WORKSHOP REPORT

Results of the Dublin Workshop, 27-28 January 2011

Evaluating the co-benefits of low-income energy-efficiency programmes

Grayson Heffner, Nina Campbell

June 2011

International Energy Agency

WORKSHOP REPORT

RESULTS OF THE DUBLIN WORKSHOP, 27-28 JANUARY 2011

Evaluating the co-benefits of low-income energy-efficiency programmes

Grayson Heffner, Nina Campbell

June 2011

This workshop report was prepared for the first of the IEA fuel poverty workshops held in January 2011. It was drafted by the IEA Energy Efficiency Unit. This paper reflects the views of the International Energy Agency (IEA) Secretariat, but does not necessarily reflect those of individual IEA member countries. For further information, please contact the Energy Efficiency and Environment Division at: nina.campbell@iea.org

International Energy Agency

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea (Republic of)
Luxembourg
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

The European Commission also participates in the work of the IEA.

International Energy Agency

International Energy Agency
9 rue de la Fédération
75739 Paris Cedex 15, France

www.iea.org

Table of Contents

List of figures

List of tables

Acknowledgements

The authors wish to acknowledge the contributions of all of the participants in the IEA's workshop on evaluating the co-benefits of low-income weatherisation programmes, held in Dublin, Ireland on 27-28 January 2011. The presentations and policy discussions during this workshop provided most of the content of this paper. Specifically, the presentations of Brenda Boardman (Emeritus Fellow, Environmental Change Institute, University of Oxford, UK), Lisa Skumatz (Skumatz Economic Research Associates, USA), Daniela Popescu (Technical University of Iasi, Romania), Sergio Tirado-Hererro (Center for Climate Change and Sustainable Energy Policy, Central European University, Hungary), Kathleen Gaffney (KEMA, Inc., USA), Sarah Brady (Northern Ireland Authority for Utility Regulation), Jenny Livingstone (NIE Energy, Northern Ireland), Clare Ryan (Community-Based Organisation Forum, Ireland), Philippa Howden-Chapman, (NZ Centre for Sustainable Cities, University of Otago, New Zealand), David Ormandy, (WHO Collaborating Centre for Housing Standards and Health, University of Warwick, UK), Véronique Ezratty (Medical Studies Dept., EDF, France), Deborah Frank (Boston Medical Center, USA), Matthew Murray (Energy Savings Trust, UK), Roger Colton (Fisher, Sheehan & Colton, USA), Bruce Tonn (Oak Ridge National Laboratory, USA), Tadhg O'Briain (Directorate General for Energy, European Commission, Brussels), Stjohn O'Connor (Department of Communications, Energy and Natural Resources, Ireland), and Jamie Torrens (Department of Energy and Climate Change, UK). The authors would also like to acknowledge the contributions of IEA colleagues to this paper, notably Bo Diczfalusy (Director of Sustainable Energy Technology and Policy Directorate) and), Richard Bradley (Head of the Energy Efficiency and Environment Division) and the IEA Publications Unit and Editorial team.

Introduction

The International Energy Agency's Energy Efficiency Unit (EEU) is beginning a new programme of work on *innovative energy-efficiency policies for mitigating fuel poverty.* The focus of the policy research effort is low-income weatherisation direct investment programmes, which many IEA member countries pursue in order to reduce the energy bills of low-income households. A common problem with such programmes is that the energy-saving benefits alone provide a relatively modest return for the energy-efficiency investment required, suggesting a weak return on government spending. However, these investments also have co-benefits for property owners, energy providers, programme participants, local communities and society as a whole. These non-energy co-benefits are not currently considered in the programme evaluations but may need to be included in order to provide a more complete picture of the impacts of low-income weatherisation programmes.

What is fuel poverty?

Households in fuel poverty[1] have energy costs which are excessive compared to overall household income. A common definition has emerged that any household spending more than 10% of its annual income on energy is in fuel poverty (Boardman, 1991). A slightly different definition - twice the median fuel expenditure as a proportion of income – is commonly used in the European Union. Regardless of the definition, the incidence of fuel poverty in IEA member countries is growing. Recent studies estimate 150 million people in fuel poverty in the European Union alone (Bird, Campbell and Lawton, 2010). Only half of these households receive fuel-poverty assistance, *e.g.* fuel aid or subsidised tariffs (EPEE, 2009). Analysts agree that the combined effects of the economic crisis and rising energy prices have further exacerbated the problem. In Northern Ireland, for example, the incidence of fuel poverty has risen from 34% in 2006 to 44% in 2009 (Brady, 2011).

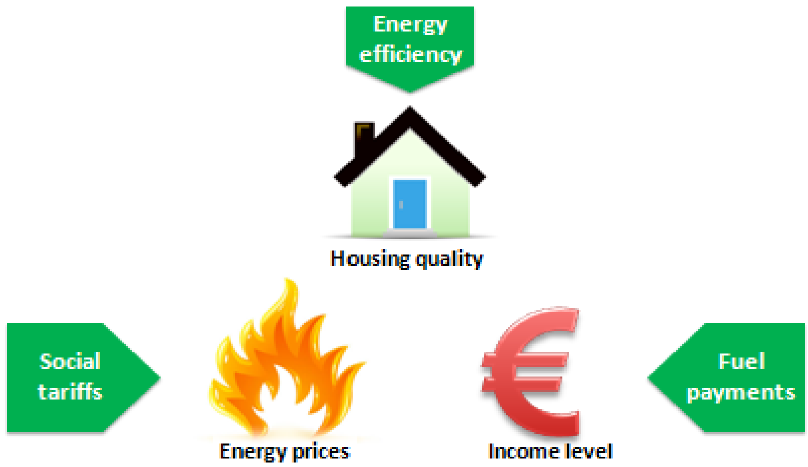
Three factors contribute to fuel poverty: income, energy prices, and housing quality (Figure 1). Combinations of low income, high energy prices and poor housing quality can force households to choose between adequate energy services (*e.g.* heat and light) and other essentials. While low-income level and high energy prices are important drivers, the tendency of lower-income households to live in older buildings with poor heating and insulation standards is key factor in fuel poverty.

Fuel poverty has always existed, but understanding its causes and the harm that can result is relatively recent. Fuel-poor households cannot adequately heat and ventilate living spaces and have difficulty paying energy bills. The broader impacts of fuel poverty are felt by low-income households and communities and include inadequate thermal comfort, increased morbidity and mortality, and poor educational outcomes, among others. A study of 40 000 excess deaths in England and Wales demonstrated a credible chain of causation linking poor housing and poverty to low indoor temperatures and cold-related deaths (Johnson and Griffiths, 2003).

Governments already use a range of policies to mitigate fuel poverty (Figure 1). These policies include income-supplementing fuel payments for qualifying households, social tariffs to reduce effective energy prices, and investments in improved quality of housing or more efficient appliances.

1 The IEA uses the term "fuel poverty" as distinct from "energy poverty" which is used by some experts but more commonly refers to the problem, faced in developing countries, of a lack of access to energy as a result of inadequate basic infrastructure. Fuel-poverty issues also appear under different names in different countries, such as "energy precariousness" in France and addressing the "vulnerable customer" in Europe. Refer to the glossary at the end of this paper.

Figure 1. Drivers of fuel poverty and related policy responses



While effective, income supplements and social tariffs are expensive. These measures are a cost to the state as well as the energy provider and may not be sustainable. For example, in 2010 the United Kingdom provided USD 5 billion (EUR 4.2 billion) in winter fuel and cold weather payments (Table 1). On the other hand, energy- efficiency improvements may not be practical or economical as a substitute for income supplements, especially for hard-to-treat residences. In these cases it may be more cost-effective to provide on-going subsidies.

Table 1. Annual targeted energy consumption subsidies and energy-efficiency spending (million EUR)

Country	Targeted consumption subsidies	Targeted energy-efficiency investments	Energy efficiency as a share of total targeted spending
Ireland	300	55	15%
United Kingdom	4 200	2 120	34%
United States	1 800	147*	8%

*Excludes stimulus American Relief and Recovery Act [US] (ARRA) spending.

Energy efficiency as a fuel-poverty reduction policy

Experience shows that improving a building's resistance to the elements (*e.g.* weatherisation) and other energy-efficiency improvements (*e.g.* water heater and piping insulation; replacing old and inefficient appliances, lighting and equipment) are effective in reducing fuel poverty. Investments in energy efficiency permanently lower energy use in low-income households while reducing government and energy provider outlays on fuel assistance and social tariffs. A 2007 study calculated that almost one million vulnerable households could be taken out of fuel poverty with a combination of efficiency and renewable energy investments (insulation, boiler improvement, solar-water heating) at a cost of USD 8.2 billion (GBP 5 billion) (Energy Action Scotland and National Energy Action [England and Wales], 2009).

Many IEA member countries have recognised the economic development and poverty reduction benefits of low-income energy-efficiency policy and have implemented weatherisation assistance programmes. In the United States, over six million homes have been weatherised over three decades via the United States Department of Energy's Weatherization Assistance Program (US DOE, 2011). In the United Kingdom, the Warm Front and Energy Assistance programmes have provided insulation and heating systems to over two million vulnerable households since 2001.

In some countries energy-efficiency experts have argued that fuel-poverty reduction budgets include too much spending on energy subsidies and too little investment on energy efficiency. Little analysis has been done on what an optimal fuel-poverty strategy might comprise, making it difficult to gauge whether the share of fuel-poverty mitigation spending (Table 1) being directed to EE measures (energy-efficiency measures) is too high or too low. Developing programme evaluation frameworks that consider the co-benefits of energy-efficiency investments for low-income households might lead to fuel-poverty programme budget reallocations in the future.

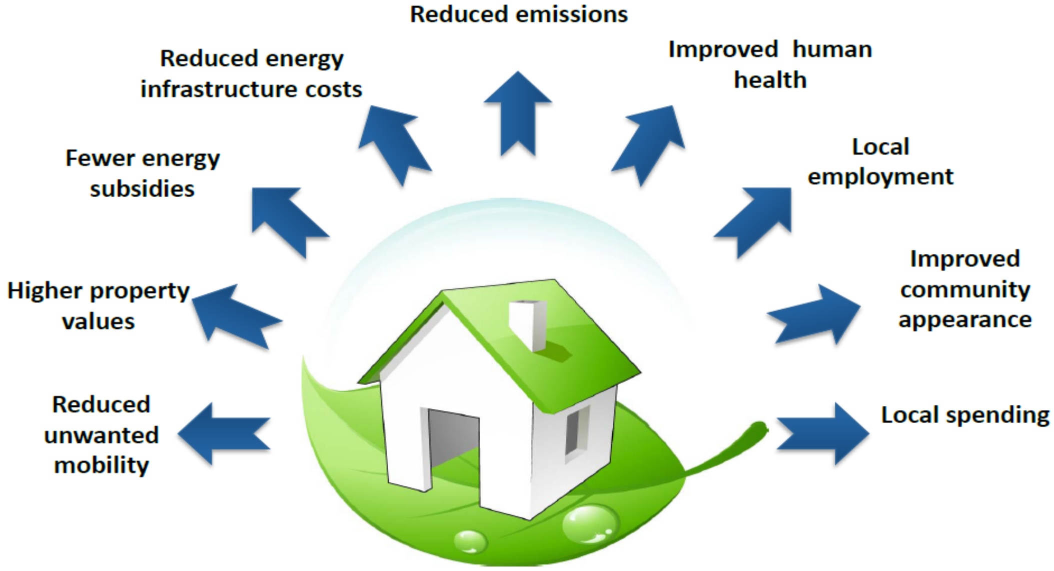
Evaluating low-income energy-efficiency programmes

Low-income energy-efficiency programmes have traditionally been evaluated on the basis of energy savings for participating households. Such evaluations compare household energy savings or bill reductions with annual programme spending to determine whether an energy-efficiency programme is cost-effective.

Some evaluations have introduced, in a qualitative way, the potential non-energy co-benefits of energy-efficiency investments (Schweitzer and Tonn, 2002). In other jurisdictions, notably New Zealand, policy makers have begun to take note of these non-energy co-benefits in programme evaluation and planning (Prevak, et al., 2010).

Non-energy benefits can accrue to different stakeholders or to society as a whole. Examples include higher property values, improved appearance of the community, local job creation, lower school and work absenteeism, and potentially lower outlays on government or utility energy subsidies (Figure 2). Some of these benefits, notably job creation, are often cited by policy makers as a rationale for government spending on low-income energy efficiency. However, programme evaluation frameworks generally do not take into account these co-benefits.

Figure 2. Non-energy co-benefits of low-income energy-efficiency programmes



Non-energy co-benefits can be categorised according to the nature of the benefit and the beneficiary. The co-benefits literature is quite diverse, but most studies describe the following categories (Table 2):

- **Direct financial co-benefits that accrue to governments and energy providers, and property owners and participants.** These include reduced outlays for energy assistance and rate subsidies, as well as other cost savings for utilities and ratepayers *(e.g.* avoided bad debt write-off; reduced carrying cost on billing arrears; reduced spending on notices, collections, customer calls, and shut-offs and reconnections for non-payment).
- **Indirect economic co-benefits to participants, ratepayers and taxpayers, property owners, and society.** These include increased individual or neighbourhood property values, economic activity (including jobs created through spending on low-income energy-efficiency programmes), improved home and fire safety, improved learning and earning capability of participants, and reduced mobility of low-income households.
- **Social welfare and livelihood co-benefits to participants, the local community and society as a whole.** These include improved health and comfort through reduction of noise, drafts, mold and mildew; improvement in community appearance; environmental benefits; and improved educational outcomes.

Table 2. Low-income energy-efficiency co-benefits and beneficiaries

BENEFICIARY / BENEFIT TYPE	Participants	Energy providers, governments, and rate/tax payers	Property owners	Society
Direct financial	Fewer reconnection fees Water savings	Fewer shut-offs Subsidies avoided Arrearages savings		
Indirect economic	Reduced mobility	Tax revenue increases	Higher property value Rents paid on time	Fewer fires Local jobs Local spending
Social welfare and livelihood	Improved comfort Improved health Improved safety	Community pride	Improved appearance	Environmental benefits, Improved heath and education outcomes

Evaluating energy-efficiency co-benefits is more difficult than evaluating direct energy savings. Estimating co-benefits is complicated by a lack of data, difficulties in accounting for intervening variables and methodological issues. Degree of difficulty does vary, however.

Co-benefits with a direct financial impact, such as reduced outlays for fuel assistance, can be estimated using the same methods now used to estimate energy benefits. Indirect economic benefits can be estimated assuming data are available and an estimation model can be developed. Social welfare and livelihood impacts are more difficult to estimate and introduce into the evaluation framework, although recent cohort studies in the United States, New Zealand and elsewhere have positively linked improved health outcomes and other benefits to low-income weatherisation. However, methodological complications remain, including establishing causality between programmes and co-benefits, monetising different types of benefits, accounting for different beneficiaries, and avoiding double-counting. Incorporating non-energy co-benefits requires a broader evaluation framework, new sources of data, new estimation methods, and new ways to express evaluation results.

Improved understanding of such causal links together with new evaluation methods justifies increased efforts to incorporate co-benefits into standard evaluation practice. Eventually, evaluation methods incorporating broader consideration of co-benefits will support improved policies and decision making on all of the fuel-poverty mitigation alternatives.

Workshop Results

The IEA, in co-operation with Sustainable Energy Ireland, organised a workshop that brought together international experts on low-income weatherisation and fuel poverty for a focused discussion on evaluating co-benefits. The workshop was structured to consider the three main categories of co-benefits cited in the literature (See Table 2). Sessions also included evaluation methods and co-benefits evaluation case studies. The workshop was intended to share information internationally on low-income energy-efficiency evaluation approaches and results, create a community of interest around this important topic, and identify opportunities for future collaboration.

Session 1: Setting the scene

Fuel poverty has always existed, but understanding its causes and the harm that can result is relatively recent. Many IEA member governments have already implemented fuel-poverty reduction programmes, including low-income energy-efficiency, with varying results. While objective gains in terms of energy savings have varied widely, participant households uniformly report positive effects on their quality of life. The opening session of the workshop included perspectives on low-income energy-efficiency programmes and how to evaluate them from Professor Emeritus Brenda Boardman of Oxford University and US energy-efficiency programme evaluation expert Dr. Lisa Skumatz.

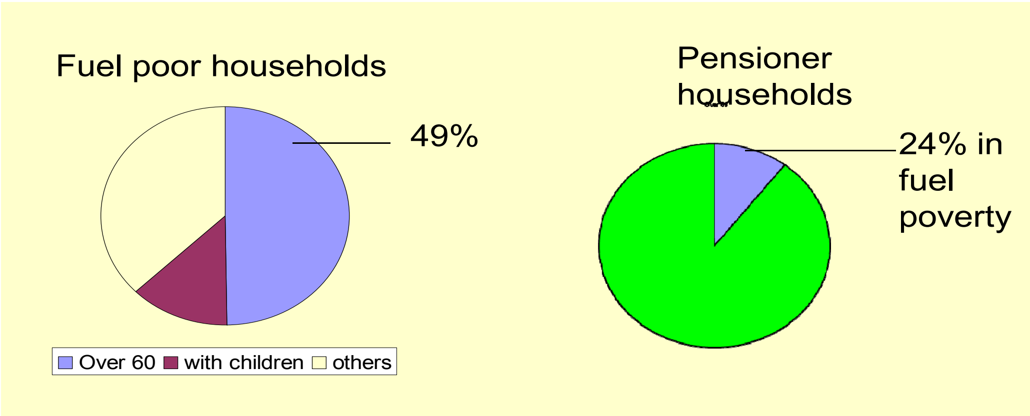
Professor Brenda Boardman described how the quality of housing and income levels combine to create conditions of fuel poverty. Fuel poverty was originally thought to be about fuel prices and income levels only, particularly as one of the common symptoms is debt and disconnections. Improved understanding of the dynamics of fuel poverty has led to an increased appreciation of the mediating role of housing quality*, e.g.* energy efficiency, in causing or preventing fuel poverty. In this sense, energy inefficiency can be seen as a main cause of fuel poverty, with the goal of low-income energy-efficiency investments being to create a condition of affordable warmth for low-income households.

Definitions of fuel poverty vary, and it is important for the definition to be clearly stated. In the United Kingdom, a household is considered to be in fuel poverty if it must spend more than 10% of income on energy in order to maintain a satisfactory heating, lighting and other energy services.

Using the 10% definition leads to an estimate of 5 to 6 million households in the United Kingdom living in fuel poverty – a little less than 20% of the population. The definition takes into account the common situation where households do not consume sufficient energy to maintain a warm environment, thus risking health consequences in exchange for fuel savings. Households with unmet demand for minimum levels of heat and warmth should be considered to be in fuel poverty regardless of their energy outlays to disposable income ratio.

This definition makes it difficult to target the fuel poor. Even if income and energy billing data are known, a household may be under-consuming for budgetary reasons. Targeting the fuel poor is imperfectly done, through proxies such as age or entitlements eligibility. The UK's Winter Fuel Payments Programme is available to all pensioner households regardless of their circumstances, which amounts to over 70% of English households. As a result, about three-quarters of these fuel assistance payments flow to non-fuel-poor households (Figure 3). One policy solution would be better targeting of the fuel poor, through improved fuel poverty definitions, better understanding of social and demographic contributors to fuel poverty and improved outreach.

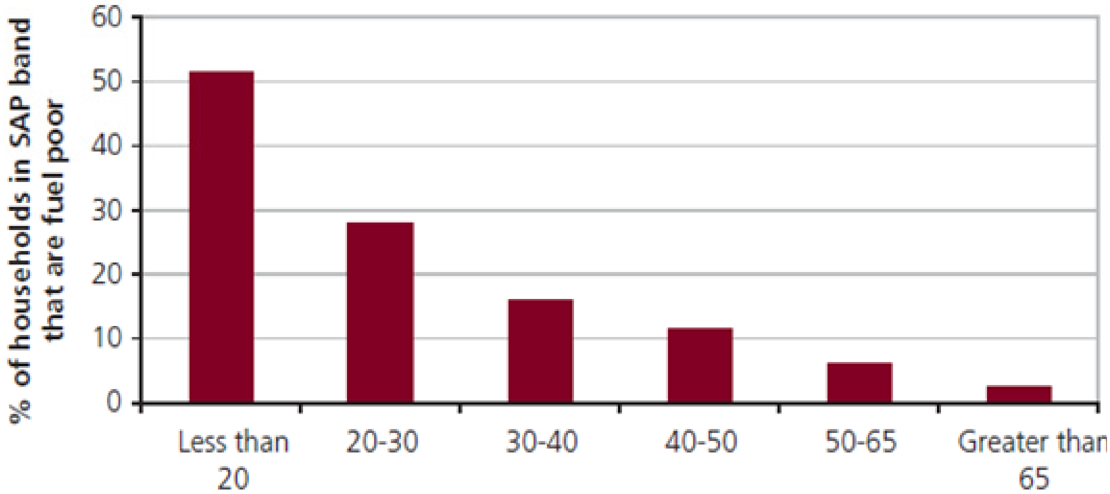
Figure 3. Demographics of winter fuel payment recipients in United Kingdom (2008)



Source: Boardman, 2011a.

The link between housing quality and fuel poverty is evident from United Kingdom data on the housing stock (Figure 4). Over half of the households in fuel poverty live in housing with a building energy-efficiency Standard Assessment Procedure (SAP)[2] score less than 20, which equals a G-rating – the lowest ranking in the UK buildings certification system. Warmth in these households is expensive and many households are not able to heat these homes to healthy levels. In this context, investments in energy efficiency are an important fuel-poverty mitigation tool.

Figure 4. United Kingdom fuel poverty by SAP rating of the home

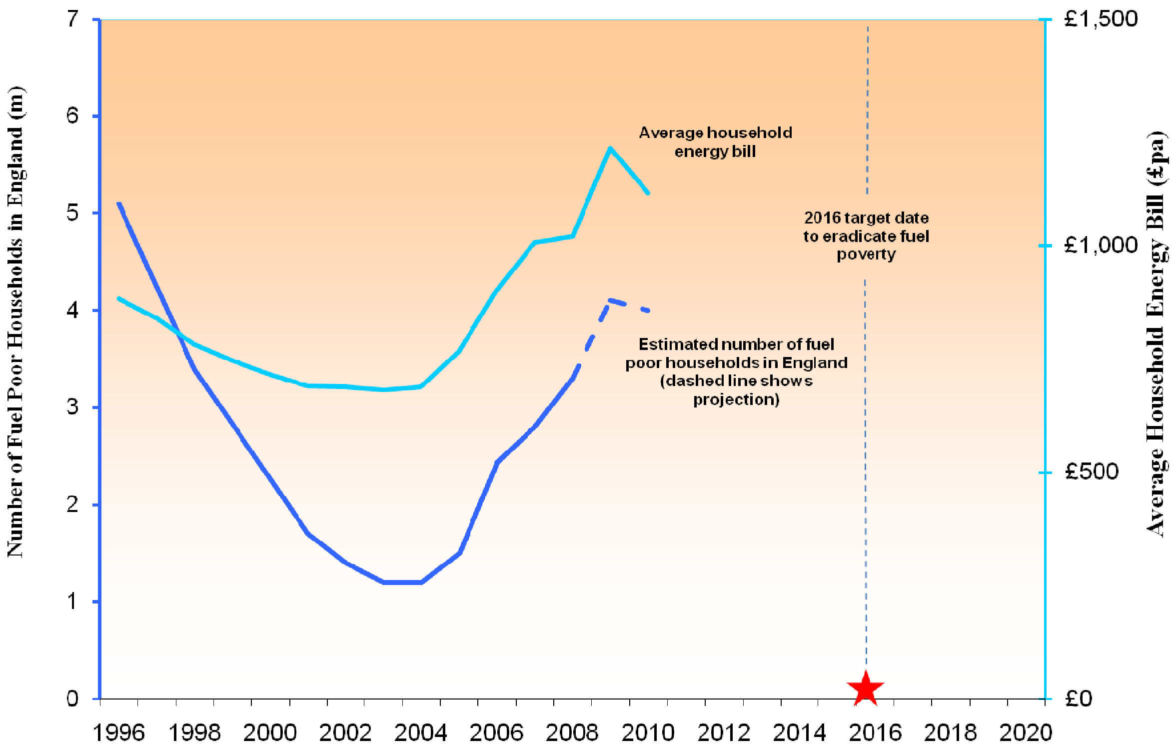


Source: DEFRA/BERR, 2008.

The UK government is legally obliged, under the terms of the Warm Homes and Energy Conservation Act 2000, to eradicate fuel poverty by 2016 "as far as reasonably practicable" (Figure 5). Meeting this 2016 goal will require delivering energy-efficiency investments to 850 000 households per year over the next four years, moving them from SAP scores in the less than 40 range to scores of 60 and above.

[2] SAP is the Standard Assessment Procedure developed by the Building Research Establishment (BRE) for gauging building quality and used by certified buildings assessors. See www.epcforepcs.co.uk/SAP_Ratings/.

Figure 5. DECC fuel poverty statistics at 2010



Source: DECC, 2010.

The demographics and climate in any one country have a strong influence on fuel-poverty policy discussion. In the United Kingdom, for example, almost two-thirds of fuel-poor households own the homes they occupy, often with paid-off mortgages. These households tend to be elderly, and will often under-consume fuel in order to avoid entering into debt. This segment would be a good choice for an energy-efficiency policy intervention. The balance of fuel-poor households live in social housing, which is of a fairly high standard in the United Kingdom, or in rental property.

Lisa Skumatz provided an overview of the low-income weatherisation co-benefits evaluation landscape. Numerous studies in the United States and elsewhere have considered how to evaluate the co-benefits (sometimes called non-energy benefits, or NEBs) of low-income energy efficiency. Many of these studies were exploratory, using indirect estimation methods such as revealed preferences. The objective of these exploratory evaluations was to bound the magnitude of the co-benefits as a first estimate. Such evaluations, while not producing a concrete value, provide an order-of-magnitude estimate that might inform policy makers' decisions. Such efforts stemmed from a consideration that even rough estimates of co-benefits are better than assuming a value of zero.

A meta-analysis suggests that non-energy co-benefits are indeed significant, adding as much as three times the benefits of direct energy savings to participants. However, the uncertainty bound around these estimates is very high indeed — from USD 300 to USD 5 000 annually per participant. These exploratory studies suggest that most co-benefits accrue to participants, with another one-third benefiting society as a whole. Only modest benefits could be found for utilities, and no attempts have been made to estimate reduced government outlays on fuel assistance as a result of low-income efficiency investments. The meta-analysis identified health and safety benefits estimation as lagging behind, but developing rapidly (Skumatz, 2011a).

Session 2: Indirect economic co-benefits

Most of the co-benefits from low-income weatherisation flow to the participants. However, low-income energy-efficiency programmes also have indirect economic benefits for other private individuals as well as society, starting with the local communities where programmes are implemented. Session 2 provided an opportunity to consider some of these benefits and how they can be evaluated. Indirect economic co-benefits include increased property values as buildings are improved and rehabilitated, increased tax revenue for governments, local job creation, and other economic activity from programme spending in local communities. Less tangible but still important social benefits can include community pride and social cohesion. These benefits are hard to measure because they accrue to numerous and diffuse beneficiaries.

This session included expert speakers from the private sector and academia discussing their research into property valuation and job creation benefits from low-income energy-efficiency programmes.

Daniela Popescu of the IMMOVALUE project team described research on the relationship between market values and green housing. Even though research on this topic is just emerging, there is increased evidence of a correlation between market value of a building and its energy efficiency. For example, a survey by the US Green Buildings Council found not only an average 8% to 9% reduction in operating expenses in green buildings, but also a 7.5% increase in market values (USGBC, 2008). The IMMOVALUE project team are working from the assumption that green value will be an integral part of future market valuation of housing and commercial buildings.

The willingness to pay for green features depends on market state, transparency, location, sector, exposure to environmental risk in the region, consumer awareness, and many other variables. For this reason it is not possible to formulate a general rule for valuing market premiums for green buildings. Rather, the valuation process will evolve through training and adaptation of existing valuation methods in order to better incorporate energy-efficiency characteristics. A critical element of this evolution will be acquisition of reliable data on the market performance of green buildings. A Guidance Note for integrating energy performance into European Valuation Standards highlights some of the most relevant aspects of environmental sustainability and its connection to property valuation. Development of market valuation premiums for green buildings will be furthered by policies that help link the benefits of green features to increased market value. These policies include strengthened regulations for new and existing buildings and information and awareness building policies such as building certification. Such supporting policies help create more consistent systems for all parties – owners, tenants, valuers – to equate degrees of energy efficiency with corresponding degrees of valuation increase.

Sergio Tirado Herrero of the Center for Climate Change and Sustainable Energy Policy (3CSEP) described manifestations of fuel poverty and the co-benefits of low-income energy-efficiency programmes in the Hungarian context. Whereas the average Hungarian household spends around 10% of its net income on energy, only 12.4% report themselves as fuel-poor — more evidence of the difficulty in effectively targeting fuel-poor households. Many residential buildings in Hungary date back to the Soviet era, with pre-fabricated concrete construction and obsolete district heating networks. Many of these households pay a fixed flat rate, with no energy metering and no thermostats. Some of the coping strategies utilised include maintaining low indoor temperatures, reducing the fraction of the floor area heated, switching fuels (natural gas to firewood, sometimes obtained illegally) and electricity theft.

3CSEP recently studied the employment benefits of a large-scale, deep-building renovation programme to improve energy efficiency in Hungary. The project scale is immense; in the lesspushed scenario, USD 1.4 billion to USD 2.8 billion per year (EUR 1 billion to EUR 2 billion per year) through 2050, with 100 000 apartments renovated per year. Such a programme would create over 100 000 additional jobs per year and result in a 40% reduction in the current Hungarian gas consumption. The study concluded that energy savings would pay back investment costs (though in a relatively long timeframe), and that fuel poverty would be practically eliminated through the programme. In addition, the study assessed the direct, indirect and induced employment benefits in an input/output modelling framework. Calculation of employment benefits necessarily took into account potential job losses likely to occur in the energy provision, distribution, and supply chain sectors as a result of reduced energy usage, and considered the durability of employment linked to one-off renovations. It also noted that the labour intensity of low-income energy-efficiency improvements is considerably higher than for other energy-efficiency investments and that deeper renovations achieving a reduction of 80 to 90% of the energy use for space heating should be prioritised in order to avoid locking-in a large fraction of the energy saving and emissions reduction potential of the building stock. They should also give more scope for workforce training in addition to better results for fuel poverty alleviation.

Session 3: Direct financial co-benefits

Low-income energy-efficiency investments in fuel-poor households can yield direct financial benefits for energy providers,[3] ratepayers and governments (Table 2). Many energy providers have initiated their own programmes to assist low-income customers, while other utilities have established programmes in response to government fuel-poverty and energy-efficiency policies.

Involvement by energy providers in fuel-poverty programmes is important and beneficial, as they have the most direct line of contact with fuel-poor families and can help identify needy households and monitor programme results. Utilities benefit directly from low-income energy-efficiency efforts. In addition to reducing the loss-making sales of energy delivered on social tariffs, utilities can reduce the carrying cost of billing arrears, expenses associated with collection activities and disconnections, and bad debt write-offs. Governments can also benefit to the extent that energy-efficiency improvements reduce outlays for fuel assistance and other subsidies to participating low-income households.

This session provided an opportunity to hear the perspectives of evaluators, regulators and energy providers regarding how to include these co-benefits in evaluating low-income weatherisation programmes.

Kathleen Gaffney of the US consultancy KEMA gave an overview of the US experience with weatherisation co-benefits. While energy providers are interested in the impact of energy savings on their bottom line, they have been slow to investigate potential co-benefits for themselves and others. US energy providers are mostly concerned about reducing collection costs and bad debt write-offs, and minimising loss-making sales on subsidised tariffs (Table 3). However, in addition to direct energy savings, programme participants benefit from a reduced need to move house (or forced mobility), lower health care costs and savings on other household bills. Governments also may financially benefit from improved tax base as well as reductions in the costs of safety inspections for low-income housing.

The key problem faced in evaluating these direct financial co-benefits is a lack of good, comparable data that can be treated as broadly representative of the different beneficiaries.

[3] The term “utilities” and “energy providers” will be used interchangeably in this instance. “Energy providers” is the more generic term as it refers to regulated energy utilities as well as unregulated energy retailers.

These evaluation challenges – data availability, measurement methods, persistence, and avoidance of double-counting – have made it difficult or cost-prohibitive to address all of the possible co-benefits. The result has been that most co-benefits are estimated with little empirical certainty, and what estimates have been developed cannot easily be generalised. As a result, this category of co-benefits continues to be largely unrepresented in programme evaluations.

Table 3. Direct financial co-benefits by beneficiary

Energy provider	Participant	Governments
Arrearages	Reduced mobility	Improved tax base
Bad-debt write-off	Lower health care costs	Inspection cost savings
Terminations	Other utility savings (water)	
Reconnections	Improved safety	
Fewer loss-making sales on discounted rates		
Collection activities		
Safety emergencies		
Electrical system reliability		

Source: Gaffney, 2011.

Kathleen Gaffney provided several examples of exploratory co-benefit evaluations carried out in Wisconsin (United States) and Quebec (Canada). The Wisconsin study used input/output analysis to identify an economic boost to the local community created when energy-efficiency measures reduced bills and left households with more disposable income. The Quebec study faced methodological challenges in concretising co-benefits such as health and comfort; efforts to do so were abandoned when the direct energy savings benefits alone proved sufficient to justify the programme.

Sarah Brady described how energy providers participate in delivering all three of the main policies for fuel-poor households in Northern Ireland. Fuel poverty is acute in Northern Ireland, where its incidence has risen from 34% to 44% since 2006; the share of fuel-poor households is by far the largest in the United Kingdom (Table 4). This reflects several factors unique to Northern Ireland, including a colder and wetter climate, housing quality and prevalence of relatively expensive oil-heating systems. Energy providers help reduce bills by discounted pre-payment meter services and through the Northern Ireland Sustainable Energy Programme (NISEP), 80% of which is ring-fenced to benefit vulnerable households.

Table 4. Incidence (%) of fuel poverty in the United Kingdom

England (2009)	Scotland (2006)	Wales (2006)	Northern Ireland (2009)
15.6	26.5	20.0	44.0

Source: Brady, 2011.

The regulator in Northern Ireland, the Northern Ireland Authority for Utility Regulation (NIAUR), is mandated to oversee utility behaviour and energy-efficiency implementation as well as the protection of vulnerable energy customers. NIAUR patrols price structures to ensure that energy providers' returns are not related to increased volumes, and uses licence and other conditions as well as the NISEP scheme to ensure energy providers have an incentive to provide energy-efficiency advice and carry out energy-efficiency projects.

Jenny Livingstone provided additional narrative on how energy providers deliver fuel-poverty interventions in Northern Ireland. Northern Ireland Electricity Energy (NIE) delivers low-income energy-efficiency schemes including heating system upgrades and weatherisation measures, which are funded through the NISEP scheme. NIE Energy also has a unique outreach program, the For Your Benefit campaign, in which NIE Energy engages vulnerable customer groups by direct mail and helps them review their eligibility for a range of low-income entitlement programmes.

In consultation with other social welfare services delivery partners, NIE Energy has completed over 10 000 benefit entitlement checks (BEC). Two of every five BECs resulted in the vulnerable household claiming additional benefits they were unaware of. NIE Energy also operates a highly successful pre-payment meter program. Almost one-third of NIE Energy's customers choose this option, which provides a 2.5% discount reflecting lower costs to serve pre-payment customers. Customers buy electricity through Paypoint, Payzone, Post Office, telephone or on the web. This customer-friendly service option helps with debt management and budgeting, while a "friendly credit" option minimises self disconnection. Providing customers with current and historical consumption information through a display has encouraged customers to use about 4% less electricity than comparable customers on the standard service (Livingstone, 2011).

NIE Energy's experience with delivering energy-efficiency programmes to low-income households has convinced them of the benefits they accrue. These include improved corporate image, customer loyalty, reduced bill arrearages and call centre costs, and closer relations with regulators and government.

Session 4: Participant co-benefits

Low-income energy-efficiency programme evaluation is currently limited to the energy bill savings for programme participants. While these energy savings are sufficient to justify government spending, other co-benefits for participating households may be larger and more important in the long run. These benefits include lower frequency of moving house, improved school and work attendance, and improvements in household comfort and safety. While recognised as important, estimating these benefits is challenging. This session examined participant co-benefits from health and wellness, quality of life and community well-being perspectives.

Brenda Boardman lead a discussion on the medical, social and psychological problems that fuel poverty poses for household occupants and the extent to which these can be addressed by energy-efficiency improvements. Some analysts suggest that excess winter deaths are an important aggregate indicator of fuel poverty. These have averaged 25 000 annually in England alone over the past ten years, which on a per-capita basis is higher than in colder regions such as Canada and Scandinavia.

Medical reports of physical health effects from fuel poverty are beginning to emerge, especially for very young children and in people above 40 years. A particular problem with poor-quality housing is condensation and mould. Mould results from condensation on cold surfaces, and is unpleasant, smelly, destructive and difficult to eradicate. Most significantly, it has been shown to cause asthma in children, which once contracted cannot be cured. Weatherisation measures have been shown to be an effective way to prevent mould, suggesting that prevention of asthma through low-income weatherisation may produce long-term health cost savings. Although data is sparse, in 1994 condensation-related health costs to the National Health Service (NHS) were estimated at USD 1.6 billion (GBP 1 billion) (Boardman, 2011b). Growing medical evidence on the link between cold and poor health suggests that more clinical research is needed.

In addition to physical illnesses being ignited or exacerbated by cold and damp in fuel-poor households, Professor Boardman pointed to studies showing significant effects on mental health (Table 5). Another study found that the incidence of anxiety or depression was halved after energy-efficiency measures (Green and Gilbertson, 2008).

Table 5. Effects of cold homes

Impact	Percent of Respondents
Made me/us feel miserable	55%
Made an existing health problem or problems worse	39%
Made me/us feel anxious or depressed	34%
Did not feel able to invite friends or family to the house	18%
Spent as much time as possible away from the house	18%
Brought on a new health problem or problems	18%
None of these	15%

Source: Anderson, Finney and White, 2010.

Denial is a major obstacle to properly identifying the fuel-poor. People often say they are warm enough, even when they are cold; this suggests a fear of social stigma may be preventing them admitting their situation. Methods that rely on self-identification through telephone or mail surveys are unlikely to obtain accurate answers. Detailed, face-to-face assessments carried out in the home are a much more reliable way to determine a condition of fuel-poverty.

Clare Ryan presented the Warm Project, which is one of several community-based, low-income energy-efficiency activities funded by Sustainable Energy Authority Ireland's Warmer Homes programme. The Warm Project is delivered in collaboration with community-based organisations, enhancing human and social capital at the community level as part of low-income energy-efficiency programme delivery. These community-based organisations have a unique understanding of the economic and social infrastructure of communities, which allows them to effectively identify and engage with fuel-poor households. Local knowledge also allows community-based programme delivery to adapt to the broader socio-economic needs of a particular community and to achieve maximum participation of fuel-poor households with no stigma attached. Community-based programme delivery can also maximise community co-benefits of low-income energy-efficiency investments in the form of improved housing stock and property values, creating local skilled jobs, providing training (especially for the long-term unemployed), and reducing pressure on local health services via improved health of participants (Ryan, 2011).

Community-based approaches might offer important opportunities to evaluate the community and societal co-benefits of targeted low-income energy-efficiency programmes. Such concentrated programmes could be accompanied with data collection and co-benefit evaluation frameworks that might identify at the community level some of the co-benefits found in Tables 2 and 3.

Professor Philippa Howden-Chapman described the work carried out by the University of Otago Housing and Health Research Programme. The He Kainga Oranga (Healthy Housing) programme considers the social gradient in health and uses solution-focused research to reduce excess winter mortality (EWM) and respiratory and circulatory problems, which have been linked to inefficient, poor quality housing. Research in New Zealand has shown that poorly insulated pre-war housing is responsible for a recurring average of 1 600 excess winter deaths annually (compared to 400 traffic fatalities). A census-mortality linkage study found higher EWM among older homes, low-income people, those living in rented accommodation and in urban areas. This suggests a social gradient within the EWM health issue. Other studies examining excess winter hospitalisation found similar links with housing vintage and income level. Based on the current 10% of household income definition, 25% of New Zealand households are estimated to be in fuel poverty.

Of particular interest to co-benefits evaluation are several New Zealand studies that tested the linkage between weatherisation, health and carbon mitigation. The 2008 Housing, Insulation and Health Study targeted 1 400 households with at least one person already experiencing chronic respiratory illness symptoms by carrying out weatherisation before and after temperature and humidity measurement. Results showed marked reductions in indoor cold and dampness as well as energy savings of 23%. Additional benefits measured included improved comfort, fewer days off school and work, reductions in cold and wheeze symptoms, and fewer hospital admissions. The 2009 community trial, the Housing, Heating and Health Study, enrolled 400 households where there was a child with doctor-diagnosed asthma and found that installing insulation and sustainable heating improved the indoor environment, reduced the children's asthma symptoms and the number of school absences.

The Housing and Health Research Programme is continuing its research into evaluating health outcomes of improved housing. One-third of houses in New Zealand have mould problems, and a study is being undertaken to investigate the relationship between cold houses with mould and the development of asthma in babies. Another community trial is looking at the benefits of winter fuel payments to 520 older people, who have been previously hospitalised for respiratory conditions. Such utilisation of solution-oriented experimental frameworks is promising from a co-benefits evaluation perspective.

Professor Howden-Chapman emphasised the role of researchers in facilitating the translation of quantitative data from community trials, which demonstrated significant causal relationships between weatherisation and co-benefits into governmental policy. Framing programme and policy trials as housing and health research — rather than just energy efficiency or poverty alleviation — proved effective in avoiding potential social and political stigma. Solution-focused studies proved more effective in communicating the available benefits to policy makers as well as to the participants themselves. The team termed their approach "Heat as Medicine", and expressed the benefits of improved housing quality as concrete number of avoided hospital admissions. This slant on weatherisation investments spoke loudly to politicians. Combining energy savings with health, educational and social impacts as well as a calculation of carbon emissions savings in the Insulation study was able to show a 2:1 cost benefit ratio from weatherisation. A cost/benefit analysis of the national roll-out of the New Zealand Insulation Fund on energy efficiency, hospitalisations, pharmaceutical usage and job creation is currently being finalised (Howden-Chapman, 2011).

Session 5: Co-benefits evaluation case studies

The fuel poverty and energy-efficiency discussion has become closely linked to health and safety issues, and considerable progress has been made in identifying the avoided medical expenses associated with low-income weatherisation. New frameworks are needed to address the correlation between housing standards and health so that these co-benefits can be incorporated into the policy-making process. This session was dedicated to case studies from the United States and the European Union in which the health benefits of low-income weatherisation has been quantified and evaluated.

Dr. Veronique Ezratty and **Prof. David Ormandy** presented research undertaken as part of the World Heath Organization's (WHO) Large Analysis and Review of European Housing and Health Status (WHO LARES) study. In 2002-03 the WHO Housing and Health Programme undertook housing and health surveys in eight European cities: Forli (Italy), Vilnius (Lithuania), Ferreira do Alentejo (Portugal), Bonn (Germany), Geneva (Switzerland), Angers (France), Bratislava (Slovakia) and Budapest (Hungary). Merging the individual city data created a powerful international database useful in studying housing-related inequalities and their potential impacts on health. The study found the incidence of respondents spending more than 20% of their income on heating is significantly higher in the three Eastern European cities of Vilnius, Budapest and Bratislava as shown in Table 6.

Table 6. Percentage of population spending more than 20% of income on heating - results from the WHO-LARES survey

Vilnius	Budapest	Bratislava	Genève	Bonn	Angers	Forli	Ferreira
46%	26%	21%	1%	1%	4%	2%	1%

Source: Ezratty and Ormandy, 2011.

Dr. Ezratty described the direct and indirect impacts of *précarité energétique* (energy precariousness). For example, under-consumption of necessary energy services resulting in low indoor temperatures could lead to respiratory and cardiovascular diseases and mental stress; use of inappropriate forms of energy for heating and lighting increases the risk of accidents, fire and CO poisoning; poor indoor air quality and dampness increase susceptibility to asthma and allergies. Such health impacts create not only individual suffering but social costs, including lost work and school days as well as increased demand on the health sector.

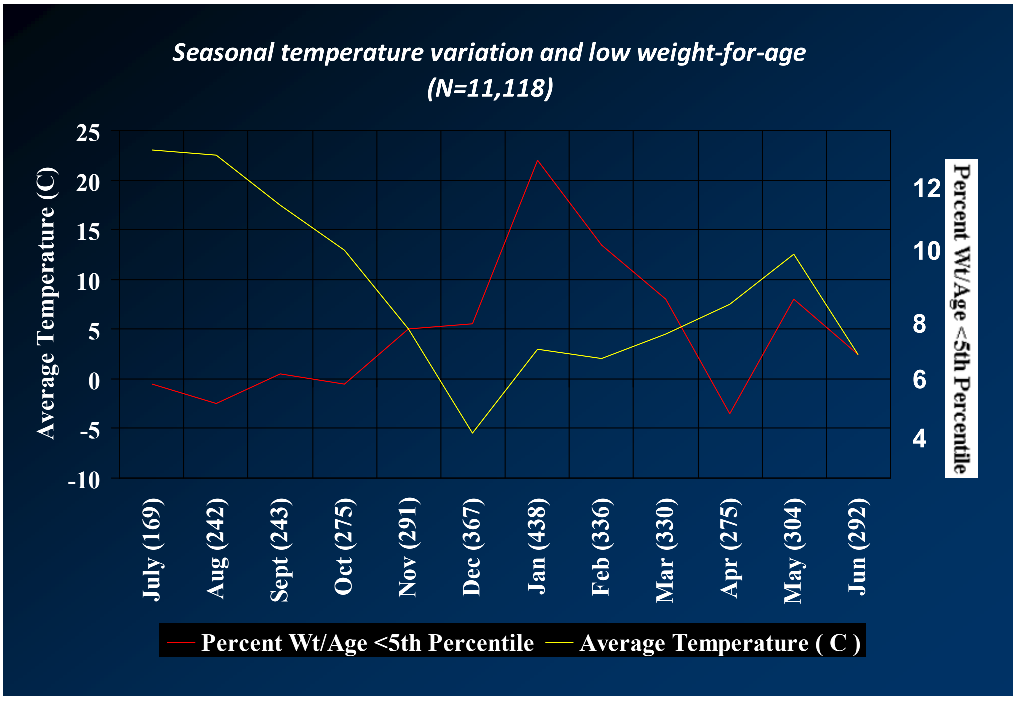
Prof. Ormandy presented results of research in England, where it has been possible to identify the cost of diagnosing and treating health outcomes arising from so-called Cold (or energy inefficient) Homes. The study drew on data on the broad condition of English housing from the English House Condition Survey (EHCS). The EHCS incorporates the Housing Health and Safety Rating System (HHSRS) which was developed by matching data on housing conditions with health outcomes records on the basis of patients' post codes. This enabled the expansion of assessment of houses to incorporate potential threats to health and/or safety in addition to building defects. Linking data on housing conditions with health data has made it possible to estimate the health-related costs attributable to energy inefficient housing. The UK National Health Service gives data on the cost of diagnosing and treating health outcomes associated with exposure to low temperatures and through a process of data correlation, gave an estimated cost of USD 1 263 million (EUR 894 million) annually, or about USD 548 (EUR 388) per dwelling per year (Ezratty and Ormandy, 2011).

The value of the HHSRS in England has created interest in replicating it elsewhere. New Zealand, the United States, and the European Union are all undertaking similar efforts. Other initiatives are underway to more strongly link data on health outcomes with data on housing quality. In France, for example, patients suffering from asthma will receive a referral for a housing survey by the *Conseiller Médical en Environnement Intérieur*. Such interventions will also provide data needed to investigate both the causes and effects of energy-efficiency measures on indoor air quality.

Dr. Deborah A. Frank presented research and viewpoints from the Children's HealthWatch programme in the United States. Children's HealthWatch is a non-partisan pediatric research network carrying out research on impacts of economic conditions and public policies on the health of children under the age of three. Children's HealthWatch has built a unique database on the linkages between household conditions and health outcomes based on interviews with families with young children in emergency departments and urgent care clinics in hospitals in five cities (Baltimore, Boston, Little Rock, Minneapolis and Philadelphia) serving largely low-income families.

One policy initiative of the Children's HealthWatch has been to construct indicators of household insecurity across three dimensions: food, housing and energy. Each of these insecurities is closely linked to negative health outcomes in young children. Indicators of severe energy insecurity include interruptions in gas, oil or electricity delivery because of non-payment, days without heating or cooling because of non-payment or use of unsafe substitute heating methods. Energy insecurity often co-occurs with food insecurity; where acceptable nutrition is not available or where a choice has to be made to between adequate energy services and other essentials such as food. This phenomenon, termed "Heat or Eat" syndrome by the Boston research team, is supported by long-term data showing a correlation between cold temperatures and underweight children (Figure 6). Energy insecurity is particularly correlated with underweight children, due both to children's physiology and the simple physics of a high surface-to-mass ratio, which increases heat loss in cold environments.

Figure 6. Heat or eat phenomenon



Source: Frank, 2011

Energy insecurity also leads to housing insecurity, indicated by household crowding and the number of times a family has to move per year in order to manage costs. These factors combine to contribute to the potential for hospitalisation or developmental risks to children. Other research suggests that cold and heat stress during pregnancy contribute to decreased birth weight.

There is also an emerging body of research regarding the health benefits of fuel-poverty mitigation policies. For example, children in families benefiting from the Low-Income Home Energy Assistance Program (LIHEAP) in the United States are 20% less likely to be underweight for age or length and 30% less likely to require admission on the day of visiting a hospital emergency room, than children in similar families with LIHEAP assistance.

Session 6: Methodological approaches and challenges

Bringing hard-to-measure benefits of energy efficiency within the scope of programme evaluation requires new data sources and new estimation methods. These methods must be developed in a way that aligns with the objective indicators (*e.g*. energy bill savings) used in existing cost-effectiveness protocols.

Lisa Skumatz described the estimation methods that have been applied to co-benefits evaluation (Table 7). Methods vary according to the type of benefit, understanding of the cause/effect linkage, and the data available. Computations or engineering estimates can be developed for direct financial co-benefits where the weatherisation intervention and the co-benefit are clearly and directly linked, (*e.g.* water savings from low-flow showerheads). Incremental impacts analysis using regression or other methods can also be used to estimate, on an aggregate level, direct financial benefits (such as utility arrearage savings). However, establishing strong correlations may be difficult unless an extensive data base is available. Model-based estimation is a broad category that includes many possible approaches, from simple regression analysis to complicated logit models, although extensive data is needed to build these models. Survey methods are more appropriate for non-financial or intangible co-benefits, such as comfort, livelihood improvements or social welfare improvements. Obtaining participant valuation of co-benefits on the basis of relative scaling of outcomes has proved effective in obtaining consistent results.

Table 7. Co-benefits estimation methods

Estimation method	Example	Limitations and issues
Computation/engineering estimation	Participant co-benefit: water savings	Requires data on shower use and water rates
Incremental impacts analysis	Utility co-benefit: reduced arrearage costs	Requires detailed data on both cost incidence and weatherisation patterns
Model-based estimation	Social co-benefit: Reductions in health costs due to fewer cold-related hospitalisations	Requires cold-related health care costs plus an experimental frame to link cause and effect
Revealed preference, contingent valuation, and other survey methods	Participant co-benefits: indoor comfort improvements	Subject to bias; difficult to compare with monetised benefits

Source: Skumatz, 2011b.

Co-benefits evaluation is fraught with methodological issues. Evaluators must take care to address five challenges:

- **Persistence or retention of co-benefits.** Unlike energy savings, other co-benefits may be short-lived. Both the magnitude and the duration of the co-benefit need to be estimated.

- **Double-counting and off-setting co-benefits.** Care must be taken to avoid counting the same co-benefit twice — *e.g.* job creation and local economic activity — and to identify co-benefits to one beneficiary that may appear as a cost to another beneficiary.
- **Harmonising valorised results from different approaches.** There is no accepted basis for combining results from surveys of willingness to pay with regression results based on energy or health care provider cost incidence. Clear rules should be established for evaluating financial and economic co-benefits vs. social welfare and livelihood co-benefits.
- **Negative co-benefits.** Some weatherisation treatments, *e.g.* solar water heaters, may impose costs such as maintenance or aesthetics on the participant. Such negative co-benefits ("co-costs") should be estimated and subtracted in any cost-effectiveness calculation.
- **Use of co-benefits in cost-effectiveness evaluation.** Care should be taken in constructing the so-called regulatory tests for weatherisation programmes. Some regulatory tests, (*e.g*. utility cost or participant cost test), will necessarily exclude some co-benefits.

US utilities have some experience in estimating the changes in arrearages and collection activities, and softer co-benefit estimation is often used in marketing and targeting. However co-benefit estimation remains largely absent from programme evaluation, except in a few jurisdictions.Developing methodologies suitable to co-benefits estimation and working through the evaluation challenges requires investment in evaluation research. Nevertheless, there must be an appetite by policy makers and regulators for co-benefits estimation results before resources will be made available to development new methods and approaches. This chicken-and-egg problem needs to be resolved before co-benefits evaluation research can move forward in a significant way (Skumatz, 2011b).

Matthew Murray of the UK Energy Saving Trust (EST) described efforts undertaken within their agency to harness existing consumer survey data to learn more about the incidence and dynamics of fuel poverty in a cost-effective manner. The method involved simple analysis of data collected through a survey of individuals who had contacted the EST and received advice on energy efficiency and other issues. Data collected from the survey included all the factors that determine fuel-poor households, *e.g.* fuel bills, dwelling type and number of rooms, employment status, family size and income.

Table 8. Comparing income to dwelling-type to estimate fuel poverty

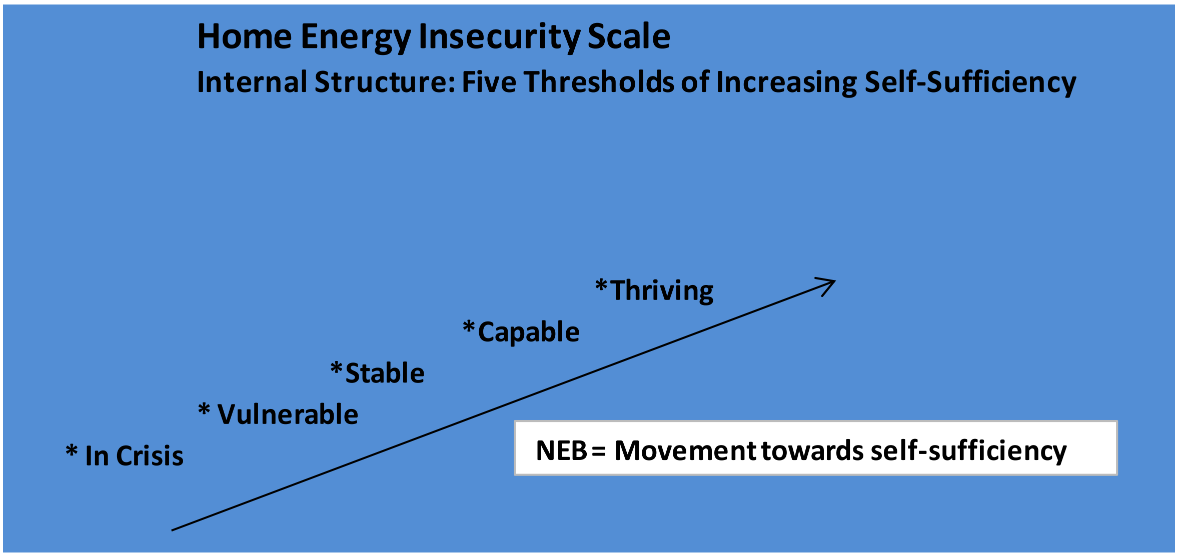
		Dwelling type and estimated fuel costs					
		Det bungalow	Det house	Flat	Terrace	Semi bungalow	Semi house
		£899	£1,388	£629	£849	£899	£989
Household income (10% of actual income)	£500	**1%**	**1%**	**1%**	**1%**	**1%**	**2%**
	£625	**1%**	**1%**	**1%**	**2%**	**0%**	**2%**
	£875	**1%**	**1%**	2%	**2%**	1%	**3%**
	£1,250	2%	**2%**	1%	3%	1%	4%
	£1,750	2%	3%	1%	2%	1%	4%
	£2,500	3%	4%	2%	3%	0%	7%
	£4,000	2%	6%	1%	3%	0%	6%
	£5,000	1%	6%	1%	1%	0%	4%

Source: Energy Savings Trust, 2011.

EST manipulated the data in two separate ways in order to consider the difference between the reported level of household energy bills and the amount of energy a household would be expected to purchase in order to require to maintain healthy living conditions with reference to the nature of the dwelling. Analysis based on reported spending yielded estimates of 19% incidence of fuel poverty while the needs-based analysis showed an incidence of 22%. Data suggested that incidence of fuel poverty is highest in detached and semi-detached houses (Table 8).[4] This work supports the argument that fuel-poor households under-consume and that there is unmet demand for energy services. This methodology is of interest, recalling the proposal made by Lisa Skumatz that, in light of the complexity and cost barriers currently faced in quantifying fuel poverty, practical methods which provide indicative and range values can be usefully pursued to inform decision-making.

Roger Colton of the US law firm Fisher, Sheehan & Colton described the development of a "Home Energy Insecurity Scale", used to show improvements in the livelihood of households after fuel-poverty reduction measures (Figure 7). Such a metric is useful for making outcomes-based evaluations of both fuel-poverty policy mixes and identifying target populations, irrespective of the type of policy being implemented. The vast majority (75% to 80%) of low-income households receiving assistance via the Weatherisation Assistance Programme (WAP) fall into the vulnerable or in crisis category. This was by design, with the intention of achieving bill reductions sufficient to move households up the home insecurity scale towards self-sufficiency. However, for some households with very high energy bill burdens the 20% reduction in affordability was not enough to lift them out of fuel poverty. This population required a different policy mix — additional weatherisation or weatherisation plus fuel bill assistance. This scale helps show the importance of measuring outcomes.

Figure 7. Home energy insecurity scale



Source: Colton, 2011.

Roger Colton described another methodology which has proven useful for energy providers in quantifying the benefits of sponsoring fuel-poverty reduction assistance programmes. The concept of NETBACK looks at costs related to collection and arrears, *e.g.* direct financial benefits

[4] The fuel costs are based on engineering estimates for each dwelling type.

to energy providers (rather than social consequences) and calculates the total amount collected by energy providers minus the total expenses involved with the collection technique, to show the net effect on the utility's bottom line.

Collection techniques are defined broadly and include traditional debt collection activities, disconnections and reconnections, energy assistance programmes and low-income energy-efficiency activities. NETBACK calculations have consistently demonstrated that assistance programmes have a positive effect on the bottom line. While bills issued to customers under a programme are generally lower, the revenue collected is higher both as a percentage of the bill and in real terms. A useful tool for energy providers, the NETBACK calculation also shows that people in assistance programmes consistently respond better than those not in such programmes.

Bruce Tonn of Oak Ridge National Laboratory (ORNL) described several aspects of an ongoing program of evaluation for the US WAP. These evaluation efforts are being carried out in close co-operation between the state and local jurisdictions that administer the WAP, and will include a wide array of different evaluation approaches and experiments.

A key element of the evaluation research programme is improving understanding of issues such as indoor-air quality impacts and non-energy co-benefits of weatherisation. A controlled experiment involving 550 single-family homes in treatment and control groups stratified by housing type has been created, including pre- and post-weatherisation sampling periods. ORNL teams are installing in-home measurement equipment for carbon monoxide, radon, formaldehyde and indoor temperature and relative humidity. Homes will also be tested pre- and post-weatherisation for carbon monoxide from combustion appliances, moisture accumulation or mould growth and air leakage (blower door) test results. This study is novel in the extent to which is intends to evaluate non-energy co-benefits in addition to health and energy outcomes. One year after weatherisation, a survey team including sociologists will gauge non-energy co-benefits, including changes in comfort, incidence of illness, need for medical attention, changes in indoor safety, changes in energy, food, medicinal security, changes in employment, school attendance and changes in family functionality. The results of both the indoor air quality and co-benefits will be correlated with larger samples from the weatherisation programme to allow the detailed results from this study to be extrapolated nationwide.

ORNL has attempted to mitigate the high financial and human resource burden of assessing weatherisation outcomes to such a close degree through innovative resource sharing between government departments —the US Environmental Protection Authority (EPA) contributed funding and scientific analysis services to the WAP research team in return for the installation of EPA's radon measurement devices being installed in addition to weatherisation measures.

Session 7: The way forward

The IEA research on innovation in low-income energy-efficiency policies is supported by member governments who have identified fuel poverty as a problem in need of various policy interventions. Policies and programmes have been developed that address each of the root causes of fuel poverty: low income, high energy prices and poor housing quality. These policies and programmes rely on balanced assessments of whether programme investments will produce meaningful outcomes in a cost-effective manner. Evaluation is a critical tool in making these policy and programme assessments, and consequently improvements in evaluation can lead to improvements in policies, programmes and outcomes.

This session provided an opportunity to discuss the importance of evaluation in the fuel-poverty policy context and the relevance of co-benefits evaluation to future programme and policy development. Speakers from the European Union, Ireland, United Kingdom and United States described the policy landscape and evaluation needs in their countries with the objective of information sharing and identifying areas for collaboration.

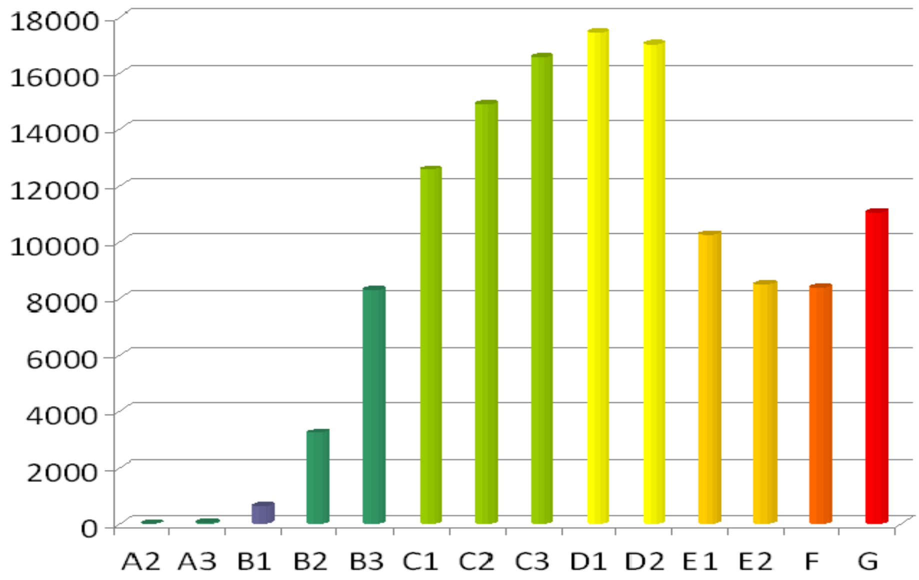
Tadg O'Brian of the European Union's Directorate-General (DG) Energy described the approach to low-income energy efficiency in overall European energy policy. Under the EU's Third Package which came into effect on 3 March 2011, emphasis has been placed on empowering the consumer and increasing consumer protection. With regards to energy efficiency, obligations for reducing energy consumption have been placed on Distribution Systems Operators (DSO) and suppliers to secure energy savings, reinforced by a renewed role for national regulators in monitoring consumer protection and market functioning.

Member states are required to institute new protection measures for energy customers, including complaint handling measures and ombudsmen interacting with other social policy measures and instituting prohibitions on disconnection at critical times. This will also include the obligation to define the concept of "vulnerable customers". In attempting to seek a broad definition, the "vulnerable customer" may refer to energy poverty, but is not specifically required to. Suppliers in turn must identify their vulnerable customers and prepare strategies for assisting them.

Stjohn O'Connor of Ireland's Department of Communications, Energy and Natural Resources described the fuel-poverty landscape in Ireland. 20% of 1.8 million Irish households are in fuel poverty based on the Boardman definition, but these figures change significantly using more specific indicators such as self-reported necessity to intermittently self-disconnect. As a result, Ireland is now working on a new metric which might allow more targeted identification of Ireland's fuel poor. Ireland considers fuel poverty among its national priorities and has developed measures and supports to address each of the three main drivers of fuel poverty. Fuel assistance totalled over USD 494 million (EUR 350 million) in 2009, split between fuel allowances and free gas and electricity. In 2010, 370 000 Irish households received fuel allowances or energy entitlements – an average outlay of USD 1 412 (EUR 1 000) per recipient. Thermal efficiency measures targeted three main buildings segments - private housing (1.6 million units), social housing (130 000 units) and voluntary housing. The Warmer Homes Scheme delivered by community-based organisations and private contractors, targets low-income households for energy-efficiency interventions. Since 2001, some 61 412 homes have been upgraded at a cumulative cost of USD 84.7 million (EUR 60 million) — again an average outlay of USD 1 412 (EUR 1 000) per recipient. Other housing initiatives include a central heating scheme for social housing, renovation grants for older and disabled persons, standards for rental accommodation, and retrofitting of vacant dwellings and apartment complexes.

These activities are modest compared to the vast opportunities for thermal efficiency improvement in Ireland. Less than 10% of social housing units rate an A or B building certification, while more than half have a D or worse rating (Figure 8). The distribution of housing-efficiency ratings for private housing stock is less well known, but likely quite a bit worse than social housing.

Figure 8. Distribution of building ratings - social housing units in Ireland



Source: O'Connor, 2011.

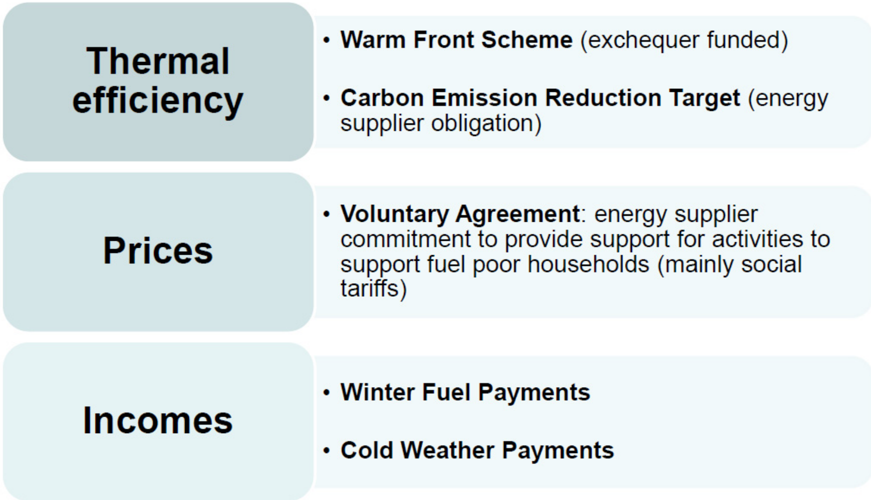
New efforts are underway to try and shift the balance of fuel-poverty reduction outlays towards more of an emphasis on thermal efficiency. A National Affordable Energy Strategy will be released in 2011 after a year of consultation and comments. Some possible innovations include calibrating fuel assistance to reflect the thermal efficiency of the property, more targeting of the mix of poverty policies for individual households, development of thermal regulations for rental property, and development of more robust data especially for private housing stock. There is also support for a more area-based approach to thermal-efficiency interventions. The hope is that concentration of effort would create economies of scale and make it easier to identify co-benefits.

Jamie Torrens of the UK Department of Energy and Climate Change (DECC) described the United Kingdom approach to fuel poverty. The United Kingdom subscribes to the Boardman definition for fuel poverty, on the basis of the expected expenditure with reference to the type of dwelling. UK fuel-poverty policy is geared to meet the target laid out in the *UK Fuel Poverty Strategy,* namely, to eradicate fuel poverty in all households in England by 2016, "as far as reasonably practicable" (DECC, 2009)[5].

As in other countries, UK fuel-poverty policies address each of the factors contributing to fuel poverty (Figure 9). Spending on thermal efficiency improvements delivered under the Carbon Emissions Reduction Target (CERT), which obliges energy suppliers to reduce carbon emissions in the domestic sector, is an important element in the fuel-poverty policy mix (Table 1). The Warm Front Scheme spent USD 573 (GBP 350 million) in 2010-11, while portfolio spending under the CERT is estimated at USD 1.8 (GBP 1.1 billion). However, energy assistance payments still dominate total outlays; 2010/11 spending on social tariffs, winter fuel payments and cold weather payments totalled USD 5.2 billion (GBP 3.2 billion). Targeting fuel-poor households remains a challenge. The approach in the United Kingdom is to target groups of households that have a higher propensity to fuel poverty, identified through receipt of some form of entitlement payment.

5 The Scottish Executive has a target to eliminate fuel poverty by 2016 while the Welsh Assembly has a target to eliminate it by 2018.

Figure 9. The UK approach in 2010/11 touched on each of the three drivers of fuel poverty



Source: DECC, 2011.

The UK Spending Review will result in major changes to the way in which support is delivered to fuel-poor households. A smaller, more focused Warm Front Scheme will continue for the next two years, closing by the end of 2012/13. DECC are currently working on the Green Deal and the Energy Company Obligation (ECO). The Green Deal is being designed to provide a route to customers to access high-quality energy- efficiency measures. Through the ECO, energy companies will be obliged to support the delivery of energy-efficiency measures, focused at the poorest and most vulnerable.

The Winter Fuel Payment and Cold Weather Payment programmes will continue and additionally, the new mandatory Warm Home Discount will require energy suppliers to provide direct energy bill support in tackling fuel poverty.

Challenges facing any thermal efficiency improvement interventions will continue, including:

- **Cost-effectiveness:** The economic impact of delivering measures to low-income households tends to be low, due both to the tendency of these households to under-heat (which means that energy and carbon savings from improvements in thermal efficiency tend to be low) and to the lack of methodologies to take into account non-energy benefits (*e.g.* healthcare savings).
- **Delivery arrangements:** It is important to target measures at those households most in need of support but difficulties in identifying fuel-poor households persist and may be compounded when policies are delivered by energy suppliers who tend to hold little information on the economic and social circumstances of their customers.
- **Linkage to climate goals**: Energy-efficiency measures generally contribute both to reducing fuel poverty and GHG emissions; however, some investments desirable from a thermal efficiency standpoint (*e.g.* new gas-fired central heating systems) can increase GHG emissions.

Of particular interest to this workshop is the role that evaluation can play in illuminating the broader economic benefits of low-income energy-efficiency policies and programmes. It is particularly important to strengthen the evidence in the following three areas:

- **Valuation research:** capturing more of the benefits of programmes in policy appraisal.
- **Behavioural research:** understanding how low-income and vulnerable households behave when they receive insulation and heating measures.

- **Delivery:** identifying which households should receive support through policies that are delivered by energy suppliers, and trading off poverty reduction and GHG emission reduction objectives.

DECC has commissioned a new study on the health impacts of improved domestic housing stock, in order to expand the range of economic benefits included in programme evaluation. The key challenge is linking benefits to interventions and then monetising the benefit estimates.

Bruce Tonn provided a review of the fuel-poverty reduction landscape in the United States. A dominant consideration in US fuel-poverty circles is the effect of the withdrawal of stimulus funding due in 2012. With the 2009 passage of the American Relief and Recovery Act (ARRA), funding of LIHEAP doubled and the WAP received an infusion of USD 5 billion over three years (compared to USD 250 million annually). The stimulus spending more than doubled the national weatherisation workforce, tripled the number of homes weatherised annually and increased funding for hot climate states and US territories. It also funded public housing weatherisation, expansion of evaluation activities and piloting of innovative approaches to financing and delivering low-income weatherisation.

When funding returns to pre-ARRA levels, economic impacts will include lost jobs and wasted investments in support infrastructure, not to mention growth in the incidence of fuel poverty. Many innovative ideas to fill the funding gap are being investigated, notably through the USD 120 million Weatherization Innovation Pilot Programme (WIPP). WIPP will explore innovation of all kinds — from technologies and delivery arrangements to financing and evaluation. Several projects will focus on innovation in financing low-income weatherisation through revolving loan funds, energy-service companies and multi-family buildings, on-bill financing, mortgage financing, property tax financing and carbon offsets. The thrust of these efforts is to find a mechanism for financing projects from savings. Innovations around delivery arrangements include YouthBuild and Habitat for Humanity, which will experiment with alternative weatherisation workforces. A parallel effort called the Sustainable Energy Resources for Consumers Program (SERC) will focus on sustainable technologies for housing, *e.g.* solar PV (Photovoltaics), solar hot water and cool roofs. SERC will pilot and then qualify promising technologies to be included in the list of approved technologies for WAP. Finally, there will be efforts to innovate around the role of state and local agencies. With less federal funding, these agencies might begin some of the following projects: offering their own fee-based services, expanding existing offerings, expanding into non-low-income housing weatherisation or undertaking large-scale weatherisation of multi-family buildings with owner or tenant co-financing. All of these efforts to broaden access to financing, upgrading technologies, reducing delivery costs and developing new markets will be necessary to fill the gap left by ARRA funding.

ORNL has traditionally been the programme evaluator for LIHEAP and WAP and is now implementing evaluations of both the WIPP and SERC activities which will examine economic benefits, implementation issues, energy savings and innovation outcomes. Other key evaluation activities include an energy-savings persistence study that examines social-services networks and their role in mitigating fuel poverty, a weatherisation deferral study and studies of under-performing homes and buildings. ORNL will also be evaluating the entire ARRA funding experience, with special focus on the effectiveness of stimulus spending in creating jobs and economic benefits for communities. As part of this effort ORNL will estimate non-energy co-benefits (*e.g.* national energy savings, household energy security, GHG emissions, and local employment) of stimulus spending. Finally the enhanced evaluation effort will address vexing programme design questions, such as linkages between weatherisation and indoor-air quality, the need to cap per-home spending, programme expansion or refinement (*e.g.* deeper retrofits, multi-family buildings) and revision of the programme cost-effectiveness test.

Conclusions and Research Priorities

As a result of two days of fruitful discussions and constructive-idea sharing, the IEA Secretariat was able to draw the following preliminary conclusions on the current state and future prospects of co-benefits estimation of low-income energy-efficiency programmes:

- **Fuel-poverty definitions should be policy-relevant and lead to practical action.** The Boardman 10% of income definition is most commonly used, but has limitations. Although based on objective indicators (energy outlays and income), it has a qualitative ingredient: satisfactory energy services. The EU definition of twice the median spending has a similar limitation. Taking a passport approach to fuel poverty — where households are evaluated based on observation as well as objective indicators — is an improvement but still a static approach to a dynamic issue. These definitions have real policy relevance, both in terms of effective targeting and also in terms of confidence in identified co-benefits.
- **However defined, fuel poverty is growing.** The long-term incidence of fuel poverty has remained steady at about 20% in many IEA member countries. However, several speakers noted recent spikes in estimated fuel-poverty incidence, for example, up to 44% in Northern Ireland. Fuel poverty is also relatively high in Eastern Europe, based on WHO LARES data. Continued economic troubles and recent increases in energy prices will doubtless continue this upward pressure.
- **Financial, economic and social welfare co-benefits of low-income energy efficiency are large, but mostly excluded from programme evaluation.** Some evaluation experts estimate non-energy co-benefits to be three times higher than energy savings. Participant co-benefits dominate, but economic benefits to communities and social welfare benefits are large as well. Benefits to energy providers are small proportionally, but documenting them might be strategic in increasing utility-delivered low-income energy efficiency.
- **Certain co-benefits stand out as opportunities for evaluation research.** Children's health stands out as a potential high-value co-benefit worthy of early evaluation research attention. For example, childhood asthma affects as many as 15% of children in some IEA member countries and has been linked to damp and mouldy indoor conditions. Similarly, a disproportionate number of under-weight small children hospitalised during cold months prove to be from energy insecure households. Being able to demonstrate a link between weatherisation and lowered incidence of asthma or underweight hospitalisations would be a powerful boost to the push for better co-benefits evaluation.
- **Co-benefit evaluation methods are scattered.** There are only a handful of jurisdictions where regulators or governments consider or study the co-benefits of low-income energy-efficiency programmes. The Massachusetts Department of Public Utilities (DPU) requires energy providers to undertake a consideration of non-energy benefits and in Wisconsin; the regulator has commissioned a study of the economic development benefits of low-income weatherisation. However, only a few evaluation experts specialise in this area and there is a need to raise awareness on this issue.
- **Co-benefits evaluation should be pursued with care.** Evaluators urge caution when developing new methods. There are many uncertainties to be addressed and pitfalls to avoid: potential for double-counting, assessing the persistence of identified co-benefits, measuring multiple benefit streams and beneficiaries and establishing linkages between interventions and outcomes are just a few.
- **Co-benefits evaluation requires different approaches.** Estimating the direct energy savings to weatherisation participants is a straight-forward application of objective data at the household level. Co-benefits evaluation will require different approaches, drawing on clinical

evidence to demonstrate causal links or developing accounting models for the aggregate impacts of low-income weatherisation on the energy providers' bottom lines. Early evaluations will likely rely on "data mining", drawing on data sets developed for other purposes. The presentations on the WHO LARES database, the EST customer satisfaction survey, and EHCS/HHSRS data bases were good examples of this. Programme evaluators will have to borrow data, expertise and experience from allied fields to make early progress.

- **Recognise the limitations of weatherisation in the fuel-poverty policy mix.** Efficiency improvements can lift many but not all fuel-poor households out of fuel poverty. Other drivers – income levels, energy prices and even climate – may render any economical amount of energy efficiency insufficient by itself. On the other hand, the current mix of fuel-poverty spending may represent under-investment in energy efficiency relative to income supplements and subsidised energy prices.
- **There are many ways to position low-income energy-efficiency policies.** Several speakers reported good progress with policy makers by re-casting low-income weatherisation in another light. New Zealand's Housing and Health Research Programme frames their programme and policy trials as housing and health research, not low-income or fuel- poverty research. Similarly, framing thermal efficiency as a form of medicine is very effective.
- **Is co-benefit evaluation the chicken or the egg?** Evaluation has a rarefied audience: regulators, governments, stakeholders, academics. Developing new evaluation approaches requires investment in evaluation research. However, there must be an appetite by policy makers and regulators for co-benefits estimation before resources will become available. This chicken-and-egg problem needs to be resolved before co-benefits evaluation research can move forward in a significant way.
- **There is scope for collaboration on co-benefits estimation.** The quality and diversity of the presentations and discussion during the workshop suggest there is real scope for collaboration on co-benefits estimation for low-income energy- efficiency programmes. Many governments face similar issues in developing and evaluating fuel-poverty policies and programmes. Moving from promising anecdotal evidence around improved health outcomes or economic development from weatherisation programmes toward formal evaluation methods will be assisted by international co-operation. For example, developing similar data protocols for clinical trials or sharing models for relating utility costs to billing arrearages could speed the pace of evaluation research and development. Workshop participants were asked to make suggestions for future work and identify which evaluation issues should be tackled first. The results are presented below.

Table 9. Co-benefits evaluation research suggestions

Top-ranked research suggestions (rank ordered)
Linking low-income efficiency programmes to carbon policy
Regulatory approaches to improving the quality of low-income housing
More detailed exploration of low-income energy-efficiency programmes and policies
Mobilising private sector investment to finance low-income energy efficiency
Estimation approaches for specific co-benefits and more detailed exploration of causes and effect
Other research suggestions (not rank ordered)
Improved definition of fuel poverty
Schemes to alleviate fuel poverty for those waiting to have their homes weatherised
Best practices in low-income energy efficiency – "what is working now"
Relevance of fuel poverty in overall context of poverty reduction
Impacts of fuel poverty on mental health

References

Anderson, W., Finney, A., and White, V. (2010), "Coping with Low Incomes and Cold Homes", findings of a study funded by *Eaga Charitable Trust*, June 2010, Centre for Sustainable Energy, www.cse.org.uk/downloads/file/you_just_have_to_get_by.pdf.

Bird, J., Campbell, R. and Lawton, K. (2010), *The Long Cold Winter: Beating fuel poverty*, Institute for Public Policy Research and National Energy Action, March 2010, www.vhscotland.org.uk/library/misc/The_Long_Cold_Winter.pdf

Boardman, B. (1991), *Fuel Poverty: From Cold Homes to Affordable Warmth*, Belhaven Press, London.

Boardman, B. (2011a), "Overview of Fuel Poverty Issues", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Boardman, B. (2011b), "Quality of life benefits (problems) that are hard to measure", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Brady, S. (2011), "Energy efficiency the Regulator's perspective: Protecting customers and in particular vulnerable customers", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Colton, R. (2011), "Quantification of NEBs: A Review of Two Options", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

DECC (Department of Energy and Climate Change) (2009), *The UK Fuel Poverty Strategy*, 7th Annual Progress Report. www.decc.gov.uk/assets/decc/statistics/fuelpoverty/1_20091021091505_e_@@_ukfuelpovertystrategy7annreport09.pdf.

DEFRA/BERR (UK) "The UK Fuel Poverty Strategy", 6th Annual progress Report, 2008 http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file48036.pdf.

Energy Action Scotland (EAS) and National Energy Action (NEA) (England and Wales), (2009), *The Cost of Affordable Warmth*, www.nea.org.uk/assets/Uploads/The-Cost-of-Affordable-WarmthFINAL-VERSION2.pdf.

EPEE (European Fuel Poverty and Energy Efficiency Project) (2009), *Tackling Fuel Poverty in Europe: Recommendations Guide for Policy Makers*, www.fuel-poverty.org/files/WP5_D15_EN.pdf?GSBYPASS=F71D11AB8E5A5A2F6CD8FCE322637A5B&N=hNRfzC&M=application/pdf&D=.

Ezratty, V. and Ormandy, D. (2011), "The Health Benefits of Energy Efficiency", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin.

Frank, D. (2011), "Heat or Eat: Children's Health Watch", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Gaffney, K. (2011), "Overview of Benefits to Energy Providers & Governments: An Evaluator's Perspective", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Green, G. and Gilbertson, J., (2008), *Warm Front Better Health: Health impact evaluation*, Centre for Regional, Economic and Social Research, Sheffield Hallam University, www.google.fr/url?sa=t&source=web&cd=1&ved=0CBgQFjAA&url=http%3A%2F%2Fwww.apho.org.uk%2Fresource%2Fview.aspx%3FRID%3D53281&ei=Fp6pTfvNA8qx8QPRoNG4Ag&usg=AFQjCNHdMI2DjMei6aCG9VGTJ3HSdignAA.

Howden-Chapman, P. (2011), "Reducing fuel poverty by improving housing", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Johnson, H. and Griffiths, C., (2003), "Estimating excess winter mortality in England and Wales", *Health Statistics Quarterly*, Vol. 20, Winter 2003, www.statistics.gov.uk/articles/hsq/HSQ20seasonal.pdf.

Livingstone, J. (2011), "Fuel poverty interventions: a utility perspective", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Schweitzer, M. and Tonn, B. (2003) "Non-energy benefits of the US Weatherization Assistance Program: a summary of their scope and magnitude", *Applied Energy* Vol. 76, 2003, pp. 321–335, Oak Ridge National Laboratory, PO Box 2008, Oak Ridge, TN 37831-6206, USA.

Murray, M. (2011), "Designing methodology and engaging participant support: practical questions", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

O'Connor, S. (2011), "Fuel Poverty Policy Approaches in Ireland", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Preval, N., Chapman, R., Pierse, N, and Howden-Chapman, P., (2010), "Evaluating energy, health and carbon co-benefits from improved domestic space heating: A randomised community trial", *Energy Policy*, Vol. 38, No. 8, August 2010, pp. 3965-3972, http://ideas.repec.org/a/eee/enepol/v38y2010i8p3965-3972.html.

Ryan, C. (2011), "The Warm Project: Energy Efficient Homes for the Community", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Skumatz, L. (2010), *Non-Energy Benefits: Status, Findings, Next Steps, and Implications for Low Income Program Analyses in California*, 11 May 2010. Skumatz Economic Research Associates, www.liob.org/docs/LIEE%20Non-Energy%20Benefits%20Revised%20Report.pdf.

Skumatz, L. (2011a), "Co-Benefits of Low-Income Weatherisation Programmes: Framing the Role of Co-Benefits", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Skumatz, L. (2011b), "Co-Benefits of Low-Income Weatherisation Programmes: Methodological Issues in NEBs", presented at the IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

Torrens, J., (2011), "Policy Approaches in the United Kingdom", presented at IEA workshop on evaluating the co-benefits of low-income weatherisation, 27-28 January 2011, Dublin, www.iea.org/work/workshopdetail.asp?WS_ID=494.

US Department of Energy (2011), Weatherization Assistance Program History, www1.eere.energy.gov/wip/wap.html.

Acronyms

3CSEP	Center for Climate Change and Sustainable Energy Policy (HU)
ARRA	American Relief and Recovery Act (US)
CERT	Carbon Emissions Reduction Target (UK)
BEC	Benefit Entitlement Checks
DSO	Distribution System Operator
EHCS	English House Condition Survey (UK)
CO	Energy Company Obligation
EPEE	European Partnership for Energy and the Environment
EST	Energy Savings Trust (UK)
EPEE	European Partnership for Energy an the Environment
HHSRS	Housing Health & Safety Rating System (UK)
LIHEAP	Low Income Home Energy Assistance Program (US)
NIAUR	Northern Ireland Authority for Utilities Regulation (NTHIE)
NIE	Northern Ireland Electricity Energy (NTHIE)
NISEP	Northern Ireland Sustainable Energy Programme (NTHIE)
ORNL	Oak Ridge National Laboratory (US)
SAP	Standard Assessment Procedure (UK) (for building quality)
SERC	Sustainable Energy Resources for Consumers Program (US)
WAP	Weatherization Assistance Program (US)
WHO LARES	World Heath Organization's Large Analysis and Review of European Housing and Health Status
WIPP	Weatherization Innovation Pilot Programme (US)

Glossary

Building energy certification: energy certification of buildings is a key policy instrument for reducing the energy consumption and improving the energy performance of new and existing buildings (IEA, 2010). It provides a means for independently assessing the energy-efficiency characteristics of a building and communicating this information to the public.

Co-benefits: the additional direct and indirect benefits of energy-efficiency policies and measures other than energy savings.

Deep building renovation: a retrofit or rehabilitation of an existing building in order to bring it to an optimum level of energy-efficiency and environmental sustainability.

Energy poverty: lack of access to sufficient electricity, heat, or other forms of modern energy to meet basic human needs; usually referring to the situation of people in the developing world. Energy poverty includes the lack of electricity and mechanical power for income-generating activities and the reliability and affordability of supply to households and to the wider economy.

Household energy insecurity: a term used to indicate how well a household is able to satisfy its energy requirements. A common concept in the United States, household energy insecurity varies in severity depending on a combination of parameters such as usage, payments, budgets and other factors, to provide a measurement of "self-sufficiency" (Colton, 2011).

Excess winter mortality: the number of additional deaths during the winter season over and above the non-winter annual monthly average, possibly attributable to harsher climatic conditions.

Fuel poverty: any household that spends more than 10% of its income on its home energy bill (drawing on the definition in *Fuel Poverty* [Boardman, 1991]); usually referring to the situation of people in TE and OECD countries. A household in fuel poverty often cannot afford to maintain healthy and comfortable conditions within the home and/or may be forced to forgo other essentials such as food.

Green housing / green buildings: buildings constructed with environmental sustainability in mind, where steps have been taken to lower the environmental impact of the building (*i.e.* energy efficiency, sustainability and non-polluting materials and processes).

Non-energy benefits (NEBs): a term used more commonly in the United States which is generally synonymous with the term "co-benefits".

Précarité energétique: this French term, literally *energy precariousness*, and is generally synonymous with the term "fuel poverty". It refers to households both in and threatened by fuel poverty and the inability to maintain healthy living conditions in the home.

Unmet demand: when the amount of energy needed in the home exceeds the amount of energy a household can access or afford to purchase. Where there is unmet demand a household may endure substandard living conditions, reduced useable living space or resort to dangerous alternative heating methods.

Vulnerable customers: a term used in the European Union Directives relating to electricity markets.[6] These Directives require each member state to define the concept independently, using general guidelines which focus on a household's financial weakness and eligibility under economic support systems.

Weatherisation: retrofit measures taken to improve a building's resilience to the elements. Weatherisation measures address the building shell and ventilation as well as internal components such as water heating and piping insulation and replacing inefficient appliances and equipment.

[6] Directive 2003/54/EC for internal market in electricity and Directive 2003/55/EC for internal market in natural gas

International
Energy Agency

9 rue de la Fédération, 75739 Paris Cedex 15

www.iea.org