scheme.

Your home has recently had energy efficiency measures and/or renewable technology installed as part of the ARBED scheme and we would like to find out how these have affected you and your family. This questionnaire consists of a series of questions to help us with this assessment. Please tick the box that best describes your opinion for each question. Please work through all the sections of the questionnaire.

It is totally up to you as to whether you fill in this questionnaire however your views and opinions will help to ensure that future projects to improve homes will be successful. There are no right or wrong answers and you can leave any questions that you don't want to answer blank.

The questionnaire should take you about **10-15 minutes** to complete. All information that you provide will be treated as **STRICTLY CONFIDENTIAL**. Information will not be given to any other companies.

If you have any queries or would like more information about this study, please contact Jo Patterson, Research Fellow at the Welsh School of Architecture at Cardiff University on telephone number **02920 874754.**

Your Home

1. In what type of home are you living?

- ☐1 Terraced / End of terrace house
- ☐2 Semi-detached house
- ☐3 Detached house
- ☐4 Bungalow
- ☐5 Flat, apartment, or maisonette
- ☐6 Other

2. In which of these ways does your household occupy this accommodation?

- ☐1 Own it outright
- ☐2 Buying it with the help of a mortgage or a loan
- ☐3 Rent it from Local Council, Housing Association, or Housing Trust
- ☐4 Rent it from a private landlord
- ☐5 Other

3. How long have you lived at this address?

☐ YEARS

4. What type of heating do you use during the winter in your main living room and bedroom?

	Living room	Bedroom
Central heating (boiler with radiators)	☐1	☐6
Fires or stoves	☐2	☐7
Electric fire	☐3	☐8
Other	☐4	☐9
None	☐5	☐10

5. On an average weekday (Monday to Friday), at what times are you at home or not at home?

	At home	NOT at home
7 am – 9 am	☐1	☐9
9 am – 11am	☐2	☐10
11am – 1 pm	☐3	☐11
1 pm – 3 pm	☐4	☐12
3 pm – 5 pm	☐5	☐13
5 pm – 7 pm	☐6	☐14
7 pm – 9 pm	☐7	☐15
9 pm - 11pm	☐8	☐16

6. In general, how satisfied are you with your current home?

☐1 Very satisfied
☐2 Fairly satisfied
☐3 Neither satisfied nor dissatisfied
☐4 Fairly dissatisfied
☐5 Very dissatisfied

7. How do you pay for your energy?

☐1 Monthly/quarterly direct debit ☐2 Pre-payment

The ARBED Scheme

8. Which of the following works have you had done to your home through the 'ARBED' scheme?

	YES	NO
External wall insulation	☐1	☐2
Solar thermal hot water panels	☐3	☐4
Solar Photovoltaic panels	☐5	☐6
Change of heating fuel eg) coal or oil to gas	☐7	☐8
Air source heat pump	☐9	☐10
Not sure/can't remember	☐11	☐12

9. Do you usually find it too expensive to heat your home as warm as you would like in winter?

☐1 Yes ☐2 No

10. How satisfied are you with the quality of work undertaken by the contractors?

☐1 Very satisfied
☐2 Fairly satisfied
☐3 Neither satisfied nor dissatisfied
☐4 Fairly dissatisfied
☐5 Very dissatisfied

11. Are there any comments that you would like to make about the quality of the work? Please write them in the box below. 6

12. Have you experienced any of the following problems BEFORE or AFTER the measures were installed? Please tick when you HAVE experienced problem.

	BEFORE	AFTER
Lack of adequate heating facilities	☐1	☐2
Condensation	☐3	☐4
Leaky roof	☐5	☐6

Damp walls, floors or foundations	☐7	☐8
Rot in window frames or floors	☐9	☐10
Draught	☐11	☐12
Mould	☐13	☐14
Noise from neighbours	☐15	☐16

13. How much do you agree with each of the following statements?

Please tick ONE BOX on EACH LINE	**Strongly disagree**	**Tend to disagree**	**Neither agree nor disagree**	**Tend to agree**	**Strongly agree**
a) My house feels warmer since the measures were installed	☐1	☐2	☐3	☐4	☐5
b) My house feels drier since the measures were installed	☐1	☐2	☐3	☐4	☐5
c) My house feels more comfortable since the measures were installed	☐1	☐2	☐3	☐4	☐5
d) I use more rooms in the house since the measures were installed	☐1	☐2	☐3	☐4	☐5
e) I am confident that I can control the temperature within my home	☐1	☐2	☐3	☐4	☐5
f) I am more aware of carbon emissions and the need to reduce them since having the measures installed	☐1	☐2	☐3	☐4	☐5

Please tick ONE BOX on EACH LINE	**Strongly disagree**	**Tend to disagree**	**Neither agree nor disagree**	**Tend to agree**	**Strongly agree**
g) I feel that my heating bills are more affordable now since the measures were installed	☐1	☐2	☐3	☐4	☐5
h) I use the heating more often since the measures were installed	☐1	☐2	☐3	☐4	☐5
i) I heat more rooms since the measures were installed	☐1	☐2	☐3	☐4	☐5
j) The quality of air in my house has worsened since the measures were installed	☐1	☐2	☐3	☐4	☐5
k) I hear less outside noise since the measures were installed	☐1	☐2	☐3	☐4	☐5
l) I hear my neighbours less often since the measures were installed	☐1	☐2	☐3	☐4	☐5
m) General character and atmosphere of the house has improved since the measures were installed	☐1	☐2	☐3	☐4	☐5
n) I think my house looks better since the measures have been installed	☐1	☐2	☐3	☐4	☐5
o) I think the area where I live looks better since the measures have been installed.	☐1	☐2	☐3	☐4	☐5

14. How much do you agree with each of the following statements?

Please tick ONE BOX on EACH LINE	**Strongly disagree**	**Tend to disagree**	**Neither agree nor disagree**	**Tend to agree**	**Strongly agree**
a) I feel better since the measures were installed	☐1	☐2	☐3	☐4	☐5
b) I feel healthier since the measures were installed	☐1	☐2	☐3	☐4	☐5
c) I visit the GP more often since the measures were installed	☐1	☐2	☐3	☐4	☐5
d) I sleep better since the measures have been installed	☐1	☐2	☐3	☐4	☐5
e) I worry less about being able to heat my home since the measures have been installed	☐1	☐2	☐3	☐4	☐5

15. Are you more aware of the amount of energy that your household use since having the work done?

☐1 Yes ☐2 No

16. Were you given useful advice about saving energy through the ARBED scheme?

☐1 Yes ☐2 No

17. Have you had to contact anyone since the installation of measures at your home to report a problem?

☐1 Yes ☐2 No

If so, who did you contact, and what about?3

18. Has the problem been rectified?

☐1 Yes ☐2 No

IF YOU HAVE ANY OTHER GOOD OR BAD COMMENTS ABOUT THE ARBED SCHEME, PLEASE WRITE THEM IN THE BOX ON THE BACK OF THIS QUESTIONNAIRE – WE WOULD LIKE TO HEAR ABOUT THEM !

Health and Well Being

19. In general, how would you say your health is?

☐1 Excellent
☐2 Very good
☐3 Good
☐4 Fair
☐5 Poor

20. In the last 12 months, how would you say your health has changed?

☐1 Much better than twelve months ago
☐2 Somewhat better than twelve months ago
☐3 About the same
☐4 Somewhat worse than twelve months ago
☐5 Much worse than twelve months ago

21. Do you have a longstanding illness or disability?

☐1 Yes ☐2 No

22. Have you had any CHEST trouble or BREATHING difficulties in the last 12 months?

☐1 Yes ☐2 No

23. Do you smoke?

☐1 I smoke daily
☐2 I smoke occasionally, but not every day
☐3 I used to smoke daily, but do not smoke at all now
☐4 I used to smoke occasionally, but do not smoke at all now
☐5 I have never smoked

Background information

Finally, we need some information about your background. As we emphasised at the start, all information that you provide will be treated as **STRICTLY CONFIDENTIAL**.

Name:

Home address:_____

_____

Postcode: ☐☐☐☐ ☐☐☐

24. What is your gender?

☐ Male ☐ Female

25. Which of the following age group do you belong to?

☐ Under 18 years
☐ 18-20 years
☐ 21-25 years
☐ 26-35 years
☐ 36-45 years
☐ 46-54 years
☐ 55-64 years
☐ 65 years or above

26. What is your marital status?

☐ Single
☐ Married
☐ Living together
☐ Divorced/Separated
☐ Widowed
☐ Other

27. Including yourself, how many people are living in this household?

☐ Adults (over 18 years) **AND** ☐ Children (under 18 years)

28. What is your current employment status?

- ☐ Full time employed (more than 30hrs per week)
- ☐ Part time employed (less than 30hrs per week)
- ☐ Self employed
- ☐ Unemployed and looking for work
- ☐ Full time looking after home and/or children
- ☐ Full time student/school
- ☐ Retired from paid work
- ☐ Long term carer
- ☐ Permanently unable to work due to illness or disability
- ☐ On a government training scheme
- ☐ Other

29. What is your highest educational qualification?

- ☐ No qualification
- ☐ GCSEs or equivalent
- ☐ A-levels or equivalent
- ☐ HNC / HND
- ☐ Undergraduate degree (e.g. BA or BSc)
- ☐ Postgraduate qualification (e.g. MSc or PhD)
- ☐ Other

30. What is your approximate total gross yearly or weekly household income?

This is any money that is received on a regular basis by all the adults living in the house including benefits.

	Annual	**Weekly**
☐	£0 – £4,999	£0 - £96
☐	£5,000 – £7,499	£97 - £144
☐	£7,500 – £9,999	£145 - £192
☐	£10,000 – £14,999	£193 - £288
☐	£15,000 – £19,999	£289 - £385
☐	£20,000 – £29,999	£386 - £577
☐	£30,000 – £39,999	£578 - £769
☐	£40,000 – £49,999	£770 – £962
☐	£50,000 or more	£963 or more

31. Which of the following ethnic groups do you consider you belong to?

- ☐ White - British
- ☐ White - Irish
- ☐ White - Other
- ☐ Black - Caribbean
- ☐ Black - African
- ☐ Black – Other
- ☐ Indian
- ☐ Pakistani
- ☐ Bangladeshi
- ☐ Chinese
- ☐ Mixed
- ☐ Other

32. In future we may want to get back in touch with you to find out about long term energy and money savings you might be making as a result of the ARBED scheme. Would you be happy for us to do this?

- ☐ Yes
- ☐ No

Please insert any comments, good or bad, that you might have about the ARBED scheme. This will help us to improve things in future.

THIS IS THE END OF THE QUESTIONNAIRE.

THANK YOU VERY MUCH FOR YOUR HELP!

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