SERVING the nation – applying lessons from the SERVE CONCERTO project to Ireland

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Abstract

In 2008, Irish Government policy in Ireland began to focus on retrofitting of existing dwellings. This policy change was driven by the dramatic reduction in new building construction, due to the economic crisis, and the need to meet relevant energy targets under the National Energy Efficiency Action Plan.

Starting in 2007, the European SERVE (Sustainable Energy for the Rural Village Environment) project has challenged the standards and policies in place nationally in relation to retrofitting. This was achieved through a targeted support programme which incentivised deeper retrofits when compared to the National Home Energy Savings Scheme.

This paper highlights the significant benefits of implementing local demonstration projects, the results of which can be utilised to influence local and national policy. This paper reviews the results of the SERVE project in the context of building retrofitting, wood biomass development and energy monitoring.

In relation to building retrofitting, savings of 8,000 kWh/dwelling with returns on investment of 11 % (for an average investment of €7,600 per dwelling) were achieved. The paper highlights the fact that the current retrofitting policy and programmes will not achieved the required targets by 2020 unless savings similar to that achieved under SERVE are targeted.

The penetration of wood biomass as a fuel for heating has been a key component of the SERVE project. This paper demonstrates that the development of new procedures for procurement, operation and maintenance of biomass heating systems has resulted in additional capacity being installed outside the SERVE region. These template contracts are being utilised to support the development of National energy supply contract (ESCO) models. In addition, the project has created a new awareness of standards for wood stoves for the residential sector.

Similarly, the results of the SERVE monitoring activities (energy data and economic impacts) are feeding into National data sets and policy development. In cooperation with the National Energy Agency, SERVE partners have demonstrated that monitored energy performance of dwellings is 13 % lower than that predicted by the National Dwelling Energy Assessment Procedure (DEAP) with electricity consumption in line with National benchmarks. Recommendations are being made in key areas (e.g. energy performance of condensing boilers) and the expansion of monitoring study into a longitudinal study.

Introduction

The construction sector in Ireland has experienced considerable change in the past 10 years. From 2000 to 2008 there was a dramatic increase in house completions per annum. In 2008 the focus began to shift towards retrofitting as the economic situation in Ireland began to deteriorate (Figure 1). Government policy in 2008 changed to focus on supporting shallow upgrade measures in residential dwellings. The funding of upgrade measures is coordinated by the National Energy Agency (Sustainable Energy Authority of Ireland) and traditionally has not involved Local or Municipal authorities in direct action. The retrofitting market continues to be focused on shallow retrofitting with buildings owners completing a small number of

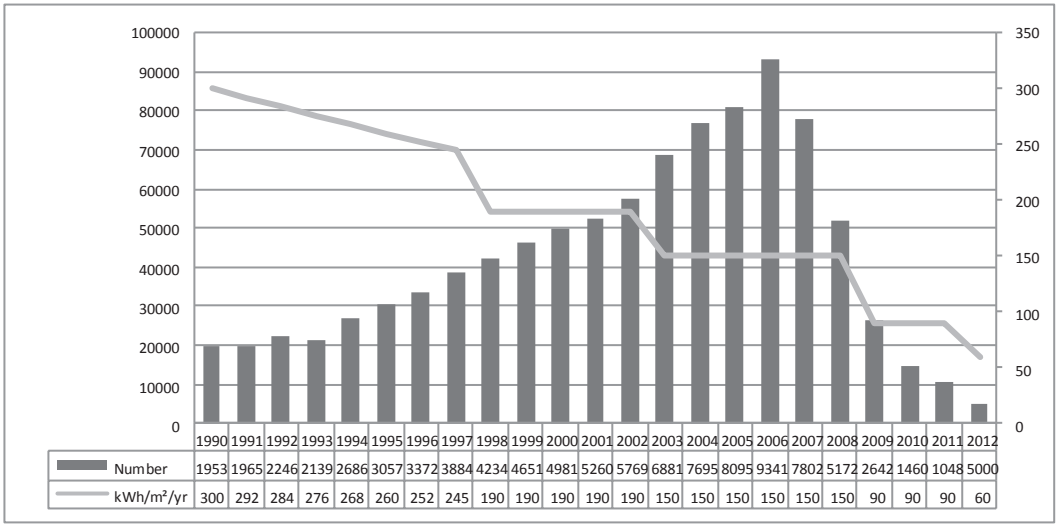

Figure 1. Housing completions in Ireland and building energy performance (Keyes, M (2012)) – Final energy demand as per building regulations.

low cost measures and there are no specific targets in relation to deep retrofitting.

Second, the penetration of biomass heating systems within residential and non-residential buildings in Ireland has not achieved the levels required for Ireland to meet its renewable energy production targets. The installation of high efficiency wood stoves within the residential sector has been hampered by a lack of standards and supports. Investment in biomass systems in non-residential buildings was hindered by the lack of standardised procurement and heat supply documentation.

Third, monitoring and analysis of the energy performance of dwellings in Ireland has generally been focused on data gathered on an annual or monthly basis. There has been limited research completed to profile energy consumption of dwellings (with data gathered at micro level (hourly/daily data)) at a significant scale. Comparison of monitoring data with predicted data from energy assessment methodologies has also been limited.

Initiatives driven at a local and regional level have sought to develop pilot demonstration projects which engaged with these issues. These initiatives have either complimented National programmes or addressed gaps which National policy was not. This paper presents the results from the SERVE Project (Sustainable Energy for the Rural Village Environment) which sought to demonstrate the impacts and benefits of investing in energy efficiency and renewable energy supply. The project was completed in North Tipperary, Ireland between 2007 and 2011 and was co-funded by the EU CONCERTO Programme[1]. The impacts of the project, and their application at a National level are discussed and reviewed.

The first chapter introduces the SERVE project, its partners and the general approach. The second chapter details the SERVE approach to deep retrofitting and profiles the results and impacts. The main impacts of the SERVE Project resulting from the establishment of a Local Authority led retrofitting scheme are outlined. The fourth chapter reviews and discusses the effects of setting standards for wood stoves and introducing new approaches for the procurement and operation of commercial scale biomass heating. The final chapter presents results from the SERVE energy monitoring activities and economic analysis. These results are compared to National data to demonstrate the benefits of focusing on deep retrofitting.

The SERVE project

In the case of Ireland, SERVE was one of two European CONCERTO projects (the other project was based in Dundalk under the HOLISTIC project). CONCERTO is a European Commission initiative within the European Research Framework Programme (FP6 and FP7) which aims to demonstrate that applying a community-wide approach to energy efficient development is more efficient and cheaper than optimising each single building. SERVE, which is based in a rural area, has focused on state-of-the-art integration of proven technologies in order to maximize the potential for rapid replication.

In the framework of the project, 400 buildings were retrofitted to dramatically improve their energy performance and approximately 500 renewable energy heating systems were installed. In addition, as part of the construction of an eco-village, the project supported 50 new eco buildings to be supplied by Ireland first renewable energy based district heating system. To increase the penetration of renewable energy, the project concentrated on the development of commercial scale biomass heating systems both for individual projects and district heating. A core component of the project was research into the socio-economic impacts of the project in terms of job creation, investment return and attitudes to sustainable energy. A large focus was placed on monitoring the energy performance of buildings, in particular within the retrofitting dwellings.

The project was coordinated by the Limerick Institute of Technology (LIT) with key partners including North Tipperary County Council (Local Authority), Tipperary Energy Agency and Sustainable Projects Ireland Limited. Expert international

1. www.concerto.eu

Table 1. National HES measures and uptake (SEAI, 2013b).

Measure Type	Grants paid (Numbers)	Grants paid (,000€)	% of Total (by value)
Cavity	89,489	33,161	22%
Roof insulation	100,427	23,675	16%
Dry-Lining Insulation	8,487	19,632	13%
External Insulation	9,311	35,271	24%
High Efficiency Gas boiler with Heating Controls Upgrade	18,447	12,211	8%
High Efficiency Oil boiler with Heating Controls Upgrade	12,832	8,687	6%
Heating Controls Upgrade only	6,229	2,983	2%
Solar Heating	3,356	2,686	2%
Integral BER	90,104	7,435	5%
Before/After BER	8,367	1,669	1%
Total	347,049	147,410	100%

partners on monitoring (ECNetwork, Denmark), socio-economic analysis (North West Croatia Energy Agency, Croatia) and dissemination (FEDARENE, Belgium) also contributed to the project.

North Tipperary County Council (NTCC) and the Tipperary Energy Agency (TEA) led the retrofitting activities. A local financial incentives scheme was developed which provided support to homeowners and businesses in the SERVE region. The scheme supported energy efficiency upgrades and the installation of renewable energy systems. NTCC administered the financial support and the TEA focusing on technical expertise, auditing and analysis. Sustainable Projects Ireland Ltd (SPIL) focused on construction of new eco buildings within an eco village. SPIL is a cooperative company established to develop a new community which has sustainability at the core of its operations [2]. ECNetwork and the Tipperary Energy Agency were responsible for the energy monitoring activities while North West Croatia Energy Agency conducted the socio-economic analysis on the project impacts.

Retrofitting – Changing the approach

SERVE RETROFITTING – MEASURES

When the SERVE project was started in November 2007, there was no national support for retrofitting of buildings in Ireland. The SERVE project was the first initiative in Ireland to focus on this aspect at a significant scale and planned to launch its retrofitting support scheme in March 2008. At the same time the Minister of Communications Energy and Natural Resources was considering the establishment of a Home Insulation Scheme (hereafter called the Home Energy Savings Scheme (HES Scheme)). A number of SERVE partners worked with the National Energy Agency to implement a pilot HES Scheme. In 2009 the full National retrofitting scheme was announced.

Under the HES Scheme, homeowners wishing to upgrade their homes could apply for support for a range of measures. A Building Energy Rating (BER) had to be completed prior to an upgrade being completed and homeowners appointed contractors to complete the works. Payments were made on receipt of documentation providing evidence of completed works. The design of the HES Scheme did not require homeowners to reach a particular energy standard nor were there mandatory measures which had to be completed. The levels of financial support have changed a number of times since the scheme was launched and it was rebranded to the Better Energy Homes Scheme in 2011. SEAI provides data on completed actions on a regular basis (SEAI, 2013b) with data from January 2013 provided in Table 1.

Following negotiations between SERVE partners, SEAI and the EU Commission, an agreement was reached which allowed SERVE residents to access both funding sources, and therefore allow SERVE to focus on supporting deeper retrofits when compared to the National HES Scheme. The SERVE Energy Efficiency Grant Scheme was launched in June 2009 for residential and non-residential buildings. Building owners were able to access financial supports from the SERVE Scheme and also had the option of applying to the HES Scheme programme for support for the relevant measures. The SERVE Residential Energy Efficiency Grant was made up of a payment of €1,000 for 3 mandatory measures (Table 2) and additional payments for further energy efficiency measures (minimum of 2 required) (Table 3). In line with the National HES Scheme grants were available for houses built before 2006. This year was selected as prior to this the Irish building regulations had limited standards in relation to insulation, heating controls and efficiency. SERVE required that a BER was completed before and after upgrade.

SERVE RETROFITTING – IMPACTS

A total of 346 dwellings were upgraded under the SERVE project (approximately 55,000 m^2). The project also completed upgrades on non-residential buildings and supported construction of new buildings in the eco-village but these are not considered in detail in this paper. A summary of achieved energy savings is provided in Table 4. Average savings of 92 $kWh/m^2.yr$ were achieved for residential retrofitting

2. www.thevillage.ie

Table 2. Mandatory measures according to the SERVE scheme (support of €1,000 when all 3 measures completed).

Measure	Standard required
Attic insulation	U-value of 0.13 W/m^2 K
Wall insulation	U-value of 0.27 W/m^2 K
Heating controls (with or without boiler)	2 zones (space & water) with seven day programmer (time & temperature) control & boiler interlock – Plus Time & temperature control of electric immersion – Plus Either one more zone control or 3 Thermostatic Radiator Valves (TRVs) >90% high efficiency boiler (if applicable) (or 85% efficient wood biomass boiler)

Table 3. SERVE Additional energy efficiency measures.

Measure	Grant amount	Standard required
Windows	€2,000	75% of total area, U-Value of ≤2.0 W/m^2 K
External Wall Insulation	€4,000	75% of total area, U-Value of ≤0.2 W/m^2 K
Novel Low Carbon Insulation	€250	U-Value of ≤0.12 W/m^2 K
Flat Roof/Room in Roof	€750	U-Value of ≤0.12 W/m^2 K
Advanced Heating Controls	€500	≥ 5 zones, no TRVs
High Efficiency Boiler	€300	≥ 94% Efficiency Boiler (with Heating Controls)
High Efficiency DHW Cylinder	€100	2008 Building Regulations (0.8W/L) Equivalent
Lighting – LEDS	30% (max €150)	3w-5w LEDS to replace down lighters
Lighting – Controls	30% (max €150)	Passive Infrared Sensor

Table 4. Summary of SERVE energy savings – delivered energy.

Sector	Total m2	Delivered Energy Before/ Reference (kWh/m^2/yr)	Delivered Energy After (kWh/m^2/yr)	Change (kWh/m^2/yr)	% Change**
Retrofit residential	54,747	210	118	92	44%
Retrofit non residential	9,926	210	145	57	27%
Eco Village Residential	8,307	120	57	64	53%
Eco Village Eco Hostel	588	309	170	139	45%
Eco Village Enterprise	599	300	170	130	43%

*** Retrofit Savings based on comparison of Pre Retrofit and Post Retrofit DEAP Analysis. Eco Village Savings based on comparison of DEAP versus Reference Building DEAP. Delivered energy in DEAP is equivalent to final energy.*

(8,000 kWh/dwelling). Comparing BER profiles for SERVE dwellings against BER profiles for dwellings nationally and in Co. Tipperary from the SEAI National BER Database (SEAI, 2013c) shows the shift of dwellings from the poor BER ratings of D, E, F and G to the much more efficient B and C ratings (Figures 2[3] and 3).

The SERVE measures went significantly beyond the requirements of the National Scheme and required multiple actions. Normally, under the National Scheme there was a tendency for homeowners to implement a small number of measures (two to three) with low investment levels (average investment of €3,000 per home) (Scheer, J. 2011). Typically these measures consisted of insulation (attic and cavity wall) and boiler upgrades. This compares to an average investment within the SERVE region of €7,660 per home and a minimum of 5 measures being implemented (Maras, H; Segon, V (2012)).

There are no published results of key energy indicators from the HES Scheme programme which would allow for comparison with the SERVE data. Scheer (2011) noted that savings of 20 % were observed from a sample of dwellings assessed. The more aggressive requirements of the SERVE project required

3. The BER Rating (Primary Energy Consumption) ranges from A1 - <75 kWh/m2.yr to G - >450 kWh/m2.yr.

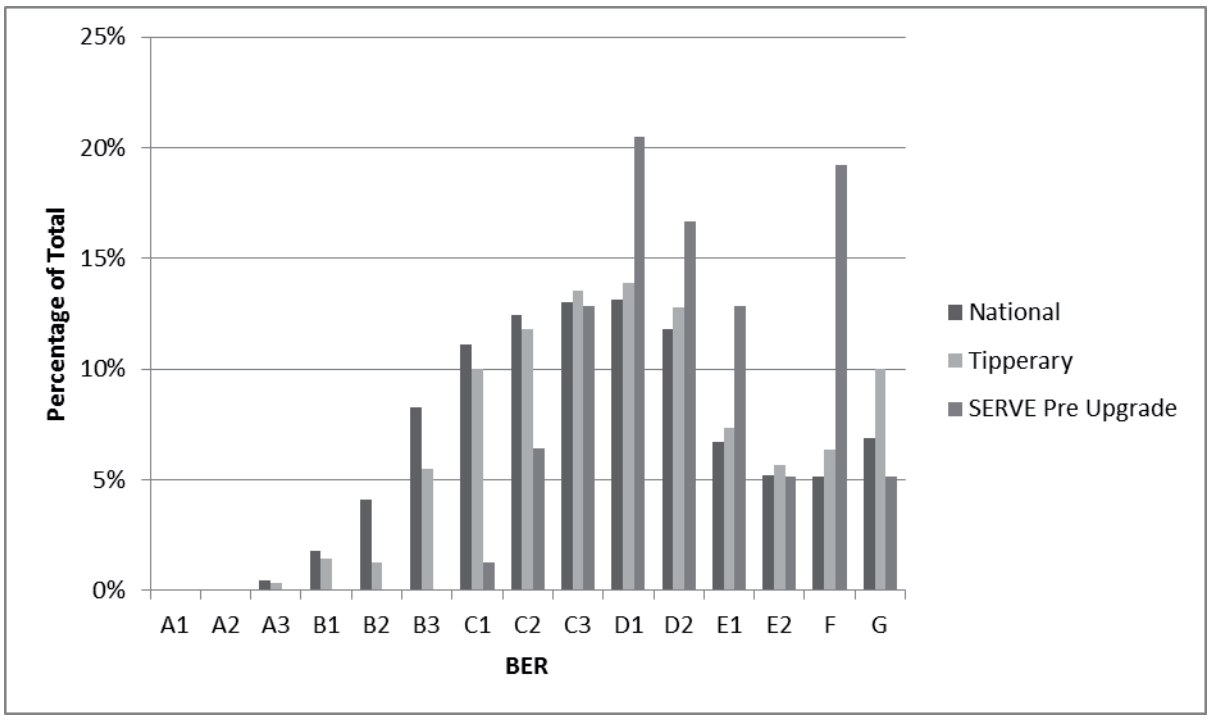

Figure 2. SERVE dwellings (before upgrade) BER profile and National and Co. Tipperary BER profiles.

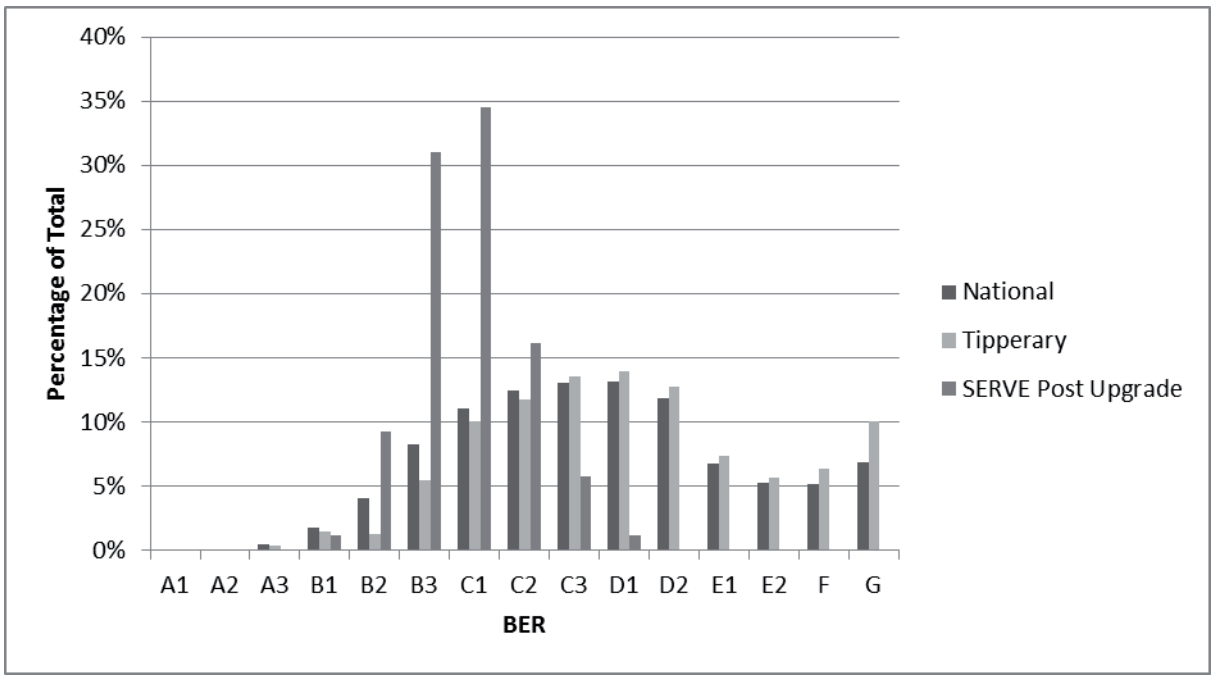

Figure 3. SERVE dwellings (after upgrade) BER profile and National and Co. Tipperary BER profiles.

Table 5. SERVE residential upgrades – key impacts from sample of 281 dwellings.

Number of dwellings	Simple payback period (years)	Discounted payback period (years)	NPV (€)	IRR (%)
281	11.3	13.4	876,218	10.54

greater investment but also resulted in greater energy savings being achieved.

From a sample of 281 dwellings, analysis was completed on the retrofitting upgrades to assess their economic impact (Table 5). Average energy savings per annum were 40 % and rates of return on investment were approximately 11 % with discounted paybacks in the region of 13 years.

Case studies of homeowners were produced in 2011 to document reaction to the project and also get greater insight into why upgrades were completed (Murphy, A; et al (2011)). Assessing these case studies it can be concluded that the issue of comfort was the main motivation behind the decision to retrofit, followed very closely by the financial assistance available through SERVE and the potential savings available in energy bills. From an environmental perspective it seems that peoples awareness varied in strength, however it was not ranked highly in the decision process to upgrade the energy efficiency of the houses. Even though some minor problems arose concerning workmanship, all householders expressed their overall satisfaction with the SERVE project and new measures installed. The fact that environmental protection is a limited driver was further emphasised as part of a socio-economic survey completed under SERVE which highlighted that since 2007, 25 % more people feel that environmental protection is less important than economic development (Segon, V; et al (2012)). This re-enforces the need to focus on comfort and financial impacts as key drivers for homeowners to invest in retrofitting. Case studies were also completed with contractors involved in the scheme, local politicians and eco village members[4].

SERVE RETROFITTING – SUCCESS FACTORS

The SERVE projects success in reaching its retrofitting target of 55,000 m^2 during a period of economic recession in Ireland was due to a number of factors. Firstly, homeowners were able to get access to funding from both Europe (via NTCC) and the SEAI HES Scheme. This meant that financial support was between 40 % & 50 % of investment costs. Therefore, the investment levels of the homeowners was reduced.

Secondly, the local authority utilised its existing relationships with local communities and individuals to promote the programme within the region. The scheme was promoted and communicated via local community groups, community and business leaders therefore reaching a wide spectrum of people. This contrasts with the National HES Scheme which was primarily promoted via TV, Radio and Web based media. The local access to information, advice and support assisted a significant number of individuals to engage in the upgrading programme. The NTCC and TEA partnership also had significant flexibility to modify the scheme to respond to a changing market place (and this was done on two occasions).

From a technical viewpoint the scheme focused on proven, realiable technological solutions. However, there was a significant requirement to address quality control and this was addressed by engaging actively with contractors and installers. Training was provided to contractors on standards expected and the requirements of the scheme. In addition, a significant level of auditing of installations was completed. Each installer was audited at least once, approximately 20 % of all installations were inspected and contractors required to make improvements if standards were not achieved. This approach to quality ensured that homeowners were assured that standards would be achieved and contractors were clear on need to ensure high quality workmanship. Repeated collaboration, consultation and training with installers ensured relevant standards were achieved.

Finally, the focus on mandatory measures which were then supplemented by a range of additional measures presented options for homeowners to considered when engaging in the scheme. This provided flexibility for homeowners to ensure the most appropriate measures were applied to their dwelling. The requirement to have a BER completed pre and post retrofitting ensured that homeowners had technical advise from a trained expert when selecting appropriate measures.

SERVE RETROFITTING – FROM LOCAL TO NATIONAL LEVEL

Sustainable Energy Authority of Ireland's (SEAI) were directed by the Department, Communications Energy and Natural Resources to implement the HES Scheme and as part of the scheme development phase invited partners from the SERVE project to discuss synergies and opportunities for cooperation (SEAI, 2009). Initially a Pilot HES Scheme programme was run in 2008 with a full scale programme implemented in 2009.

The SERVE Project had a strong influence on the structure and delivery of HES Scheme. The SERVE project acted as both an active project presenting real data to test proposed methodologies and also provided additional resources to SEAI. The relevant project partners (LIT, NTCC and TEA) were specifically involved in the definition of the survey methodology and systems to be used for energy assessments of existing dwellings. This included defining the methodology, building element default values and survey approaches (SEAI, 2013). Testing of the National Building Energy Rating (BER) assessment tool (Dwelling Energy Assessment Procedure (DEAP)) and associated National Database systems were also completed as part of the SERVE project. SERVE partners, in particular the TEA, worked with SEAI to train and audit energy assessors who were recruited by SEAI as part of the HES. In addition, the TEA also revised the Advisory Report received by the homeowner so that it demonstrated actual energy savings as a result of measures

4. www.servecommunity.ie

implemented. Finally, the SERVE project team provided significant resources to SEAI to ensure adequate quality control and correct assessment of dwellings. The TEA undertook to check each DEAP assessment completed on dwellings in the SERVE region and revised them as required with the assessor

SERVE partners (TEA and LIT) completed detailed analysis of all DEAP Assessments from the Pilot HES Scheme (approx. 1,000 assessments) and reported to SEAI on the measures to be considered for inclusion in the full National Scheme. Specifically, it recommended the inclusion of heating controls within the National Scheme as analysis highlighted that the SERVE plans to target heating efficiency and heating controls was valid.

The Irish National Energy Efficiency Action Plan targets a 20 % energy savings within the residential sector (DCENR, 2011). A revised HES Scheme programme was launched in May 2011 in the context of the Government's Jobs Initiative (Better Energy: the National Upgrade Programme). The 20 % target has been aligned with an overall ambition to upgrade 1,000,000 buildings (residential and non-residential) in Ireland by 2020 as savings from revised building regulations will be lower due to the significantly reduced construction levels. Under the Better Energy Programme a target of 5,200 GWh has been set for the residential sector within an indicative target of 800,000 homes.

To date, approximately 160,000 homes have been upgraded under the HES Scheme/Better Energy Schemes. Applying the 40 % reduction in energy consumption, in line with SERVE achievements, to the 640,000 remaining homes indicates that 6,489 GWh savings are achievable[5]. SERVE has demonstrated that an approach which requires all standard measures to be upgraded (walls, roofs, heating controls) along with a selection of other options is successful and presents options to the homeowner which allows them to match the potential upgrades to their homes. The SERVE Final report has been submitted to the relevant Government Departments and SEAI to allow them to assess how such an approach can be integrated into future action in Ireland. However, to date the National approach has not yet reflected the SERVE focus on deeper retrofits.

Analysis in the National Economic and Social Council (NESC) Interim Report "Report" Towards a New National Climate Policy" compares SERVE data with research from both SEAI and University College Cork (UCC) on a range of options for retrofitting in Ireland. The NESC Report notes "It seems that to meet existing targets, the average investment per retrofit would need to be increased from the current level of €3,000. We refer to increasing the average spend per retrofit as increasing the depth of retrofit activity. It is estimated that achieving 800,000 retrofits – but moving to deeper measures such as boiler upgrades and improved heating controls for all dwellings – would yield energy savings of around 5,210 GWh in 2020" (NESC, 2012).

The NESC report compares the SERVE economic analysis to on-going SEAI analysis and notes "Preliminary results … suggest that deeper retrofits than are currently the norm can have relatively short payback periods. In that analysis, if one million houses are targeted with an average spend of €7,600 per household (the range is estimated to lie between €2,400 and €12,500), the average simple payback is 11 years, which would equate to a discounted payback of approximately 13 years."

RETROFITTING – POTENTIAL IMPROVEMENTS

The National scheme has integrated quality control measures for BER Assessors, installers and contractors which has assisted in maintaining standards within the sector. Supporting these control measures with minimum training standards will ensure that emerging technologies, approaches and systems can be introduced into the market in a structured, controlled manner.

It is clear that to date upgrades completed under the National Upgrade Programme have not been to the level required to reduce energy use by 40% or more per dwelling. Initial evidence would indicate also that the level of applications for support under the Better Energy Scheme have reduced significantly as a result of grant rate changes in 2011. Therefore, the quantity and depth of retrofitting being completed is not reaching the levels required. The current National scheme should be modified to encourage deeper retrofitting and encourage homeowners to take a comprehensive approach.

The financial crisis presents challenges as many homeowners do not have the available funds to complete the upgrade. It is planned to introduce a Pay as You Save (PAYS) scheme in Ireland in 2013 which will potentially address the financial barrier and present an EPC/ESCO type model to homeowners for investment.

Biomass Heating – increasing penetration

SERVE BIOMASS HEATING – MEASURES

Another aim of the SERVE project was to stimulate a switch from fossil fuels to renewable fuels. Wood biomass was a particular focus in this regard and the project targeted domestic wood stoves and large scale biomass boilers. The considerable biomass resource in the region presented an opportunity for low cost intervention in the development of biomass heating systems.

In Ireland the majority of homes have a primary heating systems (oil/gas boiler) with additional space heating provided by a secondary heating system (open fire, low efficiency solid fuel stoves, electric heating etc.). 55 % of all secondary heating systems in Ireland are open fires (Kenny, 2012). The focus of the SERVE project was to provide specific financial support for the installation of high quality wood burning stoves to replace open fires. 2,300 kW of wood burning stoves were installed under the programme (approximately 400 stoves).

In addition, SERVE provided support (40 % financial support) for the installation of a number of large biomass (wood chip) fired boilers. This included the district heating boilers in the Eco-village and Gurteen Agricultural College in addition to the Nenagh Municipal pool. A total of 2.3 MW of commercial scale biomass systems were installed. Wood chip boilers in Ireland have had mixed success with a number of technical design issues and operational problems. Following discussion with the industry and local authority clients, it was agreed that a new approach to integration was needed where the contractor was required to design and commission the system correctly and accept the financial benefit or loss from good or poor design/

5. Based on data for average dwelling sizes and energy consumption from SEAI (2008) "Energy in the Residential Sector". Sustainable Energy Authority of Ireland, Dublin, Ireland.

construction. For the Nenagh pool in particular this new approach to procurement was implemented by the TEA.

SERVE BIOMASS HEATING – IMPACTS

When establishing the criteria for supporting wood stove installation it became apparent that there was no clear definition nor quality requirements for wood burning stoves in use in Ireland. Based on surveys of the stove suppliers in the SERVE region and surrounding regions, it became clear that there were two main classes of stoves supplied defined by higher and lower quality. After research, a definition was established for the purposes of stimulating the fuel switch from fossil fuels such as coal and peat to renewable sources, such as wood and wood products (Kenny, 2009).

In order to ensure that only high quality wood burning stoves would be supplied and utilised specific criteria were put in place in relation to funding supports. All contractors were provided with training on the best practice for selection and installation of wood stoves. Inspections were completed to ensure that stoves were installed correctly and funding criteria met satisfactorily. An interview with a local stove supplier highlighted the benefit of SERVE in improving standards, eliminating poor quality stoves and improving awareness in the region (Cloherty, F (2011)) .

The SERVE project has resulted in a significant increase in the number of stoves being installed (within and beyond the SERVE region) and also led to the establishment of a number of wood fuel supply companies in the region. A survey of people in the SERVE region noted a 13 % increase in the use of wood as a fuel between 2008 and 2012 (Segon, V et al,2012).

In relation to commercial biomass boilers, a key outcome from the work within SERVE was the establishment of an innovative contract, within Ireland, that rewarded all parties to perform contracted obligations to a high standard. The approach focused on a separate design and build contract for the installation of the boiler. A parallel heat supply contract (operate and maintain) for an initial 3–5 year term was also put in place with the contractor. The heat supply contract was based on kWh supplied (metered after the boiler) therefore encouraging high quality fuel. The heat supply contract also included for backup fuel supply (typically from fossil fuel boiler) therefore ensuring the contractor designed the system to minimise fossil fuel use. There was no minimum purchase of heat and the contract had acceptable termination clauses in the event of either party defaulting on obligations or a switching of business priorities.

Implementing the above approach required the SERVE partners to convince the clients to take an alternative approach to procurement. Traditionally, Irish public authorities have taken a simple 'design and build' procurement approach and have only recently begun to enter into service type contracts.

The annual savings in the Nenagh Pool is estimated at €50,000 per annum (IRR without grant of 32 % and simple payback of 4.2 years). This has had a dramatic impact on the financial viability of a public facility at a time of tightening local authority budgets.

SERVE BIOMASS HEATING – SUCCESS FACTORS

The rapid increase in the installation of wood stoves within the SERVE region was driven by a strong information campaign and clear criteria to differentiate, for the consumer, wood stoves from multi-fuel stoves. Engagement with the stove suppliers over the period of the project ensured that standards were maintained. The significant number of installations (2.3 MW of stoves in total) created a critical mass of homeowners engaging in installations of high quality wood burning stoves. An interview with a registered installer of wood stoves highlighted the fact that homeowners were installing smaller stoves (due to improved insulation levels) and high quality stoves (as a result of financial supports available). It also highlighted that fact that the cheap, low efficiency wood stoves were eliminated from the market due to the demand for high quality units (Cloherty, F. 2011).

The successful implementation of the new procurement approach for the biomass boiler in Nenagh pool was built on knowledge and experienced gained from industry exchanges to other EU countries. This allowed the TEA to apply best practice in an Irish context. Discussion and consultation with the local authorities and the industry ensured that the procurement method was appropriate for the service required. The TEA also employed staff who had specific expertise in relation to procurement which provided additional assurances to the client and contractors involved.

SERVE BIOMASS HEATING – FROM LOCAL TO NATIONAL LEVEL

The specification for wood stoves, developed by the SERVE project, has been utilised by SEAI to make specific reference to wood stoves within the National Dwelling Energy Assessment Procedure (SEAI, 2012).

Based on the experience from the SERVE project from the Nenagh biomass boiler, the same approach was utilised to stimulate the installation of biomass boilers with public bodies outside of the SERVE region. Biomass heating systems were also installed in a public pool and third level college (LIT Tipperary) in Thurles using the above contract basis. Both tenders were managed successfully on behalf of the clients by the TEA using the National Public Procurement System. Within SERVE, 1 MW of biomass heating was installed using this approach with 0.7 MW being installed outside of the SERVE region. In the case of both pool installations additional grant support was secured to improve the financial viability of the project. In the case of LIT Tipperary the investment was done without any financial support.

The SERVE approach and experience to biomass heating of large buildings and facilities was used as key experience in the generation of the Regional Approaches to Stimulating Local Renewable Energy Solutions (RASLERES) project's template ESCO contract for the public sector[6]. The principles of the approach were developed further in North Tipperary to include energy efficiency measures and third party finance. This allowed a local authority to utilise savings achieved through the installation of a biomass heating system to subsidised additional energy efficiency measures.

In late 2012, a high level ESCO interdepartmental working group has been formed by the Government to establish a national retrofit fund and contracts to utilise the fund to significantly increase the retrofitting and renewable supply to Ireland. Based on the experience of the SERVE project, the TEA was in-

6. http://www.raslres.eu/

Table 6. SERVE retrofitting monitoring structure for residential buildings.

Baseline – Pre data	Theoretical Building Energy Rating	353 buildings
	Oil bill analysis	142 houses (with valid data)
	Electricity bill analysis	184 houses (with valid data)
Post data	Theoretical Building Energy Rating	353 buildings
	Oil Bill Analysis	142 houses (with valid data)
	Electricity Bill Analysis	184 houses (with valid data)
	Monitoring Equipment	98 houses
	Secondary Fuel Survey (manually)	98 houses

vited to sit on this working group. The initial phase of the work will focus on five detailed case studies on projects which have been implemented to allow for benchmarks to be developed. The ESCO methodology implemented in North Tipperary will be one of these five case studies. A fund[7] has been established in the national budget in December 2012 to develop projects based on these methodologies in 2013.

BIOMASS HEATING – POTENTIAL IMPROVEMENTS

There is an immediate need to improve the standards of wood fuel supplied for both residential (wood logs) and commercial applications. The National Wood Fuel Quality Assurance (WFQA) scheme is evolving but there are a limited number of companies (3) registered to date (WFQA, 2013). There is also a need to increase the knowledge of consumers of wood fuel as to the requirement to purchase quality products.

The next phases of the National ESCO Working Group will be vital to promote and develop the take up of ESCO approaches to biomass heating, and other project installations. In addition, there is a need to provide training and upskilling to procurement officers in public bodies so that they have the knowledge to engage in this alternative financing approaches.

Energy monitoring

SERVE ENERGY MONITORING – MEASURES

As part of the CONCERTO project, detailed energy monitoring needed to be completed for a wide range of energy actions. Within the case of SERVE, a specific focus was placed on energy use within the residential sector. All buildings which completed upgrades had BERs completed before and after upgrade along with collection of energy bill data (heating and electricity). In addition, 100 dwellings were selected for the installation of detailed energy monitoring equipment. This work is one of the most comprehensive analyses of energy use within the Irish residential sector. This monitoring work is being continued after the SERVE project end date (31st October 2012). As the monitoring work is co-funded by SEAI, all data and analysis will be provided to SEAI and fed into the relevant areas of policy and technical analysis.

The analysis being conducted by the TEA and SEAI will produce data to compare energy performance of dwellings within the region. Comparison with National datasets and benchmarks will also be provided. Key indicators which will be calculated include:

- Absolute and relative reduction in electricity end-use.
- Renewable energy use for heating (% of final energy demand and % increase during SERVE).
- CO_2 emissions reductions (Tonnes CO_2).
- BER before and after upgrade (kWh/m^2.yr) compared to metered energy use.
- Disaggregated electricity use in a typical dwelling.
- Secondary fuel use.

In addition, the monitoring activities are also examining, for a smaller sample of dwellings, domestic hot water consumption (10 dwellings), boiler efficiency for condensing and non condensing boilers (6 dwellings) and solar water heating system performance (4 dwellings). The following datasets have been delivered during the project.

Each of the 98 houses that had monitoring equipment installed had a detailed energy use survey carried out. This analysed all electrical circuits and appliances. Analysis of the data is on-going and data will continue to be gathered until April 2013 to ensure that the monitored data covers two heating seasons. Data is also being utilised to provide reports to home owners on their buildings energy performance.

SERVE ENERGY MONITORING – IMPACTS

A draft report has been produced in December 2012 for publication in early 2013 (Petersen, K L, et al, 2012). A number of conclusions have already emerged. Boiler efficiency of the condensing boilers is lower than expected and affected by system return temperatures, oil usage and load patterns. Further analysis of these relationships based on a wider sample is required to provide further evidence on this issue. The average electricity consumption was calculated at 4,826 kWh/dwelling/year (range of 1,276 to 11,845 kWh/year) which is in line with available national indicators. The monitored BER of dwellings is on average 13 % lower than that calculated by DEAP (Figure 4). This is in line with expectations as the DEAP Methodology is generally pessimistic in approach but is also not designed to be an operational rating but an asset rating. The analysis has also confirmed that the DEAP methodology is relatively accurate as a measure of energy performance when utilised for dwellings with standard energy

7. Department of Finance (2012), "Expenditure Report 2013" Page 41. Available from: http://budget.gov.ie/Budgets/2013/Documents/Expenditure%20Report%202013%20Part%20I.pdf.

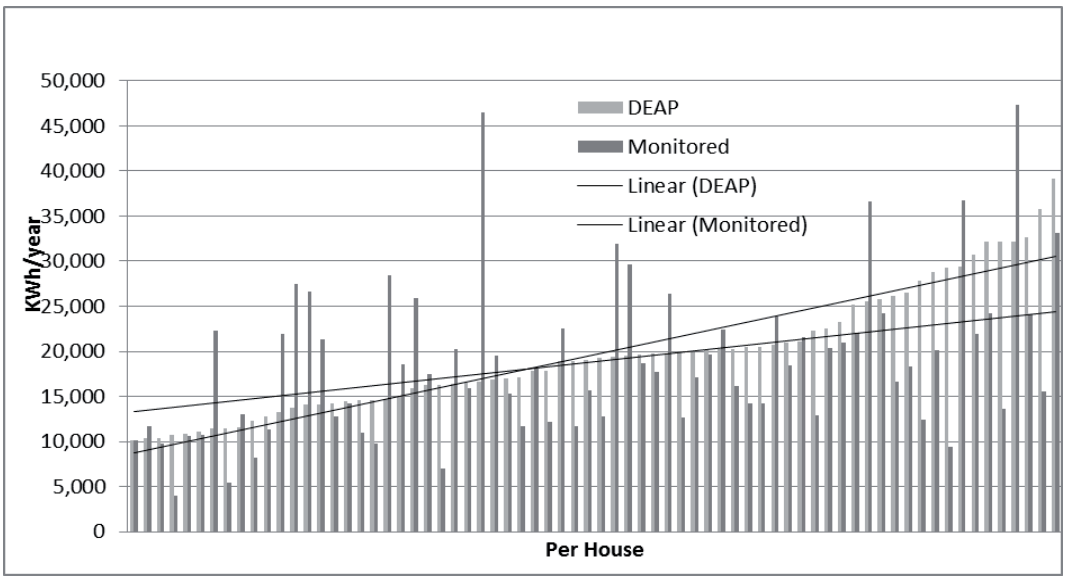

Figure 4. Delivered energy (oil consumption and secondary fuel) after upgrade (70 monitored houses)

performance but larger discrepancies occur at very poor and very good energy performance levels.

However, when compared to DEAP two particular issues are highlighted where differences emerge between measured data and DEAP assumptions. Heat supply from secondary fuel in the monitoring houses within the SERVE region was on average 35 % which is considerably higher than that assumed within DEAP (10 %). Temperatures within dwellings are generally lower than that expected in DEAP. In particular, for dwellings prior to upgrade it is evident that homes were significantly under-heated and in some cases unhealthy (Figure 5). Further analysis is on-going on both of these issues.

SERVE ENERGY MONITORING – SUCCESS FACTORS

The SERVE project monitoring system monitored a large number of data points across all the upgraded buildings. The data points for each dwelling allowed the data to be reviewed to ascertain the real and theoretical energy use before and after the upgrade. At project conception stage, the main outputs of the analysis were detailed, with the raw data requirements being laid out in advance. Each of these data points were discussed with a team of experts to detail all the possible methods of collecting the required data. Each element of data was analyzed to understand the accuracy and data integrity risks. The monitoring design allowed an expert to review where the data was not guaranteed to be accurate and discard the data point or use an appropriate method of ensuring continuity of analysis.

The interaction with each dwelling owner was key to understanding the accuracy of some of the less guaranteed data sources. An example of this is the secondary fuel monitoring where three separate methods were employed to try to identify the quantum of fuel used in a heating season. These included a survey of purchasing fuel (quantity, quality/ type, frequency, delivery method, bills etc.), a survey of fuel use (discreet boxes/ baskets, frequency of use by month, quantum of use per lighting instance) and a temperature monitor installed adjacent to the appliance to identify discreet use of the appliance. These three methods were reviewed with the homeowner and the kWh, price and quantity of fuel used guided the expert and homeowner to identify the most accurate estimate of secondary fuel use.

SERVE ENERGY MONITORING – FROM LOCAL TO NATIONAL LEVEL

Discussions are currently on-going to extend the monitoring activity into a longitudinal study which would increase the data accuracy and also provide valuable trend data and profiles across a longer time-span. In addition, two Post-graduate research projects are planned which will complete additional more detailed analysis on the data. One key data point that is being analysed for immediate use is the comparison of theoretical energy use to actual use. This data point will be used to guide the County Kerry Sustainable Energy Action Plan and also the National Energy Efficiency Action Plan Version 2. Both of these documents are published in March and April 2013, respectively.

SERVE ENERGY MONITORING – IMPROVEMENTS

The SERVE project attempted to numerically quantify the exact energy and hence cost savings ascertained post retrofit of all the dwellings upgraded. This presented a number of challenges based on a typical cohort of houses in the area. A key challenge to the accuracy of the estimating of energy savings was a change in use an operational of the dwelling. The challenges encountered included insufficient data due to a change of ownership of the dwelling within 2 years either side of the upgrade, a change in the number and behavioural pattern of the occupants (e.g. a child going to college, a new born baby arriving in the monitored dwelling, a change in employment circumstance etc.) and rebound effect due to increased internal temperatures after upgrade. Given that the energy supply was primarily via oil and solid wood biomass there was significant challenges in gathering accurate bill data. A study completed in the context of the National Smart Meter Roll out (SEAI, 2012b)

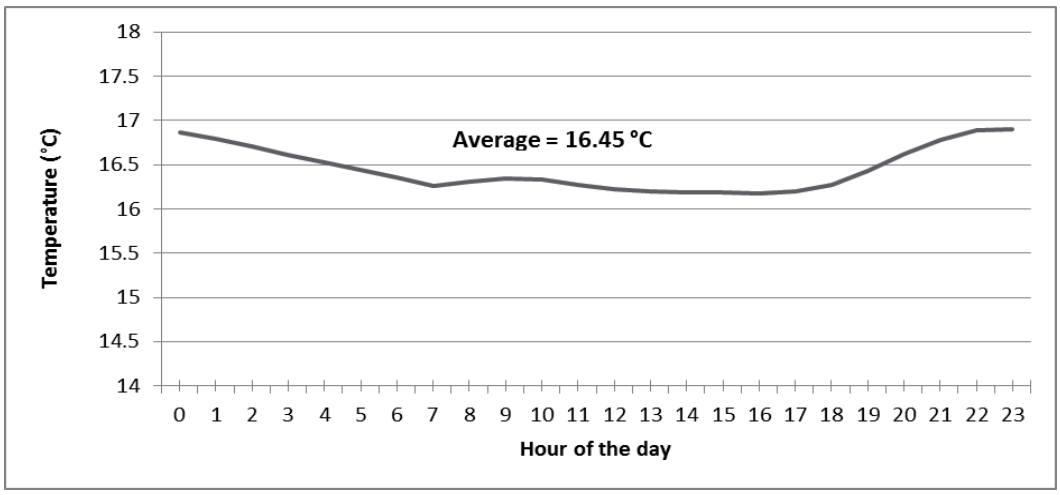

Figure 5. Temperature profile within monitoring dwelling (average winter temperatures in bedroom).

has provided a significant data set of energy data from electricity and gas bill data for dwellings across Ireland. Further analysis is required to compare data profiles from the SERVE data with this data set.

Future monitoring activities will need to take a number of recommendations on board including seeking to utilise dwellings which have a measurable fuel source (via oil meter or existing gas meter), temperature monitoring pre upgrade, increased sample size and additional monitoring of secondary fuel use.

Conclusion

The SERVE project has been a success when compared against the initial project objectives. In total 10.4 million Euros have been invested in sustainable energy demonstration, research and development actions within a rural region.

Beyond local impacts, SERVE has had a specific impact on the development of the retrofitting market in Ireland and has influenced national policy. Based on its work on the Pilot HES Scheme it influenced the inclusion of heating controls as a supported measure within the National Retrofitting programme. Its work on supporting deeper retrofits has been recognised in current policy documents which are setting future energy and climate change policy.

Within the wood energy and biomass market the experience from SERVE has helped to support the development of local wood fuel supply and use of energy efficient wood stoves within and beyond the SERVE region. The SERVE approach to defining standards for wood stoves has been recognised within the National DEAP Manual. The approach to procurement of biomass heating systems within the SERVE project and for associated projects has been built up in other projects and is now feeding in National initiatives in relation to ESCO's.

One of the key legacies of the SERVE project is the range and scope of data which has been gathered as part of the extensive monitoring work completed. This analysis, which is feeding directly into the National Energy Agency is profiling energy use in domestic dwellings and also providing key data on energy performance on a range of technologies.

While National energy policy which was in place when the SERVE project was conceived was developed has evolved, the progress made within the SERVE project in the context of retrofitting has been considerable. In addition to the energy and monetary savings resulting from the investment new standards, approaches and knowledge have been developed and disseminated. The rate and depth of retrofitting will have to increase significantly if National energy saving targets are to be achieved.

The CONCERTO approach of taking an integrated approach to sustainable energy supply is entirely valid and local and National Governments need to ensure that energy policy takes a comprehensive approach rather than operating on a project by project basis. CONCERTO has supported a wide range of demonstration projects across the EU, the results of which are being fed into regional and national policy actions. These and other demonstration projects provide the opportunity to test new approaches, achieve scale within defined control conditions and ensure the results are monitored and disseminated widely.

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