# Target 2050

## future-proofing homes

# in Stroud District and beyond

Stroud District Council working in partnership with Severn Wye Energy Agency

October 2011

SevernWye
ENERGY AGENCY

STROUD DISTRICT COUNCIL
www.stroud.gov.uk

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Stroud District
Target 2050
Countdown to a low carbon home

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*Severn Wye Energy Agency, October 2011*

# Foreword by Cllr Frances Roden

## Leader, Stroud District Council

The Target 2050 homes project is the domestic strand of the overall Target 2050 programme developed and delivered by Severn Wye Energy Agency for Stroud District Council. The Target 2050 programme was commissioned by Stroud District Council as a means of achieving targets set in the Council's 2007-2027 Environment Strategy.

A critical factor in the perceived need for the Target 2050 homes project was the lack of market penetration of insulation measures for 'hard to treat' homes, and renewable energy systems.

Local and national programmes support, in the main, installation of the most cost-effective energy efficiency measures, where the combination of low capital costs and high energy savings provide a quick 'payback period'. However, the measures categorised as cost-effective in these terms are insufficient to reach the target for 2050, currently an 80% cut in emissions against a 1990 baseline. Further, these measures are not applicable to all homes, including period homes and those with no access to mains gas, and will not therefore deliver affordable warmth for all.

**The project sought to address these issues through the provision of home energy surveys and action plans and the development of case studies of exemplar homes, along with the establishment of a local installers' network to assist residents in making important decisions with regard to their home.**

Having established the Target 2050 homes project, Stroud District Council, in partnership with Severn Wye Energy Agency, was selected by Central Government to be one of only five national pilots for the Pay As You Save (PAYS) loans scheme. Learning from the PAYS scheme has been used to direct the Government's 'Green Deal' initiative.

**This report seeks to inform the reader about the Target 2050 domestic approach, the significant outcomes achieved, and the learning gained, which can and has been applied to other projects going forward.**

Alleviation of fuel poverty, now and in the future, by 'future-proofing' local homes to protect even the most vulnerable households against future fuel price rises, continues to be a priority for the Council.

It is no coincidence that Stroud was reported in the regional survey for 2010-11 as having installed more new renewable energy projects than any other district authority in South West England.

Alleviation of fuel poverty, now and in the future, by 'future-proofing' local homes to protect even the most vulnerable households against future fuel price rises, continues to be a priority for the Council

**Cllr Frances Roden**
Leader, Stroud District Council

# Foreword by Catrin Maby
## Chief Executive, Severn Wye Energy Agency

This is just the beginning of a long journey to address the challenge of making existing homes energy efficient

Severn Wye Energy Agency is an independent not-for-profit company and educational charity. Established under the EU SAVE programme in 1999, we have continued to take an active role in EU partnerships and have led or participated in 30 European projects with over 100 partners in 25 countries.

We aim to promote sustainable energy and affordable warmth through partnership, awareness-raising, innovation and strategic action, across the domestic, community, business and public sectors.

Local authorities are key to achieving these aims, and we place high value on our partnership with Stroud District Council, developed over more than a decade of positive action on climate change and fuel poverty.

**We present Target 2050 as a good practice example of holistic, cross-sectoral action at local level, where policy aims have been applied to the development of practical action on the ground, using community-based market intelligence to design and deliver an approach which is complementary and additional to centrally-driven programmes.**

**Led by the District Council, the work has fully engaged the business, voluntary and domestic sectors, and provides a flagship for what can be achieved where this type of innovation is facilitated and encouraged.**

A core feature of our approach has been to enable co-learning by installers, suppliers, home owners, advisors, building control and planning through the development of a set of 50 local case study homes. Selected to cover a wide range of house types and households, these case studies illustrate both the potential for carbon saving through available retrofit measures and the practical barriers and solutions encountered in applying these measures.

**This is just the beginning of a long journey to address the challenge of making existing homes energy efficient.**

**The Target 2050 experience has enabled us to develop a plan of action for the next phase of this journey, which will be an ongoing process of innovation, learning, persistence in overcoming barriers and finding solutions, and celebration of solutions and successes along the way.**

**Catrin Maby**
**Chief Executive, Severn Wye Energy Agency**

# Executive Summary

Target 2050 Homes has provided the basis for an effective, long-term targeted approach to achieving deep energy and carbon cuts in existing homes in the UK

Stroud District Council commissioned Severn Wye Energy Agency to design and deliver a new programme of work to tackle climate change in April 2007.

The result was 'Target 2050': designed to complement national programmes and to stimulate a **step change** in achievement across the **public, domestic, business and community sectors**. This report describes the Target 2050 Homes strand of the work, and is part of a set of reports covering the different sectors, each illustrated by real-life case studies.

**Target 2050 Homes has provided the basis for an effective, long-term targeted approach to achieving deep energy and carbon cuts in existing homes in the UK.**

**This report supports our conclusion that the ideal programme to achieve deep cuts in energy consumption and carbon emissions in existing homes should be:**

- ✔ **tailored** to the practical realities of the existing building stock and its complexity and imperfections
- ✔ designed to deliver to the **real and multiple practical needs** of households and home owners
- ✔ able to **engage** with all key actors in the supply chain, and **deliver to their needs**
- ✔ intelligent, and **can flex and develop** as providers learn, markets develop, and external factors change
- ✔ **open and transparent**, allowing benefits and learning to be shared

Target 2050 Homes was established against a background of mature affordable warmth and home energy efficiency partnerships. It recognised the need to achieve deeper cuts in energy consumption and carbon emissions than those which are realised by only installing measures with a relatively quick 'payback' on investment.

## Informing UK and EU governments

This successful programme provides a valuable practical knowledge base to inform the development of the Government's Green Deal framework, as well as being shared further afield via the European networks within which Severn Wye Energy Agency is active.

## Integrated non-profit local partnership

There is significant value in moving forward with an integrated non-profit local partnership model. By extending to neighbouring local authority areas, and broadening the partnership, we aim to achieve some economies of scale, while at the same time maintaining the benefits of local knowledge and a personalised service.

## Commercially impartial & practical

The evaluation of the Department of Energy and Climate Change Pay As You Save pilots, one of which was run through Target 2050 Homes, indicated householder preference for a programme led by public/non-profit providers that are commercially impartial, and the importance that they placed on practical knowledge and expertise.

# Executive Summary

"It was great to sit down and talk to someone who was unbiased about renewable energy and what works best for individuals and their property"

### Supporting local jobs and businesses

Linking strategic aims for affordable warmth, climate change, local jobs and economic regeneration, the approach was uniquely ambitious in aiming to stimulate and support local business growth in providing a comprehensive range of sustainable energy technologies .

## Key features of Target 2050

### Bespoke energy advice

For each of a wide range of homes and households, advisors identified all the feasible energy and carbon saving measures and quantified the potential savings, helping householders to prioritise and understand the practical opportunities:

- **248 detailed home surveys and tailored advice reports were completed**
- **Follow-on support was offered to turn advice into action**
- **102 households are known to have already acted on the advice and improved the energy efficiency of their homes**

### Case studies of a range of homes

Case studies of 50 local homes were written, broadly representing the wide range of building types in Stroud and neighbouring districts, to illustrate what can be achieved and how, and to highlight and explain the practical barriers and solutions encountered in applying solutions.

### Establishing a local installer network

The market for sustainable energy retrofit was stimulated through the development of a local installer network, which now has over 100 members covering the full range of relevant technologies. The network is run on an open, inclusive and capacity building basis, with a co-learning rather than a profit objective.

### Practical support on costs and finance

Target 2050 advisors helped households to identify finance and obtain quotations for works, as well as a highly successful Pay As You Save pilot. This has provided valuable insights into the costs and householder perspective on investing in improvements, and the practical issues as regards financial support mechanisms

### Engaging with communities

A model for local dissemination was developed through local events and seminars, case studies, and 'open homes', raising awareness of the opportunities with both householders and installers.

248 detailed home surveys and tailored advice reports were completed

# Specific outcomes and lessons learned

## 1 Measures and the potential for savings

**It is possible to achieve deep energy carbon cuts by retrofitting measures which are currently available, *if all the practical opportunities to install these measures are taken.***

### Bespoke surveys, quantifying savings

**An average of 57% potential savings were indicated in annual energy consumption and 58% in $CO_2$ emissions across the full sample of 248 homes surveyed**

**Measures known to have been installed to date in 102 of these homes could save an average of 24% a year in both energy consumption and $CO_2$ emissions**

**The top ten case studies installed measures with potential savings of 41-74% in carbon emissions and 22-70% in energy consumption**

**The same top ten case studies spent between £14,000 and £47,000 and have potential fuel bill savings of up to £2,000 a year at current fuel prices**

The exact mix of measures that will achieve the deepest carbon cuts depends on the individual characteristics of each home, hence the need for bespoke surveys in most cases, with quantified savings estimates, especially when guiding householder investment.

### Look at heat loss AND heating provision

Insulation measures, including the higher cost ones such as solid wall insulation, are generally the most effective investment to reduce carbon emissions and to help mitigate the risk of fuel poverty for current and future occupants of the home. However, to achieve deep carbon cuts it is generally necessary to address both heat loss and heating provision: nine of the top ten case studies installed insulation, and eight made changes to heating – such as replacing boilers, and changing to a lower carbon fuel.

"Talking it through with the advisor was very helpful – probably even more informative than the report"

### Be aware of variables

There is a great deal of variation in the detail of existing homes in the UK, and both the costs of, and potential savings from, applying all but the simplest of measures tend to vary considerably with this detail.

It is not always possible or practical to separate out the costs of energy retrofit from other associated building costs, and finance programmes that do not take this into account can create unnecessary barriers.

"We will certainly refer to the report when we have money and intend to make changes to our home"

"We found the way different aspects that we need to tackle were broken down and given a figure for savings very useful"

## 2 Advice and households

### Retrofit advice must be specific to the home and household

To achieve deep carbon cuts, retrofit advice needs to be specific to the home and household, practical in nature, and holistic. The advice should cover the full range of measures, and all aspects of support, from the surveys identifying the measures through to how to finance and install, and overcome barriers.

### Advice needs to be flexible, longer term and realistically resourced

Advice needs are multi-stage, not one-off, and advice provision should be designed as a relatively long-term relationship with the household. This may in practice be characterised by increasing depth and detail as household knowledge grows. This requires a realistic view of the cost of advice and support in managing a programme of retrofit.

'Cheap and quick' may not be effective in view of the relative complexity of existing buildings and applicable measures, in a programme aiming to achieve substantial cuts, as opposed to implementing single and relatively simple measures such as cavity wall and loft insulation.

Our sample indicated a preference by home owners for installing the less invasive measures such as solar PV, solar water heating, replacement boilers and double glazing (at least in the first instance), even though our advice highlights the carbon savings from all feasible measures. This is a characteristic of short term actions, and does not preclude a difference response at a later date – however this again highlights the need to maintain interest and contact over the longer term.

It is not realistic to expect all potential improvements to be implemented at the same time, except where major renovation or refurbishment is taking place, due mainly to cost, disruption and availability of finance.

Several measures involving major disruption are more practical, convenient and significantly less costly if carried out as part of renovation, and in this case the energy efficiency elements might be considered as marginal costs.

Not giving advice at the right time means that we lose an opportunity to improve the energy efficiency of a home which may not arise again for decades

## 3 Getting the timing right

The trigger for renovation may be disrepair or the purchase of a new home, rather than a perceived need for improved energy efficiency, and a key action is to ensure that opportunities for maximising energy improvements are enabled at this point in time. Prime examples include:

- window replacement
- solid wall insulation
- floor and sloping ceiling insulation

Not giving advice at the right time means that we lose an opportunity to improve a home which may not come around again for decades.

Advice on retrofit will need to include user behaviour if the full benefits of improvements are to be realised, such as the use of new technologies including heat pumps, solar hot water and electricity, as well as heating and hot water controls.

Further savings can be realised through advice on using other appliances more efficiently, and by engaging households in self-monitoring and peer support groups.

Advice needs are multi-stage, not one-off, and advice provision should be designed as a relatively long-term relationship with the household

## 4 Installers

### Making sustainable energy mainstream

Supporting existing local small and micro businesses which already offer home repair and improvements to encourage them to offer a range of energy retrofit measures brings the following advantages:

1. They are often the first port of call for home owners wanting to get work done on their homes, and are well placed to identify opportunities to include energy improvements
2. By supporting existing local businesses, rather than focusing on specialist providers, this supports the local economy, building capacity to ensure future supply, and enhancing the opportunities for householder choice

### Listen to the installers

To reach a wide audience and provide an effective programme it is essential to develop a service that works for the installers, as a sales tool and a source of referrals and opportunities for joint marketing.

Adopting new technologies carries risk for small businesses, part of which is the time taken to source supplies and deal with teething problems. Support programmes should ensure local supplies and relevant information are available for installers as well as home owners.

Training and advice for installers needs to be tailored to real requirements and practical realities, including the cost of lost working time: topping up existing knowledge, not too basic and conveniently located.

Local exemplars are useful to all, and offer an opportunity for co-learning of households, installers, advisors, building control and planning.

To reach a wide audience and provide an effective programme it is essential to develop a service that works for the installers, as a sales tool and a source of referrals and opportunities for joint marketing

## 5 Finance

### Getting the balance right

Home owners are interested in energy saving potential and the cost and savings implications; saving money on fuel bills is a core motivating factor in making energy efficiency improvements. However they are also interested in comfort, and in practice they are aware that fuel bills are rising, so the precise calculation of payback on investment appeared in the Pay As You Save pilot to be less crucial than the affordability of monthly repayments. Once interest rates are applied to loans in future programmes, this issue will become even more significant.

Flexibility and choice appears to be important, in terms of measures, repayment periods and so on. Fixed terms such as maximum loans and proportions of costs that can be covered can have negative consequences such as partial insulation, or home owners requesting several re-quotes to try and fit a package of works into the maximum allowed.

A simple and streamlined application process is a crucial factor, as is the customer service in keeping home owners informed and motivated.

# 1 Why Target 2050?

Action to achieve deep cuts in carbon emissions must focus on retrofit of existing homes as well as behavioural change

In April 2007 Stroud District Council launched a new programme of work to tackle climate change. Severn Wye Energy Agency was commissioned to develop and deliver the programme, and has achieved this through close collaboration with Council staff and a wide range of other local partners over a four-year period.

The Target 2050 brand was inspired by the headline target for a 60% reduction in carbon dioxide ($CO_2$) emissions on 1990 levels by 2050, as proposed by the Royal Commission on Environmental Pollution report of 2000, and adopted in the 2007 Energy White Paper. This target has been subsequently adopted and raised in the Climate Change Act of 2008, and the 'Target 2050' concept remains a powerful one.

The Target 2050 approach is holistic, looking at the needs of and provision to different sectors within the locality, against the background of the strategic framework. After an initial feasibility stage, the full programme was launched in the autumn of 2007.

"With the insulation our home is cosy and warm, the PV panels hit their annual generation target in 11 months, and the solar thermal gives us nearly all our summer hot water"

## Initial activity

A programme of local activity was developed to complement what was provided through the market and/or national programmes. This consisted broadly of:

### Target 2050 Homes

Development of a targeted approach to achieving deep carbon cuts in existing homes.

### Target 2050 Business

Bespoke advice to SMEs, with on-site surveys and action plans. This was designed to complement the Carbon Trust provision by targeting those whose annual energy spend was below their threshold for face-to-face support.

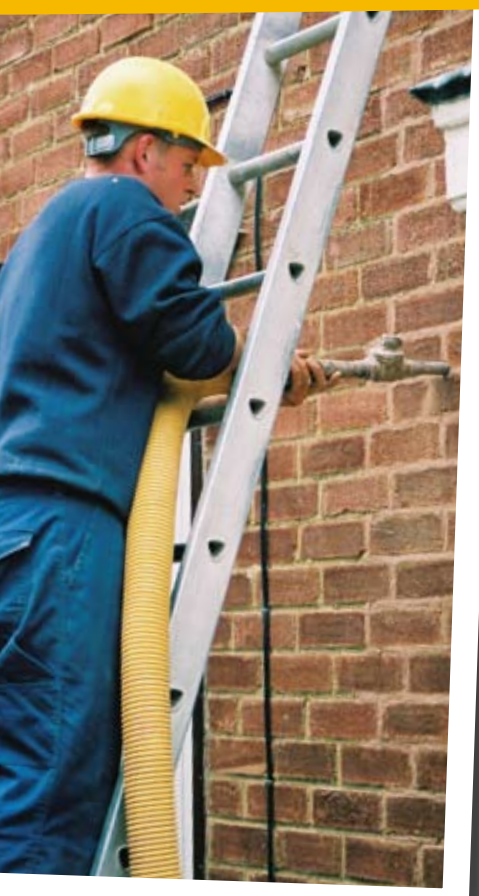
### Target 2050 Community Buildings

On-site surveys, advice and help with finance for measures to improve energy efficiency and promote renewables in community buildings.

The programme also incorporated completion of the Eco-Management and Audit Scheme (EMAS) for the local authority's own operations and support for development of a forward-looking local planning policy through mapping of heat loads and resources for renewable energy against housing needs.

**This report describes the Target 2050 Homes theme of the programme in detail, from the reasons behind its inception to how the work may be taken forward in future.**

***The business and community themes are covered in separate reports available from Severn Wye Energy Agency.***



# 2 Developing Target 2050

## Designing the programme

The 2005 '40% House' report by the Environmental Change Institute at the University of Oxford highlighted the fact that at current rates of demolition and new build, we might expect two thirds of the homes standing in 2050 to be already in existence.

Whilst one of the policy options put forward in the conclusions was a significant increase in demolition rates of the most energy inefficient housing, the study did not go on to investigate the broader environmental or social impacts of this option.

It also established that an increase in demolition rates would not be enough on its own – and that **action to achieve deep cuts in carbon emissions from homes must focus on retrofit of existing homes, as well as behavioural change in the broadest sense.**

The programme in Stroud was developed against the background of mature affordable warmth and home energy efficiency partnerships, delivering effectively to mainstream targets. However, **a critical factor in the perceived need for the project was the lack of market penetration of 'non-standard' energy efficiency and micro-generation measures.**

A critical factor in the perceived need for the project was the lack of market penetration of 'non-standard' energy efficiency and micro-generation measures

**Current national and local programmes tend to support, in the main, the installation of the most 'cost-effective' measures only – that is with capital costs low enough and returns in energy saving high enough to provide a relatively quick 'payback' on investment.**

**The dilemma faced is that these measures alone are insufficient to achieve either the 60% reduction target <u>or</u> the levels of affordable warmth needed for homes to be suitable for lower income households.**

An initial feasibility study was carried out to review the current position and design a programme to support low carbon retrofit activity in the locality.

The feasibility study:

- reviewed the housing stock in Stroud
- analysed in detail a small sample of local homes
- investigated the local supply chain
- conducted a consumer survey
- reviewed financing options available to home owners

In order to design a programme of work that would make a real difference within a limited time span, the project team were at pains to seek the views of interested parties on both the consumer and supply side, to work with them to identify the specific barriers encountered, and suggest solutions to overcome them. The feasibility stage was crucial in this respect.

"My young son no longer gets up complaining that he is cold"

## What the feasibility study told us

**The feasibility study concluded that a target of 60% plus reduction in $CO_2$ emissions in existing homes does appear to be a realistic (albeit challenging) average to aim for, although with a wide variation in potential between homes.**

**The target is achievable if all applicable and available improvements are implemented, based on already known and available technologies, together with a reasonable level of behavioural change.**

We concluded that to achieve deep carbon cuts, both motivational messaging and measures selection needed to move away from the focus on quick returns on investment

The small sample assessed in the feasibility study indicated a cost of the order of £20-£30,000 per home to implement all recommended measures, but that it is not realistic to expect all potential improvements to be implemented at the same time, except where major renovation or refurbishment is taking place, due mainly to cost, disruption and availability of finance.

We concluded that to achieve deep carbon cuts, both motivational messaging and measures selection needed to move away from the focus on quick returns on investment, implied in much of the material available through national or nationally regulated programmes such as in Energy Performance Certificates, Warm Front and Carbon Emissions Reduction Target programmes.

## Developing the retrofit supply-side

The study highlighted that supply-side support needed to address the real barriers indicated by the wider supply chain: installers, suppliers, planning and building control.

Discussion with different supply chain actors indicated the familiar supply and demand vicious circle effect, with barriers cited by installers (most commonly the consumer-facing part of the supply chain) including:

- perceived or actual planning restrictions
- lack of demand due to cost (related as much to conversions of quotes into orders as lack of initial interest – with time lost in quoting for interested consumers who then do not proceed with the more costly elements)
- poor range of relevant items held by local building suppliers – leading to time lost in sourcing supplies

"The range and attention to detail were very helpful – didn't realise cavity wall insulation was so important"

## How the programme developed

In developing delivery plans for carbon reduction and fuel poverty (National Indicators 186 and 187) for Gloucestershire's Local Area Agreement, approaches developed in Stroud District were extended to neighbouring areas.

The SME advice programme was extended to the whole of Gloucestershire, and some aspects of the Target 2050 homes programme were replicated in Cheltenham, Cotswold District, Gloucester, South Gloucestershire and Wiltshire. This was with support from the relevant local authorities, Gloucestershire County Council and the South West Councils Regional Improvement and Efficiency Partnership.

Similar work to improve the energy performance of community buildings has been carried out in parallel in other Gloucestershire districts and the former district of North Wiltshire.

In 2009 Stroud District Council was selected to provide one of the UK's five Pay As You Save (PAYS) pilots through the Target 2050 Homes programme, on behalf of the Department of Energy and Climate Change.

The pilot ran from 2009-2011, and involved the provision of long-term low cost loans to households for energy improvements.

**This type of approach is seen as having major potential as an enabling mechanism for retrofit of homes in future.** The shape of ongoing programmes and potential sources of finance is being reviewed by government and stakeholders at the time of writing this report, within the framework of the 'Green Deal'.

# 3 Building on the success of Target 2050

"We found the details of how the measures can be undertaken and contact lists of installers really helpful"

**The Target 2050 approach, engaging a partnership of public, private and third sector key actors within a sub-regional geographical area, has proved to be a successful delivery mechanism, and is highly replicable. However, it needs a new and more substantial source of capital finance to enable delivery of the full retrofit needs within the housing stock.**

Discussions led by Stroud District with neighbouring small and medium authorities have indicated similar issues and interests, and an awareness of the need to show leadership in enabling and supporting activity to maximise benefits both to local residents and the local economy.

**The challenge is to scale up activity at a time of increasingly constrained resources both within the public sector and private household incomes.**

The challenge is to scale up activity at a time of increasingly constrained resources both with the public sector and private household incomes

## Countdown to low carbon homes

The Target 2050 partnership is looking to the future, and to build upon the success of the programme. We have developed a new delivery model, which extends the approach to include neighbouring areas, in order to achieve economies of scale at a level which will also:

- maintain the benefits of the local approach in terms of local knowledge and accountability
- provide a personalised advice service
- support small businesses as installers, suppliers and beneficiaries of the service.

**The new model is a local non-profit partnership response to the development by government of the new Green Deal framework, and aims to provide a longer term model, sustainable without grants.**

Included in the new model will be the development of a **new financial product suitable for home retrofit**, based on the adaptation of the Revolving Retrofit Guarantee Fund successfully applied in Hungary and Estonia. The aim of the guarantee fund is to reduce the risk and costs of finance for private loans, and has the potential to provide a streamlined and flexible product to complement emerging commercial Green Deal offers.

# 4 What we did – the project

**The implementation programme for Target 2050 Homes was designed to help address complementary local policy aims, including:**

1. Providing **an effective framework** for a significant future reduction in domestic sector carbon emissions in the area
2. Providing **a significant range of examples** of how existing technologies might be used to achieve deep carbon cuts in existing homes, while preserving built heritage and character
3. **Stimulating the local market** for sustainable energy retrofit, through practical supply and demand support activities which address the barriers identified by the consumers and supply chain in the feasibility study
4. Alleviation of fuel poverty, now and in the future – by **'future-proofing' local homes** to protect even the most vulnerable households against future fuel price rises
5. **Enabling local suppliers** to participate in this area of economic activity

**The main features of the programme were the development and delivery of:**

- **An expert advice programme** to support whole house sustainable energy retrofit
- **Ongoing support for an installer network**, covering the full range of relevant technologies with an inclusive, capacity-building ethos
- **A set of case study homes**, broadly representative of the range of building types in the area, to illustrate the barriers and solutions to achieving deep carbon cuts through sustainable energy retrofit
- **An effective communications programme** to make the knowledge and experience available throughout the community.
- **A pilot PAYS (Pay As You Save) loans programme**, to test consumer interest in this approach and learn practical lessons about delivery

"The insulation has made our house a much nicer place to live"

## • Energy advice

**To support whole-house sustainable energy retrofit, the advice programme needed to cover a range of measures, not restricted to those which recoup their costs through savings over a short time frame.**

Current thinking on acceptable payback time is based typically on the average time that a home is owned by one owner-occupier – a presumption that effectively excludes the perspective of all those that fall outside the average.

**The assumption that households are only interested in 'cost-effectiveness' may in practice be a self-fulfilling one, and if a term such as 'cost-effective' is used in giving advice, it is important that it is defined.**

All of the advice was customer-led rather than formulaic

The programme we developed was made up of a home survey and written report with follow up advice. It was designed to be of direct practical use to the householder by giving clear, technically accurate and easily understandable information about current performance, and the savings that could be made by installing all measures feasible in that specific home.

The relevance of the programme was maintained by helping customers obtain quotes, prioritise next steps, and to finance measures.

**All of the advice was customer-led rather than formulaic – covering whatever actual questions and barriers arose and providing further depth and detail according to the needs, interest and level of knowledge of the householder as this developed.**

## The home survey and report

As software designed for 'field audit' use on existing homes tended to limit the range of improvement options to a fixed list, we decided to use NHER Plan Assessor. In addition to the full SAP assessment this enabled us to maximise our ability to enter 'real' data and options, rather than default values.

**The Home Energy Report was designed to be clear and understandable to someone without specialist technical knowledge, but detailed enough to give useful technical data.**

Alongside a description of features of the home relevant to its energy performance, the contents include modelled data about energy consumption, carbon dioxide emissions and fuel costs, as a whole and per square metre floor area, which are then compared to national average figures as a benchmark.

The report goes on to describe each energy saving recommendation in detail, with modelled savings and considerations specific to each home. A chart shows the relative energy, carbon dioxide and fuel cost savings that may be achieved by each applicable measure.

**248 home surveys and detailed reports were provided during the course of the project.**

A set of local case studies were developed to illustrate the real life barriers and solutions to achieving deep carbon savings

## Follow-on support

Our small local team was contactable by telephone or e-mail, enabling customers to speak to a known individual. One of the benefits of this local personalised approach is that the advisors are already familiar with the home in question, and can quickly recall and identify the building issues and household in question.

In practice this advice covers as wide a range of issues as might be faced by any home owner making home improvements, including:

- **integrating a technology into the existing building fabric or services – practically and aesthetically**
- **where to find an installer for a specific measure, how to choose between quotations, and understanding technical terminology in quotations**
- **how to access finance such as grants and loans**
- **when planning or listed building permission is needed and how to apply**
- **building specific problems that may arise**

1920s semi-detached Stroud

This and many other case studies are also available online at www.target2050.org.uk

Stroud District Target 2050 Countdown to a low carbon home

Case study 11

£492 Saving on fuel bills

38% Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Internal solid wall insulation | £1,633 | 0.90 | £118 |
| Floor insulation | £1,822 | 0.30 | £31 |
| Replacement boiler and controls | £3,769 | 1.20 | £151 |
| Double glazing | £2,127 | 0.05 | £16 |
| Solar hot water | £3,882 | 0.30 | £33 |
| Solar PV (2.04 kWp) | £8,943 | 0.68 | £143 |
| Total package | £22,176 | 3.43 | £492 |
| Plus income from PV Feed-In Tariff (FIT) | | | £670 |

The home

When purchased in 2005, this semi-detached 1920s family home was heated by gas central heating with an F-rated gas boiler. It had solid brick walls, a mix of suspended timber and solid concrete ground floors, large single glazed sash windows and open fireplaces. There was 150mm insulation in the loft.

What they did

In 2007, the owners embarked on a programme of improvements to create more living space. This included a loft conversion and removal of a wall between the kitchen and dining room which contained a large fireplace.

The family were keen to include as many energy saving improvements as possible within the renovation. The planned alterations to the house offered an opportunity to implement some of the more major measures such as internal wall insulation and floor insulation. Replacement double glazing was installed in all except the sash windows at the front, and LED lighting was fitted.

As well as the fabric improvements, a new under-floor heating system was planned. The initial aim was to integrate a log burner with a back boiler and solar water heating with a condensing gas boiler for back up, all feeding a single hot water cylinder, but in the end they decided to have the log burner as a separate source of supplementary heating.

"With the insulation our home is cosy and warm. The solar thermal gives us nearly all our hot water in summer, and the PV panels hit their annual generation target within 11 months."

£670 Income from Feed-In Tariff (FIT)

SevernWye Energy Agency

Stroud District Council www.stroud.gov.uk

## • Case study exemplar homes

**The aim of establishing exemplar homes was to develop a set of local case studies to illustrate how deep carbon and energy savings may be made in practice in existing homes, and to work through the barriers encountered and the solutions found.**

We avoided having a single 'show home' as this would tend to illustrate only one type of home. Instead we reviewed the range of house types in the local housing stock and came up with a list of the types we wanted to cover, as a basis for the selection criteria. In summary our selection criteria were:

- owner occupier living in Stroud District
- willing in principle to carry out sustainable energy improvements – subject to affordability and other practical considerations
- willing to participate in publicity and dissemination of the project, in particular to feature in a written case study
- representation of range of building types, including at least one listed building and three off the mains gas network
- a mix of households: families, couples and singles of different ages and income levels

**23 households were selected from nearly 200 applicants.**

The exemplar programme consisted of a full home energy survey as described above and development of an action plan with each household. Help was provided to install as many measures as possible during the project, including applications for grants where applicable, and up to £6,000 additional support towards the cost of measures from a dedicated fund.

Households were required to apply for other available grants first, and the remainder of costs was 50% funded by a Target 2050 grant, with the householder contributing the rest. Low income households were able to apply to another special Stroud District Council grant programme to fund their 50% contribution.

**The participating households monitored their energy use and provided meter readings to the project team.** They also took part in a behavioural change programme and had regular contact with the project team and each other through meetings, events and a website.

While the theme of the project was to achieve a 60% reduction in $CO_2$ emissions, the aim was to show how this might be done through recommended measures, and to illustrate the practical barriers and solutions encountered in applying these measures.

**The target reduction is linked to the 2050 perspective, and it was not anticipated that it would be physically achieved during the relatively brief timescale of the project, in view of the expected costs, disruption and other practical considerations.**

A further 37 exemplar homes have been developed through the extension of the Stroud Target 2050 approach into neighbouring areas, which has enabled a greater range of measures to be installed, and enhancing the set of case studies. The full set of case studies will be made available on the website, *www.target2050.org.uk*.

## Behavioural change programme

The behavioural change programme aimed to complement the core advice service through:

**Feedback:** Enabling and encouraging households to monitor energy use, to see what they have (or have not) achieved and take further action.

Participating households were asked to log energy use on a monthly basis and this was fed back to them annually. More immediate feedback was to be provided through a locally-developed energy monitoring system known as "EMU" (Energy Monitoring Utility). This was installed in seven homes as an initial trial, but not rolled out further as it did not deliver sufficiently reliable results. The output that it did produce was impressively detailed however, enabling monitoring of individual electrical circuits, and gas and water use for the home as a whole. The "efergy" energy monitor was subsequently used in all 23 exemplar homes, and proved useful although less detailed.

**Peer group support:** Motivating households to maintain energy saving behaviour through interaction with the other households in the group, developing a sense of being part of a club, and physically enabled via the project website, newsletters, social gatherings and events.

**Sense of agency:** A term sometimes used with regard to pro-environmental behaviour, in that if people feel empowered that they CAN make a difference if they make certain decisions, then they are more likely to do so. Our aim was to encourage households to develop this sense of agency through the experience of being part of the exemplars group. This in turn, was part of the bigger programme within Stroud, visibly supported by the District Council. Feedback on achievements was enabled at group as well as individual level.

**Contextual support:** Providing additional information and advice in accessible form, to make it easy for households to be efficient in their usage behaviour, and purchase of energy using appliances and related products.

In order to facilitate change of habit, each area of behaviour was taken in turn as the focus for a monthly topic, for example one month covered the use and purchase of fridges and freezers in detail, and another featured washing machines and tumble dryers.

"The survey was very professional and thorough, practical and not dogmatic in the way potential solutions were identified"

## • Installers

**The local installer network is a core feature of the Target 2050 programme. As with other aspects of the programme, it was developed specifically to address the supply and demand issues identified in the feasibility study, and does not aim to generate profit for the scheme manager or broader partnership.**

It is **a free service to both installer members and consumers**, and is relatively light touch and simple to administer. It builds upon rather than duplicates national accreditation schemes, and is flexible and able to adapt to changes in the market.

The network includes the full range of sustainable energy retrofit technologies, in order to encourage and consolidate a more holistic approach to home energy performance than is implied in the separate accreditation schemes for micro-generation, heating and insulation.

Technologies covered include:

- cavity wall, solid wall, loft, flat roof, sloping ceiling and floor insulation
- double and secondary glazing
- gas, oil and biomass heating and boiler replacement
- air and ground source heat pumps
- solar thermal and photo-voltaic panels
- mzicro-wind and hydro

Participating installers must be members of the relevant accreditation schemes, have appropriate insurance cover, and be either based in or active in the local area. From the consumers' perspective, this avoids the need to trawl through lists of installers not very likely to be interested in quoting for their job because of distance.

**This approach aims to support the many smaller companies that characterise the general building repair, improvement and maintenance market, and encourage them to include energy improvement technologies in their portfolio, as well as to support newer companies entering the market by providing information and referrals.**

## Growth of the installer network

Initially the network was tailored only to the Stroud area, but it was subsequently expanded to cater for two counties, Gloucestershire and South Gloucestershire, in tandem with the replication of other aspects of the Target 2050 programme at county level in support of Local Area Agreement activities in both counties.

Both programmes included small grants to help in achievement of local targets, and the Stroud programme benefitted from additional investment by the District Council as well as the pilot PAYS (Pay As You Save) loans during the final phase.

**This resulted in a mutually beneficial relationship where installers on the list were able to promote the finance options during their surveys and advisors were able to refer customers to the installer list to find a locally based accredited installer.**

Feedback on the network has been extremely positive

The installers' network continues to grow steadily:

- 106 companies are currently registered
- 60 are MCS (Microgeneration Certification Scheme) accredited installers of renewable energy technologies
- 46 are installers of energy saving measures including insulation, heating, glazing and specialist draught proofing.

Installer application is simple, via an application form, and potential customers are able to download the list from Severn Wye's website.

"We are really pleased that the work carried out has not only helped us save energy but been in keeping with the distinctive character of our home"

## Support and promotion

Other aspects of the network support include information-sharing events bringing together installers, exemplar homes and relevant experts, such as specialist suppliers, Council planning and building control personnel, and facilitated by Severn Wye energy advisors.

In addition, the installer group list is promoted at a wide range of relevant events within the locality while the installers themselves are updated with the latest information about grants and promotions, for them to use to support their own marketing. They also receive regular email updates as well as six-monthly meetings and three-monthly newsletters.

## Success of the installer network

The installer network has proved to be a success for both installers and customers. Customer feedback is obtained through follow up questionnaires and site visits from Severn Wye. Feedback has also been sought from installers through questionnaires at installer events.

**Feedback on the network has been extremely positive, with customers referring to the list as "crucial to finding the right installer" and "a very useful resource". Impartiality and expertise were highlighted as an important function of having such a list.**

Installers cited the benefits of participation in the Network as:

- the opportunity to talk to other similar businesses and share experiences
- links from installer lists on the Severn Wye website and participating Local Authority websites to the installers' business websites worked well
- linked advice from Severn Wye offered a 'first port of call' site where customers can get simple, straightforward and impartial information on the measures and latest schemes

In 2009 Stroud District Council was selected to provide one of the UK's five Pay As You Save (PAYS) Pilots through the Target 2050 Homes programme, on behalf of the Department of Energy and Climate Change

"We have been spurred on to do work following the advice"

The installers endorsed the need for strong promotion of grants and loans to help their sales and for clear information from ***an independent source*** for their customers to assess the energy savings of measures, as is provided in the Target 2050 advice reports.

A successful approach has been to run joint promotional events, with both installers and exemplar homes residents describing their experience, entering into debate and answering questions from the public, supported by Severn Wye and Council staff. An example is the Low Carbon Home Show described on page 26.

## • Finance for measures

**The Target 2050 programme brought in finance for measures from a range of sources including:**

- Warm Front help for vulnerable households, where relevant
- energy supplier CERT (Carbon Emission Reduction Target) programmes, for cavity wall and loft insulation
- the Gloucestershire Warm and Well programme which integrated CERT with private sector housing grants for the 'not quite able to pay' households that fall outside Warm Front and the CERT priority group
- local authority grants for micro-generation, run in support of Local Area Agreement targets during 2007-11
- a small number of local authority special grants for homes requiring solid wall or sloping ceiling insulation
- the Low Carbon Buildings Programme grants for renewable energy systems

**A core feature of the programme, and one which sets it apart from much activity of recent years, was to avoid applying artificial distinctions between measures in terms of 'cost-effectiveness'.**

**Home owners were able to the use the advice from Target 2050 and their own judgement to decide what they wanted to go ahead with, within their own perspective as to how long they expected to stay in their homes, what finance of their own they were able to access and their personal priorities.**

## Pay As You Save loan scheme

During the final year of the programme the opportunity arose to join the Department of Energy and Climate Change Pay As You Save (PAYS) pilot, and Stroud District was one of just five pilots selected.

It was relatively straightforward to apply the approach to the Target 2050 programme, as the appropriate partnership was already in place, together with a relevant advice approach with the requisite quantification of potential savings, and an installer group covering the necessary technologies.

The District Council Environmental Health team adapted their grants and loans programme to meet the needs of a long-term loan repaid in monthly instalments, alongside the Council tax billing system, and put the necessary legal framework in place. A charge was registered against the property on the Land Registry to provide security for the loan in case of change of ownership.

*Table 1: The two types of PAYS loan*

| | PAYS 1 | PAYS 2 |
|---|---|---|
| Proportion of cost covered | Up to 100% | Up to 50% |
| Repayment period | Up to 25 years | Up to 10 years |
| Loan amount | £1,000 – £10,000 | £1,000 – £10,000 |

To qualify for the PAYS loan, the measures covered had to have a carbon saving attributed in the home energy report, but the order in which these were applied was not according to a strict hierarchy, in view of the many other practical considerations.

It was, however, required that the following core set of minor measures, where appropriate, were applied outside of the PAYS loan – on the basis that these are quick and easy to get done and have quick returns on investment:

- cavity wall insulation
- loft insulation
- hot water cylinder insulation
- draught proofing windows and exterior doors
- central heating controls

The two types of loan that were offered are summarised in Table 1 (above):

**For either loan, the list of eligible measures was as follows:**

- solid wall insulation (internal or external)
- floor insulation
- flat roof insulation
- sloping ceiling insulation
- oil or gas boiler upgrade (only if existing boiler G rated)
- solar thermal (solar hot water)
- photovoltaic panel (solar electricity)
- heat pump: air or ground source
- wood fuelled boilers and stoves
- double or secondary glazing

A qualification on this was that wood burning stoves were only covered where these replaced an open fire, and double or secondary glazing was only covered if carried out together with another major measure (such as solid wall insulation). The reasoning behind this was that these two measures are relatively popular consumer items which may be seen as desirable in their own right (not only as an energy efficiency measure), and that there was a risk that too many of the limited number of loans available might be taken up for these items in isolation, rather than as part of an energy efficiency improvement package.

## Repayment mechanism

The aim initially was to set repayments to be equal or less than the estimated savings on fuel bills from installing the measures. This would have restricted measures allowed to those with simple payback times of less than the period

"Our home has been transformed: what used to be a cold and mouldy kitchen and conservatory is now the warm heart of the home"

of the loan. In practice it was found that many applicable measures had longer returns on investment, but that repayments were still relatively low when spread over such an extended period, and consumers keen to go ahead. For the sake of the pilot, we were permitted to relax this rule.

It should be noted, however, that a zero interest rate was applied to the loans under the pilot, a factor which would have an impact on the costs of long-term loans and the difference between repayments and savings. Applying interest to the loans would make the costs higher and the balance against savings less good. On the other hand, a more complex analysis of return on investment, taking into account predicted future energy prices, might have the opposite effect.

**On balance the advice team decided that it was more helpful to present a simple analysis, with no assumptions about future energy prices.**

85% of households interviewed said the involvement of Severn Wye Energy Agency made them more likely to apply, and 80% said the same with respect to Stroud District Council

## Results of the PAYS pilot

**The Stroud Target 2050 pilot delivered 49 loans to home owners in Stroud District. This 98% success rate (against a target of 50) was the highest achieving of the five UK PAYS pilots.**

Set against a very tight timescale and relatively limited resources, **this result is an endorsement of the value and expertise of the local partnership**. Other pilots were run by very much larger organisations, with considerably more resources at their disposal.

The value of the local partnership is further supported by the householder perception of the partners reported in the Energy Saving Trust and Department of Energy and Climate Change evaluation of the pilots (Home Energy Pay As You Save Pilot Review, August 2011):

**85% of households interviewed said the involvement of Severn Wye Energy Agency made them more likely to apply, and 80% said the same with respect to Stroud District Council.**

**Positive attributes** that householders indicated as important with regards to partners included:

- financially stable provider
- flexibility in finance arrangements and expectation that they will act reasonably in management of charges and repayments over a long period
- good quality of service from an organisation with a good reputation
- impartial advice and support
- expertise in energy efficiency, micro-generation and complex building works
- public or non-profit rather than private organisations

**Unique features** of the Stroud pilot were:

- the wide range of measures offered and installed
- householder choice of installer
- choice of repayment period

**The Stroud pilot was one of the two (the other being the London Borough of Sutton/B&Q partnership) that offered the most detailed expert advice approach, including a tailored assessment, detailed report and follow up support.**

"I now feel more confident in my future plans for our house"

The evaluation referred to above highlighted the value of this level of support, with assessments making a real difference to choice of measures, and the inadequacies of a more generic approach used in other cases.

**The average loan given was £8,820 and the majority (70%) chose the longest (25 year) repayment option.**

## • Spreading the word

**The aim of the Target 2050 programme was to develop both the supply and demand side through the development and delivery of the bespoke advice service, the installer group and the exemplar homes.**

**These activities will only have a significant impact upon the level of retrofit in the area if effectively communicated, and this aspect of activity was built into the programme from the outset.**

### Website and online forum

The website was established at **www.target2050.org.uk**, initially to facilitate information sharing among the exemplar home owners in between quarterly meetings, but always with a longer-term view towards dissemination of their experiences and other information in support of the project. The website now includes downloadable fact sheets on a range of energy saving measures, news, events, links to the installer network list and all the case studies.

### Low Carbon Homes Show

A one-hour seminar format was developed to communicate the project to interested home owners and installers. Locations around Stroud District were chosen and a presentation from Severn Wye energy advisors was complemented by information stands manned by advisors and installers, who also took part in a question and answer session.

### Open Homes

The Stroud Open Homes for a Sustainable Future weekend, run by Transition Stroud, has taken place in September for the last three years and looks set to continue, with both visitor and participant numbers growing year on year. In 2010, 12 out of the 22 homes open had received a Target 2050 home energy survey. Over 1,000 visits were made to the 24 homes over the weekend in 2010, and 300 people visited the central exhibition which was open only on the Saturday.

### Retrofit challenge conference

A conference was held in the summer of 2009 to bring together installers, households and other interested 'key actors' within the chain of action on retrofit, such as building control and planning officers, construction skills trainers, energy advisors and economic development. Held at Stroud College, the event provided a platform for an interesting exchange, with representatives of each of these interest groups presenting their personal views and experience.

# 5 What we discovered – analysis of results

The Target 2050 'top ten' homes should achieve carbon savings of 41%-74%, and energy savings of 22%-70%

## Key outcomes from 248 homes surveyed:

- **The surveys indicate the potential to achieve an average annual reduction of 58% in CO2 emissions, 57% in energy consumption and £960 on fuel bills, by applying known and available measures**
- **102 of the households surveyed are known to have gone on to install energy saving measures which could reduce their energy consumption and carbon emissions by an average of 24%, and their fuel bills by £406**
- **Of the 50 case study homes, the ten with the greatest savings potential as a result of the measures already installed could achieve carbon savings of 41-74%, energy savings of 22%-70% and fuel bill savings ranging from £186 to £2,160**
- **The top ten homes all addressed heat loss in one form or another. Five of them switched their main heating fuel and a further four improved the efficiency of their heating by replacing their gas or LPG boiler**
- **Between £14,000 and £47,000 was invested in each of the top ten homes**
- **No obvious direct correlation was found between the amount of money spent and the carbon savings achieved, due mainly to the wide variation in practical opportunities for improvement, as well as differing priorities and restrictions for each household**

## Potential for a 58% reduction in $CO_2$ emissions

**If all the applicable measures were installed in the full sample of 248 homes surveyed, the modelled savings that could be achieved reached an average of 58%.**

The Target 2050 home energy assessments included all opportunities to install measures which would lead to a quantifiable saving, including those where planning permission and listed building consent would be required.

The homes surveyed were essentially self-selecting in response to marketing, or referred by partner organisations as likely to benefit from the in-depth advice offered by Target 2050. Where it was not possible to inspect the construction without disturbing it, homes were assumed to be built to the standards set out in the Building Regulations at the time of construction.



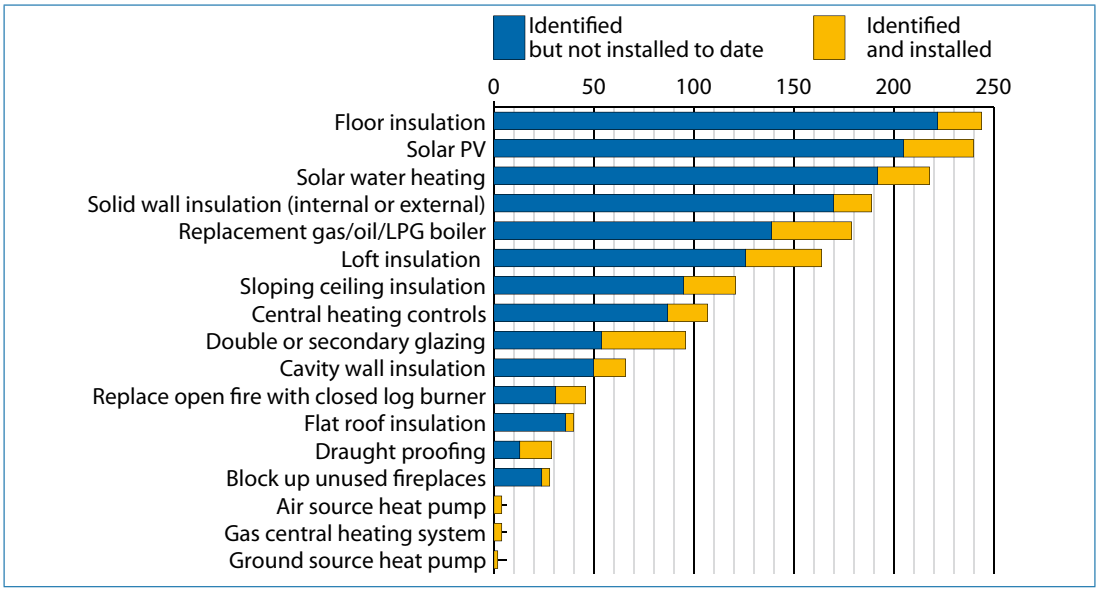
**About the data**: The NHER software models energy use, fuel costs and emissions of carbon dioxide based on a standard occupancy pattern. While this may not reflect the actual use of the building by the current occupants, it does provide a useful tool for comparing properties of different sizes and construction types on a like-for-like basis. The data presented here is based on this modelling.

Actual carbon savings achievable will vary according to occupancy and behaviour. All of the case study homes were asked to record monthly meter readings in order to assess the actual savings achieved against a baseline year established from previous energy bills. The data available so far is presented alongside the modelled data on savings from measures installed, but has been limited to the 12 homes for which we have a full year of data so far. For the remaining cases less than a year has elapsed since installation of measures, and monitoring is still in progress.

*Table 1a: Average potential annual savings in 248 properties*

| | At survey | With all measures installed | Potential saving | % Reduction |
|---|---|---|---|---|
| Annual energy use (kWh) | 40,248 | 17,224 | 23,024 | 57% |
| Annual $CO_2$ emissions (tonnes) | 9.48 | 3.97 | 5.51 | 58% |
| Annual fuel bills | £1,817 | £857 | £960 | 53% |

*Figure 1: Applicable measures identified and installed*




On average, $CO_2$ emissions at the time of the survey were higher than the national average of 7.1 tonnes[1], but it was still possible to identify measures which, once installed, should lead to an average 58% reduction in emissions across the sample.

The savings in Table 1a (above) do not include the potential for the occupants to adopt more energy efficient habits, including heating to lower temperatures, minimising their use of lighting, appliances and hot water or choosing efficient replacement appliances.

The surveys revealed some general patterns in the potential for measures to be installed, illustrated in Figure 1 (above), namely that:

- Most of these homes do not have floor insulation as they pre-date the Building Regulations which required it[2]. Similarly, there are few homes with solid walls and sloping ceilings that have already been insulated
- There are more opportunities to install solar photovoltaic panels than might be expected as reasonable yields can be achieved from panels sited on a roof that faces anywhere between due east and due west, or on a gable end wall.

  The opportunities to install solar water heating are similar but slightly fewer as there needs to be space inside the home to install a hot water cylinder, if not already present. Installations of both types of solar panel have increased during recent years, largely thanks to grant programmes and the Feed-In Tariff
- Most of the homes surveyed had a boiler, the majority of these were C-rated or worse and therefore noticeable savings were produced when a replacement was modelled
- When it comes to the less invasive measures such as cavity wall and loft insulation, low energy lighting, draught proofing, double glazing and central heating controls we found that many of the homes had already installed some or all of the applicable measures

[1] English House Condition Survey, 2007 (private sector housing only).

[2] From 1996 the Building Regulations required 25mm insulation under a solid concrete floor; this was subsequently increased to 75mm in 2003 and 100mm in 2007.

*Table 2: Average annual potential savings from measures installed in 102 properties*

| | At survey | Post installation | Potential savings | Potential savings (%) |
|---|---|---|---|---|
| Annual energy use (kWh) | 41,310 | 31,285 | 10,025 | 24% |
| Annual $CO_2$ emissions (tonnes) | 9.80 | 7.42 | 2.38 | 24% |
| Annual fuel bills | £1,920 | £1,520 | £400 | 21% |

*Table 3: Actual savings in 12 homes from household meter readings*

| | April 2007 – March 2008 | April 2010 – March 2011 | Average saving achieved | Saving achieved (%) |
|---|---|---|---|---|
| Average annual gas use (kWh) | 16,432 | 11,972 | 4,460 | 27% |
| Average annual electricity use (kWh) | 3,520 | 3,190 | 330 | 9% |
| Combined gas and electricity use (kWh) | 19,952 | 15,162 | 4,790 | 24% |
| Average annual $CO_2$ emissions (tonnes) | 4.67 | 3.67 | 1.00 | 21% |

## 24% carbon saving from measures installed to date

**Follow-up advice to survey clients has revealed that highlighting opportunities to improve the home will prompt many households to install the low cost and quick payback measures in the first instance, especially where there is grant assistance available.**

**More costly and disruptive measures usually have to wait for appropriate opportunities and/or finance but assessing the carbon and cost savings for each measure helps the household to prioritise investment in the home and may bring forward the decision to install.**

We have details of the measures installed in 102 of the 248 homes surveyed to date, due to the participation of the owners in the two linked support programmes to finance measures:

- Target 2050 exemplar grants
- Pay As You Save loans pilot

Other households which installed measures following our advice have not been included in this analysis as their installations have not been verified and the costs are not known.

The modelled savings achievable as a result of the measures installed in these 102 homes are given in Table 2 (above), and indicate an average potential annual carbon saving of 24%.

Participants in the case study homes programmes were asked to record monthly meter readings in order to assess the actual savings achieved against a baseline year established from previous energy bills.

Actual fuel use data from bills and meter readings provided by 12 of the case study homes (electricity) and ten homes (for gas) detailed in Table 3 (above) shows that on average they achieved a 21% reduction in carbon emissions following the installation of measures[3]. Only 12 are presented here as others do not yet have a full year of data. It has not been possible to accurately measure use of unmetered fuels (oil, LPG and solid fuel) so these are not included.

It is apparent that these 12 homes were previously fairly average consumers of energy, and have achieved noticeable savings despite the fact that 2010-11 was a colder year than 2007-8.

It is impossible to tell how much of the savings are due to measures installed and how much to behaviour change on the part of the occupants, but it is likely that most of the savings are due to the installation of measures, notably insulation and improvements to heating and hot water efficiency judging from the larger decrease in gas use.

## Benchmarking progress in the 248 homes surveyed

In order to compare the homes surveyed through Target 2050 with other homes purely on the basis of their energy use characteristics, it is useful to remove the size of the property from the equation by presenting the data per square metre of heated floor area.

Table 4 (next page) compares the 102 Target 2050 homes where measures were installed with benchmarks for the average UK home, and two target benchmarks for very high standards of energy efficiency retrofit in existing homes.

It is clear that although these homes were performing slightly worse than the current UK average at the time of the survey, **it is possible to achieve deep carbon cuts with fairly standard measures, *if all the practical opportunities to install these measures are taken*.**

[3] Calculated using the emission factors in NHER software of 0.422 $KgCO_2$/kWh for electricity and 0.194 $KgCO_2$/kWh for mains gas.

*Table 4: How 102 Target 2050 homes where measures were installed compare to the UK average home*

| | UK average benchmark[4] | At survey | Post installation | With all measures installed | Target benchmark |
|---|---|---|---|---|---|
| Annual energy use (kWh/m²) | 243 | 295 | 223 | 128 | 120[5] |
| Annual $CO_2$ emissions (Kg $CO_2$/m²) | 72 | 70 | 53 | 31 | 17[6] |
| Annual fuel cost (£/m²) | £12.15 | £13.72 | £10.81 | £7.50 | N/A |

## Savings in individual homes

**Table 5 (opposite) shows that the ten homes which have the greatest potential to reduce their carbon emissions as a result of the measures installed are a variety of house types and ages.** *Further details are included in the case studies which are appendices to this report from p36.*

In addition to the fuel switches, a further four households improved the efficiency of their heating by replacing the boiler without switching fuel and three homes installed solar panels for water heating.

Table 5 indicates that in order to achieve deep carbon cuts it is likely the household would need to consider both how heat is provided and the various ways in which heat loss can be slowed down.

Eight of the top ten homes did both: of the other two, one was already well insulated and the other had a gas boiler which the householder did not want to replace as it was in good working order and of relatively low priority.

The exact mix of measures that will achieve the deepest carbon cuts depends very much on the individual characteristics of each home, hence the need for bespoke surveys in most cases.

## The measures that deliver the most benefit

**Householders and policy makers have different priorities for investing in energy saving measures. The most rational financial investment for a householder is likely to be the one with the shortest "payback period": the period of time over which the cost of the measure will be recouped through savings on fuel bills.**

Policy makers having to consider the wider social costs of carbon emissions are more likely to prioritise the measures which deliver long-term carbon savings for the lowest cost, as shown in the final column of Table 6 (middle of p32).

Various factors affect the longevity, effectiveness and in particular, the cost of measures, each of which will have an impact on the calculations in Table 6. As an example, if a gas boiler lasted for 20 years instead of 12 it could save 20.4 tonnes of carbon over its lifetime, assuming no degradation in performance. The cost per tonne of carbon saved could then theoretically fall from £288 to £173, making it competitive with external wall insulation. Unlike the other measures listed, however, boilers are likely to be installed as a result of boiler failure or absence of adequate heat provision (where installation may actually increase carbon emissions) rather than as a carbon reduction measure.

A clearer distinction is made between the benefit delivered by investment in solar panels versus insulation. Even the higher cost insulation measures such as solid wall and sloping ceiling insulation deliver carbon savings at a lower cost over their lifetime than either type of solar panels. Investing in solid wall insulation would also help to mitigate the risk of fuel poverty for current and future occupants of the property.

## The measures that people choose

**The measures that deliver the most benefit are not necessarily the same as the measures that are installed, even when the householder is considering the "payback period".**

The level of disruption seems to be a key consideration because the top four measures in Figure 2 (bottom of p32) are some of the least invasive – and also the most visible. It is likely that insulation for solid walls, sloping ceilings and floors would not have featured so highly in this chart if householders had been given a completely free choice.

[4] Based on a floor area of 98m² (English House Condition Survey, 2007), annual energy consumption of 19,800 kWh (Ofgem, January 2011) and annual carbon emissions of 7.1 tonnes (English House Condition Survey, 2007).

[5] The EnerPHit Refurbishment Standard, see www.passivhaus.org.uk

[6] The target level for the Technology Strategy Board's Retrofit for the Future projects, see http://www.retrofitforthefuture.org

*Table 5: Potential savings achieved by the top ten case studies*

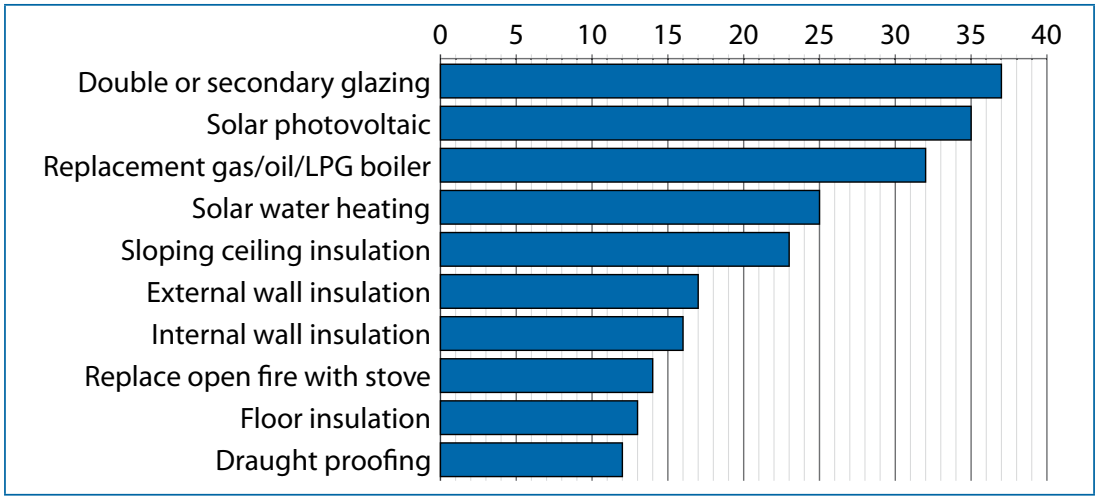
| Case study no. | Built form | Age | Wall type | Heating at survey | Measures installed | Cost of measures | Carbon emissions | Energy use | Fuel bills |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Detached house | 1980s | Cavity (insulated) | Oil central heating | Wood pellet boiler, solar water heating, solar PV | £24,378 | 74% | 28% | £828 |
| 2 | Detached house | 1970s | Cavity | Oil central heating | Cavity wall insulation; wood stove and large solar panels feeding thermal store with backup oil boiler | £24,470 | 71% | 24% | £933 |
| 3 | End-terrace house | Pre-1900 | Solid | Gas central heating | Solid wall insulation (mainly internal, part external), sloping ceiling insulation, replacement gas boiler, solar water heating | £21,653 | 56% | 58% | £635 |
| 4 | Detached house | c. 1900 | Cavity | Electric night storage heaters | Gas central heating, wood stove, insulation to cavity walls, loft, sloping ceilings, a small area of the ground floor and a small area of solid wall (insulated internally) | £14,539 | 64% | 45% | £2,144 |
| 5 | Detached house | Pre-1900 | Solid | LPG central heating | Internal wall and sloping ceiling insulation, replacement LPG boiler | £12,967 | 59% | 66% | £2,194 |
| 6 | Detached bungalow | 1960s | Solid | Oil central heating | External wall insulation, double glazing, ground source heat pump, mechanical ventilation with heat recovery | £46,900 | 59% | 70% | £1,469 |
| 7 | Mid-terrace house | c. 1850 | Solid | Anthracite central heating | Wood fuelled range, double glazing, roof insulation | £16,948 | 54% | 22% | £186 |
| 8 | Semi-detached house | 1900s | Solid | Gas central heating | Internal wall insulation, double glazing, replacement gas boiler with thermal store | £24,987 | 51% | 58% | £1,278 |
| 9 | Detached house | 1970s | Timber frame with timber cladding | Gas warm air heating | Loft insulation, full gas central heating, ground floor insulation, spray foam insulation to walls, solar water heating, LED lighting | £18,017 | 48% | 54% | £1,214 |
| 10 | End-terrace house | 1920s | Solid | Gas central heating | Internal wall insulation, loft insulation, double glazing, solar PV | £24,221 | 47% | 49% | £502 |

There are two main themes in the type of measures installed: nine of these ten households installed measures to reduce heat loss from their home (highlighted in green – the one home where no heat loss measures were installed was already well insulated) and five changed their main heating fuel to a lower carbon one (highlighted in blue).

*Table 6: The cost per tonne of carbon saved over the lifetime of measures*

| | Average annual $CO_2$ saving | Assumed lifetime (years)[7] | Average cost[8] | Average $CO_2$ saving (tonnes) over lifetime of measure | Average cost/tonne of $CO_2$ saved over lifetime of measure |
|---|---|---|---|---|---|
| Cavity wall insulation | 0.85 | 40 | £500 | 34.00 | £15 |
| Loft insulation (from 50mm or less to 270mm) | 0.44 | 40 | £500 | 17.60 | £28 |
| Loft insulation (from 50mm or more to 270mm) | 0.23 | 40 | £500 | 9.20 | £54 |
| Internal wall insulation[9] | 2.05 | 30 | £5,935 | 61.50 | £97 |
| Sloping ceiling insulation[9] | 0.67 | 30 | £2,977 | 20.10 | £148 |
| External wall insulation[10] | 2.05[11] | 30 | £10,286 | 61.50 | £167 |
| Replacement oil/gas/LPG boiler and controls if needed | 1.02 | 12 | £3,524 | 12.24 | £288 |
| Solar PV (2 kWp) | 0.84 | 25 | £9,644 | 21.00 | £459 |
| Flat roof insulation | 0.26 | 20 | £2,625 | 5.20 | £505 |
| Solar water heating | 0.25 | 25 | £4,323 | 6.25 | £692 |

*Figure 2: The ten most frequently installed measures*




7 CERT 2008-11 Technical Guidance Manual, June 2008, except flat roof insulation (estimate from contractor, but highly dependent on roof design, construction and maintenance) and solar PV (Centre for Alternative Technology website, see www. info.cat.org.uk).

8 Loft and cavity wall insulation costs do not include CERT subsidies – Energy Saving Trust website, 2011. Other cost data are average costs from Target 2050 installations, not including any grants.

9 Costs for internal wall insulation and sloping ceiling include making good up to the point of redecoration.

10 Costs for external wall insulation include all necessary alterations to pipes, guttering and other services.

11 The savings for internal and external wall insulation are the same because the improvement modelled in the NHER software is to a set U value regardless of method.

# 6 What we learned - opportunities, barriers & solutions

"Using the brick slips has meant our newly insulated home looks just like all the others in the street but is much warmer"

Target 2050 Homes has provided the basis for an effective longer term targeted approach to achieving deep energy and carbon cuts in existing homes, including:

**An advice approach and advisor experience** in identifying and prioritising a range of energy and carbon saving measures in a range of house types, and with a range of households, including development of a tailored home energy report and provision of 248 detailed home surveys

**A significant range of 50 case study homes**, illustrating what can be achieved and how, and the practical barriers and solutions encountered in applying solutions

**A model for dissemination** through events and seminars, case studies, and 'open homes', raising awareness of the opportunities with both householders and installers

Stimulation of the market for sustainable energy retrofit **through development of a local installer network**, which now has over 100 members installing a range of energy efficiency and renewable energy measures

**An understanding of the costs and householder perspective** on investing in improvements, and the practical issues as regards financial support mechanisms, through the experience of managing grants programmes and the PAYS pilot, and in supporting households in identifying finance and obtaining quotations for works

**Our overall conclusion is that there is significant value in moving forward with an integrated non-profit local partnership model which builds further upon these positive features. By extending this to neighbouring local authority areas, we aim to achieve some economies of scale while maintaining the benefits of local knowledge and a personalised service.**

The evaluation of the PAYS pilots indicated householder preference for a programme led by public/non-profit providers that are commercially impartial, and the importance that they placed on practical knowledge and expertise. In the emerging market for sustainable energy retrofit, this depends upon an open and transparent sharing of experience, and a culture of continuous learning and improvement.

While a streamlined customer journey is a positive ideal, the value of allowing for multiple entry points to a service should be recognised, and to facilitate this it is important to engage all key actors and to ensure that communication lines remain open so that problems can be resolved as they arise.

## Specific learning points arising from Target 2050 Homes include:

### 1 Measures and the potential for savings

The results of the Target 2050 programme show that it is possible to achieve deep energy and carbon cuts by retrofitting measures which are currently available, **if all the practical opportunities to install these measures are taken**.

The exact mix of measures that will achieve the deepest carbon cuts depends on the individual characteristics of each home, hence the need for bespoke surveys in most cases, including quantified estimates of savings, especially when guiding householder investment.

Insulation measures, including the higher cost ones such as solid wall insulation, are generally the most effective investment to reduce carbon emissions and to help mitigate the risk of fuel poverty for current and future occupants of the home. **However, to achieve deep carbon cuts it is generally necessary to address both heat loss AND heating provision**.

There is a great deal of variation in the detail of existing homes in the UK. The costs of, and potential savings from, all but the simplest of measures tend to vary considerably with this detail. Some typical examples are:

- bay windows
- extensions and loft conversions
- dropped eaves and attic rooms with complex heat loss areas
- a variety of window types, door and window surrounds
- decorative wood and plasterwork, especially in listed buildings where it forms part of the listing
- multiple wall, roof and floor types
- several sources of heat or hot water

It is not always possible or practical to separate out the costs of energy retrofit from other building work or aesthetic improvements, whether these are essential or opportunistic. Typical problems are in apportioning the cost of labour and ancillaries such as scaffolding.

**A degree of experience and understanding is required to split costs accurately. Finance programmes that do not take this into account can create unnecessary barriers.**

Examples include:

- insulating rooms internally when the trigger for the work is the need for re-plastering. Either job would necessitate removal and replacement of all skirting boards, switches and sockets, but only the insulation would require extensions to internal window sills. Other considerations include flue and cable lengths, and door and window surrounds
- aesthetic improvements alongside external wall insulation, for example use of brick slips instead of a render finish, or constructing insulated pitched roofs over bay windows which were previously flat roofs. In the former case, two quotes would be required: one for the essential work to achieve the energy improvement and a separate quote for the higher cost aesthetic work
- heating and hot water system upgrade or alterations (to pipes, controls or tanks) in conjunction with boiler replacement or solar thermal installation
- exceeding the minimum requirements set out in the Building Regulations when carrying out a loft conversion or extension
- insulating between the rafters when replacing a roof (on homes with attic rooms, especially listed buildings which cannot be disturbed internally)
- fitting solar panels while work is being carried out on the roof

## 2 Advice and households

Retrofit advice to achieve deep carbon cuts **needs to be specific to the home and household, practical in nature, and holistic**.

The advice should cover the full range of measures, and all aspects of support, from the surveys identifying the measures through to how to finance and install, and overcome barriers that present themselves.

**Advice needs are multi-stage, not one-off**, and advice provision should be designed as a relatively long-term relationship with the household. This may in practice be characterised by increasing depth and detail as household knowledge grows. This requires a **realistic view of the cost of advice and support in managing a programme of retrofit**.

'Cheap and quick' may not be effective in view of the relative complexity of existing buildings and applicable measures, in a programme aiming to achieve substantial cuts, as opposed to implementing single and relatively simple measures such as cavity wall and loft insulation.

Home owners in our sample indicated a preference for installing the less invasive measures such as solar PV, solar water heating, replacement boilers and double glazing (at least in the first instance), even though our advice highlights the carbon savings from all feasible measures. This is a characteristic of short-term actions, and does not preclude a different response at a later date – however this again highlights a need to **maintain interest and contact over the longer term**.

It is not realistic to expect all potential improvements to be implemented at the same time, except where major renovation or refurbishment is taking place, due mainly to cost, disruption and availability of finance.

Several measures involving major disruption are more practical, convenient and significantly less costly if carried out as part of more major renovation, and in this case the energy efficiency elements might be considered as marginal costs.

## 3 Getting the timing right

The trigger for renovation may be disrepair or the purchase of a new home, rather than a perceived need for improved energy efficiency, and a key action is to ensure that

opportunities for maximising energy improvements are enabled at this point in time. Prime examples include:

- window replacement
- solid wall insulation
- floor and sloping ceiling insulation

Not giving advice at the right time means that we lose an opportunity to improve a home which may not come around again for decades.

Advice on retrofit may need to include user behaviour if the full benefits of improvements are to be realised such as the use of new technologies including heat pumps, solar hot water and solar electricity, as well as heating and hot water controls.

Further savings can be realised through advice on using other appliances more efficiently, and by engaging households in self-monitoring and peer support groups.

## 4 Installers

Supporting existing local small and micro businesses which already offer home repair and improvements to encourage them to offer a range of energy retrofit measures brings the following advantages:

1. They are often the first port of call for home owners wanting to get work done on their homes, and are well placed to identify opportunities to include energy improvements
2. By supporting existing local businesses, rather than focusing on specialist providers, this supports the local economy, building capacity to ensure future supply, and enhancing the opportunities for householder choice

**To provide an effective carbon reduction programme reaching a wide audience, it is essential to develop a service that also works for the installers**, for example by:

- saving them time by providing advice and information to customers, which they might otherwise be asked for, such as choice of appropriate measures or indicating where choices exist
- filtering out casual enquiries
- explaining the value of accreditation for products and installers
- providing relevant referrals following on from advice
- advising on and helping to access available funding
- offering opportunities for joint marketing, cross-referrals and recommendations

Adopting new technologies carries risk for small businesses, part of which is the time taken to source supplies and deal with teething problems. Support programmes should ensure local supplies and relevant information are available for installers as well as home owners.

Training and advice for installers needs to be tailored to real requirements and practical realities, including the cost of lost working time: toppingup existing knowledge, not too basic and conveniently located.

Local exemplars are useful to all, and offer an opportunity for co-learning of households, installers, advisors, building control and planning officers.

There are several factors in favour of supporting existing local businesses as providers, such as bringing benefits to local jobs and economy, capacity building to ensure future supply, and enhancing the opportunities for householder choice (indicated as a preference in the PAYS evaluation).

## 5 Finance

Home owners are interested in energy saving potential and the cost and savings implications, and saving money on fuel bills is a core motivating factor in installing energy efficiency improvements. However they are also interested in comfort, and in practice they are aware that fuel bills are rising, so the precise calculation of payback on investment appeared in the PAYS pilot to be less crucial than the affordability of monthly repayments. Once interest rates are applied to loans in future programmes, this issue will become even more significant.

Flexibility and choice appears to be important, in terms of measures and repayment periods, as there are many personal, financial and practical considerations which can have a bearing.

Fixed terms such as maximum loans and proportions of costs that can be covered can have negative consequences such as partial insulation, or home owners requesting several re-quotes to try and fit a package of works into the maximum allowed

A simple and streamlined application process is a crucial factor, as is the customer service in keeping home owners informed and motivated.

**In summary, the ideal programme to support the achievement of deep cuts in energy consumption and carbon emissions in existing homes is:**

- ✔ **tailored** to the practical realities of the existing building stock and its complexity and imperfections
- ✔ designed to deliver to the **real and multiple practical needs** of households and home-owners
- ✔ able to **engage** with all key actors in the supply chain, and **deliver to <u>their</u> needs**
- ✔ intelligent, and **can flex and develop** as providers learn, markets develop, and external factors change
- ✔ **open and transparent**, allowing benefits and learning to be shared

# 1980s detached house Stroud

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 1

**£828** Saving on fuel bills

**74%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Pellet boiler | £10,669 | 6.66 | £694 |
| Solar hot water | £5,328 | 0.44 | £46 |
| Solar PV (1.26 kWp) | £8,381 | 0.42 | £88 |
| Total package | £24,378 | 7.52 | £828 |
| Plus income from PV Feed-In Tariff (FIT) | | | £574 |

## The home

This detached farmhouse was built in a south facing location on the owner's farm in 1983. The cavity walls were insulated as they were built and the house has had a loft conversion with 150mm of insulation throughout and double glazed windows. The house was heated by an old F-rated oil boiler with an open fire in the living room.

## What they did

In spite of living in a relatively modern house, with reasonable levels of insulation, this family has found a number of ways to reduce their carbon emissions and become more self-sufficient. Replacing the old boiler was the obvious first step. With oil prices increasing and no access to mains gas, the householders decided to install a wood pellet boiler and solar water heating. This gives them the continued benefits of an automated and well-controlled central heating system, but with a low carbon fuel. They also replaced the open fire with a wood burning stove, for improved efficiency.

Later they added solar photovoltaic panels to generate electricity, benefitting from the introduction of the Feed-In Tariff. Future plans include a 10kW wind turbine – subject to planning permission.

This practical and innovative household has taken further steps to reducing its dependency on fossil fuel by producing bio-diesel from waste oil for use in the farm vehicles.

**£574** Income from Feed-In Tariff (FIT)

"Insulation is the most important thing. The pellet boiler is great for the environment but it was a big investment so we can't afford to be leaking heat."

SevernWye ENERGY AGENCY

STROUD DISTRICT COUNCIL
www.stroud.gov.uk

## Wood pellet boiler

Wood pellets are made of compressed waste sawdust, so although some energy is required to make and transport them, they are a very low carbon fuel.

When this boiler was installed in 2008 it was slightly more expensive to heat with wood pellets than with oil, but oil prices were rising and it was anticipated that pellet prices would fall as the market expanded. The oil boiler had been in use for 25 years so the householders felt it was wise to take a long-term view. As a farming family, they have plenty of storage space which means they can purchase pellets in bulk whenever the price is low.

The key advantage of using wood pellets instead of logs or waste wood is that the system can be controlled by a conventional thermostat and timer. The pellets have to be manually loaded into the storage hopper, but once that has been done they are fed into the boiler automatically when the controls indicate more heat is required. This means that inside the home, the system works exactly like the old oil central heating.


*Wood pellet boiler and hopper*

## Wood burning stove

The open fire in the living room was replaced with a wood burning stove, which has reduced the amount of wood being burnt for secondary heating, but the householders report that this still uses far too much wood for the amount of heat it produces.

## Solar water heating

A solar water heating system was installed at the same time as the pellet boiler. Both feed into a large 300 litre cylinder, so if the solar panels are providing enough heat for the hot water demand, the thermostat prevents the boiler firing up. The householders find that they get free hot water virtually all summer, and that the large, well-insulated cylinder means one sunny day can provide up to two days' worth of hot water.

The combined effect of these measures has made the household virtually fossil fuel-free when it comes to meeting their space and water heating needs. The boiler and solar panels were installed by Windhager UK of Chippenham, Wiltshire for a cost of £10,670.

## Solar electricity

In 2009 the household decided to invest in solar photovoltaic panels to generate electricity. A relatively small system with a peak output of 1.26 kilowatts was installed, but this is sufficient to produce a quarter of the electricity required for the home. It is eligible for Feed-In Tariff payments, which has brought in enough income to pay all their electricity bills for the last year.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 37,200 | 175 |
| After improvement (2010) | 26,626 | 125 |
| With all possible measures | 21,792 | 102 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 10.18 | 48 |
| After improvement (2010) | 2.61 | 12 |
| With all possible measures | 2.69 | 13 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £1,677 | £7.87 |
| After improvement (2010) - excl FIT income | £849 | £3.99 |
| With all possible measures | £791 | £3.71 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Insulation to solid concrete floors | 0.90 | £120 |
| Sloping ceiling insulation | 0.21 | £28 |
| Total | 1.11 | 148 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

Energy performance and carbon emissions in the Target 2050 exemplar homes have been modelled using the UK Standard Assessment Procedure (SAP). The savings data presented here is based on a standard occupancy pattern. This may not reflect actual usage by the building's current residents but is used to compare homes of different sizes and types in a way that assesses the building itself rather than the behaviour of any particular occupant. 2011

# 1970s detached house Cranham

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 2

**£933** Saving on fuel bills

**71%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Cavity wall insulation | £260 | 1.37 | £216 |
| Wood burning stove with thermal store | £6,203 | 3.76 | £355 |
| Solar hot water | £12,992 | 0.53 | £240 |
| New oil boiler and heating controls | £5,015 | 0.86 | £122 |
| Total package | £24,470 | 6.52 | £933 |

## The home

This early 1970s detached house is deceptively large, with a single storey at the front and two at the back, the lower floor being built into the hillside.

With no insulation in its cavity walls, a mix of single and double glazed windows, high ceilings and an open plan layout, the current owners, who bought the house around 10 years ago, had always found it a challenge to heat.

It is not on the mains gas network, and has oil-fired central heating, which was still powered by the original 40 year old boiler when they joined the Target 2050 programme.

## What they did

The first and most significant step was to insulate the cavity walls, the main area of heat loss. This was done simply and effectively for around £200, by a Swindon-based company called Warm Space Insulation, with a noticeable impact in terms of comfort.

The remaining single glazed windows and the single glazed front door and porch were then replaced with UPVC double glazing by Clive Budding, an independent double glazing contractor based in Gloucester.

This was quickly followed by the decision to replace the old oil boiler and look at innovative ways of reducing the household's dependence on oil. The householders were keen to investigate if and how they could use renewable energy, and found a solution that combined solar and biomass technologies with what they already had in place.

"Our house has changed from a cold draughty house to a warm cosy one."

SevernWye ENERGY AGENCY

STROUD DISTRICT COUNCIL
www.stroud.gov.uk

## Large solar thermal system

With measures to reduce heat loss completed, the family needed ideas to improve and update the house's space and water heating systems. The old oil boiler needed replacing and the householders wanted to maximise the efficiency of the heating system while integrating renewable technologies, to reduce their reliance on oil.

The chosen system consists of six evacuated tube solar panels and a wood burning stove serving a very large thermal store, with a small oil boiler as back up. As the main roofs of the house face east and west, solar panels were positioned on the south facing gable end wall. They were mounted on brackets protruding more than 200mm from the house, so planning permission was needed. This was granted without a problem by Stroud District Council, but the time taken for this process to be completed meant they were installed two months after the main heating system.

## Wood burning stove with thermal store

The new Lenius log burner is a modern design providing the family with a delightful focal point in the evenings. It supplies 30% of its heat to the room, heating the whole of their living space on the upper floor, with the remaining 70% feeding into the 800 litre Solus II thermal store, an immense hot water tank in a store room on the lower floor. The stored heat provides all the remaining space heating and mains pressure hot water. When space heating is required, the stored heat is circulated around the radiator system without running a new heat source. The entire system was installed by the Green Shop of Bisley, near Stroud, for £24,200.

The solar panels supply most of the hot water needs in the summer, while the log burner is used as a top up in the winter and on cloudy days to ensure there is enough hot water in the morning. The householders estimate that although they are burning more logs, their oil consumption will reduce by over 50% over a year. They have also seen a reduction in electricity use of nearly 25%, which is partly due to the householders' more energy efficient habits but may also have something to do with the inefficiency of the pumps on the old central heating system.

*High efficiency woodburning stove*

## Next steps

The family is now considering improving the depth of insulation in some of the sloping ceiling areas and replacing some of the older double glazing that is starting to fail. They are also thinking about installing solar photovoltaic panels which will further reduce their carbon emissions as well as reducing electricity bills and providing income for the electricity generated.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 33,074 | 230 |
| After improvement (2010) | 25,232 | 175 |
| With all possible measures | 21,622 | 150 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 9.17 | 64 |
| After improvement (2010) | 2.65 | 18 |
| With all possible measures | 1.92 | 13 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £1,670 | £11.61 |
| After improvement (2010) | £737 | £5.12 |
| With all possible measures | £588 | £4.09 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Double glazing | 0.30 | £48 |
| Solar PV (1 kWp) | 0.29 | £61 |
| Total | 0.59 | £109 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

Energy performance and carbon emissions in the Target 2050 exemplar homes have been modelled using the UK Standard Assessment Procedure (SAP). The savings data presented here is based on a standard occupancy pattern. This may not reflect actual usage by the building's current residents but is used to compare homes of different sizes and types in a way that assesses the building itself rather than the behaviour of any particular occupant. 2011

# End-terrace stone house Nailsworth

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 3

**£635** Saving on fuel bills

**56%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Loft insulation top-up | £300 | 0.50 | £100 |
| Internal solid wall insulation | £7,074 | 0.75 | £110 |
| External solid wall insulation | £2,386 | 0.25 | £37 |
| Floor insulation | £1,818 | 0.90 | £173 |
| Replacement boiler | £5,155 | 1.30 | £190 |
| Solar hot water | £4,920 | 0.30 | £25 |
| Total package | £21,653 | 4.00 | £635 |

## The home

This home is a Cotswold stone end-terrace house built before 1900. There are three floors including "rooms in the roof" with sloping ceilings.

The walls and ground floor are solid, so prior to improvement there was considerable heat loss from all elements of the building fabric. To compound this further, the conservatory at the rear was open to the rest of the house and only had a thin polycarbonate roof. The gas central heating system was powered by an old 'combi' boiler providing both heating and instantaneous hot water.

## What they did

Having lived in the property for 18 months the householder had found it impossible to get the house warm. The conservatory was noticeably drawing what little heat there was from the rest of the house, and this was replaced with an extension, which is more thermally efficient, but has increased the heated area by about 50%. The replacement for the conservatory has a green roof.

Work then began on improving the insulation in the existing original walls and sloping ceiling areas of the house with a mix of internal and external wall insulation. The existing loft insulation was also topped up.

The heating system was upgraded to include a new efficient boiler with solar thermal hot water, sufficient to provide most of their hot water in the summer months.

All of the rear windows of the house were replaced with triple glazed units during the refurbishment work to further reduce heat loss from the home.

"Our home has been transformed: what used to be a cold and mouldy kitchen and conservatory is now the warm heart of the home"

SevernWye ENERGY AGENCY

STROUD DISTRICT COUNCIL
www.stroud.gov.uk

## Solid wall insulation

The outside appearance at the front of the property was to be preserved, and the front and side wall were insulated internally using 50mm phenolic foam insulation bonded to standard gauge plasterboard. Initially the householder was concerned that the living space would be noticeably reduced but this hasn't been the case. The window reveals are deeper and new internal sills were required but they feel this adds to the character of the home as it gives the impression of thicker walls.

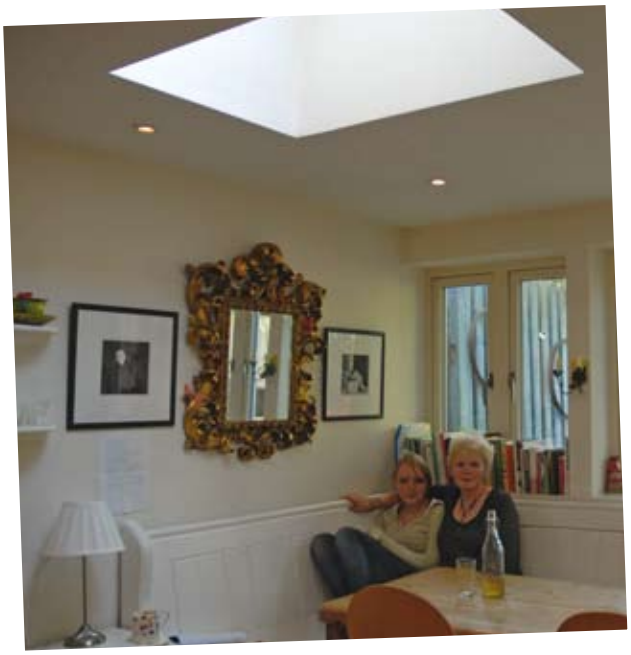
External insulation was applied to a small area of wall on the first floor at the rear of the house. As this wall area was already rendered, a new Parex insulation layer that comprised polystyrene, mesh and render did not significantly change the existing appearance, but greatly reduced heat loss from this area.

## Sloping ceiling insulation

The second floor of the home previously comprised one large room which was not heated. As this area was being renovated to provide two new bedrooms and a bathroom the heating system was extended to this floor. It was therefore imperative that this area, that comprised sloping ceilings and solid walls, be properly insulated. Using the same material that was used for internal insulation at the front and side of the house, a 50mm phenolic foam insulated plasterboard was attached to the sloping ceilings as well as the walls. The top floor of the house is now well heated and the householders can control any overheating with thermostatic radiator valves (TRV).

## Heating improvements

Solar thermal panels were installed on the new rear extension, and the old gas boiler was replaced with an 'A' rated one that was relocated to a new cupboard on the second floor. This entailed adjustment to the hot and cold water pipework, and moving the gas pipe, and allowed for adding a new hot water cylinder, located close to the new solar water heating panels. This helps to ensure minimal heat loss, something that would not have been possible with the existing boiler on the ground floor. In 2010 the household used no gas to heat water between the end of March and the end of September.



*Well insulated and comfortable extension*

Overall, the householder commented that although the work undertaken was a major upheaval, and required them to move out of their home for several months, it had definitely been worthwhile. Sifting through the options and developing the specifications for the project had been a challenge, but with the advice from Severn Wye Energy Agency, and by thinking through what their requirements were, they felt that they had found the right solutions to significantly improve the energy efficiency of their home.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 34,800 | 355 |
| After improvement (2010) | 14,500 | 126 |
| With all possible measures | 13,700 | 119 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 7.10 | 72 |
| After improvement (2010) | 3.10 | 27 |
| With all possible measures | 2.70 | 23 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £1,200 | £12.23 |
| After improvement (2010) | £565 | £4.91 |
| With all possible measures | £526 | £4.57 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Solar PV (1 kWp) | 0.30 | £39 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

Energy performance and carbon emissions in the Target 2050 exemplar homes have been modelled using the UK Standard Assessment Procedure (SAP). The savings data presented here is based on a standard occupancy pattern. This may not reflect actual usage by the building's current residents but is used to compare homes of different sizes and types in a way that assesses the building itself rather than the behaviour of any particular occupant. 2011

# 1900s detached house Stonehouse

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 4

**£2,144** Saving on fuel bills

**64%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Cavity wall insulation | £422 | 9.00 | £1,088 |
| Loft insulation top-up | £2,650 | 0.14 | £17 |
| Internal solid wall insulation | included in above | 0.72 | £87 |
| Sloping ceiling insulation | included in above | 1.77 | £213 |
| Floor insulation | included in above | 0.35 | £42 |
| Gas central heating | £9,172 | 5.25 | £664 |
| Closed log burner in open fireplace | £2,295 | 0.41 | £33 |
| Total package | £14,539 | 17.64 | £2,144 |

## The home

This detached house was built around 1900 and unusually for its age, it has cavity walls.

The large attic room has extensive areas of sloping ceilings, so that although there was 100mm of insulation in the loft space, this had limited benefit overall as it covered a relatively small area.

Many of the original windows had already been replaced with double glazing.

The only heating in this five bedroom home was four electric night storage heaters and a wood burning stove in the kitchen, although the property is in the town and has access to the mains gas network.

## What they did

The current owners purchased the house in 2009 with the intention of refurbishing it to provide a family home. They intended to install gas central heating but had not really considered insulation, and it was a complete surprise when the Target 2050 survey revealed they had cavity walls. The survey also identified the benefits of insulating the attic room, and various smaller wall and floor areas. A modern efficient gas central heating system was installed, to be supplemented by a wood burning stove replacing the open fire in the living room.

The householders had a limited budget for their improvements but were able to do more due to being offered the opportunity to take out a Pay As You Save (PAYS) interest-free loan.

"The insulation has made our house a much nicer place to live. Plus our heating bills have been considerably lower than we expected, so it's been a win all round!"

SevernWye ENERGY AGENCY

STROUD DISTRICT COUNCIL
www.stroud.gov.uk

## Cavity wall insulation

A free survey from the cavity wall insulation contractor, including a visual inspection of the cavities, confirmed that they could be insulated. This is not always the case with older homes as there are a number of reasons why cavities can't be insulated, for example if they are too narrow or contain rubble. The total cost would have been £880 but with a discount through the Gloucestershire Warm and Well scheme this was reduced to £422.

## Attic room insulation

The householders say that the attic room was pretty much unusable until it was insulated, with the lack of insulation making it too hot in the summer and too cold in winter. To minimise the loss of headroom, phenolic foam insulation was used as this achieves the best insulation value for its thickness. A "multifoil" insulation was considered, as this material is much thinner, but depending on which multifoil product is used, a substantial air gap and/or a layer of another material are required to achieve a satisfactory insulation value, so there is no space-saving benefit. The contractor also topped up the existing loft insulation to 300mm and carried out two further insulation jobs, described below.

## Further insulation work

Phenolic foam was also used to internally insulate a small area of solid wall in the extension. The same material was used underneath the suspended timber floor in the study. As there is no cellar, the floor boards were lifted and the insulation boards were fitted tightly between the floor joists with wooden battens underneath for support. This has produced a real benefit for the householder, who works from home regularly.

## Gas central heating

The gas supply had to be brought to the house and is not included in the cost stated for the central heating. A complete system was installed, with a condensing boiler, all pipe work and radiators with thermostatic radiator valves. Overall control of the system includes a weather compensator which adjusts the heat output from the boiler according to the outside temperature. The householders considered installing solar water heating but could not stretch their budget at that time, however the hot water cylinder installed has a second input coil which can easily be connected to solar panels in future.

*Installing insulation below floor boards*

## Wood burning stove

Finally, the householders installed a wood burning stove in place of the open fire in the living room, getting rid of the draught from the open chimney as well as providing a more efficient use of wood fuel.

## Next steps

The next step is to insulate the living room floor, having felt the benefits of a warm floor in the study.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 65,232 | 278 |
| After improvement (2010) | 35,907 | 153 |
| With all possible measures | 27,742 | 118 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 27.54 | 117 |
| After improvement (2010) | 9.90 | 42 |
| With all possible measures | 6.77 | 29 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £4,022 | £17.16 |
| After improvement (2010) | £1,878 | £8.01 |
| With all possible measures | £1,450 | £6.19 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Solar hot water | 0.27 | £38 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

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# Traditional stone cottage Painswick

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 5

**£2,194** Saving on fuel bills

**59%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Sloping ceiling insulation | £3,659 | 2.21 | £590 |
| Internal solid wall insulation | £5,370 | 4.57 | £1,224 |
| Replacement LPG boiler and controls | £3,938 | 1.55 | £380 |
| Total package | £12,967 | 8.33 | £2,194 |

## The home

This traditional Cotswold stone cottage has many period features, including walls which are up to two foot thick in places, exposed beams and rooms in the roof with sloping ceilings and dormer windows.

There is a combination of steel and wood framed windows, mostly double glazed, and the flooring is mix of suspended timber and flagstone.

Accessible areas of loft were found to have less than 100mm of insulation, and with no mains gas to the property, the central heating was supplied by an LPG boiler. This was supplemented by a log burner in the living room and an LPG Aga for cooking.

## What they did

The owners were finding it very expensive to heat the house, and it took a long time to warm up when they got home from work. Having lived in the property for two years, they were planning a substantial renovation and were keen to incorporate energy saving measures wherever possible.

Initially they thought this would involve installing "high tech" solutions, but the Target 2050 report persuaded them that simpler solutions such as insulation and heating improvements would make a significant difference.

"Target 2050 has changed our view of what it means to be green: there's so much more to it than solar panels! Having felt the benefits of insulation we've become real advocates for it."

SevernWye ENERGY AGENCY

STROUD DISTRICT COUNCIL
www.stroud.gov.uk

## Solid wall and sloping ceiling insulation

The first priority was to insulate the roof and walls. This had to be done internally, in order to preserve the appearance of the house. It was achieved by insulating all the external heat loss surfaces of the upper floor of the home, including all the sloping ceilings, dormers and walls with Thermaline Super 65. Although this is 65mm thick, the exposed beams are still visible and the installer took care to replicate the curved window reveals so as not to lose the period character of the home. The cost for the upper floor was £5,394. The householders found the insulation so effective that they then decided to insulate the majority of the walls on the ground floor as well at a cost of £3,635. The overall effect is a much warmer and more comfortable home, without any loss of historic features, and a good example of sensitive sustainable renovation.

*Insulated walls finished in keeping with character of the cottage*

## Wood fuel options

The householders wanted to change from LPG heating to something more sustainable and considered a boiler fuelled by wood pellets. Two options were considered, either of which could have been connected to their existing radiators. The cheaper option would have required wood pellets to be manually loaded from 2kg bags. The current owners would have been happy with this arrangement, but they were worried that a heating system that involved manual handling of fuel might put off potential buyers, if they ever came to sell the house.

On further investigation they discovered that the second option, a system with the pellets automatically fed to the boiler, was considerably more expensive, and in this case more than twice the price.

## Replacement LPG boiler

In the end they decided to install a replacement LPG boiler, so that the modern convenience of a fully automated system would be available to any future occupants. In practice, they rarely use it themselves, as they also have the wood burning stove which they find adequate most of the time.

The cost of the replacement boiler was quite high at £3,938 because of additional works required, including removal of the old hot water tank, replacement of a corroded gas pipe and burying some of the pipe work in a wall.

They also took the opportunity to upgrade the heating controls to include thermostatic radiator valves that can be controlled wirelessly by the central heating programmer. This effectively means that a separate heating programme can be set for each room.

This case study is a good example of the effective practical compromises that can be made to improve energy efficiency in an older building.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 60,000 | 393 |
| After improvement (2010) | 20,679 | 135 |
| With all possible measures | 13,679 | 90 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 14.21 | 93 |
| After improvement (2010) | 5.88 | 38 |
| With all possible measures | 3.99 | 26 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £3,049 | £19.95 |
| After improvement | £855 | £5.59 |
| With all possible measures | £425 | £2.78 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Solar PV (1 kWp) | 0.33 | £138 |
| Solar hot water | 0.33 | £35 |
| Total | 0.66 | £173 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

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# 1960s detached bungalow Wiltshire

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 6

**£1,469** Saving on fuel bills

**59%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| External wall insulation | £16,702 | 2.73 | £556 |
| Double glazing | £8,713 | 1.42 | £291 |
| Ground source heat pump | £18,505 | 3.19 | £622 |
| Mechanical ventilation with heat recovery | £2,980 | 0.00 | £0 |
| Total package | £46,900 | 7.34 | £1,469 |

## The home

This detached bungalow was built in the mid-1960s with a coal boiler, single glazing and no insulation.

An oil boiler had subsequently been installed, leaving coal as the secondary heating in an open fireplace.

The loft had also been insulated to a depth of 200mm.

The property has been privately rented for some years, and the current tenants were frustrated that the costly oil heating was delivering little benefit, so they would often retreat to the sitting room and build a large coal fire to keep warm.

## What they did

The owners were aware that the thermal performance of this house could be improved, but that this was likely to be expensive. A detached bungalow tends to be difficult to keep warm, as it loses heat from every external wall as well as the roof and floor. As the loft had already been done, the next step was to insulate the solid walls externally, and then to install double glazing. Once this was done, a ground source heat pump became a viable option to replace the oil boiler, and the finishing touches were a ventilation system with heat recovery and a wood burning stove in place of the open fire.

Plans for the future include installation of solar water heating, which can be integrated with the heat pump fairly easily, and solar photovoltaic (PV) panels for the generation of electricity.

"Before the eco measures were in place, the tenants consumed £600 of oil in December 2010 alone. Now this sum is expected to cover heating for a whole year"

SevernWye ENERGY AGENCY

Supported by Wiltshire Council Where everybody matters

## Double glazing

The glazing installed was A-rated for energy and cost £8,700 in total. It features a 28mm gap between the panes and the edges are sealed with plastic rather than metal, which is known as a "warm edge". The glass itself has a low emissivity coating which reflects heat back into the room. The windows were replaced before the walls were insulated, helping to ensure a neat and effective finish.

## External wall insulation

The external wall insulation is made up of 100mm phenolic foam board, fixed to the walls with both adhesive and mechanical fixings. A basecoat render is added, reinforced with mesh, and then finished with a coloured silicon render topcoat. The total cost for this measure was £16,700, including replacement of all soffits and fascias and construction of timber "bonnets" over the bay windows which were previously flat roofed. Careful detailing was required to ensure good weatherproofing around the new roof join.

*Installing external wall insulation*

## Ground source heat pump

The owners wished to move away from expensive and high-carbon oil central heating. With improved insulation and draught proofing, a heat pump became a viable option. This would previously have been unsuitable, and could have increased heating costs because it would have needed to work extremely hard and run at high flow temperatures, raising its electricity consumption, in order to maintain the temperature in a poorly insulated home.

The owner of an adjacent field allowed a ground loop to be installed. This does not prohibit the continued use of the land for arable farming, as the collector is buried around 1.5-2.0m deep. The existing radiators and piping were power flushed, two radiators were added and a plant room was constructed to house the new equipment. The total cost of the heat pump, including the ground-works and plant room construction, was £18,505.

## Ventilation with heat recovery

The next measure installed was a mechanical ventilation system with heat recovery. This reduces the need to open windows, minimising uncontrolled heat loss.

Extractor units in the kitchen and bathroom, driven by a central fan in the loft, remove warm, moist air and expel it to the outside, once it has passed through a heat exchanger. The heat exchanger captures the heat from the outgoing air and uses it to pre-warm incoming fresh air supplied to the dining room and main bedroom. The system can recover around 90% of the waste heat but modelling the exact savings is difficult as this is dictated by user behaviour.

Installing the heat recovery system in the loft was relatively straightforward, and extra loft insulation was added afterwards.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 43,685 | 419 |
| After improvement (2010) | 13,119 | 126 |
| With all possible measures | 3,987 | 38 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 12.46 | 119 |
| After improvement (2010) | 5.12 | 49 |
| With all possible measures | 1.95 | 19 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £2,788 | £26.73 |
| After improvement (2010) | £1,319 | £12.65 |
| With all possible measures | £814 | £7.80 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Wood burning stove | 1.02 | 84 |
| Solid floor insulation | 1.28 | 260 |
| Solar hot water | 0.34 | 74 |
| Solar PV (1 kWp) | 0.53 | 95 |
| Total | 3.17 | 513 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

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# 1850s mid-terrace house Wiltshire

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 7

**£186** Saving on fuel bills

**54%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Loft and sloping ceiling insulation | £2,495 | 0.03 | £3 |
| New range / boiler | £5,252 | 5.64 | £124 |
| Double glazing | £9,201 | 0.65 | £59 |
| Total package | £16,948 | 6.32 | £186 |

## The home

This home is a mid-terrace property built around 1850 as workers' accommodation for the Savernake Estate near Marlborough. It is constructed from solid brick with flint panels on the rear elevation and is built around a large four-chimney stack in the centre of the property. Although it is characterised by a number of period features, it is not a listed building, and does not lie within a conservation area. The property had no mains gas supply, and was heated by an anthracite-fuelled Rayburn, with hot water provided by solar panels installed in the late 1990s.

The annual energy consumption of the property was significantly higher than an average property of its size, and due to its reliance on burning coal, it also registered higher than average carbon emissions. The old and draughty single glazed windows were causing noticeable heat loss.

## What they did

There were three key areas of energy inefficiency highlighted within the Target 2050 advice report that the owners were keen to address. The first priority was to find practical ways to reduce the heat loss through the roof by improving the insulation within the loft and surrounding ceiling area.

The next step was to replace the old inefficient single glazed windows, and the third important area to address was the heating, and in particular to replace the Rayburn with a cleaner, more efficient alternative.

"During the very cold spell in December 2010 the house was noticeably warmer than usual. Before the loft insulation and double glazing, the old Rayburn struggled to keep the house warm"

SevernWye ENERGY AGENCY

Supported by Wiltshire Council Where everybody matters

## Loft insulation

Part of the loft area at the front of the property had previously been converted to living space, but at the back it was not insulated and losing heat. On examination it was discovered that the ceiling above the first floor rear bedroom was structurally unsound, so this was replaced, which provided the opportunity to insulate behind the small area of sloping ceiling, at the same time as the floor of the loft space and the walls separating the loft space from the adjacent living space. This work was carried out by a local carpentry and joinery company for just over £2,300, not including the structural work.

*Sloping ceiling insulation being installed*

## Double glazing

Tucker Joinery based in Andover were commissioned to replace all the original sash windows with bespoke double glazed replacements that would replicate the appearance of the originals. These new units have been constructed with hardwood frames and 'Slimlite' double glazed panes, a particular brand of replacement window specifically designed for historic homes. The design comprises a 4mm clear outer pane, a 4mm gap filled with an inert gas that performs well in smaller cavities, and a 4mm inner pane of low emissivity glass. The windows have trickle vents to allow controlled ventilation of the living space.

The family also took this opportunity to replace the old single glazed rear door with a hardwood, Slimlite glazed replacement and had a small amount of refurbishment work done to move it to a better position at the back of the house.

## Replacing the Rayburn

The owners were keen to keep the same style of combined cooker and heating, but recognised that a change in fuel would help to lower their carbon emissions and reduce fuel costs. Sarson Stoves from Andover were employed to install an Esse wood-fired range, which is a cooker combined with a thermostatically controlled boiler providing heat to the radiators and hot water cylinder. The cooker provides a hot plate, fast and slow ovens, and the system performs at its optimum when burning good quality, well seasoned logs. Designed for continuous use, it can be kept alight indefinitely, and should require only occasional ash removal.

The Esse will provide all the space heating requirements for the house, with the existing solar thermal system providing additional heat for the hot water produced by the stove, particularly in the summer months. The cost to install the stove with required alteration work amounted to around £5,200.

## Next steps

Future plans include adding porches to the front and rear doors to reduce draughts, and replacing the existing halogen lighting with LEDs.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 37,024 | 327 |
| After improvement (2010) | 29,048 | 257 |
| With all possible measures | 17,221 | 152 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 11.65 | 103 |
| After improvement (2010) | 5.33 | 47 |
| With all possible measures | 1.61 | 14 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £1,404 | £12.40 |
| After improvement (2010) | £1,218 | £10.76 |
| With all possible measures | £844 | £7.46 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Solid wall insulation | 2.85 | £252 |
| Solar PV (1 kWp) | 0.49 | £88 |
| Total | 3.34 | £340 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

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# 1900s semi-detached Stroud

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 8

**£1,278** Saving on fuel bills

**51%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Internal solid wall insulation | £8,685 | 5.48 | £817 |
| Replacement double glazing | £10,016 | 0.77 | £157 |
| Replacement boiler + controls | £4,286 | 1.13 | £196 |
| Log burner in open fireplace | £2,000 | 0.72 | £108 |
| Total package | £24,987 | 8.10 | £1,278 |

## The home

This four storey semi-detached house was built around 1900 with solid brick walls, rendered on the side and rear. The lower ground floor is built into the side of the hill.

The top floor is a self contained flat, which was heated by electric night storage heaters. With no insulation in the sloping ceilings and solid walls, it was difficult to keep the flat warm in spite of the 200mm of insulation in the loft.

The main house was heated by an E-rated mains gas boiler, supplemented by a gas Aga and an open fire.

## What they did

The householders were only too aware how energy inefficient their home was; the home office was "absolutely freezing" in winter and the house was generally chilly and draughty except for the kitchen which was kept warm by the Aga.

A particular area of concern was the windows. Although they were double glazed, they were installed some time ago so the air gap was narrow by today's standards and the aluminium frames were not insulated. There were also plans to refurbish the flat before re-letting it.

The render on the side and rear was cracked in several places, which was causing damp on the internal side wall. As the render needed replacing anyway, external wall insulation was considered but this was very expensive due to the size of the area and the scaffolding requirements. The render was repaired for a much lower cost and the insulation scheme changed to internal.

"I'm very pleased with the external temperature controller on the central heating as this keeps the house temperature sensible when there's warmer weather outside some days."

SevernWye ENERGY AGENCY

STROUD DISTRICT COUNCIL
www.stroud.gov.uk

## Internal wall insulation

External wall insulation was not an option for the front of the house with its period frontage, but it was relatively straightforward to insulate these walls internally. 50mm phenolic foam bonded to standard gauge plasterboard was applied to almost all the walls on the top three floors, plus the small areas of sloping ceiling on the top floor.

Part of the side wall had become damp as a result of the cracked render, but after the re-rendering was finished there was sufficient time for it to dry out and be included in the internal insulation. The only area excluded was a short wall return, exposed because the attached house is set slightly further back. Insulating this wall would have covered some original decorative plasterwork and reduced the depth of the alcove, making it asymmetrical with the alcove on the other side of the fireplace. The lower ground floor was not insulated at this time as the householder had future plans for this area.

## Double glazing

All of the old, aluminium framed double glazing was replaced when the insulation was done. The same contractor was used for the glazing and insulation, which simplified the process, with the windows replaced first and the insulation fitted around them. The work was completed one room at a time, to minimise disruption. The extra wall depth means that things can now be put on the windowsills.

The new timber framed windows were chosen for their high performance and the lower environmental impact of timber over alternative frame materials, such as uPVC or aluminium.

## Heating improvements

The storage heaters in the flat were replaced with a small condensing combination boiler. The householders looked into various heating options for the main house, including a thermal store system with heat inputs from solar panels and a wood or wood pellet stove, with a small gas boiler as back-up. The quotes for this system proved expensive, so they opted for a modulating condensing gas boiler controlled by a digital thermostat and a weather compensator, which adjusts the heat output from the boiler in response to changes in the outdoor temperature. A new 300 litre twin coil hot water cylinder was installed, so solar water heating panels can easily be connected in future.

*Finished internal wall insulation and new high efficiency window*

## The Aga saga

The family was divided over the issue of whether to keep the gas Aga in the kitchen, so they had a separate gas meter installed to monitor consumption and were shocked to find that 63% of their annual gas use was due to the Aga. The Aga is now to be replaced with a radiator.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 84,900 | 376 |
| After improvement (2010) | 35,840 | 159 |
| With all possible measures | 26,900 | 119 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 15.93 | 70 |
| After improvement (2010) | 7.83 | 35 |
| With all possible measures | 6.89 | 30 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £2,700 | £11.95 |
| After improvement (2010) | £1,422 | £6.29 |
| With all possible measures | £1,291 | £5.71 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Insulation to solid concrete floors | 0.34 | £50 |
| Solar water heating | 0.29 | £36 |
| Solar PV (1kWp) | 0.33 | £39 |
| Total | 0.96 | £125 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

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# 1970s timber frame house Chalford

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 9

**£1,214** Saving on fuel bills

**48%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Loft top-up | £350 | 0.33 | £56 |
| Internal wall insulation | £3,137 | 3.28 | £554 |
| Replace warm air heating with central heating | £9,690 | 1.63 | £334 |
| Floor insulation | £560 | 0.33 | £50 |
| Solar hot water | £3,000 | 0.40 | £55 |
| Log burner | £850 | 0.22 | £105 |
| Replace halogen bulbs with LED lighting | £430 | 0.23 | £60 |
| Total package | £18,017 | 6.42 | £1,214 |

## The home

This detached house of timber frame construction was built around 1970 and extended in the mid 1980s. The timber frame walls have no insulation in the original construction and a small amount in the extension, and there was approximately 100mm of insulation in the loft.

The house has a solid floor and the main heating was a ducted warm air system from an F-rated mains gas boiler.

## What they did

In spring 2008 the family applied to take part in the Target 2050 scheme. The resulting survey and report highlighted a number of actions that they could consider to enable them to improve the energy efficiency, comfort and warmth of the house, and to lower the associated running costs and $CO_2$ emissions. Together with the home owners an action plan was developed to implement the improvements. Ideally this would have started with the insulation, but some time was needed to review the options for insulating the timber frame structure, so the first thing they did was to replace the warm air heating with a wet system, with an efficient boiler and incorporating solar hot water.

Two log burners were installed, providing extra warmth in the living and dining areas, and an alternative form of heat for times when the whole house heating is not needed.

This was followed by finding and implementing a solution for the wall insulation, as well as topping up the loft insulation and LED lighting in the kitchen/diner.

"We found the report very useful, it was great to be able to talk in detail to someone who was unbiased and helped us decide what was best for our home."

SevernWye ENERGY AGENCY

STROUD DISTRICT COUNCIL
www.stroud.gov.uk

## Heating improvements

The house was very difficult to keep warm with the old boiler and ducted warm air heating system. The owners decided to replace it with a new wet central heating system with an A-rated condensing boiler and radiators. A solar hot water system was installed at the same time, with panels on the roof and a new well insulated hot water cylinder to replace the existing poorly insulated one.

A log burner was installed in the open fireplace, to improve the efficiency of the secondary heating system in the living room and a second log burner installed in the new enlarged kitchen/dining room area.

## Loft insulation

The householders decided to top up the loft insulation themselves, as a DIY job. They raised the level of insulation from 100mm to approximately 300mm.

## Wall insulation

The external walls consisted of a timber frame sandwiched between timber cladding on the outside and plasterboard inside, and had very little mass or heat retention. As the frame is based on four foot squares and has many smaller areas it was not practical to blow insulating material into the cavities. One wall in the bathroom was DIY insulated with solid foam board, but this was found to be very time consuming, and the owners were aware of the importance of getting a good fit to prevent air movement around the insulation. After investigating the options, the final decision was to have spray foam insulation sprayed into all the cavities. The family did the preparatory work themselves, removing the plasterboard from the external walls so that the company could install the insulation to all the walls at once, without having to make repeat visits.

Having stripped the plasterboard to insulate these walls it was decided to take advantage of the disruption and to do other major work at the same time. They decided to rearrange the layout of some of the internal walls. The internal partitions between the kitchen, utility room and dining room were removed and the solid floor in this area dug up. This area was insulated and underfloor heating installed under the new floor screed.

*Spraying foam insulation into timber frame walls*

## LED lighting

LED lighting was chosen for the new kitchen/dining area. As the new ceiling was put up in this area, the wiring was put in place for recessed lighting using LED bulbs. These use only one tenth of the energy to give the same light output as halogen bulbs and the household were surprised to find how brightly this room was lit when they had finished.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 69,120 | 343 |
| After improvement (2010) | 32,061 | 159 |
| With all possible measures | 29,561 | 147 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 13.49 | 67 |
| After improvement (2010) | 7.07 | 35 |
| With all possible measures | 6.37 | 32 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £2,578 | £12.79 |
| After improvement | £1,364 | £6.77 |
| With all possible measures | £1,232 | £6.11 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Solar PV (1 kWp) | 0.33 | £71 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

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# 1920s end-terrace house Stroud

This and many other case studies are also available online at **www.target2050.org.uk**

Stroud District Target 2050
Countdown to a low carbon home

Case study 10

**£502** Saving on fuel bills

**47%** Reduction in carbon emissions

| Measures installed | Total cost | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|---|
| Internal solid wall insulation | £8,621 | 2.30 | £325 |
| Loft insulation top-up | £159 | 0.20 | £24 |
| Replacement double glazing | £7,073 | 0.40 | £47 |
| Solar PV (1.5 kWp) | £8,368 | 0.49 | £106 |
| Total package | £24,221 | 3.39 | £502 |
| Plus income from PV Feed-In Tariff (FIT) | | | £683 |

## The home

This 1920s end-of terrace house has two storeys at the front and a third lower storey at the rear which is built into the north facing hillside and is consequently very cold.

The walls are constructed of hollow bricks, which could not be insulated using conventional cavity filling techniques. There are sloping ceilings, and at the time of the survey, the windows were single glazed, with secondary glazing added only to some windows in the main living areas.

## What they did

When the owner applied to take part in Target 2050 she had lived in this row of cottages for almost a year. Living on a budget, she was looking for cost-effective ways to make the home warmer and more comfortable for her and her family.

The main area of heat loss was the walls, so the first measure installed was internal solid wall insulation, which was also carried over onto the small areas of sloping ceiling present under the dropped eaves.

The second step was to top up the loft insulation, which she was able to install herself.

She then had some double glazing installed, and finally was able to install solar photovoltaic panels with an interest-free loan through the Stroud Pay As You Save scheme.

**£683** Income from Feed-In Tariff (FIT)

"I really enjoyed the meetings with other Target 2050 households and I've also taken part in two Open Homes events where it's been great to talk to visitors about what we've done."

SevernWye ENERGY AGENCY

STROUD DISTRICT COUNCIL
www.stroud.gov.uk

## Solid wall insulation

The owners of all four homes in the terrace had expressed an interest in Target 2050 and initially a quote was sought to externally insulate the whole terrace together. This was abandoned due to the high cost, partly due to the difficulty of accessing the three storeys at the rear from the steep slope below. This aspect had to be included to achieve full benefits as it is north facing.

The owner of this end-terrace home went on to internally insulate the front, side and rear walls of the house on the ground and first floors, except for the bathroom. Most of the fitted kitchen units are located on an internal wall which meant the kitchen/diner could be fully insulated but the difficulty and expense of removing and replacing the bathroom suite ruled this room out.

As the radiators had to be removed to install the insulation, the householder took the opportunity to have thermostatic radiator valves fitted.

Alongside the wall insulation, small areas of sloping ceiling were insulated in each of the upstairs rooms, except the bathroom, and the benefit of this was so noticeable the householder decided to have the bathroom done as well. The open stairwell to the lower ground floor was boxed in to reduce the loss of heat from the kitchen/diner.

## Double glazing

Hardwood framed double glazing was chosen in preference to uPVC for its lower environmental impact and because the material is in keeping with the age of the property. The relatively high cost of wood over uPVC limited the replacement to key rooms: the living and bedrooms.

## DIY loft insulation

The householder installed her own loft insulation using a loft board product so that she could still use the loft for storage. There was already 75mm of glass fibre insulation between the joists; adding two 50mm layers of insulation board over the joists achieved an insulation value similar to 270mm of glass fibre insulation. The high compressive strength of the insulation board means that a chipboard floor can be laid over the top without the need to add timber to increase the depth of the joists.

*Sloping ceiling insulation ready for decoration*

## Solar electricity

The original budget did not stretch to solar panels, so the householder was pleased to be offered an interest-free loan through the Pay As You Save pilot for photovoltaic panels. Solar water heating was also considered, but the householder was happy with her existing combi boiler and there was only room on the roof for one kind of panel. A problem was encountered when the installer discovered the roof tiles contained asbestos, but with care and reference to HSE guidance the installation went ahead.

| Energy consumption | Total (kWh) | Per m² floor area |
|---|---|---|
| Before improvement (2007) | 41,500 | 497 |
| After improvement (2010) | 21,134 | 253 |
| With all possible measures | 15,400 | 184 |
| UK average (2010) | 19,800[1] | 243[4] |

| $CO_2$ emissions | Total (tonnes) | Kg per m² floor area |
|---|---|---|
| Before improvement (2007) | 8.30 | 99 |
| After improvement (2010) | 4.41 | 53 |
| With all possible measures | 3.30 | 40 |
| UK average (2010) | 7.10[2] | 72[4] |

| Running costs | Total | Per m² floor area |
|---|---|---|
| Before improvement (2007) | £1,351 | £16.18 |
| After improvement (2010) - excl FIT income | £849 | £10.17 |
| With all possible measures | £679 | £8.13 |
| UK average (2010) | £1,032[3] | £12.15[4] |

| Possible next steps | Annual $CO_2$ saving (tonnes) | Annual fuel bill saving |
|---|---|---|
| Replacement condensing boiler | 0.80 | £102 |
| Insulation to solid concrete floors | 0.30 | £40 |
| Total | 1.10 | £142 |

[1] Energy Saving Trust, 2010
[2] English House Condition Survey, 2007 (private sector housing only)
[3] U Switch, March 2010
[4] Based on 98m² from English House Condition Survey, 2007 (private sector housing only)

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**Published by Stroud District Council and Severn Wye Energy Agency October 2011**

Severn Wye Energy Agency Limited is a non-profit company and educational charity. It was established in 1999 under the European Commission SAVE programme to promote sustainable energy and affordable warmth through partnership, awareness-raising, innovation and strategic action.

**www.swea.co.uk**

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