

# **Innovations to Reduce Residential Energy Use and Carbon Emissions: An Integrated Approach**

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**Abstract:**

Research in energy sustainability is gaining a renewed priority because of the growing importance of climate change issues and the ratification of the Kyoto Protocol by many countries. Increased energy efficiency and substitution to less carbon-intensive fuels are proposed as the principal means to reduce greenhouse gas (GHG) emissions and associated climate change. The residential sector is an important area for improvement as it accounts for 22 percent of global energy consumption. The paper illustrates the integration of four dimensions of energy issues within a single community study in Waterloo Region, Canada. First, it overcomes the limitations of single discipline approaches to energy studies by recognising the importance of social context in measuring the potential to reduce energy consumption. The 'socio-technical' potential to reduce residential consumption by 25 percent is lower in our analysis than traditional measures of the technical potential, but is considered more achievable. Second, the paper examines how community-based implementation can enhance the effectiveness of a national energy efficiency program (*EnerGuide for Houses* or EGH). Controlled marketing experiments demonstrated higher response rates for materials highlighting local partners. Third, the local capacity developed by diverse stakeholders (city councils, regional government, federal government agencies, local utilities, local businesses, environmental non-governmental organisations and the local university) was an important means to overcome many of the barriers to taking action. Fourth, issues of energy efficiency and fuel substitution were examined through a survey of residents' attitudes and comparison to behaviour. For example, the stated 'willingness to pay' was compared to the actual sign-up rate for the first introduction of 'green' electricity in the Ontario residential market. The integration of these four dimensions in a single study offers a framework that can be reviewed and adapted to meet the needs of other projects.

Keywords:

residential energy, efficiency, greenhouse gas emissions, barriers, green electricity, partnerships

## **Innovations to Reduce Residential Energy Use and Carbon Emissions: An Integrated Approach**

### **Introduction**

In the near term, the greatest opportunities for cleaner energy lie in energy efficiency on the demand side and switching to less polluting fuels and energy conversions on the supply side. Although this conclusion is apparent from the CEF [Clean Energy Future] analysis of the United States, it is equally true for other countries throughout the world. (IWG 2000 p. 8.1)

Research in energy sustainability is gaining a renewed priority because of the international importance of climate change issues and the ratification of the Kyoto Protocol by many countries. Increased energy efficiency and substitution to less carbon-intensive fuels are proposed as the key means to reduce greenhouse gas (GHG) emissions and associated climatic changes. Geographers were actively engaged in the debate and research surrounding energy issues in the 1970s and 1980s (see Robinson 1984; Jackson 1988; Kuhn 1988). A decade ago, *The Canadian Geographer* published papers from Canadian geographers working on energy and sustainability. Pierce (1992) agreed with Repetto (1985) that energy was one of the five essential transitions needed to shift society toward a path of sustainable development. Kuhn (1992) identified the differences in energy policy preferences held by people with 'ecocentric' versus 'technocentric' worldviews. Robinson (1988) advocated back-casting techniques to identify and work toward desired energy pathways. Chapman's 1989 text entitled *Geography and Energy* reviewed each of the major commercial energy systems and summarized Canadian energy policy and changes in the fuel mix over the last century. Despite the insights and knowledge gained from these earlier studies, society has not achieved its goal of shifting to sustainable energy systems. Innovative approaches that can link knowledge to practice are required.

Energy studies share the general pattern of research in resource and environmental management where most studies have a narrow focus, yet leading researchers call for integrative approaches. The need for integrative approaches in energy studies is highlighted by recent American research where five national research laboratories prepared the *Scenarios for U.S. Carbon Reduction* report (IWG 1997) without an integrating analysis that recognized intersectoral effects (IWG 2000). The need for integration was recognized and the five laboratories used an integrated

analytical framework for their subsequent report *Scenarios for a Clean Energy Future* (IWG 2000, Brown *et al.* 2001). Many studies that had identified potential cost-effective investments in energy efficiency in the building, transportation, industrial and electricity sectors were recognized, but it was noted that in most cases action or implementation strategies were lacking. The resulting ‘efficiency gap’ is considered to be a product of many market failures and barriers to action (Brown 2001, Jaffe and Stavins 1994). Over 50 public policies and programs were examined as the means to comprehensively bridge the gap in the CEF study (IWG 2000).

This paper concurs with the need for integration in energy studies. Rather than examine a single question such as “Can the technical efficiency of the residential sector be improved?”, it links the technical efficiency question with the social attitudes and behaviour of residents by assessing the ‘socio-technical’ potential to improve residential energy efficiency. It also links the knowledge that the potential for improvement exists to the practical issue of policy implementation or “How can improved energy efficiency be achieved at the local level?”. The paper’s objective is thus to illustrate the integration of different dimensions of energy issues within a single community study. The resulting approach offers a framework for other researchers seeking to integrate multiple dimensions within a single study of energy sustainability.

Four dimensions of integration are often identified in the wider environmental literature on integrated assessment and modeling (and others could be added). The term integration has been used to describe methods that integrate across disciplines (engineering/technical vs. social science/behavioural), scale (global/national vs. local), stakeholders (diverse interests) and issues (conservation vs. substitution) (Figure 1; Parker, *et al.* 2002). Rather than restrict integration to a single dimension, this paper examines the four dimensions of integration in a Canadian case study at the community level. First, the paper recognises the importance of social context in measuring the ‘socio-technical’ potential to reduce energy consumption. The first integrative step in energy studies is often to link engineering and economic components together. The case study reviewed in this paper incorporates a wider social dimension by engaging homeowners in discussions about the technical changes they would consider as part of their plan to upgrade residential energy efficiency. The second type of integration examined is how community-based implementation can enhance the effectiveness of a national energy efficiency program (the *EnerGuide for Houses* or EGH program administered by Natural Resources Canada). Third, the paper reviews the implementation of the EGH program through the development of local capacity via a network of public, private and not-for-profit partners. Fourth, it examines both energy efficiency and

substitution by surveying residents' attitudes and reported behaviours in both areas. The integration of these four dimensions in a single project offers a comprehensive framework that can be reviewed and adapted to meet the needs of other national and local energy policies or studies. The need for this innovative approach is demonstrated by continued increases in international residential energy consumption and GHG emissions.

Insert Figure 1 Four Dimensions of Integration in Energy Studies

### **Context: Residential Energy Consumption and GHG Emissions**

The present pattern of energy production and consumption is considered unsustainable because of its massive emissions of GHGs, the increased concentration of these gases in the atmosphere and the climatic consequences (IPCC 2001). At the global level, residential energy use is second only to industrial energy use with 70 exajoules (EJ =  $10^{18}$  J), or 22 percent of global energy use consumed annually in the mid 1990s. Rather than continuing the trend of increased energy use and GHG emissions, improved energy efficiency is advocated by most governments and analysts in industrialized countries as an important means to reduce emissions (OGWC 1991; Jaccard, *et al.* 1996; Koomey *et al.* 1998, NRCan 1998; PIAD&DSF 1999, OEE 2000a).

Canada exemplifies the problem of countries where energy demand is growing faster than gains in energy efficiency. The Canadian government signed and ratified the United Nations Framework Convention on Climate Change and then signed and ratified the Kyoto Protocol to indicate its intention to reduce GHG emissions by six percent from 1990 levels by 2008-2012. Efficiency gains are estimated to have reduced the growth in direct Canadian energy use from 15 percent to 9 percent over the 1990-98 period and avoided an estimated \$5 billion being added to the annual national fuel bill (OEE 2000a). However, the overall trend in Canada is continued increases in GHG emissions (from 612 million tonnes carbon dioxide, Mt CO<sub>2</sub> in 1990 to 692 Mt CO<sub>2</sub> in 1998) (EC 2000).

The residential sector is the third largest consumer of energy and source of GHG emissions in Canada (17 percent and 15 percent respectively in 1998, OEE 2000a). The trend over time shows that direct Canadian residential CO<sub>2</sub> emissions peaked in the early 1970s and declined with the efficiency gains stimulated by high oil prices and government programs in the 1970s and early 1980s (IEA 2000). The average energy efficiency of houses has improved markedly over the last

century with those built in the 1990s being three times as efficient in space heating needs as those built in the early 1900s (Parker *et al.* 2000b). Despite the substantial improvements in efficiency in newer houses, total Canadian residential CO<sub>2</sub> emissions increased gradually in the late 1980s and 1990s (IEA 2000).

Canadian residential energy consumption is forecast to continue rising despite further assumed improvements in efficiency (NRCAN 1999). Ontario's residential energy consumption is forecast to increase quickly (13 percent above 1990 levels by 2010) and the associated GHG emissions are forecast to increase even faster (17 percent above 1990 levels by 2010) (NRCAN 1999). Peak Ontario electricity demand is expected to shift to the summer (as in 1998 and 1999, OPG 2000; and in 2001 when the previous record consumption level of January 1994 was surpassed in July and again in August, IEMO 2001). In addition, most new generating capacity is expected to be fossil fuel-based. Given that trends during the 1990s and official forecasts both show that expected improvements in residential energy efficiency are not enough to reduce GHG emissions, let alone achieve the Kyoto Protocol target, innovations in the way we study energy and the way we implement energy policies are needed.

### **Why is Innovation Needed? Past Failures to Reduce Emissions**

The failure to reduce GHG emissions documented above can be attributed to several causes: the lack of integration in energy policies at local, provincial, national and international levels; the lack of inclusion of multiple stakeholders; the lack of integration across different disciplinary perspectives in energy studies; the lack of integration across energy issues such as conservation and fuel substitution; the persistence of inadequate price signals; multiple market failures; conflicting energy and environmental policies; and institutional barriers. These failures demonstrate the need for increased integration in energy studies and policies to achieve society's goal of reducing GHG emissions. Examples are given below of inadequacies in the traditional specialized approaches to energy studies and the inadequate implementation of energy policies.

Traditional energy studies in the residential sector can be divided into two general categories: technical and social/behavioural (Scott, *et al.* 2000a). The technical studies typically have an engineering approach with new technologies presented and the benefits of their adoption measured. The benefits of universal adoption (or adoption of a fixed percentage) are calculated, but little attention is paid to the challenge of achieving high rates of adoption. These studies are

exemplified by the detailed studies of Canadian residential energy use by Urgusal, Fung and others at Dalhousie University (Ugursal and Fung 1996, 1998; CREEDAC 1999, 2000) or American studies by researchers such as Koomey at the Lawrence Berkley National Laboratory (Koomey *et al.* 1998).

The technical potential to reduce GHG emissions has been widely stated and governments have responded with programs to encourage technical improvements. In Canada, an example of programs designed to improve the technical performance of houses is the approach adopted in the R-2000 standard for new houses. Established in 1982, the R-2000 Home Program aims to encourage the building of 'energy-efficient houses that are environmentally friendly and healthy to live in' (OEE 2000b). The building envelope is constructed to provide a high level of insulation and minimal heat loss through air leakage. Controlled ventilation (through a heat recovery ventilator) ensures adequate fresh air. Although the standard has been available since 1982, its adoption is estimated at 0.7 percent of the new houses built (1990-96) and only 8,000 houses had been registered as meeting the R-2000 standard by the year 2000 (NRCAN 1998; OEE 2000b). Given a national housing stock of 10 million units, this national technical solution for energy efficiency in new houses requires much broader implementation to make a significant impact. In addition, the technical efficiency of houses could easily surpass the R-2000 standard by the use of many advanced techniques and technologies currently available.

Social barriers restrict the implementation of technical solutions and these social aspects need equal attention (Brown *et al.* 1998; Brown 2001). Scott, *et al.* (2000b) reviewed demographic and attitudinal attributes affecting personal decisions to invest in energy efficient technology, to manage energy consumption more effectively and to forgo some of the benefits resulting from energy consumption. They supported earlier calls to explore the social dimensions of energy decisions at the same time as technical dimensions (Robinson 1991; Shove 1998). Social barriers requiring examination include the lack of information, time, financing and trust.

Behavioural energy studies focus on people and their energy-related decisions (Stern 1992; Lutzenhiser 1993). These studies can be further divided between energy economics where demand is calculated using income and price elasticities, and psychological studies that use surveys to collect attitudinal and behavioural data to explain the inadequacies of economic models of behaviour. Haas and Schipper (1998) expressed amazement at the persistence of economic studies based on income and price elasticities despite the demonstrated importance of

technology. The different price sensitivities found between high and low-income households (Nesbakken 1999) is not only found in economic studies, but represents one of many issues explored in the broader behavioural literature. Energy-related decisions are influenced by attitudes, information, capacity and incentives to act, as well as by barriers that prevent or restrict actions to improve energy efficiency (Stern and Aronson 1984; Geller 1992; Stern 1992; Scott *et al.* 2000b; Brown 2001).

Rather than remain in one of these narrow approaches, an integrated study of residential energy efficiency would seek to examine the interactions among technical and behavioural factors (Brown *et al.* 1998; Shove 1998). This approach would extend established techniques to assess technical potential by incorporating behavioural and social insights. The Residential Energy Efficiency Project in Waterloo Region (REEP) is a Canadian example of such an innovative approach. It sought to integrate the disciplinary approaches of technical and behavioural studies, address the scalar problem by linking local and national initiatives, include the diverse needs of stakeholders, and recognise the complementary issues of conservation through efficiency and fuel substitution. This project will be briefly introduced and each of the four dimensions examined.

### **REEP Case Study**

The overall vision for REEP is citizen action to contribute to a healthier, more sustainable community, while simultaneously furthering Canada's international commitment to the Kyoto Protocol (REEP 1998). The project is situated in Waterloo Region (population 450,000) in south-western Ontario, 100 kilometers from Toronto. The project is designed to build public awareness and understanding of the climate change issue and to provide technical information and social dialogue about the link to personal energy consumption (Parker, *et al.* 2000a). More importantly, through direct personal contact, the project aims to empower behavioural change by identifying the sustained benefits of energy efficiency and providing a practical course of action for homeowners to follow.

The study was funded in large part by the Government of Canada's Climate Change Action Fund and the *EnerGuide for Houses* (EGH) program (administered by Natural Resources Canada). The REEP project completed 2,491 home energy evaluations between May 1999 and April 2001 (and over 3700 by December 2002). Participants were self-selected as they responded to various advertising and information campaigns or social networking and called the project office to

arrange an energy evaluation of their home. The single detached houses in the sample have a similar age profile as the total Waterloo Region housing stock (Parker, *et al.* 2000b). The technical data on the houses are complemented by a comprehensive survey of attitudes and behaviours related to energy use (Scott, *et al.* 2000b) and policy preferences (Rowlands, *et al.* 2000a). The survey was given to homeowners at the time of the evaluation and a prepaid envelope was included for its return. A total of 527 valid surveys were returned from residents in the 823 single detached dwellings evaluated during the first year of operation for a response rate of 64 percent. In contrast, the row houses were typically evaluated as a group and discussions were held with the maintenance manager instead of the resident, so surveys were not distributed to this group.

The ability of this project, REEP, to apply each of the four dimensions of integration (disciplinary, scalar, stakeholder and issues) in a community level study will be examined in the next four sections.

### **Dimension 1 – Disciplinary integration: The socio-technical potential for efficiency gains**

REEP included a detailed technical energy evaluation conducted with *HOT 2XP* modeling software provided by the Office of Energy Efficiency, Natural Resources Canada, to identify upgrades that could be made and to calculate potential energy savings and cost savings, as well as the expected new EGH rating for each house. However, rather than examine technical energy saving potential in abstract by upgrading structural attributes and heating/cooling systems of each house as closely to the R-2000 standard as possible, the evaluator used the EGH results to discuss what changes the residents would consider. In other words, two technically identical houses may have different sets of upgrades outlined in their home energy plan if the discussions between the homeowner and evaluator differed and indicated that certain actions are very unlikely to be taken. The estimated socio-technical energy saving potential derived from this ‘socially negotiated’ approach incorporates some of the social constraints to individual action. This enabled REEP to go beyond the abstract technical question of whether it is possible to have more efficient houses (as documented in many studies), to examine what actions homeowners might be reasonably expected to undertake to improve energy efficiency.

As a northern nation, heat loss in Canada's housing stock represents a substantial opportunity for energy efficiency gains. The reduction in heat loss through the building envelope reduces the

amount of energy used to heat or cool each house and thus cuts fuel consumption and the associated GHG emissions. It was found that the heat loss of houses built before 1940 could be reduced by 60-70 GJ per year on average (Figure 2). Reducing air leaks, and insulating the walls and foundations were the three most important areas for improvement in these homes (Parker, *et al.* 2000b). The potential savings through the addition of further insulation in the attic remains significant, but not as large as might have been expected because this upgrade was targeted in government programs following the oil crises of the 1970s (Ferguson 1993). Houses that were built in the 1940s, 1950s and 1960s could reduce their heat loss by 30 GJ per year on average. Insulating foundations, sealing air leaks, and upgrading doors and windows offer the greatest potential savings for these houses. Houses built in the 1980s and 1990s still can have air leaks sealed, but adequate ventilation must be ensured. In some cases, selected doors and windows should be replaced, or insulation added to the foundation or attic. The actions appropriate for each particular house were identified by the EGH energy evaluator and discussed with the homeowner.

Insert Figure 2: Recommended areas to reduce heat loss in single detached dwellings

The difference between conventional technical evaluations of potential energy savings and the integrated socio-technical potential is well illustrated by the potential to upgrade furnaces. High efficiency furnaces typically have an efficiency rating of over 90 percent and offer great improvements over old furnaces rated at 60 percent efficiency or less. Clearly, less fuel would be used if all houses had these high efficiency furnaces. However, many people choose not to make the upgrade. In one-third of the REEP evaluations where a high efficiency furnace could be installed, the discussion led the evaluator to conclude that it is not feasible for this household and a high efficiency furnace was not included in the recommended actions. The reasons for this are typically that the payback period would be too long because the house has a small level of demand, or a new mid-efficiency (80 percent) furnace with an expected life span of 20 years was recently installed. These decisions result in a lower measure of the potential energy savings than a traditional technical potential measure.

Through detailed analysis of each individual house and discussions with the homeowner, evaluators identified ways to reduce energy consumption by 25 percent (n=1,937 single detached dwellings evaluated May 1999 - April 2001). These conservative measures of socio-technical potential to reduce energy use are less than could be achieved if all possible upgrades were made. For example, Jaccard, *et al.* (1996) projected that per capita residential energy demand could be

reduced by 65 percent in Ontario, Quebec and British Columbia under technically optimal conditions. However, the high cost of many upgrades (e.g., insulating exterior walls, installing advanced windows), means that many of these improvements are very unlikely to be made. The socio-technical potential is considered to be a better measure of the potential to reduce energy consumption and GHG emissions, but full implementation of these recommendations still remains unlikely. If all of the proposed upgrades were implemented, average residential energy consumption would be cut by 25 percent and CO<sub>2</sub> emissions reduced by 18 percent.<sup>1</sup> This finding corresponds closely with the national average energy savings potential of 26 percent per household reported during the first two years of the EGH program (NRCan 2001).

The social context of the above assessment is important so if conditions change from those prevailing in 1999-2001, the socio-technical potential for improved energy efficiency would change accordingly. For example, higher fuel prices triggered by scarcity of supply or higher demand, or the introduction of a carbon tax to internalize the costs of environmental and health damage, or new public priorities and policies to slow the pace of climate change could stimulate a greater willingness to improve energy efficiency. The knowledge gained from studies that recognize social differences in response rates should also be used in the design of programs that seek to stimulate local action to achieve national policy objectives. This scalar dimension of energy projects is examined in the next section.

## **Dimension 2 – Scalar integration: Global issue, national program, local implementation**

One of Canada's national responses to climate change is the development of the EGH program administered by the federal Office of Energy Efficiency, Natural Resources Canada. If houses are not built to a high initial standard, then efficiency needs to be upgraded by improving the building envelope and heating/cooling equipment at a future date (usually at a greater cost). The EGH program was designed to offer a standard technical assessment of houses that would enable the opportunities for energy efficiency improvements to be identified. Houses are rated on a standard scale (0-100) with a house that required no net commercial energy rated at 100, an R-2000 home rated at 80 and a house that consumed five times as much energy as an R-2000 home rated at 0.

The question as to who can best deliver national programs to reduce GHG emissions is being addressed in many countries. In the United Kingdom, the government decided to set the emission reduction target for the residential sector, but to let local governments be responsible for

developing policies and programs to achieve the target. In Canada, the federal government decided to experiment with various public, private and non-governmental organisations as local delivery agents for the national EGH program. The federal government paid a standard fee of \$150 for each completed evaluation (including the associated data file) to a variety of delivery agents (OEE 2000c). In each case, a detailed technical evaluation was made of the house to measure its current energy requirements and to identify areas for potential improvement (see Parker *et al.* 2000a for further details). Implementation rates of the national program vary (Table 1). The Green Communities Association (GCA) delivers EGH evaluations throughout Ontario (with the exception of the Sudbury area), through its member environmental non-governmental organisations (ENGOS) located in 11 Ontario communities. The Elora Centre for Environmental Excellence (ECEE) is the GCA partner in REEP. In other provinces private interests take the lead, as demonstrated by the Home Builders Association in Nova Scotia, the Sun Ridge Group in Saskatchewan, and Building Insight Technologies in the other western provinces. The last firm has the distinction of generating more evaluations than any other agent in the country. Their approach is a traditional direct marketing technique with phone calls made from a central call centre to prospective clients. In contrast, the Yukon delivery agent is in the public sector. The Yukon Housing Corporation not only makes evaluations, but offers a subsidy in mortgage rates (1 percent below average commercial lending rates) to houses that achieve an EGH rating of 80 or more (OEE, 2000c).

Insert Table 1 Technical EGH evaluations by Canadian region

The community-based approach of the REEP project contributed 10 percent of all EGH evaluations nationwide in 1999-2001, despite the region having only 1.4 percent of Canada's population (Table 1). By October 2000, the project had achieved a much higher participation rate than the national norm, over 3 evaluations per thousand population. The Yukon Housing Corporation achieved the highest participation rate of over 10 evaluations per 1000 population. The private firms operating in the western provinces averaged 1 evaluation per 1000 population, while the eastern provinces had lower participation rates.

The success of REEP in engaging local homeowners is argued to be a function of active community participation, the development of local partnerships (examined more fully in the next section) and the removal of information, time, trust, and financial barriers to the home energy evaluation. The merit of including local partners to deliver a national program was tested through

a series of marketing experiments and by examining how people came to participate in REEP. Each participant was asked "How did you hear about REEP?". Although some participants cited multiple information sources, only the primary source was used for the analysis (Table 2).

#### Insert Table 2: How Participants Became Aware of REEP

The largest source of evaluations during the first year of operation was the media (37 percent). Several newspaper stories were prepared by project staff and printed in local daily, weekly and neighbourhood papers. In addition, the official launch of the project received coverage from a local television station. The second largest source of evaluations was personal referrals (32 percent overall and over 50 percent during the first four months). The support from employees in partner organisations was critical for generating a significant number of evaluations at the onset of the project. Once initial evaluations were made, people told family, neighbours and friends, and the sequence of referrals continued.

Direct marketing was the third largest source of evaluations during the first year and became the largest source in the second year. Another innovation of the project was the use of GIS analysis (based on two structural and four demographic census variables) to identify neighbourhoods that were most likely to benefit from energy efficiency evaluations for the direct marketing tests. Direct marketing was used to test several types of marketing materials, including the comparison of response rates to locally designed materials and nationally designed materials. When local and federal pamphlets of similar size and paper quality were delivered in November 1999, the REEP pamphlets generated 4.0 bookings per thousand pieces delivered while the federal pamphlets resulted in no bookings. In January 2000, the households that had received REEP pamphlets were given federal pamphlets and vice versa. Again the federal pamphlets resulted in no bookings, but the response rate to REEP pamphlets rose to 6.8 bookings per thousand pieces delivered (Kennedy, *et al.* 2000). An experiment was also conducted with national and REEP designed inserts to be distributed with advertising fliers. The federal inserts had a response rate of 0.7 bookings per thousand pieces distributed while the REEP inserts generated 3.3 bookings per thousand pieces (Kennedy, *et al.* 2000).

Television promotion also showed significant differences between national and local campaigns. A series of television spots on the *Weather Network* highlighted the EGH program in the fall of 1999 and resulted in two bookings in Waterloo Region. In contrast, when REEP was presented as

a local news story in September 1999 on the local CTV station, 110 bookings resulted (as previously noted). However, local broadcasts are not guaranteed to generate results, as audience size and composition varies. For example, a five-minute segment about the project on a community cable television channel generated no bookings (Kennedy, *et al.* 2000). Similar differences were found between national advertising campaigns in major daily newspapers and news articles written about the local project.

Local marketing initiatives were found to be much more effective than national advertising campaigns in getting people to take the first step and book an EGH evaluation. One of the reasons for the effective local implementation of the national program was the participation of many local partners.

### **Dimension 3 – Stakeholder integration: Improved local capacity through partnerships**

An extensive literature argues that local partnerships are a critical means to build local capacity. Community economic development, local economic development and sustainable development literatures advocate the importance of building local capacity to achieve local goals (Parker 2001; Roseland 1992). In the case of REEP, local partnerships are argued to improve the implementation rate of the national EGH program described above. Partnerships build local capacity through increased financial capacity, information capacity and community reputation/trust. This increased capacity enables people to overcome the information, financial, time and trust barriers to taking the desired action.

Financial capacity is strengthened by the combination of federal and local resources. The availability of federal funds enabled the project management team to persuade local governments of the benefits of leveraging small contributions from several partners to achieve shared project goals. The three city councils (Cambridge, Kitchener and Waterloo) as well as the Regional Municipality of Waterloo and the private utility, Union Gas, contributed financially to the first phase of the project. These contributions from federal and local partners enabled the evaluation fee paid by homeowners to be set at \$25, far lower than the \$100-150 fee in other Ontario communities (Kennedy, *et al.* 2000). The local electricity utilities (Kitchener-Wilmot Hydro, Waterloo North Hydro and Cambridge North Dumfries Hydro) and the gas utility (Kitchener Utilities) agreed to financially support the project in its third year of operation.

The information resources and analytical capacity of the partnership were strengthened by the active involvement of a local university, utilities, local governments and environmental non-governmental organisations. The reputation of the partners (e.g., university and utilities) added to the trust and credibility given to the project by private residents.

The time barrier of having an evaluator take 3-4 hours to complete a detailed energy evaluation was reduced to 2 hours on average by having a student intern work with each evaluator. In addition, a laptop computer and portable printer were used to prepare the 7-page report and official EGH label on site, rather than having to arrange a second time to re-visit the home and discuss the report with the homeowner.

Partners also benefited from their participation in the project. For example, the project assisted the utilities by offering a means to identify ways to reduce energy consumption at a time when energy bills were rising and to offer a response to high bill complaints. The university benefited by the creation of training and employment opportunities for students. Local businesses supported the project by encouraging their employees to participate, often as part of Clean Air or Commuter Challenge campaigns. Housing co-operatives supported the project by having their units evaluated, and benefited by using the findings from evaluations to set priorities for maintenance work and investment. One of the unexpected benefits was the discovery of substantial variability in air leakage and heat loss among adjacent units of a 1990s housing co-operative. Although the units appeared similar on the surface, the inconsistent quality of construction resulted in some units having much larger air leaks and using 50 percent more energy than adjacent units. These assessments allowed maintenance staff to focus their efforts. Neighbourhood associations and service clubs also supported the project by inviting staff to make presentations and to recruit participants.

The efforts made to form diverse partnerships and to achieve a high participation rate were rewarded with the project being a finalist for the Region of Waterloo's Sustainability Award in 2000. While REEP was a new project, the other two finalists had been active community initiatives since the 1980s. The recognition further assisted in maintaining project visibility and credibility. Overall, the inclusion of diverse stakeholders enabled the project to overcome multiple barriers and achieve the higher participation rates noted in the previous section. The shared stakeholder goal of increased energy efficiency was achieved while partners also benefited individually.

#### **Dimension 4 – Issue integration: Fuel substitution to reduce GHG emissions**

Improved energy efficiency may be one of the greatest opportunities for a clean energy future (IGW 2000), but the efficiency gains reported above that would result in 25 percent reduced energy consumption and 18 percent reduced GHG emissions per house, still fail to enable the residential sector to meet Canada's Kyoto target of a 6 percent reduction below 1990 levels because of continued growth in the sector. To achieve greater GHG emission reductions, the issue of fuel substitution can be linked to improved efficiency. In the residential sector, an example of fuel substitution to less carbon intensive fuels is the replacement of oil furnaces with natural gas furnaces (though the motivation for such a switch has not always been reducing GHG emissions). Switching to another fuel source (natural gas or propane) was an important means to reduce the CO<sub>2</sub> emissions from 41 percent of houses consuming oil at the time of the evaluation. In other cases, oil consumption could be reduced significantly (from 4200 l/yr to 2500 l/yr on average) through conservation measures.

Given that electricity is a 'fuel' that is widely used in Canadian homes, the replacement of less sustainable sources of energy in power generation (in particular, coal) with more sustainable sources (in particular, solar and wind) is another example of fuel substitution. Indeed, the technical potential is clear: with Waterloo Region receiving the equivalent of approximately 2,000 hours of 'bright sunshine' a year, existing solar energy technologies could be used to meet all of the electricity needs of Waterloo homes. Of course, a variety of social barriers preclude this technical possibility from happening.

To better understand the barriers to, and opportunities for, increased use of more sustainable electricity sources in the home, Waterloo Region residents' interest in 'green' electricity was explored. When asked, 80 percent of survey respondents stated that they would be willing to pay a premium (varying between 5 percent and 25 percent) for a 'greener' portfolio of energy resources in their electricity supply (as compared with present) (Rowlands, *et al.* 2000b).

These results, however, need to be placed in a wider context. It is one thing to indicate on a survey that you would be willing to pay more for green power, and altogether another thing to actually do it once the option is available. Following research in other jurisdictions, it is estimated that the actual market for residential green electricity will be of the order of 0 to 5 per cent of the

population (Wiser, *et al.* 2000). In this way, social analysis serves to temper the technical potential for the broad adoption of renewable technologies. By recognising the range of social barriers, business approaches to supplying homes with green electricity can be made on more realistic projections. Not surprisingly, when residents of the City of Cambridge (in Waterloo Region) were given the first opportunity to purchase 'green' electricity in Ontario by paying a premium price (\$6.50 on an average monthly bill) only 0.3 percent of potential customers signed up in the first year (Goodwin 2002). These customers were offered a 20 percent discount on an EGH evaluation by REEP to identify ways to reduce energy use. This attempt to link conservation and 'green' electricity initiatives received little public attention and the response rate to the inserts in residential utility bills was low.

The provision of green electricity by means of a premium pricing system is an example of the classic policy problem known as 'provision of a public good'. Consumption of the good – that is, the purchase of green electricity at a premium price – will bring public benefits such as reduced GHG emissions or cleaner air – benefits that are not restricted to those who are paying more for their electricity. Consequently, there is the incentive for individuals to 'free-ride' – that is, not purchase the good, hope that others do, and thereby reap the benefits without incurring the cost. Citizens may ask why renewable sources cost more: 'if they give rise to all kinds of benefits, why doesn't the government support them, or at least tax more heavily the damaging kinds of electricity generation?' Other means of supporting greener electricity will inevitably be discussed in future public debate. We investigated the potential social acceptability of several policy options:

- renewable portfolio standards - require all electricity suppliers to have at least some percent (e.g., 5 percent) of their power generated by renewable sources
- solar pioneers - instigate a program that facilitates the establishment of solar panels on peoples' houses
- disclosure labels - require all electricity providers to provide information about the resources (and associated emissions) used to generate the electricity they sell
- systems benefits charges - use funds collected (from a charge placed on every unit of electricity) to promote renewable energy and/or energy efficiency
- stronger regulations - increase the energy efficiency requirements in new home construction

- financial incentives - offer tax exemptions or tax credits for energy efficiency or renewable energy projects; offer lower-interest rate mortgages for more energy sustainable homes
- home energy rating systems - make home energy ratings mandatory

Given that many variations on each of these strategies have been adopted by jurisdictions in the United States and Europe, additional description and analysis is readily available (see Scott, *et al.* 2001). Though public acceptance of these strategies is by no means a sufficient condition for their successful implementation, it is nevertheless a useful indicator of potential public interest. As part of the survey described previously, REEP participants were asked for their opinion on these strategies (Table 3).

Insert Table 3 here

It is clear that public support for full disclosure of the source(s) of electricity is exceptionally high: not only does it rank first overall, but it also ranked highest in terms of the share of respondents who ‘strongly agreed’ with the strategy (58 percent). With only 2 percent of all respondents in opposition, and only 4 percent without an opinion, this strategy would appear to have the potential to have overwhelming public support. It is also noteworthy that those strategies categorized as ‘financial incentives’ also attracted considerable support. Individually, they ranked second, fourth and fifth out of the nine identified strategies. Given that such proposals would pass on financial advantages to those engaging in environmentally-responsible residential energy action (exactly the kind of people who would pay for a home energy rating service), this is probably not particularly surprising. Similarly, those strategies that clearly involve personal financial sacrifice on the part of the homeowner – system benefits charges and participation in a solar pioneers program – rank towards the bottom of the list. Indeed, the ‘tax proposal’, system benefits charges, attracted a significant share of opposition – 24 percent of respondents.

Finally, the proposal that governments should implement stronger energy efficiency standards for new homes was either agreed to or strongly agreed to by 92 percent of respondents. This opinion is not surprising, since the respondents had just undertaken an evaluation that identified opportunities to improve energy efficiency in their homes. However, it raises the question as to how this objective can best be achieved. In October 2000, the United Kingdom Government proposed that all new homes would have to display an energy rating notice (UKDETR 2000). In Australia, the Australian Capital Territory government introduced mandatory energy evaluations

and ratings for all residential real estate transactions. The Government of Canada plans to promote voluntary EGH evaluations of Canadian new houses in 2002. Each of these initiatives would be supported by a large majority of survey respondents.

### **Barriers and Opportunities**

Barriers to program implementation are a well known problem in energy policy and resource management circles (Brown 2001). The establishment of policy goals, the specification of objectives and the creation of programs are of little use if the programs are not implemented at the local level (IWG 2000). Financial, information and trust barriers were each addressed in the REEP case study reviewed above. The partnership among local and federal actors enabled the evaluation fee to be reduced (to \$25) so that residents would take the first step and have an evaluation of their house's energy performance. This also overcame the information barrier by providing a personal energy plan to upgrade their home in an energy efficient and cost effective manner.

Trust based on the established reputation of the local university and local utilities reassured residents that they could accept the proposed energy plan and not fear that it was designed to give advantage to a particular commercial operation. Responses from the first 351 returned surveys indicated that 46 percent of respondents wanted the EGH service to be delivered by a university while 40 percent selected an environmental non-governmental organization (note: this reflects the local practice where these two groups were the lead partners in REEP). The remaining 14 percent of preferences were divided among local government (6 percent), consultants (4 percent), local utilities (3 percent) and others (1 percent).

To maximise GHG emission reductions in the residential sector, the priority of the EGH program should be to encourage the participation of houses with the largest emission reduction potential. Analysis of the REEP database has shown that pre-1940 houses have the greatest potential for improved energy efficiency (Figure 2) and emission reductions (overall, 20 percent of the housing stock has 50 percent of the potential GHG emission reduction) (Scott *et al.* 2001). One approach to prioritising recruitment is to identify neighbourhoods with the largest energy saving potential and to actively recruit the participation of homeowners in these areas. REEP has experimented with a geographical information system (GIS), which incorporated six variables available from the Canadian census, to rank the suitability of houses in Enumeration Areas for EGH

participation. Initial results have been positive and the use of census variables as selection criteria makes refinement of the technique straightforward. Opportunities clearly exist to integrate additional components into local energy projects.

## **Conclusion**

Researchers in energy studies join their colleagues in other areas of resource and environmental management to call for increased integration in both research and policy implementation. The integrated approach offers an innovative and effective means to overcome many of the limitations of traditional specialized energy studies and the low implementation rates of national policies. Four dimensions of the integrated approach were examined in this paper: disciplinary, scalar, stakeholders and issues.

First, the integrated approach recognised the importance of multiple disciplines as social factors were introduced in the assessment of energy saving opportunities. The ‘efficiency gap’ between the possible technical improvements to residential energy efficiency and the current state of those houses is well established in the literature. Rather than simply assessing the large technical potential to improve residential energy efficiency, the REEP case study reported in this paper engaged homeowners in discussions to identify areas where specific improvements could be adopted. In this way, the high values for technical potential to reduce residential energy demand (e.g., 65 percent according to Jaccard, *et al.* 1996) are revised to more realistic assessments of the socio-technical potential to reduce energy consumption (e.g., 25 percent in the Waterloo Region or 26 percent in Canada). In other words, energy evaluators can identify means to reduce average Canadian residential energy consumption by one-quarter under current conditions. Of course, if the social context changes (e.g., higher energy prices, new carbon or environmental taxes, or the introduction of strong conservation policies) then the socio-technical potential would rise accordingly. This improved knowledge of the current potential savings is only the first step towards achieving such savings.

Second, climate change highlights the importance of scalar issues where global atmospheric balances are changed by aggregate individual behaviour and the solution to the global problem requires local action. International agreements may be signed and national policies pronounced, but local action is essential to address the issue. The need for local action is well illustrated by Canada’s R-2000 program where improved building standards are specified at the national level

but the provincial governments have not upgraded their building codes to that standard and less than 1 percent of new houses are built to this standard voluntarily. The EGH program began in 1998 and recognized the potential to have a greater impact in promoting retrofit activity through the use of a variety of local delivery agents. The REEP project compared the response rates of residents to national and local promotional materials and found that the response rates were higher and the costs lower for local materials. To reduce GHG emissions from the residential sector, an integrated approach recognizes the improved effectiveness of local promotion and implementation.

Third, the success of the local approach illustrated by REEP is based on its inclusion of multiple stakeholders who shared the project's goal and addressed several of the barriers to action. The stakeholders cooperated for individual benefit as well as a shared goal. Homeowners were motivated to reduce energy costs, local governments could meet their public commitments to Partners for Climate Protection or other programs, utilities could defer investments in new capacity by shifting supplies from existing to new customers and the university could create employment and training for students. The community-based focus built local capacity through partnerships to reduce financial, information, time and trust barriers. The Waterloo Region case study illustrated how a region with 1.4 percent of Canada's population could generate 10 percent of Canada's EGH evaluations by its second year of operation.

Fourth, the integration of multiple issues in a single project was also shown in the REEP case study. The linking of energy efficiency and fuel substitution as means to reduce GHG emissions was also attempted. The substitution of natural gas for oil illustrates the recommended shift to a less carbon intensive heating fuel in some of the houses evaluated. More often, electricity generation accounts for a large proportion of GHG emissions from residential energy consumption and the option of switching to 'greener' sources of electricity offers opportunities for significant emission reductions. The restructuring of the electricity system in Ontario creates opportunities for the substitution of conventional power sources with 'green' sources. Respondents to the REEP survey strongly supported policy options to promote such fuel substitution, but less than 1 percent actually signed contracts to pay a premium for 'green electricity' when given the opportunity.

The integrated project reviewed above was selected as the success story for the residential sector in *The State of Energy Efficiency in Canada 2000* (OEE 2000a). Other communities could adapt

the four dimensions of the project to meet their needs. However, the initial success of the project needs to be extended. Current trends and forecasts point to increased aggregate energy consumption and GHG emissions by the residential sector, despite improved energy efficiency. Even if the current socio-technical potential for a 25 percent reduction in energy use per house was implemented in 100 percent of Canada's housing stock by 2008-2012, the residential sector would still not meet Canada's Kyoto target of a reduction in GHG emissions to 6 percent below 1990s levels because of the growth in the number of houses, the size of houses and their increased use of electrical devices.

A significant change in the social context (energy price rises, emission taxes, new policies, etc.) is required to raise the socio-technical potential for residential energy efficiency in Canada. To overcome the barriers to achieving this potential requires an integrated approach where local stakeholders are engaged to promote change. Survey results demonstrate strong support for initiatives that encourage conservation and substitution to less environmentally damaging sources of energy. As the climate change issue continues to grow in importance, new initiatives will be required to meet the public desire for improved environmental performance.

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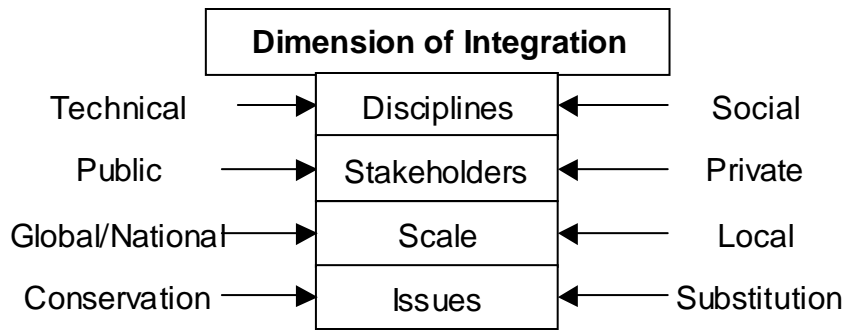
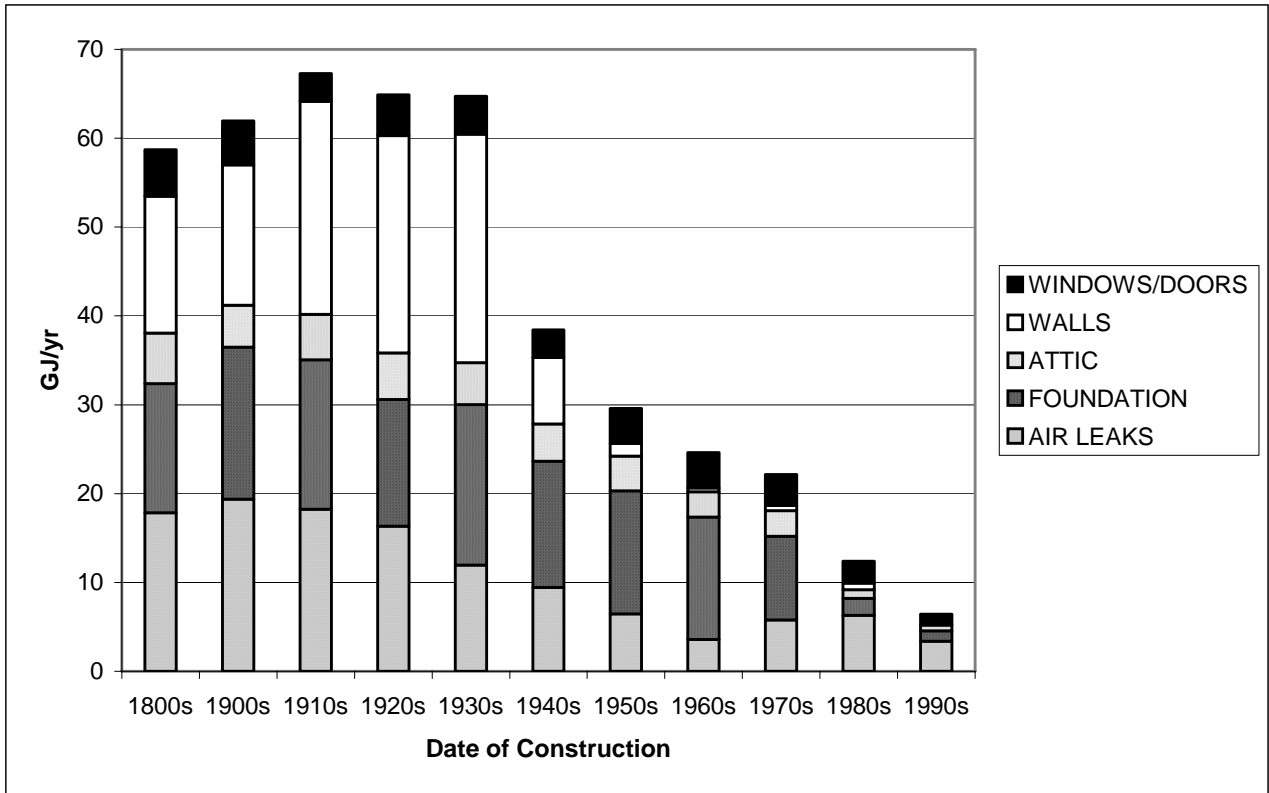


Figure 1: Four dimensions of integration in energy studies



Source: REEP EGH database, n = 1,937

Figure 2: Recommended areas to reduce heat loss in single detached dwellings

Table 1: EGH Evaluations by Canadian Region and Year

Region	Delivery Agent	1998/99	1999/00	2000/01*	Total
Ontario, Total	Green Communities Association	796	3100	1660	5556
	Waterloo Reg. REEP	0	793	797	1590
	Ontario, Other Green Communities Association	796	2307	863	3966
Newfoundland	Heat Seal	40	13	148	201
NS, PEI, NB	Home Builders Association	0	291	204	495
Quebec	Agence de l'efficacite energetique	161	211	212	584
Saskatchewan	Sun Ridge Group	14	520	558	1092
BC, AB, MB	Building Insight Technologies	3589	4818	4416	12823
Yukon	Yukon Housing Corporation	86	192	35	313
Canada	All	4686	9145	7233	21064

\* Note: data are for financial years (April to March) except 2000/01 (April to October)

Source: OEE 2000.

Table 2: How Participants Became Aware of REEP

Source	1999-2000	2000-01
Referrals	32%	23%
Direct Marketing	21%	61%
Media	37%	8%
Community Event/Meeting	9%	7%
Passive Marketing	1%	1%
Total	100% (n = 791)	100% (n = 1021)

Source: REEP Contact database

Note: Participants who could not identify the source were excluded from the analysis.

Table 3: Percentage of respondents ‘strongly agreeing’ or ‘agreeing’ with the policy option

disclosure labels	94.9
tax exemptions	93.1
stronger regulations	91.8
lower interest-rate mortgages	87.2
tax credits	85.2
home energy rating systems	74.3
systems benefits charges	70.7
solar pioneers	68.2
<u>renewable portfolio standards</u>	<u>64.4</u>

Note: n = 527 respondents

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<sup>1</sup> The smaller reduction in CO<sub>2</sub> emissions is caused by the reduced use of electricity (7 percent) being less than the cut in oil (62 percent) and natural gas (26 percent) (n=1,937 single detached dwellings). The calculation of CO<sub>2</sub> emissions assumes that coal-fired power stations are the marginal supplier of electricity.