HEALTHY RETROFITS:

The Case for Better Integration of Children's Environmental Health Protection into Energy Efficiency Programs

March 2011

CANADIAN ENVIRONMENTAL LAW ASSOCIATION

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Foreword

March 2011

More than a decade ago, the partner organizations of the Canadian Partnership for Children's Health and Environment (CPCHE) came together to collectively advance efforts to reduce the known and suspected risks to children's health associated with environmental exposures to toxic chemicals and pollutants. We are convinced that a healthy environment — including the indoor environments where children in Canada spend up to 90% of their time — is essential to enabling children to take their first steps towards lifelong health. We recognize that children living in low-income and disadvantaged circumstances typically bear the greatest burden of environmental health exposures and risks.

Over the past year, with the generous support of the Ontario Trillium Foundation, CPCHE has been working to gain an in-depth understanding of the specific indoor environmental health risks associated with renovation and retrofit projects aimed at increasing home energy efficiency. This research has revealed that there is much work to be done — together with much interest and commitment among stakeholders — to ensure that, as we invest in making homes more energy efficient, we seize the opportunity to also make homes healthier and safer for their occupants.

The central theme of CPCHE's work in this area is to strive for a "win–win." We strongly support efforts to promote increased energy efficiency in residential settings as a key element in combating climate change. Within these vital efforts, our goal is to work with others to achieve a greater integration between energy efficiency improvements and indoor environmental health protection measures.

We welcome the publication of this report prepared by the Canadian Environmental Law Association (CELA). CELA is serving as the lead CPCHE partner for this two-year initiative and brings to the project a longstanding focus on the needs of low-income and disadvantaged communities, a wealth of expertise on children's environmental health, and a direct liaison with the Low-Income Energy Network (LIEN) as an active and founding member of both CPCHE and LIEN.

This report provides a baseline assessment of the current situation and an outline of possible opportunities for improvement. As such, it provides a solid foundation for next steps. Drawing upon the findings of this research and the rich input received from stakeholders, CELA has compiled a forward-looking list of recommendations (Chapter 8) that CPCHE partners and others can consider for further work in this area.

The review of energy efficiency programs in Ontario and at the federal level, described in Chapter 6, reveals that these programs, although effective at promoting energy efficiency, largely do not address the potential for increased exposures to toxic substances, such as lead, when existing materials in older homes are disturbed during renovation activities or when new materials containing toxic chemicals are

introduced. Results of our online survey suggest that awareness of indoor environmental health issues among homeowners, landlords and residents is generally low, and that there is an appetite for training and education on these issues among energy efficiency auditors and other building professionals.

Our aim in 2011 is to work with interested stakeholders to increase awareness about the what, why and how of addressing indoor environmental health risks within energy efficiency upgrade projects. We are motivated by our knowledge that preventive measures — such as properly handling leaded paint found in older homes, selecting low-VOC building materials and ensuring adequate air exchange once the building envelope is tightened — are particularly important for protecting the developing fetus and child, given their greater exposure and vulnerability to environmental toxicants.

We look forward to a day when every renovation or retrofit project is embraced as an opportunity to create healthier environments for children and their families. We invite you to join us in these efforts.

CPCHE PARTNERS

Canadian Association of Physicians for the Environment

Canadian Child Care Federation

Canadian Environmental Law Association

Learning Disabilities Association of Canada

Environmental Health Clinic – Women's College Hospital

Environmental Health Institute of Canada

Ontario College of Family Physicians

Ontario Public Health Association

Pollution Probe

South Riverdale Community Health Centre

Toronto Public Health

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Executive Summary

This report is a key milestone within a two-year Ontario-focused project of the Canadian Partnership for Children's Health and Environment (CPCHE) that aims to raise awareness of the risks to fetal and child health from potential exposures to environmental contaminants during and after energy efficiency retrofits. The project also aims to increase awareness among multiple players about measures that can be taken to help reduce these risks.

This report, prepared by the Canadian Environmental Law Association (CELA) as a contribution to the broader project, provides a review and analysis of key issues, programs, educational and policy tools, and gaps. It describes multiple opportunities where greater integration between the field of children's environmental health and energy efficiency initiatives can and should occur, and offers specific recommendations for improvement in education, training and policy.

Children are at greatest risk from toxic exposures; renovation activities can significantly increase this risk

Overall inspiration for this work is concern for children's health due to the multiple toxic contaminants and other health risks that can arise from renovation activities in general, including those done for the sake of improving energy efficiency. More positive inspiration comes from the fact that a "win–win" opportunity is available in which the work done to achieve gains in energy efficiency, if done with a view to improving indoor environmental health, would not only lower greenhouse gas emissions and energy costs, but would also make homes healthier for children and their families. The benefits of such integration would likely be most significant for low-income families who typically bear disproportionate exposures to and health risks from environmental health hazards.

Solid evidence confirms that, compared with adults, children are at greater risk from exposure to environmental contaminants, particularly those that occur indoors where children spend most of their time. Numerous factors, including children's higher respiratory and metabolic rates, their behaviours such as hand-to-mouth activity and the vulnerability of their developing brains and other organ systems, contribute to this greater risk. As well, the developing fetus is especially vulnerable, highlighting the need to limit maternal exposure to contaminants.

Particulate matter in indoor air and contaminants in house dust are priority concerns. There is a lack of both awareness and policy guidance to address these and other key issues, most notably the still very current problem of lead in old paint. These day-to-day risks are known to be even more acute for children living in low-income circumstances due to sub-standard housing conditions, proximity of housing to traffic and industry, and other factors.

Renovation activities including energy retrofits, if not done carefully, can greatly increase indoor contaminant exposures. Renovations may disturb toxic contaminants such as lead, asbestos or polychlorinated biphenyls (PCBs) that are legacies of past product uses and practices. Air sealing or tightening a building can reduce the frequency of air exchange and potentially lead to higher radon levels in indoor air, as well as moisture and mould problems. A tighter building envelope may also allow for more concentrated levels of indoor pollutants, a problem that can be made more acute by the choice of building and renovation materials as well as ongoing consumer product choices after retrofits are completed. Where there is a lack of awareness of these issues and ways they can be addressed both during and after renovations and retrofits projects, health risks can arise, with children and developing fetuses at greatest risk. Conversely, well-executed renovations and energy efficiency retrofits can reduce environmental contaminants, prevent moisture and condensation problems, improve ventilation and comfort, and generally create a healthier indoor environment, in addition to providing the benefits of reducing both greenhouse gas emissions and energy costs.

Analysis of energy efficiency programs reveals insufficient attention to indoor environmental health concerns

Various government-sponsored energy efficiency programs are reviewed in this report, including those provided by the federal and Ontario governments as well as activity at the municipal level. These programs offer grants and incentives to homeowners and businesses to undertake energy efficiency improvements. The federal ecoENERGY Retrofit programs have established the framework for most energy efficiency incentive programs in Canada. Implementation revolves around an initial audit conducted by an energy auditor certified by Natural Resources Canada (NRCan) who assesses the energy characteristics of a home or building and provides recommendations for energy conservation measures.

An important aspect of program success has been the assistance provided to homeowners and businesses by non-governmental or community-based organizations such as Green Communities Canada. Similarly, much progress on larger commercial and/or urban renewal retrofit projects has occurred through the efforts of Leadership in Energy and Environmental Design (LEED) Canada, an industry-sponsored collaboration organized by the Canada Green Building Council.

The federal government estimates that under the ecoENERGY Retrofit — Homes program and its federal forerunners, almost 1 million homes across Canada have been rated for energy efficiency and 400,000 homes have benefited from improved energy efficiency. Between the two main federal programs (ecoENERGY Retrofit — Homes and ecoENERGY Retrofit — Small and Medium Organizations) it is projected that there will be a reduction in greenhouse gas emissions of 0.4 megatonnes. As well, a wide range of educational materials has been created and is available online from these and other provincially based programs.

Many of the energy efficiency programs available in Ontario are in transition; many finished at the end of 2010 while others will end during 2011. Federal programs are being phased out or are ending in 2011. The Ontario Home Energy Savings Program is continuing to offer grants for homeowners despite the phase-out of the federal ecoENERGY Retrofit — Homes program to which it was linked.

While Ontario's utility-based programs, sponsored by Enbridge Gas, Union Gas and the Ontario Power Authority, are also ending, new programs are under development to replace them. Several of these new programs are specifically intended to assist low-income households. At the municipal level, Toronto is the only municipality in Ontario with unique energy efficiency grant programs for both homeowners and multi-unit residential buildings. Other municipalities simply facilitate access to the provincial or federal programs and are often served by non-governmental organizations, such as Green Communities Canada or GreenSaver.

Across all these government or utility-sponsored programs, although ventilation and air exchange evaluations are integrated into energy efficiency programs, other potential indoor air and/or environmental health concerns are not systematically identified. Asbestos and mould may be identified and noted during the energy audit/energy assessment process, but other concerns such as lead, PCBs and radon are usually not mentioned. There is little information available or emphasis on the choice of materials used for energy efficiency retrofits or their potential impact on environmental health. Cautionary advice on the use of chemicals or pesticides in the home after renovations have tightened the building envelope is almost never included in energy efficiency programs.

Research reveals a lack of training, awareness among energy efficiency auditors and other building professionals

Energy efficiency auditors play a key role in energy efficiency program delivery as they are the main point of contact for the homeowners, building owners and managers who are their clients. An online survey conducted as part of the research for this report reveals that existing knowledge on indoor environmental health issues among energy efficiency professionals is generally limited to ventilation issues often coupled with an understanding of moisture-related mould problems and asbestos risks. Knowledge of many other indoor environmental health risks is low, particularly when it comes to lead and other toxic substances. Despite this, these professionals report seeing opportunities to integrate more environmental health information into their work. They recommend the program design stage as the most appropriate place to accommodate such integration.

Survey respondents also noted concerns for liability and lack of authorization to discuss additional environmental health issues in clients' homes beyond those specified in the programs they serve. Other constraints include lack of relevant training and/or lack of authoritative information and guidance, e.g., from the Canada Mortgage and Housing Corporation (CMHC), the source most professionals indicated they rely upon for information about indoor environmental health issues. Concerns raised included issues of information overload, cost and workload increases, and training requirements that would be necessary to integrate a broader range of indoor environmental health issues into their work with clients on energy efficiency improvements.

Current opportunities for improvement

With the phase-out of federal energy efficiency incentive programs, an opportunity exists to assess progress and recommend changes for the future. While this report recommends that these federal programs be renewed and indeed expanded, nevertheless, Ontario-based programs are adjusting to the shrinking federal role and moving forward to implement new requirements flowing from Ontario's *Green Energy Act*. Important progress can occur in Ontario's utility-operated programs since they will expand province-wide and will include a suite of deeper measures, particularly with respect to insulation, of low-income residences.

This evolving situation represents an opportunity to look at the entire approach to encouraging and supporting the adoption of energy efficiency measures. Overall, this report concludes that greater integration of indoor environmental health issues into energy efficiency programs can and should occur. Moreover, there is a need to properly address legacy contaminants, such as lead, during *any* renovation activities.

The greater risks faced by children from exposure to environmental contaminants on a daily basis, and the potential for increased exposures to arise from renovation activities such as energy efficiency retrofits, underscore the need for greater awareness and policy guidance in several areas. The solutions are reasonably straightforward and a "win–win" proposition. Moreover, this research reveals a growing surge of interest in linking these two streams of effort in the interest of improving the health and living circumstances of families in Canada while taking meaningful action on climate change.

Opportunities for improvement are identified in five areas — program design, auditor training, program coverage, educational activity, and supporting policy — with a series of recommendations made to address these issues. More detailed advice from stakeholders about future educational efforts and policy and program implementation is captured in Chapter 8 in support of the specific recommendations.

Recommendations

The following recommendations derive from the research and stakeholder consultation conducted for this report. The overall objective of these recommendations is to seek the integration of the two broad issue areas discussed in this report – indoor environmental health and energy efficiency retrofits - by identifying specific opportunities for improvement.

The recommendations are directed to the following diverse groups or individuals as they engage in energy efficiency issues and activities:

- government agencies, energy companies/ utilities and others responsible for the design of energy efficiency programs
- energy efficiency auditors and other energy efficiency professionals
- energy efficiency program delivery agents
- builders, contractors, renovators and interior designers, including their industry or trade associations
- educators involved in vocational training and apprenticeship programs for builders, contractors, renovators and interior designers
- retailers supplying the home building and renovation industry
- home inspectors, real estate agents and loan/ financial institutions involved in real estate transactions
- landlords, building owners and managers
- municipal public health and waste management departments
- non-governmental organizations

Design of Energy Efficiency Programs:

1. Government agencies, energy companies and others responsible for the design of energy efficiency programs should make indoor environmental health an integral part of program objectives and deliverables.

2. Program design improvements should include

   - expansion of the "whole building" or "building as a system" concept in energy audits to more comprehensively address energy, safety and environmental health concerns
   - allowance for a portion of energy efficiency program funding to be applied to health and safety hazards encountered during audits, particularly within programs designed for low-income housing.

3. The federal government should renew and expand the scope of its ecoENERGY programs by integrating the multiple indoor environmental health issues raised in this report, and developing national sectoral targets, for example, reaching a level of 15% of all Canadian homes retrofitted by 2015, including 130,000 low-income households, by investing $1.25 billion over five years, as recommended by the Green Budget Coalition.[1]

4. The Ontario Energy Board, the Ontario Power Authority, and Ontario's utilities should ensure that program design currently underway for a province-wide weatherization program for low-income families integrates the multiple indoor environmental health issues raised in this report.

Auditor Training:

5. The federal government's NRCan training module for energy efficiency auditors is a trusted resource for energy auditors that should be expanded to include the following:

   - A module explaining the greater vulnerability and exposure of children to environmental contaminants, particularly indoors, with an emphasis on indoor

particulate matter and dust as primary exposure media for children. The module should emphasize the potentially dangerous exposures that can arise from renovation and retrofit activities.

- A module explaining the potential sources, indoor exposure pathways and prevention/control options for indoor environmental health concerns beyond those already addressed in NRCan training, including lead in paint, PCBs in old caulking, radon, and VOCs in new building materials.

Effectively Reaching Diverse Audiences:

6. A national focal point for healthy and energy efficient housing should be designated. A key role for this entity would be to integrate and make accessible to building professionals and the public all existing government information, guidance and regulations pertaining to indoor environmental health concerns as well as energy efficiency measures. The national focal point could be within a federal department (e.g., CMHC) or a designated, federally supported non-governmental entity.

7. A consolidated set of protocols, encompassing both regulations and guidance, should be developed for Canada, similar to the US Environmental Protection Agency's draft Healthy Indoor Environment Protocols for Home Energy Upgrades.

Improved Training, Guidance and Requirements for Specific Contaminants:

Lead Paint Remediation:

8. Drawing on elements of the US Renovation, Repair and Painting Rule, and in collaboration with the Provinces and Territories, mandatory requirements should be established across Canada for the training, certification and conduct of lead paint remediation activity, with these requirements applicable to all renovation activities, including but not limited to energy efficiency retrofits.

9. Diverse federal government educational materials addressing lead in paint should be reviewed and updated to provide a single and unambiguous message about the danger of lead in any paint applied prior to 1978, accompanied by educational materials about safe lead remediation practices that draw upon excellent resources already available in the US and from CMHC.

10. The federal government should immediately lower the blood-lead intervention level to recognize current scientific consensus that there is no safe level of lead exposure for fetuses and young children.

Mould Remediation:

11. CMHC should expand its Indoor Air Quality training program to provide certification for contractors so homeowners have a more reliable means of evaluating the credentials of those offering indoor air quality or mould remediation services.

Handling of Caulking Material Likely to Contain PCBs:

12. To control exposure to PCBs, Canada should issue guidance, similar to that of the US Environmental Protection Agency, on the proper maintenance, removal, and disposal of caulking materials likely to have been installed prior to 1978.

Radon Safety:

13. Canada should integrate into energy efficiency training and programs educational outreach activities about home radon testing and corrective measures.

14. Retailers should make cost-effective radon testing kits more widely available and use Health Canada's educational materials to promote them at point of sale.

Raising Awareness and Improving Labelling Requirements for Products Containing Toxic Substances:

15. The federal government should revise the *Hazardous Products Act*, or its replacement provisions contained in the *Canada Consumer Product Safety Act*, once that law is in force, to expand the information required on product labels to include listing of substances known to be associated with chronic toxicity, including cancer and developmental and reproductive harm.

16. In addition to improved labelling, government, manufacturers and retailers all have roles to play in enabling contractors, builders and do-it-yourself homeowners/residents to make more informed choices, including choosing safer alternatives, when purchasing surface coatings, adhesives and other building/renovation materials. Point-of-sale information on product hazards, information sessions for contractors and do-it-yourselfers, and product rating schemes are among the possible measures that would support informed purchasing and use of building/renovation materials.

1. Introduction and Rationale

Established in 2001, the Canadian Partnership for Children's Health and Environment (CPCHE) is an affiliation of 11 organizations that aims to protect children's health from environmental exposures to toxic chemicals and pollutants. Since its inception, one of CPCHE's primary concerns has been the effects of indoor pollutants on children's health.[1]

The concern for children's health, particularly children living in low-income families where environmental risks can be more acute, has been the inspiration for a two-year project for which this report is a key milestone. The aim of the overall project is to raise awareness of the risks to children from exposure to environmental contaminants during and after energy retrofits, and to increase the knowledge and capacity among energy efficiency professionals, building owners and residents to help reduce these risks. Funded by the Ontario Trillium Foundation, the project is being implemented by the CPCHE partnership, with the Canadian Environmental Law Association (CELA) serving as the lead CPCHE partner. CELA is an Ontario legal aid clinic that provides legal services to low-income people and advocates for the application and improvement of environmental and product safety legislation.

CPCHE and CELA's goal in undertaking this work is to promote the "win–win" of increased energy efficiency and better protection of children's environmental health in residential settings.

This baseline report summarizes the knowledge gained through the first year of the project and, as such, provides an important baseline for future project activities. It examines the programs directed at making Canadian homes and buildings more energy efficient and explores the potential to foster greater attention to environmental health concerns within these worthwhile efforts.

Currently, energy efficiency programs, including some specifically designed for low-income families, are offered at every level of government and by major energy companies. Energy efficiency is also a key focus of non-governmental, industry-sponsored "green" building initiatives, such as the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, a third-party certification system created by the Canada Green Building Council. In Ontario, many of the government programs are promoted and delivered by community-based non-profit organizations, such as Green Communities Canada and GreenSaver. Energy efficiency programs have been established to reduce the use of fossil fuels for energy generation with the goal of controlling carbon dioxide levels and addressing global climate change. At the same time, the programs benefit homeowners, renters and businesses by lowering energy costs and making buildings more comfortable.

Despite these benefits, energy efficiency renovations and retrofits, like home renovations more generally, also have the potential to create or exacerbate problems that put children's health at risk. For example, in older buildings renovation, retrofit, painting and/or sanding activities may disturb contaminants that are legacies of past product uses and practices. Air sealing or tightening a building can reduce the frequency of air exchange and lead to more concentrated levels of indoor pollutants. In cases where awareness of these issues and ways to address them is lacking, renovations and retrofits may pose a risk to the health of all those who live in or spend time in these homes, especially children, pregnant women (the risk is to the fetus), and, as discussed further below, those in low-income situations. Further, individuals working in this field who are not properly trained or adequately protected may also be personally at risk when carrying out renovation, repair and painting activities. They may additionally carry hazardous exposures back to their own homes and families on their footwear, hair, clothing or equipment.

A central premise of this report and the broader project is that energy efficiency programs are not only important vehicles for lowering greenhouse gas emissions and energy costs, but are also opportunities to make homes healthier for children and their families. By matching knowledge and experience of energy retrofitting

1 Note that CPCHE uses the word "children" as a writing convenience. Reference to children's exposure risks throughout this report should be interpreted inclusively as exposure that may occur prenatally and throughout childhood and adolescence. Both maternal and paternal preconception exposures may also be relevant.

with expertise in environmental health concerns and associated protective measures, this report looks for the best ways to achieve both goals simultaneously.

1.1 The Greater Vulnerability of Children to Environmental Risks

Throughout its work on children's health and the environment, CPCHE addresses developmental stages from conception through to the end of adolescence. This wide lens recognizes the reality of ongoing vulnerability to environmental threats throughout this broad definition of "childhood," with the prenatal development stage being of particular importance.[2]

1.1.1 Greater exposures, greater vulnerabilities

Infants and children are more exposed than are adults to environmental chemicals and pollution, and they are uniquely exposed in the womb and during breastfeeding. A child's smaller size, more rapid breathing and metabolic rate, and age-specific behaviours, such as hand-to-mouth activity, all contribute to greater exposure. Children's developing bodies may absorb toxic substances more readily than adults, and, additionally, their immature organ systems can be less able to metabolize them. Environmental threats to children can also include preconception exposures for both mothers and fathers. There are many different environmental contaminants known or suspected to affect human reproduction, pregnancy outcomes and subsequent child development.

Children are more susceptible to adverse health impacts than are adults because their bodies, including complex organs like the brain and lungs or detoxification systems such as in the liver and kidneys, are developing in the womb and are immature at birth. In some cases, this immaturity and ongoing development continues well into childhood and adolescence. If crucial developmental stages are disrupted by exposure to toxicants, permanent damage can result.

1.1.2 Sources of toxic exposures in the indoor environment

Children in Canada spend up to 90% of their time indoors. A diverse array of products routinely found in the home — ranging from building materials, furnishings and electronics to personal care products, food packaging, and products used in home cleaning, renovation or hobbies — may be significant sources of toxic contaminants in house dust and indoor air.[3]

1.1.3 Some children are at greater risk

Some children are at even greater risk than others due to genetic predispositions, such as those genetically more susceptible to asthma. Like all health conditions, many risk factors are at play with asthma and certain genetic traits are known to increase vulnerability.[4] Such genetically vulnerable children can then be more seriously affected by other asthma risk factors such as indoor and outdoor air pollution.

It is also well known that poverty directly contributes to poorer health[5,6,7] and can also be associated with greater toxic exposures.[8,9] For example, lead exposure is known to be higher among children in low-income families.[10] Old paint that is in poor condition is often a key source of their lead exposure. Sub-standard housing is also known to contribute to poorer health in general, not solely for children,[11] for example via excess moisture and related mould problems. In low-income households there may also be frequent use of pesticides to control insects or rodents. Low-income families may also live near polluting industries or major transportation corridors where air pollution levels can be high.[12] Where nutrition is sub-optimal, often the case for poor families, a child's digestive system will absorb more lead.[13] This occurs particularly if their diet is low in calcium and iron.

Given the fact that one in every ten children in Canada lives in poverty, very large numbers of children are potentially at risk. In First Nations communities, this number rises to one in four.[14] First Nations and other Aboriginal children are potentially at the greatest risk among all children in Canada. Low-quality and poorly maintained housing, polluted drinking water and inadequate sewage disposal, along with poor nutrition and unique exposures to higher levels of environmental contaminants in fish and other traditional foods, can all contribute to greater health and environmental risks for Aboriginal children.[15]

2. Purpose and Objectives

The purpose of this report is to evaluate the current state of knowledge and practice with respect to energy efficient renovations and retrofits in Canada generally and Ontario specifically, and the extent to which the programs that support these efforts incorporate children's environmental health concerns.

The objectives of this report, and the broader project within which it is situated, are to

- raise awareness about the potential hazards caused by energy retrofits for children's health, particularly children in low-income families
- examine the opportunities provided by energy retrofits to make homes and buildings safer and healthier for children

- make policy recommendations that would further these goals.

3. Report Methodology

Three research techniques were employed to prepare this report, including (1) consulting the scientific literature about indoor environmental health risks and the social determinants of health; (2) conducting key informant interviews with energy efficiency professionals, environmental and public health experts, and specialists in low-income housing; and (3) conducting an online survey of energy efficiency professionals to gauge the knowledge and application of indoor air quality and other indoor environmental health concerns within energy efficiency programs. An Advisory Committee convened for this project provided expert guidance and advice. As well, a multi-stakeholder roundtable session was held on November 16, 2010 during which CPCHE/CELA shared an early draft of this report and solicited ideas and perspectives from a diverse array of stakeholders, including Advisory Committee members, report key informants, members of the Low-Income Energy Network (LIEN), energy efficiency professionals, builders and others.

4. Towards the "Win-Win": The Case for Better Integration of Children's Environmental Health Protection and Energy Efficiency Programs

Along with existing benefits, including reducing Canada's use of fossil fuels and helping combat climate change, reducing residents' energy costs and making homes more comfortable, energy efficiency programs also have the potential to improve the health of children and their families by routinely addressing an array of indoor environmental health concerns.

4.1 Economic Benefits of Energy Efficiency Measures

These benefits are particularly important for low-income families who, compared to higher-income earners, spend a much greater percentage of their income on water, fuel (excluding fuel for transportation) and electricity, described collectively as the "energy burden." According to Statistics Canada, in 2006 the average energy burden for families in the lowest 10% income bracket was 7.3% of total household income compared to 3.1% for all households combined. The 10% of families with the highest incomes spent only 2% of their total household revenue on energy.[16]

Different approaches are used to define "energy poverty" but generally focus on the percentage of after-tax income spent on energy costs. LIEN applies a level of 6% (calculated as 20% of the threshold for shelter), whereas others such as the UK government set a threshold of 10%. At this higher level, based on 2006 Statistics Canada census data, Green Communities Canada has estimated that, of the 12.76 million households in Canada, about one million families spent 10% or more of their income on energy costs.

Hence, where energy costs are lowered through effective retrofits, the economic benefits can be substantial, particularly for low-income families. In addition to saving money on energy bills, participants in the US Weatherization Assistance Program, a program established to reduce energy costs for low-income families, also saved money through reduced water and sewer costs, and reduced shutoff and reconnection fees.[17] Similarly impressive benefits continue to occur in Manitoba through the work of BUILD, a community-based agency that works in partnership with government agencies and the public utility to provide training to inner-city Winnipeg residents to upgrade insulation, toilets and showerheads in low-income dwellings.[18] In Ontario, many low-income families have had to turn to energy assistance funds to pay bills that are in arrears and to cover reconnection costs.[19] For these families, the savings realized through reduced energy bills, reduced water and sewer costs and reduced shutoff and reconnection fees could be redirected to essential needs such as food, clothing and shelter.

4.2 Health and Safety Benefits of Energy Efficiency Measures

In addition to economic benefits, energy retrofits can improve the health and safety of housing, including preventing premature death of occupants. Evidence gathered in the UK, in response to that country's high rate of "excess winter mortality," indicates a causal connection between residing in older, poorly insulated, poorly heated housing, living in poverty and experiencing low indoor temperatures and the incidence of cold-related deaths from

cardiovascular and respiratory disease.[20] Additional studies in the UK and other countries confirm that among low-income people living in energy poverty there is a relationship between living in sub-standard housing and experiencing higher rates of these health conditions during the winter months.[21,22] Colder housing can also be damp, which can lead to the growth of mould, itself a risk factor for asthma and other respiratory conditions in children.[23,24]

Where energy retrofits have effectively addressed such deficiencies in housing, affected residents have experienced significant improvements to their health. According to a New Zealand study that looked at the effect on low-income families of insulating their houses, people in homes made warmer through an energy retrofit reported less wheezing, fewer absences from school and work, and fewer visits to doctors.[25] A more recent study by the same authors found that improved heating in homes reduced school absences for asthmatic children.[26] Asthma is the leading cause of school absenteeism in Canada.[27] Indeed, pediatric researchers have found that as household energy insecurity increases, infants and toddlers face a greater likelihood of household and child food insecurity and of reported poor health, hospitalizations and developmental risks.[28,29]

Well-executed retrofits can reduce the environmental contaminants in buildings — such as mould, lead, carbon monoxide and dust — to which children may be exposed. Such retrofits can reduce moisture and condensation, improve ventilation and comfort, and generally create healthier indoor environments.[30]

Retrofits also offer an opportunity to identify and eliminate potential injury hazards for children. For example, reducing the temperature of hot water heaters saves energy and reduces scalding risk, although care must be taken when selecting the water temperature so as not to create health risks associated with *Legionella*, a bacterium including species that cause legionellosis, or Legionnaires' disease.[31,32] When lighting is being replaced, attention can be paid to dimly lit areas in homes and buildings to reduce the risk of accidents or injuries. Similarly, homes and buildings can be checked for the presence of smoke alarms and carbon monoxide monitors.

However, these benefits depend on how energy efficiency measures are implemented and maintained.[33] Indeed, as with building renovations more generally, work that is done to improve energy efficiency can *create* conditions that increase risks to children's health. Retrofitting a home for energy efficiency can and should "tighten" it, but this can trap moisture and pollutants indoors if steps are not taken to ensure adequate outside air exchange. The result can be poor indoor air quality, dampness and associated mould growth, and trapping of contaminants. Disturbing existing toxic materials is another important concern. If not properly controlled, energy efficiency measures, such as replacing windows and doors or drilling into walls to inject insulation, can generate dust containing lead or other contaminants.

When energy renovations and retrofits take into account broader issues of energy poverty, children's exposure to environmental contaminants during and after retrofits, and the overall health and safety of retrofitted homes, they have the potential to yield substantial economic and health benefits to Canadian families. Moreover, the greatest financial and health benefits can occur where they are most needed, among low-income families.

5. Addressing Potential Impacts on Children's Health During and After Retrofits

5.1 Introduction: The Importance of Indoor Air and House Dust for Children's Exposures to Toxic Substances

Before, during and after any retrofit activity, it is important to recognize the importance of indoor air and house dust as a key source of exposure to multiple contaminants. Children spend up to 90% of their time in their homes, schools, daycares or other indoor environments.[34] Particulate matter (PM) and dust in any indoor environment can include a complex mixture of fine and ultra-fine PM (often suspended in the air) and settled particles, the latter of which are of particular concern for crawling infants and young children.

In addition to other constituents of house dust, such as skin flakes, animal dander, human and animal hair, soil particles and cloth fibres, the burden of toxic substances in normal house dust is surprising. A recent literature review [35] summarizes an extensive evidence base that describes numerous reasons why house dust and PM in indoor air are of primary importance to a consideration of children's exposures to toxic substances.

More than 100 potentially toxic substances and allergens have been identified in house dust. Sources are both indoors, from multiple consumer products, and outdoors, including tracking in contaminated soil and dust on shoes, stroller or bicycle wheels, and so on. Larger dust and soil particles can adhere to skin, clothing and other objects and be ingested by children via mouthing behaviour. Smaller particles can become airborne and be inhaled into the upper respiratory system and lungs. Some particles are small enough to reach the deep regions of the lungs and even pass directly into the blood stream. The concentration of pesticides and polyaromatic hydrocarbons (PAHs) in house dust are much higher on inhalable and respirable particles than on larger particles. Airborne particles and dust also settle, contributing to contaminant-bearing house dust.

House dust is the main source of infant exposure to allergens, lead and polybrominated diphenyl ethers (PBDEs) and is a major in-home exposure source for pesticides, PAHs, phthalates and other endocrine disrupting compounds (EDCs), arsenic, chromium, mould, endotoxin and bacteria. Studies also demonstrate that these contaminants further concentrate on cleaning tools such as brooms, dusters or mops, and in the contents of a vacuum cleaner and even dryer lint.[36,37]

Activities associated with energy efficiency retrofits, like any renovations, have the potential to greatly increase levels of contaminants in air and dust. Workers are also exposed to these contaminants and can carry them home to their families, or into their vehicles, in the form of dust on their equipment, shoes, hair and clothing (also known as take-home exposure).

If dust is not controlled and isolated to the workspace area, it may migrate throughout the house, settling on floors, food, food preparation surfaces, furniture and toys. Efforts to control the creation of dust (and fine particles), contain its movement, remove it through filters and exhaust it to the outside can greatly reduce levels within the home during and after energy efficiency renovations.

5.2 During Retrofits

Three areas require attention during retrofits to prevent potentially harmful exposures and improve the overall health and safety of housing. These are 1) attending to legacy hazards, 2)

Cigarette Smoke and Indoor Air Quality

Where there is cigarette smoking indoors, air quality is seriously compromised. Environmental tobacco smoke (ETS) is a complex mixture of thousands of substances. It contains more than 60 known carcinogens and is associated with a wide range of adverse health effects, particularly among children for whom ETS exposure contributes to ear infections, asthma and respiratory illnesses.[38] It can also trigger asthma. Because of their faster breathing rate and developing respiratory systems, children are more susceptible to the effects of ETS than are adults. Tobacco smoke also contains lead. Children exposed to tobacco smoke indoors or in cars are exposed to more lead than are children living with non-smokers.

Obviously, smoking should not occur indoors at all and it stands to reason that, as homes become tighter through energy efficiency retrofits, ETS generated by smokers will reach greater concentrations in the indoor air and have a greater impact on children.

ensuring adequate air exchange in a tighter building envelope, and 3) choosing green building products. Following retrofits, attention should be paid to safer use of products within a tighter building envelope.

5.2.1 Legacy hazards — Lead

Lead was often used in paints during the 20th century, especially in housing built before the 1950s and, to a lesser extent, through the 1970s. Lead was also used extensively in plumbing (pipes and solder) and many other industrial and consumer products. Lead is a potent neurotoxicant, especially for the developing fetus and child. It has been associated with learning and behavioural problems including IQ deficits, attention deficit hyperactivity disorder (ADHD) or hyperactivity, and increased aggression.

The older the house, the higher the lead content in paint is likely to be. Paint from the 1960s and earlier could contain up to 50% lead by dry weight. Because it can lend durability and bright colour, paint containing high concentrations of lead was used extensively on building exteriors and interior "high-traffic" surfaces including trim-work, window sills, sashes and frames, baseboards, wainscoting, doors and doorframes, and high gloss wall surfaces such as those in kitchens and bathrooms.[39] It has been estimated that an older house can contain up to 225 kg of lead. The risk of exposure is present not only when paint is poorly maintained, but also when renovation, repair or painting activities are undertaken without appropriate measures to control the migration of dust and paint chips containing lead.

The first regulation for lead in indoor paint in Canada was set in 1976 limiting the amount of lead that could be added to paint to 5,000 parts per million (ppm), the same limit then allowed in the US. In 1978 the US reduced this limit to 600 ppm. Since that time Canada benefited from the lower US limit due to the overall integration of the paint industry in North America, which generally followed the US regulation. In 1991 the paint and coatings industry voluntarily reduced the lead limit in paint in Canada to 600 ppm. In 2005 Canada regulated lead in paint at the lower limit of 600 ppm in all consumer paint.[40] In 2009 the US further reduced the lead limit in paint to 90 ppm; Canada did the same as of November 2010. The central message, then, is that **painted surfaces in any home or building constructed prior to 1978 can contain hazardous levels of lead.** Exceptionally high levels of lead in paint can be expected in buildings constructed prior to 1960.

Lead-based paint is one of the main sources of lead contamination of house dust, especially when the paint is in poor condition or following renovations.[41] Studies have estimated that 50% of the daily lead intake of two-year old urban

children comes from house dust and normal hand-to-mouth behaviour.[42] Some children may also ingest non-food items like soil or paint chips. Older leaded paint has a sweet taste, which may encourage a child to repeat this behaviour. A case of lead poisoning from a child eating paint chips was reported in Canada as recently as 2004.[43]

In housing units where there is poor insulation or older unsealed windows, water condensing on the inside of windows can cause the layers of paint on window frames and sills to flake. As paint flakes, it can easily be picked up by a child and ingested.

Low-income families often live in sub-standard, poorly insulated housing, which increases their children's risk for exposure to residential lead hazards, such as paint chips, contaminated house dust or soil.

Although it is well understood that children living in poverty are at the highest risk for lead exposure, studies in the US have shown that excess lead exposure occurs among children of higher-income families as well and that it can be attributed to renovation and remodelling activities in their homes, reinforcing the fact that lead paint needs to be handled appropriately in all older housing.[44,45]

As with renovations more generally, if lead-based paint is disturbed during activities to improve energy efficiency, it can contaminate house dust,[46] and cause lead poisoning in children. However, studies have shown that when windows were replaced carefully with appropriate cleanup, homes had significantly lower lead levels on floors, window sills and window troughs after the work was completed.[47]

Nevertheless, *any* lead exposure remains of significant concern. Evidence reviewed by the US Centers for Disease Control and Prevention, the World Health Organization, and the European Food Safety Commission, among others, confirms that there is no safe exposure level. Children under the age of 6 are most at risk from lead, which even at very low exposure levels can cause permanent impacts on the developing brain. Since prenatal exposure to lead is also of significant concern, it is important that pregnant women and women of child-bearing age not be exposed to lead.

Low-income children are consistently more highly exposed to lead than are those in higher income families. Results from Cycle One of the Canada Health Measures Survey, Canada's national biomonitoring program, show that blood lead levels are higher in young children, lower-income persons and those who live in older housing (50 years or older).[48] Children under the age of six (the age group most at risk from lead exposure) were not included in Cycle One of the Canada Health Measures Survey, although Cycle Two will include children aged three and up.[49] Data from Statistics Canada show that over half the housing stock in Canada was built before 1980, and that 75.6% of the lowest income group in Canada lives in this housing.[50]

Biomonitoring data indicate that children's blood-lead levels in Canada and the US declined from 1978 to 2008 alongside government regulations restricting the use of lead in products, and, in particular, the ban on lead in gasoline, reduction of lead levels in paint and the discontinuation of lead solder in food storage cans. Although the overall reduction in blood lead levels since the 1970s demonstrates the effectiveness of public policy measures to control exposures to lead, current average blood-lead levels remain at least two orders of magnitude higher than in pre-industrial times,[51] reflecting the continued reality of widespread environmental lead contamination.

Today's blood-lead levels are considered to result from exposure to lead in paint, interior settled dust, and exterior soil and dust in and around older housing, as well as from food, drinking water and consumer products.[52] Lead plumbing in older homes, either lead-based pipes or lead-soldered copper pipes, is also a contributing factor. A Canadian study of house dust done in 2001 found that a significant proportion of childhood lead exposure may come from household dust, noting that as much as 69% of children's lead exposure may come from dust in the home.[53]

To protect women and children from lead exposures during renovations, the US has recently put in place requirements for lead-safe work practices during renovations in pre-1978 housing and child-occupied facilities.[54] As of April 2010, this *Lead Renovation, Repair and Painting Rule* requires that renovators be trained and certified, and follow specific work practices that will prevent lead contamination. The rule includes weatherization work that disturbs painted surfaces and window replacement. Contractors

must contain the work area, minimize dust and clean up thoroughly following specified protocols. In some cases, clearance testing is also required to show the absence of lead contamination with the results being provided to the owners and occupants of the building. No comparable legislation exists in Canada.

5.2.2 Legacy hazards — Asbestos

Asbestos is a naturally occurring fibrous, durable and heat-resistant mineral that was widely used in building products until the early 1980s. Asbestos fibres can also be present in vermiculite insulation manufactured until 1990. Asbestos is a carcinogen and is causally linked to lung cancer, mesothelioma and asbestosis.[55,56,57] Like lead, no safe level of asbestos has been established.

Asbestos-containing products may be present in Canadian homes and buildings built or renovated between the 1930s and the early 1980s, or insulated with vermiculite up until 1990. It is unknown how many buildings in Canada contain asbestos. For vermiculite insulation products alone, asbestos-containing insulation was used in over 300,000 Canadian homes as loose fill in attics until 1990 when it was removed from the market.

In addition to older vermiculite insulation, asbestos can be present in ceiling tiles, old vinyl flooring, shingles (roofing and siding), textured paints, and insulation used on stoves, furnaces and pipes. According to the US Environmental Protection Agency (EPA), the vast majority of asbestos products that were produced and installed in the past are still present in US buildings today.[58] It is likely that a similar situation exists in Canada given the integration of most products within the North American market. According to Health Canada,[59] vermiculite insulation, sold as Zonolite Attic Insulation,[60] is a particular concern. Although it was not marketed as a product containing asbestos, most of it contains asbestos fibres.

Generally the levels of asbestos in indoor air are at trace or non-detectable levels. The concern arises when asbestos-containing materials are disturbed or become friable, either condition of which can release microscopic fibres into the air.

The CMHC describes the many ways in which asbestos can become a risk: disturbing loose-fill insulation, removing roof shingles or siding, tampering with roofing felt, ripping away asbestos insulation from a hot water tank, sanding or scraping asbestos floor tiles, breaking apart acoustical ceiling tiles, and sanding plaster or coatings such as roofing compounds, sealants, paint, putty caulking or drywall containing asbestos.[61] Some of these activities would be undertaken during energy efficiency improvements to homes and buildings.

For asbestos-containing insulation, the risk is low when it is sealed behind wallboards and floorboards or isolated in attics. However, replacing this insulation, or disturbing it during air sealing, when adding more insulation to attics, or when carrying out other renovations in close proximity may cause it to become airborne and create a potential health hazard for both workers and building occupants.

In Ontario, asbestos is a designated substance regulated under the *Occupational Health and Safety Act*. The asbestos regulations require building owners and landlords to do an inventory of asbestos-containing materials in their buildings, to train all staff who come into contact with asbestos, to notify contractors who will come into contact with asbestos during their work, and to abate the exposure to asbestos through containment or removal.

The regulations do not, however, apply to private homes or residential buildings with four or fewer units when the home or unit within a building is occupied by the owner, and the owner is doing the asbestos abatement work. CMHC advises that if homeowners suspect asbestos is present and may be disturbed during renovations, they should consult an expert in asbestos abatement and removal. The regulations do, however, apply to construction companies, employers and workers involved in private construction projects and repair or maintenance on private homes or other buildings.

Federal regulations under the *Hazardous Products Act* now restrict the use of asbestos in most products with the result that very few products on the market in Canada today contain asbestos.

5.2.3 Legacy hazards — Polychlorinated Biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are a large family of persistent, bioaccumulative and highly toxic substances once widely used as ingredients in industrial materials, such as sealing and caulking compounds, cutting oils, inks and paint

additives. PCBs were also used in fluorescent light fixtures prior to 1978. PCBs have been shown to cause cancer in animals,[62] and toxic effects are suspected in the immune system, the reproductive system, the developing nervous system and the endocrine system.[63]

Buildings constructed or renovated in Canada between 1950 and 1978 could also have PCB-contaminated caulk around windows and door frames, between masonry columns and in other masonry building materials. PCBs were added to caulk to increase its flexibility. Use of PCB-containing caulk was a widespread practice in Canada and the US until being discontinued in 1978.[64],[65] PCBs were also used in some floor finishes during the 1950s and 1960s. Disturbing such finishes during renovations or sanding them during refinishing will create PCB-contaminated dust. Simple wear and tear on such surfaces, particularly in poorly maintained housing, will also contribute to the PCB burden in house dust.[66]

Renovations, including energy efficiency upgrades, can include the removal of caulk and the surrounding brick or masonry and can lead to contamination of indoor air and dust with PCBs.

Canada has regulated the use, importation, manufacture, storage and release of PCBs under the *Canadian Environmental Protection Act*; and the US has similar regulations. To address this legacy of PCB use in caulking, the US EPA has published guidance for school administrators and building managers on how to minimize exposures to PCBs in caulking in schools built before 1978.[67] Information is also available for contractors handling PCBs in caulk during renovations.[68] No such governmental guidance exists in Canada. Fluorescent light fixtures manufactured prior to 1978 also contain PCBs and these may be replaced during energy retrofits that address multiple aspects of energy consumption in buildings. The US EPA has recently issued guidance on this issue as well, focused on school buildings, with recommendations for proper maintenance, removal and disposal.[69] Again, no comparable government guidance exists in Canada.

5.2.4 Adequate ventilation — Mould

Mould is one of the most common indoor air quality concerns. It can grow when there is excess humidity or moisture either from indoor sources not adequately vented or due to drainage or leakage problems in the building envelope. Mould is a trigger for asthma and other allergy-like symptoms including wheezing and itchy eyes and throat among sensitive individuals.[70] It can be a very serious problem for children already diagnosed with asthma and it is suspected, though not causally linked, with asthma onset.[71]

Asthma is one of the most common chronic diseases among children worldwide and a major reason for emergency room visits, hospitalizations and school absences.[72],[73] In Canada, 15.6% of children between the ages of four and 11 years have been diagnosed with asthma.[74] In reporting of more recent data, this number is just under 10% for children aged two to 7 years.[75]

Any circumstance that results in excess humidity and moisture can cause mould to grow on its food sources such as wood, paper-faced wallboard, or other cellulose-based material used in buildings. Common causes or sources of excess moisture include

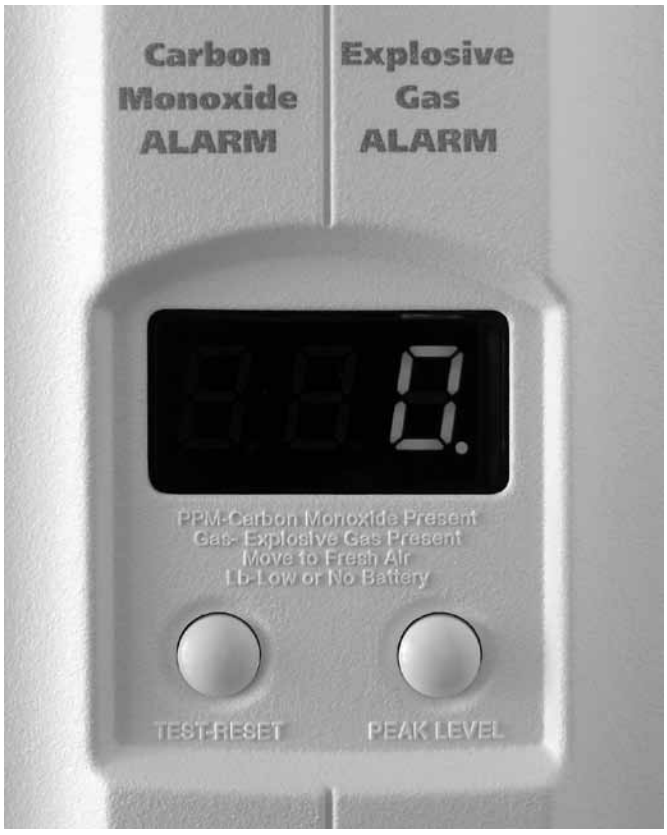
- rain and other types of water leaks into a building, for example due to faulty or poorly maintained roof drainage and basement leaks
- plumbing leaks
- humidity and condensation problems due to damp basements where a dehumidifier is not in use
- inadequate, missing or poorly maintained bathroom or kitchen ventilation
- excess moisture from humidifiers or unvented clothes dryers
- overcrowding of people

- inadequate insulation
- low indoor temperatures during cold weather creating higher relative humidity and greater opportunity for moisture to condense on colder surfaces.

Low-income families living in older, sub-standard or poorly maintained housing and who may have trouble meeting energy costs can be more susceptible to mould problems, as many of the above conditions would apply.[76]

In a 1991 survey of mould and dampness in 30 Canadian communities, of which 15 were in Ontario, researchers found that 37.8% of households reported problems with mould and dampness, and all respiratory symptoms were consistently higher in these homes.[77],[78] The most common sources of mould damage were lack of ventilation, damp basements and poor cleaning. Other building conditions that contributed to high indoor moisture levels were insufficient ventilation and humidifiers set too high.

Clearly, moisture-related problems that can create conditions for mould growth are already a significant issue in many homes, particularly in low-income circumstances. During energy efficiency renovations, a central objective is to tighten the building envelope. Thus, unless moisture-related issues are adequately addressed, circumstances can be created that can either worsen an existing situation or create new problems of excess moisture that enable mould growth.



5.2.5 Adequate ventilation — Carbon monoxide

Carbon monoxide (CO) is a colourless, odourless gas that can be lethal in as few as one to three minutes at high levels of exposure. At lower but still hazardous levels, exposures for several hours can cause headaches, tiredness, shortness of breath, impaired motor functions, dizziness, chest paint, convulsions or coma. CO can contaminate indoor air from various sources including fuel-burning appliances such as furnaces, fireplaces, gas stoves and water heaters (especially where these are not properly vented or maintained) or when chimneys are blocked or dirty. Additional sources include idling vehicles in attached garages, tobacco smoke, and the inappropriate use indoors of barbecues, grills, space heaters and other non-vented fuel-burning appliances.[79]

If families lose their energy services through unpaid utility bills or otherwise have inefficient furnaces or expensive sources of space heating (such as electric baseboard heaters) they may resort to heating their homes with an open gas oven or by burning coal or wood in sub-standard or inefficient equipment. Children can be thus exposed to CO and other hazardous substances such as PM and PAHs.

The potential for CO problems is present in any Canadian home with a furnace or appliances that burn natural gas, gasoline, propane, coal, oil or wood. For this reason, fire departments and other public safety officials strongly recommend the installation of CO detectors, although these are only mandatory for new construction in Ontario, whereas smoke detectors are required by law on every floor in all residences.[80]

Making a home more airtight during an energy efficiency retrofit can potentially increase levels of combustion products in the home, including CO, if care is not taken to avoid chimney backdrafting and spillage. Backdrafting occurs when the building pressure draws air from the chimney back down into the living space of the home.

Health Canada has adopted a residential indoor air quality guideline for carbon monoxide of 25 ppm over one hour and 10 ppm over 24 hours.[81]

5.2.6 Addressing radon risks

Radon is a naturally occurring colourless, odourless gas.[82] It emits alpha particles and produces solid radioactive products called radon daughters. It comes from radium in the ground and in groundwater in areas with uranium-containing soil, and from building materials (e.g., concrete block, gypsum board) in certain regions.

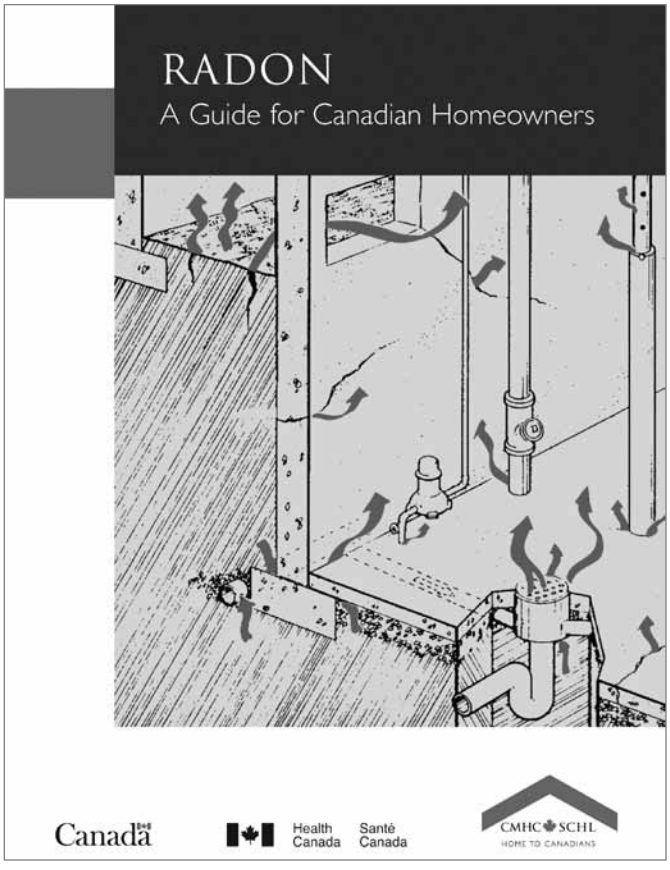
It can flow into the indoor air of a home through any openings between the house and contact with the surrounding soil, such as through cracks in foundation walls and floor slabs, construction joints, gaps around service pipes, support posts, window casements, floor drains, sumps or cavities inside walls.[83] The National Cancer Institute of Canada estimates that 10% of lung cancer deaths in Canada may be caused by radon exposure.[84]

Radon is found in all homes in Canada at varying levels.[85] The federal government recently released data from the first year of the Cross Canada Survey of Radon Concentrations in Homes,[86] which found that 7% of Canadian homes have radon levels that exceeded Health Canada's radon guideline of 200 becquerels per cubic metre (Bq/m^3).[87] This national survey confirms previous regional data from various parts of the country showing that radon levels in homes can be variable from home to home within an individual community and that certain locations in Canada have elevated levels.[88]

For example, these regional data showed that in selected Canadian cities a certain percentage of houses had levels above the national guideline. In the three Ontario cities tested, radon levels above the guideline ranged from a high of 6% of homes in Thunder Bay and 5.4% in Sudbury to 0.3% of homes in Toronto. In another study, government researchers looked at radon levels in soil and indoor air in a pilot study of the City of Ottawa.[89] In this survey, 12% of homes had radon concentrations above the Canadian guideline with more than half of the 169 homes tested having radon levels above 100 Bq/m^3.

Studies of uranium miners and other workers exposed to high levels of radon breakdown products (radon daughters) have shown that occupational exposure increases the risk of lung cancer.[90] In children, due to differences in lung shape and size, and faster respiration rates, their radon doses may be higher than for adults. The risk of radon-induced lung cancer from childhood exposure may be almost twice as high as the risk to adults exposed to the same amount of radon.[91] This conclusion is in keeping with more detailed understanding of health risks from ionizing radiation where children are known to be more susceptible than adults, and where exposures in childhood may result in a higher risk of cancer than exposures at other ages.[92]

Radon is thus another indoor air contaminant in homes for which greater awareness is necessary regardless of whether renovations, including energy efficiency retrofits, are conducted. Sealing a house generally causes the natural air exchange rate (that is, the intake and outflow to the home of outside air) to decrease, potentially enabling radon levels to increase and become a significant health risk.[93] Moreover, some energy efficiency interventions will cause increased negative pressure in houses, for example the installation of ventilation fans in bathrooms or kitchens. The resulting increased depressurization can draw in more radon from the soil. It is thus important to conduct a radon test before energy retrofit work is done. Health Canada notes that radon levels in a house can vary considerably over a one-day period and seasonal variations can be even greater, with the highest levels likely in fall and winter when air circulation and ventilation is decreased. Thus, Health Canada recommends



that homes be tested for the presence of radon for a minimum of three months, ideally during the winter months.[94]

Where there is sufficient awareness about how radon enters a home, the tightening of the building associated with energy efficiency measures can target and eliminate areas where radon can enter. However, where this awareness is lacking, tightening may increase the entry of radon from the surrounding soil. Where an initial test indicates radon entering the home, another test should be done after any renovations or retrofits are conducted to ensure that radon entry has not been exaggerated.

There are no requirements in Canada for radon testing, but both CMHC and Health Canada recommend that all houses in Canada be tested for radon, a step also encouraged by the Health Minister during lung cancer awareness month in November 2010, and upon public release of the results of the Cross Canada Survey of Radon Concentrations in Homes, described above.[95] Currently, this advice is not integrated with information about energy efficiency retrofits. For example, it is not mentioned in *Keeping the Heat In*, the document consulted by most energy auditors and homeowners. In the US, radon testing is required in some states and municipalities prior to a home purchase, and disclosure is also required to potential buyers as to radon levels and potential concerns within the building.[96]

5.2.7 Building materials — VOCs

Building materials used in renovations can continue to off-gas and concentrations will be higher in homes with lower rates of air exchange. Building materials of concern include, but are not limited to, those containing volatile organic compounds (VOCs), such as caulking, sealants, glues and insulation materials and, insulation products, such as polystyrene, discussed in section 5.3.8 below.

VOCs include a large and diverse range of chemicals containing carbon and hydrogen and

are gaseous at room temperature.[97] They are present in a wide variety of products as well as from combustion sources including fuel-burning appliances, vehicle exhaust and tobacco smoke. Product sources can include

- building materials such as vinyl or laminate flooring, panelling, some insulation materials and paints, varnishes, glues, adhesives and caulking
- home furnishings, such as those made from particle board, plywood and fibreboard, carpet backing, and vinyl products such as shower curtains
- carpets, drapes and permanent press fabrics
- air fresheners, cleaning products and disinfectants.

Some VOCs are very toxic; these include benzene, toluene and formaldehyde among others. All buildings have detectable levels of VOCs in indoor air. In fact, VOC levels can be two to five times higher inside the home than outside regardless of housing location, including proximity to industry.[98] As with other air contaminants, children are more highly exposed than adults, due to size and metabolic differences. Their developing lungs are also more vulnerable to irritant or toxic effects, as described in Section 1.1 above.

Many materials used as home building materials, including those used to make homes more energy efficient, contain known toxic substances. Many are VOCs or they may be semi-volatile compounds or otherwise substances that sequester to house dust. These can include solvents, flame retardants and biocides. [99] Common VOC-containing product applications during retrofits include caulking for sealing around windows and doors, foam insulation for closing larger air leaks, additional insulation materials, as well as glues, paints, varnishes and other materials used in finishing.

One of the most well-studied toxic VOCs is formaldehyde, which the International Agency for Research on Cancer classifies as a known human carcinogen and the US EPA considers a probable human carcinogen.[100] Formaldehyde is used in some insulation materials and as an adhesive in pressed wood products, among many other uses. Because of chronic population-wide exposure from both outdoor and indoor air to formaldehyde and concerns about its toxicity, the US EPA is reassessing it,[101] and California has regulated its use in pressed wood products such as plywood and particleboard.[102] Health Canada considers indoor air exposure to formaldehyde to be a potential respiratory irritant but does not consider it a cancer risk and has set a residential indoor air quality guideline of 100 parts per billion over one hour and 40 parts per billion over eight hours.[103]

Reduced ventilation resulting from energy efficiency work may result in the accumulation of formaldehyde and other VOCs in indoor air. In addition, studies have shown that formaldehyde concentrations in homes originating from indoor sources, such as pressed wood products, tend to persist during the lifetime of the housing.[104]

Among the many sources and types of VOCs, much uncertainty exists about the health effects of these chemicals in the home. A recent review[105] of 21 epidemiological studies of relationships between respiratory health or asthma in infants and children and indoor residential chemical emissions found that the risk factors most frequently cited were formaldehyde, or particleboard with formaldehyde-based glues, phthalates or plastic materials, and recent painting. Elevated risks were also found for renovation and cleaning activities, new furniture and carpets or textile wallpaper. Children and adults diagnosed with environmental sensitivities are particularly affected by exposure to VOCs, which may aggravate their symptoms.[106]

VOCs and other toxic substances are regulated under the *Canadian Environmental Protection Act* and for most product uses under the *Hazardous Products Act*. Labelling requirements under the *Hazardous Products Act* and its regulations apply to many products used during home renovations. These requirements contain extensive provisions for labelling and warnings about product ingredients or containers that can be very hazardous, such as ingredients that are poisonous or acutely toxic, flammable or corrosive or containers that may explode if heated. Far less stringent requirements exist for warnings, or disclosure of ingredients, in products containing substances associated with chronic toxicity.

5.2.8 Building materials — Insulation products

There are many varieties of insulation available for energy efficiency projects and retrofitting. They can range from relatively non-toxic materials to products with multiple hazardous properties as indicated by multiple hazard warnings and precautions about proper use and handling.

For example, a typical spray polyurethane foam insulation product might contain the three ingredients of methylene diphenyl diisocyanate (MDI) monomer, polyurethane resin and propane isobutinate. Such products typically come with warnings that they are very flammable during dispensing, there is a need to wear eye protection and rubber or plastic gloves during use, and the product should not be used in a closed area, the latter being somewhat difficult to adhere to when the product is used indoors to close off exterior air flow into a building. The chemical components are highly reactive with each other during application

and then become tightly bound with the intended result of stable, hardened foam that adheres to clean surfaces and does not shrink. Off-gassing from such products is substantial during and for about 24 hours after application but then drops to very low levels. Like formaldehyde-containing insulation products, low level releases to indoor air can continue from polyurethane foam insulation after retrofitting work is completed. Thus, it is important to be aware that such off-gassing will occur, albeit at very low levels, and to consider additional measures to either seal in such products with low-VOC paints or to ensure adequate ongoing air exchange for the entire home.

In another example, builders concerned about environmental health issues have questioned the widespread use of polystyrene as an insulation material.[107] Polystyrene insulation, both extruded and expanded, is one of the most popular rigid insulation materials in North America, used both in new building construction and in energy retrofits of older buildings.

The manufacture of polystyrene involves combining ethylene with benzene to produce ethylbenzene, which then forms styrene. Benzene and ethylbenzene are both classified as carcinogens. Polystyrene foam insulation also contains the flame retardant, hexabromocyclododecane (HBCD). A draft screening assessment from Health Canada

and Environment Canada has concluded that HBCD is persistent in the environment and bioaccumulative.[108] These agencies note that exposure can occur through inhalation or orally since products containing HBCD may gradually release this chemical through their use and abrasion. The main risk to human health is reproductive toxicity, including decreased fertility and effects on the thyroid. HBCD is very similar to other brominated flame retardants that have been progressively phased out via regulatory action. Like PBDEs (highly toxic, persistent and bioaccumulative chemicals that are increasingly being banned worldwide), HBCD is used as a flame retardant in multiple consumer products and levels are rising worldwide in the environment. It also appears that house dust represents a significant exposure media for children. The highest exposures to HBCD occur among breastfed infants. In the context of concerns raised about its use in insulation products, HBCD is an example of a chemical for which there are multiple sources contributing to house dust contamination, including its use in insulation.

5.2.9 Greener/healthier building materials

There is a growing demand for building materials that present minimal or no health risks to residents, builders or contractors, and/or for materials that reduce the impact of building activities on the environment. The number of possible parameters to consider when choosing greener/healthier building materials can be daunting and range from the sustainability of the source materials and the energy and inputs used during manufacture to the potential for release of toxic chemicals during and after installation, among many others.

To help residents and builders address concerns about building materials, a number of guides and rating systems are beginning to emerge. Although most of these are online resources created by concerned homeowners or building professionals and are typically small in scale and scope, in the US there are some larger non-profit efforts to create a usable national standard. One example is the Pharos Project, established by the US-based Healthy Building Network to help consumers and the building industry identify and use materials that minimize or eliminate harm to the environment or human health.[109] The Pharos Project screens and ranks materials according to their impacts; it aims to become the leading materials evaluation tool.[110] As an example, the Pharos Project has identified a number of insulation products that do not release formaldehyde.

The Pharos Project excludes building products from its approved lists if they contain specific chemicals of concern including

- bisphenol-A, an endocrine disruptor used as a building block for the epoxies in many high performance coatings, caulks and composite materials
- formaldehyde, a known carcinogen used as a binder in composite wood and insulation
- phthalates, associated with asthma, cancer and reproductive problems, used in building materials to make polyvinyl chloride flexible
- halogenated flame retardants, associated with developmental damage, used in polyurethane foams and other plastics
- highly persistent perfluorocompounds, associated with cancer, endocrine and immune system toxicity, used to make water and stain resistant materials and frictionless surfaces.

In November 2010, the Pharos Project partnered with the GreenSpec Directory to create a single green building product database. GreenSpec is a project of Building Green, an organization that analyzes building materials for various environmental and health impacts. The partnership has the potential to boost the awareness and accessibility of healthy building materials dramatically, as GreenSpec is a large database and a widely recognized authority on green building materials.

5.3 After Retrofits

Previous sections have discussed potential exposures to children from common indoor contaminants and the potential for these exposures to increase, or new contaminant sources to arise, from energy renovations and retrofits, as well as the often greater exposure risks that can exist for low-income families prior to conducting energy retrofits. It is also important to recognize that residents' activities and consumer product choices post-renovation

can contribute potentially harmful pollutants that may build up in indoor air and become health risks, especially once the building envelope has been tightened.

Among the broad range of VOCs described in the previous section, many arise from common products such as pesticides, household cleaners, aerosol sprays, air fresheners, personal care products and furnishings in the home. Likewise, as described above with respect to PM and dust, a wide range of contaminants have been identified that often originate from consumer products used in the home.

For example, in addition to the numerous studies reviewed by Roberts et al.[111] (and summarized above with respect to PM and dust), another study of 52 homes on the border between Mexico and Arizona found approximately 400 individual chemicals in the indoor environment, ranging from pesticides and a wide variety of hydrocarbons to fragrances such as musk xylenes, alcohols, esters and phthalate esters.[112]

Of notable concern are pesticides used in the home and their effects on children. Although Statistics Canada found that homeowners in Canada were using fewer pesticides on their lawns and gardens in 2006 compared to 1996, there are no comparable statistics available on indoor use of pesticides.[113] US data show that the indoor use of pesticides is high with 75% of households reporting use of at least one pesticide indoors.[114] In contrast, a limited survey done by Toronto Public Health found that 17% of parents reported using pesticides indoors.[115]

Multiple studies have found an increased risk for childhood cancers related to the use of household pesticides. For example, maternal exposure to the residential use of pesticides during pregnancy has been associated in multiple studies with more than a twofold increase in the risk of childhood leukemia.[116],[117],[118] Another study found a significant risk of childhood brain cancer (the second most common form of childhood cancer) associated with exposure to herbicides from outdoor residential use, with investigators noting that their observations were consistent with previous literature.[119] Although Ontario has banned the cosmetic use of pesticides on lawns and gardens, pesticides continue to be used in homes for insects and other pests.

One of the potential benefits of energy retrofits for housing, and particularly for low-income housing, is the opportunity to seal the holes and passageways in buildings that allow for the infiltration of pests, such as mice and cockroaches. Sealing residences can reduce or eliminate the need for indoor pesticide use. Indeed, such techniques are included among many other non-chemical alternatives to the use of pesticides.

6. Review of Energy Efficiency Programs, Policies and Guidelines

This chapter examines programs directed at reducing energy use for homes and multi-residential buildings in Ontario and includes federal, provincial and municipal programs. It considers the extent to which these programs identify and manage the indoor air quality and other environmental health concerns discussed in the previous chapter.

6.1 Federal Energy Efficiency Programs

The following section describes Canada's national federally run energy efficiency programs for retrofitting existing homes and multi-residential buildings such as apartments and condominiums. It also looks at the way in which these programs influence provincial and municipal energy efficiency initiatives.

The federal programs, which are available in all provinces and territories, include the two most well known Natural Resources Canada (NRCan) programs: ecoENERGY Retrofit — Homes and ecoENERGY Retrofit — Small and Medium Organizations.

In addition, the federal government funds two special programs that are part of the national economic stimulus package: the On-Reserve Housing Retrofit Initiative and the Social Housing Renovation and Retrofit Program.

Notably, all these programs are ending. The federal government has set termination dates for the two ecoENERGY programs, while the other two programs are part of the government's time-limited Economic Action Plan.

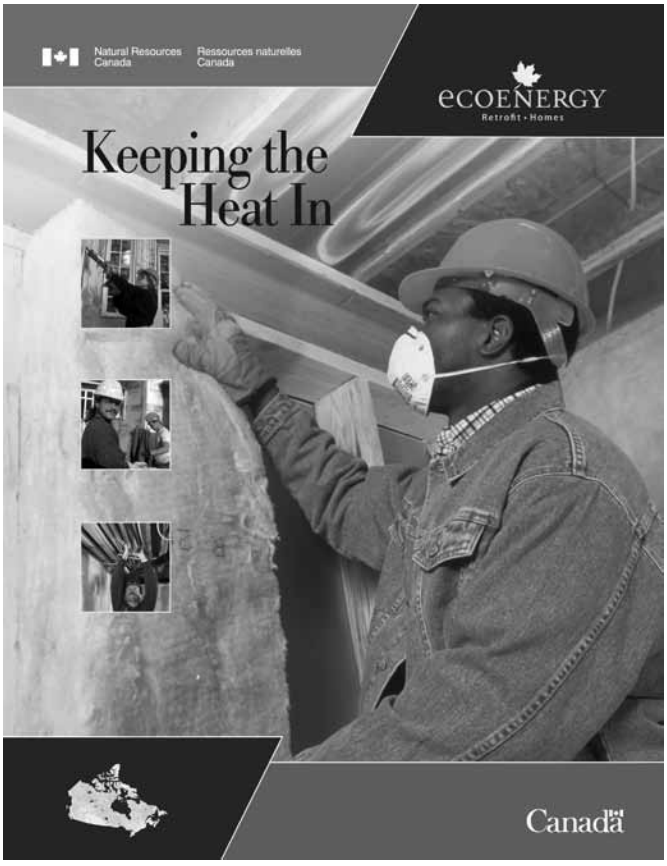
Each of these programs is discussed within this section, below, with the exception of the Social Housing Renovation and Retrofit Program. As a joint federal–provincial initiative administered by the provinces, it is discussed in Section 6.2 with other energy efficiency programs in Ontario.

6.1.1 EcoENERGY Retrofit — Homes

The **ecoENERGY Retrofit — Homes** program, administered by the Office of Energy Efficiency of NRCan, has been the most extensive and well-known Canadian energy efficiency program. Close to one million homes across Canada have been rated for energy efficiency under this program and its federal forerunners, and some 400,000 homes have been retrofitted and improved as a result.[120] NRCan estimates that one in 20 homeowners in Canada made energy efficiency improvements in their homes as a result of this program,[121] leading to a projected reduction in greenhouse gas emissions of 0.32 megatonnes.[122]

The ecoENERGY Retrofit — Homes program was also integrated with provincial-level energy efficiency programs in nine provinces, including Ontario's Home Energy Savings Program (HESP), and with a complementary energy program run by the City of Toronto called Home Energy Assistance Toronto (HEAT). Unfortunately, ecoENERGY Retrofit — Homes, available to homeowners across Canada since April 2007, was closed to new applications effective March 31, 2010. Homeowners who had an initial energy audit done before April 2010 remain eligible for grants until March 2011. The program is limited to the owners of single-family homes and low-rise residential properties.

The program provided incentives of up to $5,000 per home to encourage homeowners to have an audit or assessment done and make energy efficiency improvements. Grants were awarded after energy upgrades were completed and evaluated. Eligible upgrades included heating and cooling systems, heat recovery ventilators, insulation, draftproofing, windows, doors and skylights, hot water systems and water conservation.



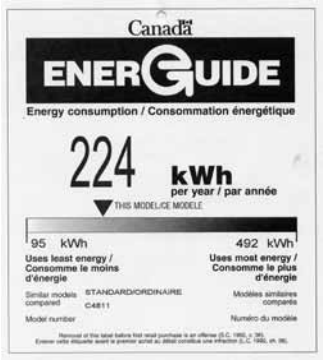
Pre- and Post-Audit Retrofit Evaluations

To qualify for grants, homeowners were required to book an initial home energy audit by an energy auditor/assessor certified by NRCan.

The audit includes a blower door test to measure air tightness and locate leaks. The energy auditor/assessor provides the homeowner with an audit report evaluating energy losses and identifying improvements for making the home more energy efficient. A key feature of the audit report is an EnerGuide rating for houses that ranks their energy efficiency between 0 and 100. EnerGuide is the official Government of Canada mark that rates the overall energy efficiency of homes as well as rating and labeling the energy efficiency of appliances, heating, ventilation and air conditioning equipment.[123]

The homeowner chooses which upgrades to have done and pays for them. Once the recommended energy efficiency upgrades are completed, a follow up visit by the energy auditor includes a second air tightness test. The auditor also confirms that the upgrades are done and processes the necessary paperwork for the homeowner to receive the grants from the appropriate level of government. Grants are based on the type of upgrade done. For example, homeowners replacing a window with a new ENERGY STAR qualified window are eligible for a $40 grant.[124]

Because the homeowner must pay for the audit and the retrofit work upfront, many low-income homeowners would not be able to participate in this program, even if they were later compensated to some extent by government grants. On its website, NRCan directs low-income homeowners who cannot afford these renovations to the Homeowner Residential Rehabilitation Assistance Program (RRAP) administered by the Canada Mortgage and Housing Corporation.[125] This program provides funding not only for energy efficiency upgrades but for major repairs to heating, electrical, plumbing and fire safety



systems. Eligibility for assistance depends on income, house value and postal code information.

Role of the Auditor in Identifying Environmental Health Concerns

An auditor's evaluation includes recommendations for specific energy efficiency measures. Thus, auditors are the key link between homeowners and any work conducted under this and most other federal and provincial energy efficiency programs that utilize NRCan-trained auditors. They receive training on a selected set of indoor air quality issues, as described in Box 1.

If auditors observe indoor environmental health problems or other potential problems that do not relate to their energy efficiency training, they will generally advise homeowners or building managers to consult a qualified professional. In certain cases where an energy audit is being done for a low-income household and major problems are encountered, auditors may refer homeowners to CMHC's Homeowner RRAP. For example, these referrals might be made in cases where an extensive mould problem is apparent.

Other environmental health concerns, such as lead in paint, PCBs in caulking or radon infiltration from surrounding soil, are not identified during an audit. The ecoENERGY Retrofit — Homes program is intended to upgrade older homes where the potential to reduce energy use is the greatest. However, such homes are also most likely to contain legacy contaminants. Because of their age, many of these homes would have lead paint and possibly old caulking, which would be disturbed during certain retrofit activities for which homeowners are compensated. These include draftproofing around, or replacement of, windows and doors, and the installation of insulation. Older homes may also have more significant cracks or small openings in the foundation than newer homes which could contribute to greater infiltration of radon.

The management of lead, PCBs and dust during energy retrofit activities, or consideration of radon infiltration, is the responsibility of the contractor, or the homeowner if they retrofit their own homes. In some cases, auditors are employed

by service delivery organizations that supply contractors to do the energy efficiency retrofits chosen by the homeowners. In other cases, auditors work independently but may recommend contractors with experience in energy efficiency work.

The choice of materials, such as caulking and insulation, is determined by the homeowner and/or the contractor. The contractor is also responsible for the containment of lead and dust and proper cleanup procedures in the home during and after the retrofit.

Box 1 Selected Indoor Air Quality Issues Addressed in NRCan Training of Certified Energy Auditors

Energy auditors/advisors are trained and certified by service organizations licensed by the Natural Resources Canada ecoENERGY Retrofit — Homes program. Audits are the first step in most of the energy efficiency programs described in this chapter.

Auditors assess the energy characteristics of a home or building, identify energy conservation measures to improve efficiency and make recommendations. While the audit does not address the full range of environmental health concerns that can arise during renovation work, NRCan-training includes several specific indoor air quality issues. These include

- air leakage
- backdrafting
- vermiculite insulation possibly containing asbestos
- moisture problems.

The initial evaluation measures the building's **air leakage** and ventilation rate. In homes where energy efficiency improvements are limited to replacing older furnaces with new high efficiency furnaces, changes in ventilation are typically not addressed. However, when a building envelope is being tightened through improved insulation and air sealing, auditors must advise about adequate ventilation.

If a house falls below a certain simulated air change rate (which is 0.15 air changes per hour (ACPH) in the worst month of the year), recommending a heat recovery ventilator is mandatory.[126] For houses leakier than this ventilation rate, local exhaust fans may be recommended as an alternative.

In houses with exhaust fans (e.g., in bathrooms and/or kitchens) a screening test is done to see how strong the depressurization effect is on the building. Auditors check for evidence of **backdrafting**, particularly where homes are heated with gas. The overall objective is to ensure that homes do not become depressurized by ventilation fans and draw carbon monoxide fumes and combustion products into the home from the chimney.

If there is no evidence of a ventilation problem or other indoor air quality issues (such as excess moisture or mould) during the initial evaluation, but where recommended upgrades may lead to new risks or exacerbate existing ones, homeowners are advised to include a heat recovery ventilator in their upgrade plans or take other steps to deal with the issue of supplying fresh air to the occupants. During the post-retrofit evaluation, air leakage and backdrafting tests are repeated with further advice provided based on these findings.

Training modules also educate auditors to consider the possible presence of **vermiculite insulation which may contain asbestos**. If vermiculite is found, auditors generally advise that sampling and testing be done before work is undertaken in the area. If asbestos is present in the attic or walls, auditors provide homeowners with a Health Canada brochure that explains vermiculite insulation may contain asbestos and should not be disturbed. If energy efficiency retrofits will disturb the insulation, homeowners are advised to contact qualified professionals before proceeding.

Many auditors are also trained to identify potential **moisture problems**, which could result in the growth of mould. If problems are identified, the auditor makes recommendations to the homeowner to eliminate or manage the problem.

NRCan Educational Materials

For homeowners doing their own energy efficiency retrofits, NRCan's Office of Energy Efficiency has developed educational materials. Their comprehensive guide to energy retrofits, *Keeping the Heat In*,[127] is available online and is distributed as a DVD or a booklet to homeowners who participate in federal and provincial energy efficiency programs.

For environmental health concerns, *Keeping the Heat In* provides guidance to homeowners on specific health and safety considerations. A section within the guide on health and safety includes warnings about asbestos and lead in older homes. It also includes advice on how to minimize exposure to particles, dust, fibres and harmful vapours that can result from multiple products used for insulation and caulking.

Retailers are another potential source of information on energy efficiency renovation projects for contractors and do-it-yourself homeowners (see Box 2).

Box 2	*At the Retail Level*

Non-profit organizations like Peterborough Green Up, part of Green Communities Canada, have partnered with companies like Home Depot to offer energy efficiency workshops in their stores. This outreach work has informed people about the multiple benefits of improved energy efficiency and helped homeowners take advantage of various energy efficiency programs. The retailer benefits from sales of energy-related products to people coming in for the workshop.

6.1.2 EcoENERGY Retrofit — Small and Medium Organizations

NRCan's Office of Energy Efficiency also administers the ecoENERGY Retrofit for Small and Medium Organizations program. Aimed at commercial and institutional buildings, including condominiums or larger apartment buildings, this program is smaller than ecoENERGY Retrofit — Homes, which received $490 million over four years, as compared to $50 million for larger buildings.

Multi-residential and mixed-use buildings are eligible for this program if they are more than three stories, have a footprint greater than 600 square metres and have more than 20 units.[128] The program provides up to 25% of the cost of a project to a maximum of $50,000, based on the estimated energy savings.

Like the ecoENERGY Retrofit — Homes program, a pre-project energy audit is required. The audit can be conducted by a qualified professional, such as an engineer, or by an NRCan certified energy advisor, in which case the same approach is applied to indoor air quality and environmental health concerns as is described in Box 1.

Projects may also qualify for funding from utilities and other levels of government. The ecoENERGY Retrofit — Small and Medium Organizations program will finish on March 31, 2011, because, according to NRCan, the demand for this program has been "less than expected."[129] It is estimated that 0.08 megatonnes of greenhouse gas emissions have been saved by projects funded under this program.[130]

6.1.3 On-Reserve Housing Retrofit Initiative

Under Canada's Economic Action Plan, $125 million in funding was made available over two years to First Nation communities for repairs, renovations and energy retrofits of social housing projects on reserves. CMHC administers this program, known as the On-Reserve Housing Retrofit Initiative. Projects are proposed by First Nations, and proceed after approval by CMHC.

In Ontario, on-reserve houses retrofitted under this program were primarily single-family homes. The funding, which was to be used in the fiscal years 2009–2010 and 2010–2011, was closed to new applications as of February 2010.

Because this program is part of the Economic Action Plan, its main focus is job creation, and a wide range of repair and retrofit projects are eligible for funding, including improvements

Box 3 The LEED Canada Initiative

The Canada Green Building Council (CGBC)[131] has created the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, building on the pioneering work in this field of the US Green Building Council (USGBC).[132] LEED is a third-party certification program that includes a comprehensive set of benchmarks for the design, construction and operation of high performance green buildings. Applying a whole-building approach, it addresses performance issues in five overall areas: sustainable site development, water efficiency, energy efficiency, materials selection and indoor environmental quality.

While the work of LEED in both countries is heavily focused on new construction (LEED for New Construction), for existing buildings it is applied to multiple aspects of building operations and maintenance. Other LEED rating systems are available for commercial, institutional and industrial buildings including LEED for Commercial Interiors (when just the interior is being addressed) and LEED for Core and Shell (when just the shell is being addressed). For indoor environmental quality, attention is focused primarily on ensuring good air quality and ventilation, minimizing particulate matter (PM), purchasing sustainable materials and resources (e.g., building materials with low VOC emissions or replacing older mercury-containing lights with mercury-free versions), and adopting "green cleaning" and integrated pest management practices. Requirements for assessing the existing building prior to undertaking energy retrofits are focused on the efficiency of existing energy systems.

Whether assessing an existing building or addressing indoor environmental quality, in neither case are issues of old lead paint in existing buildings considered. The unfortunate result is that a building can receive LEED Gold Certification for employing a suite of highly progressive and laudable energy efficiency measures without recognizing a serious hazard of old lead paint. This situation underscores the need for a broader consideration of environmental health issues in older buildings across the board, including within LEED.

In the case of existing homes, LEED certification can be obtained if homes undergo a gut and rehabilitation process that exposes the full thermal envelope, where the full insulation on the exterior walls of the house are exposed, either by the removal inside of drywall or removal outside of all siding. For smaller renovations, LEED certification is not employed but the CGBC provides a referral to the ReGreen Guidelines[133] prepared by the USGBC in conjunction with the American Society of Interior Designers. These guidelines address indoor environmental health issues quite comprehensively in that they include the need to address risks from lead, radon, mould, VOCs and other potential indoor exposures.

made to make homes more energy efficient. Areas of eligible repairs include roofs, exterior doors, windows and exterior caulking. Energy efficiency measures could include improved air leakage control, increased insulation and installation of high efficiency boilers, furnaces, lighting and windows.[134]

Renovations completed for the purpose of improving energy efficiency in housing must result in minimum energy standards being met. However, approved projects do not have to show energy savings to receive their funding, and the work is not required to result in a specific overall EnerGuide rating. Further, neither energy auditing nor blower door testing are funded or required under this program. However, many First Nations have professional staff members that have been trained as NRCan-certified energy advisors.

While not specifically focused on energy efficiency, CMHC also funds a program called Aboriginal Capacity Development that provides funds for training First Nations' community members to develop and maintain healthy housing. Training modules target indoor air quality, the installation and maintenance of heat recovery ventilators, the prevention of mould and other topics.

6.2 Ontario's Energy Efficiency Programs

In general, provincial programs follow the template of the federal ecoENERGY Retrofit — Homes program, using the same trained auditors and adopting the same approaches to indoor air quality concerns.

The main program in Ontario for homeowners is the Home Energy Savings Program (HESP). In addition, a number of utility-based energy efficiency programs in Ontario are directed specifically at improvements to low-income housing, both single-family homes and multi-

residential buildings. These include low-income weatherization programs for single-family homes developed by Enbridge Gas Distribution and Union Gas, and the Multifamily Energy Efficiency Rebate program for large low-income apartment buildings developed by the Ontario Power Authority (OPA).

Enbridge and Union Gas also offer incentives to reduce the use of natural gas in multifamily residences. In addition, the Social Housing Renovation and Retrofit Program, a joint federal–provincial program created specifically to upgrade social housing, also considers low-income housing.

In some cases, grants and loans for improving the energy efficiency of larger buildings are available for the same housing stock. Additional funds for improving energy efficiency in non-profit housing may be obtained as loans from the Infrastructure Ontario Loan Program. Alternatively, funds from this loan program may be used for other improvements so that money available under other programs, such as the Social Housing Renovation and Retrofit Program, may be used for energy efficiency.[135]

The future direction of energy efficiency programs in Ontario will be strongly influenced by how the *Green Energy Act* (GEA) is implemented. Introduced in 2009, the GEA contains provisions to require utilities to create energy conservation plans and meet conservation targets, and to develop measures to help low-income consumers reduce their energy burden. It also contains a provision for mandatory home energy audits before the sale of a home. The new requirements for utilities are under active development, but the provision requiring energy audits prior to home sales has yet to be proclaimed in force by the legislature.

6.2.1 Home Energy Savings Program

Ontario's most comprehensive energy efficiency program for homes is the **Home Energy Savings Program** (HESP), developed as a complementary program to the federal government's ecoENERGY Retrofit — Homes.

Administered by the Ontario Ministry of Energy, HESP reimburses homeowners 50% of the cost of an audit up to $150, and provides grants of up to $5,000 for energy efficiency work. Approximately 348,000 homes have taken advantage of this program. Although federal funding under ecoENERGY Retrofit — Homes is no longer available to match provincial grants, provincial grants remain available.[136]

In practice, the federal ecoENERGY Retrofit — Homes and the provincial HESP programs have been conducted as a single program. Energy advisors trained and certified by organizations

licensed by NRCan conduct the home audits, the necessary prerequisite for receiving federal and provincial grants.

A broad range of energy efficiency measures is eligible for HESP grants. These include "deeper measures" such as ceiling, wall, floor and basement insulation, draftproofing, and door and window replacement. Many of these measures could result in tighter building envelopes, and affect indoor air quality. As discussed with respect to the federal ecoENERGY Retrofit — Homes program, auditors test the air leakage rates through blower door tests in the homes both before and after energy retrofits.

An example of a typical Energy Efficiency Evaluation Report is provided on the Ministry of Energy's website.[137] It shows that, in addition to the featured advice on ventilation and the appropriate use of heat recovery ventilators discussed in Box 1, a typical audit report includes supplementary advice to the homeowner on other indoor air and environmental health concerns. These include how to address mould problems and maintain the appropriate humidity level in a home, guidance on wood burning, and a short summary on how to handle vermiculite insulation during renovations.

Aside from the audit guidance on indoor air quality issues and the post-audit check on air leakage, the actual retrofit and renovation work is done by either contractors or homeowners themselves. Therefore, control of dust and the management of lead paint during renovations, or consideration of other issues such as radon or VOCs from products used during the work, are the responsibility of the contractor or the homeowner.

Energy service providers such as GreenSaver, which do both energy audits and retrofits, do consider the relative merits and toxicity of different types of insulation in their choice of materials. GreenSaver, which is the largest delivery agent in Ontario for the federal ecoENERGY Retrofit programs, uses cellulose

or foam insulations that do not contain formaldehyde.[138]

In addition, the NRCan guide, *Keeping the Heat In*, is distributed to homeowners participating in the provincial program. Therefore, the same indoor air quality concerns that are addressed under the federal program through training of assessors and through available public information are part of the joint federal/provincial program.

6.2.2 Ontario Energy Board programs

In addition to the HESP program, Ontario has a number of programs designed to help low-income families. These programs have been developed by the Ontario Energy Board (OEB) in conjunction with utility service companies, both gas and electrical, operating in the province.

The OEB is an independent quasi-judicial agency that regulates Ontario's electricity and natural gas sectors, including Enbridge Gas Distribution, Union Gas and the OPA. It reports to the Ontario Ministry of Energy. Pursuant to Ministry directives, gas companies operating in Ontario and the OPA have framework agreements with the OEB that require them to contribute to programs for low-income families and to fund conservation through their rates.[139]

A number of the utilities' programs currently in place offer low-income families basic energy conservation measures. For example, programs such as Enbridge Gas' Enhanced TAPS program and Union Gas' Helping Homes Conserve distribute kits to low-income families that include low-flow showerheads, foam pipe insulation and programmable thermostats, and offer them free professional installation. Every Kilowatt Counts, the OPA's only residential program, offers cash incentives to encourage the replacement of outdated furnaces and air conditioning equipment. These programs have no direct impact on air quality, with the possible exception of thermostat replacement measures. If old thermostats containing mercury are not carefully handled and properly disposed of as hazardous waste, families may unknowingly expose themselves and their children to mercury.

In 2009, the OEB announced the creation of a Low-Income Energy Assistance Program (LEAP). However, the OEB was asked by the Ontario Minister of Energy to put its planning on hold while the province developed a program in accordance with the newly enacted GEA. In July 2010, the Minister directed the OEB to resume work on the strategy to help low-income consumers reduce energy consumption and costs. The program has three components: emergency financial assistance for customers in need, access to more flexible service rules for bill payment and disconnection notice, and targeted conservation and demand management programs.[140]

The new programs for low-income residents in Ontario are under development with some program elements having launched in January 2011 (e.g., emergency energy funds and implementation of flexible service rules among other measures) while the new conservation and retrofit programs are expected by mid-year of 2011. The OEB wants the electricity and natural gas utilities to coordinate their approach to energy conservation and demand management programs. When the OEB announced its resumption of work on LEAP, it issued a draft code for electricity distributors, setting a target of reducing electricity consumption by 6,000 gigawatt hours over a four-year period beginning in January 2011.[141]

Important progress on the integration of indoor environmental health concerns is possible as these new GEA requirements are implemented in the coming years since they are being expanded province-wide and will include a suite of deeper measures, particularly insulation, of low-income residences.

6.2.3 Programs for low-income single family homes

Both Enbridge Gas and Union Gas have extensive energy efficiency programs that pay for deep energy conservation measures, that is, measures that can dramatically improve efficiency such as full house insulation as compared to more modest measures such as changing showerheads. These programs are geared to low-income housing in designated areas of the province where natural gas is used for heating.

The two primary residential programs are Enbridge Gas' Low-Income Home Weatherization Retrofit Program, and Union Gas' Helping Homes Conserve Weatherization Program. These programs are available at no cost to single family homes (owned or rented) as long as the customer is paying the gas bills and meets certain income requirements. Eligible customers must apply to

either the gas company or to companies such as GreenSaver, which provide both auditing services and carry out the energy efficiency work on behalf of the gas company.

Both programs generally follow the same approach as the federal ecoENERGY Retrofit — Homes program. A certified energy advisor audits the homes, identifies energy efficiency measures, recommends improvements, and conducts a follow-up assessment of energy savings. The retrofit work is done by contractors working with the auditors. The program is designed around prescribed measures: attic, wall and basement insulation, and draftproofing, which includes weatherstripping and caulking.[142] Door and window replacements are not included.

Ensuring adequate ventilation is the main indoor air quality issue addressed. Auditors will also check for vermiculite insulation, but other environmental health concerns such as lead or radon are not considered under these programs.

These programs are focused primarily on older homes, where the greatest energy savings can be made and also where lead-bearing paint will be common. Although window and door replacement, which would cause the most disturbance to the paint, are not included in these programs, caulking and weatherstripping could also disturb lead paint or old PCB-containing caulking material.

Enbridge Gas' Low-Income Home Weatherization Retrofit Program:

Enbridge has implemented its energy retrofit program in 630 gas-heated homes in their franchise areas since 2007 when the Low-Income Home Weatherization Retrofit Program began. A pilot project was launched in Toronto and Peel region and then expanded to York Region, Region of Durham, Ottawa and the Niagara Region. Homes receive an average of $2,000 worth of retrofit work under the program, which ended on December 31, 2010 with the 2011 program set to begin following OEB approval. A condition of the Enbridge program is that homes must be at least 30 years old, so that significant energy efficiency gains can be realized to make the program worthwhile. In addition, residents must be willing to engage.

Union Gas' Helping Homes Conserve Weatherization Program:

Union Gas also has a low-income weatherization program for homes, although its program has been applied to fewer residences than the Enbridge program. The Union Gas' Helping Homes Conserve Weatherization Program also offered free energy audits, attic and basement insulation, and draftproofing. In 2008, 15 detached homes in Hamilton were made more energy efficient, primarily through the installation of attic and wall insulation. In 2009, 150 row homes in Cornwall were upgraded through basement insulation.[143] During 2010, an additional small number of homes in Cornwall and also in Windsor were upgraded. As with Enbridge, the new Union Gas program for 2011 will commence following OEB approval.

Because these programs involve more significant retrofit work, they have the potential not only to reduce energy costs for low-income families but to make homes healthier and more comfortable. However, as with the federal and provincial programs, the energy advisors and the contractors who carry out the retrofit work determine the way in which indoor air quality and environmental health issues are managed.

Neither the auditors nor the contractors deal with structural or environmental health problems beyond ensuring adequate ventilation. They may refer families to other professionals or other programs for help. Because the weatherization programs are directed at low-income families, if problems such as mould are found, families may be referred to the federal Residential Rehabilitation Assistance Program (RRAP).[144] Mould is regarded as a health and safety issue, rather than as an energy efficiency-related issue.

In addition to these programs for low-income families in single family homes, Enbridge and Union Gas also have programs for multi-residential buildings, discussed in the next section.

6.2.4 Programs for multi-residential buildings

A number of programs in Ontario focus on energy efficiency improvements in multi-residential buildings, such as apartments, co-ops, shelters, condominiums and multi-use residential buildings. Some of these apply specifically to buildings housing low-income families. In addition to these programs, loans can be accessed

through the Infrastructure Ontario Loan program for making improvements to non-profit housing.

Although these programs are intended to reduce the use of electricity or gas in multi-residential buildings, they are often focused on upgrading technical equipment or systems, and, for this reason, have little impact on indoor air and generally do not raise significant environmental health concerns.

Enbridge and Union Gas, as part of their OEB-mandated demand/supply management programs, also offer financial assistance to building owners and managers of multi-residential buildings such as apartments. These programs are part of the overall strategy to decrease the use of natural gas in the areas served by the two gas companies.

Enbridge Gas Commercial Audit Incentives Program:

Under its Commercial Audit Incentives Program, Enbridge Gas provides rebates of half the cost of an audit up to $5,000 per building or $15,000 for a group of buildings. Enbridge also has a number of other multi-residential programs that offer financial incentives based on the amount of natural gas savings estimated for the first year. The projects are generally limited to technical retrofits of energy-efficiency and water conservation systems. These include upgrades to higher efficiency equipment such as boilers, water and space heaters, ventilation equipment and showerheads. Energy efficiency measures such as insulation and draftproofing that would have an effect on air quality by tightening buildings are not offered under these programs.

Union Gas EnerSmart Multi-Family Program:

Union Gas offers a multi-family energy conservation program that applies to apartment buildings, condominiums, rowhouses and townhouses under its EnerSmart Multi-Family Program. Energy efficiency programs for multi-family buildings include upgrades to indoor heating systems such as forced air furnaces and gas-fired rooftop space heaters. Like Enbridge, Union Gas offers money for audits — in this case, 50% of the cost of an energy efficiency feasibility study up to $10,000. It also offers incentives of 15% of the costs up to $40,000 for investments in high efficiency process equipment and building envelope technologies that reduce natural gas consumption.

Union Gas also provides helpful information online for building owners and property managers on indoor air quality.[145] The focus is on ventilation technology and maintaining building ventilation rates, particulate filtration, humidity and temperatures. Building owners and property managers are also encouraged to control sources of microbial contaminants, which could lead to the development of mould, through routine cleaning of HVAC systems and addressing water damage in building areas within 24 hours. Guidance is also given with respect to chemical contaminant sources by promoting remedial action during and after building renovation, as well as containing and removing combustion gases and tobacco smoke. Issues such as lead and asbestos are not addressed in the indoor air quality advice.

Ontario Hydro's Low-income Multifamily Energy Efficiency Rebate Program:

The largest program available for low-income apartments was the Multifamily Energy Efficiency Rebate (MEER) program. MEER offered financial incentives of up to 50% of the cost of upgrades to building owners and property managers. Assisted and social housing and privately owned buildings with six or more units were eligible.

MEER was a program of the OPA and ended on December 31, 2010. It was part of OPA's strategy to reduce electricity consumption and meet demand management targets mandated by the OEB.

The types of activities funded included energy audits and the replacement or installation of energy efficient equipment and systems. The most common retrofits were improved lighting and electrical systems, upgraded heating and cooling systems, and the replacement of water heaters, thermostats and appliances. Many of these retrofits reduce energy consumption but have little direct impact on indoor air quality.

Energy audit rebates of up to $35 per unit were paid up to the full cost of the audit if at least four energy conservation measures were assessed and an energy savings rebate was applied for at the same time, including at least one audit-recommended measure. Prescriptive measures and custom upgrades were possible under the program. Prescriptive measures included lighting, heating, ventilation and air conditioning, appliances and hot water service. Incentives were up to 40% of total costs.

The program was delivered by GreenSaver outside of Toronto and by the Better Buildings Partnership within Toronto. Green Light on a Better Environment (GLOBE), a subsidiary of the Social Housing Services Corporation, helped social housing providers apply for funding under the MEER program both in and outside of Toronto. GLOBE, which is funded by the OPA, offered financial incentives and educational programs to promote audits and retrofits of social housing.

6.2.5 Social Housing Renovation and Retrofit Program

One of the newer programs in Ontario providing funding for energy retrofits of low-income multi-residential buildings is the Social Housing Renovation and Retrofit Program (SHRRP). This two-year program, created under Canada's Economic Action Plan, was announced in the federal budget in June 2009.

The total funding for this project is approximately $704 million, split between the federal and provincial governments, and administered by the Ontario Ministry of Municipal Affairs and Housing. The number of social housing units eligible for funding in Ontario is about 225,000, many of which are more than 40 years old.

The program has a broad scope. It is intended to upgrade existing and new affordable housing projects through retrofits that improve the health and safety of tenants, increase the energy efficiency of buildings, and increase building accessibility for seniors and persons with disabilities.[146] Service managers, who administer social housing, have to identify projects that need repair and that would be considered capital improvements. The government's intent was that the majority of money provided through this fund would be used for energy efficiency improvements.

Although, energy efficiency improvements are not technically defined for the purposes of this program, projects are expected to meet provincial energy efficiency standards based on the age of a building, and existing high-rise buildings should be more efficient than the federal Model National Energy Code for Buildings.[147]

The federal Model National Energy Code for Houses[148] and the Model National Energy Code for Buildings were both developed by the National Research Council, NRCan, and the Canadian Electricity Association in 1997, and are being updated. The province of Ontario has referenced the Model National Energy Code for Buildings in the Ontario Building Code. The Model Codes require that all heating, ventilation and air conditioning equipment and systems in buildings and houses be sized appropriately to meet the needs of the spaces in which they operate in accordance with provincial or municipal regulations. They do not apply to other air quality or environmental health concerns.

The minimum standards established for SHRRP allow for considerable scope; installing a new roof or new windows and doors could be considered energy efficiency improvements. Other energy efficiency improvements promoted under this program include heating and cooling systems, heat recovery ventilators, insulation and the installation of lighting. Although energy audits are not mandatory, the program guidelines suggest that work should be based on audits.

Due to its design, an important effect of this program has been to encourage service managers to do building service audits and to evaluate not only energy efficiency opportunities but also health and safety issues such as mould and asbestos.

There has been no tracking to date of the energy efficiency improvements undertaken as a result of this program. Social housing projects, which are eligible to receive money under this program, are also eligible for money under programs such as MEER or Enbridge and Union Gas' multi-residential programs.

6.3 Municipal Energy Efficiency Programs

As of late 2010, the City of Toronto was the only municipality in Ontario that offers grants to complement federal and provincial programs. It also provides additional information on energy efficiency measures as well as incentives to reduce energy consumption. While other municipalities in Ontario do not yet offer discrete energy efficiency programs, many have websites that offer information and links to existing federal and provincial programs.[149]

This section discusses the City of Toronto's programs, their relationship to other programs and the extent to which they take into account the potential for exposures to environmental contaminants. The programs are Home Energy Assistance Toronto, the Better Buildings Partnership and TowerWise.

6.3.1 City of Toronto Home Energy Assistance Toronto

The Toronto Environmental Office, under the Home Energy Assistance Toronto (HEAT) program, offers funds to homeowners and building owners

who are participating in the federal ecoENERGY Retrofit — Homes program and the provincial HESP program. The City wanted to create incentives that would encourage homeowners to undertake more extensive energy efficiency measures than those encouraged under the federal and provincial programs. The HEAT program focuses on insulation, and is designed to supplement the federal program under which most people replaced furnaces and windows.

The City signed a legal agreement with the federal government stipulating that once an energy advisor calculates the energy savings for the home and the amount of money due to the homeowner in grants, the advisor is also responsible for calculating the grant for achieving an improved R-value of the walls as a result of additional insulation; the City pays this grant to the homeowner. The incentives amount to approximately 50% of the value of the insulation.

Air quality and environmental health considerations are the same as those identified by the auditors under the federal and provincial programs. No additional conditions or recommendations related to indoor air quality or environmental health are imposed by HEAT.

6.3.2 City of Toronto Better Buildings Partnership

The Better Buildings Partnership is a program for large buildings in Toronto that offers grants and loans to reduce greenhouse gas emissions. It is focused on all large buildings in the city and includes energy efficiency retrofits of multi-residential buildings, including social housing and private sector buildings for low-income families.

As the agent for the OPA's MEER program in Toronto, the Better Buildings Partnership offers incentives for electricity savings. It also offers zero interest loans available from the City of Toronto from each of two funds: the Toronto Energy Conservation Fund (for retrofits to existing buildings) and the Toronto Green Energy Fund; these are known collectively as the Sustainable Energy Fund. Loans are based on energy savings, and can be 49% of a project's total eligible cost up to a maximum of $1 million per project.

Under this program, indoor air quality considerations in buildings following the completion of retrofits go no further than the legal requirements for heating and ventilation specified in the Ontario Building Code.

6.3.3 City of Toronto TowerWise

TowerWise is an outreach and advisory service developed to help owners and managers of residential high-rise buildings understand and take advantage of the numerous grants and loans available in the City of Toronto for improving the energy efficiency of their buildings. It does not include social housing, which is handled by other organizations such as GLOBE (discussed in Section 6.2.4 above). TowerWise promotes both Toronto-specific programs and broader-based utility programs such as Enbridge's multi-residential program and NRCan's program for multi-residential retrofits. TowerWise is a project of the Toronto Atmospheric Fund, an agency of the City of Toronto.

Box 4 ***Community Organizations***

Green Communities Canada (GCC), a national non-profit organization, has been a leader in the promotion and delivery of energy efficiency programs in municipalities across Canada. GCC helped develop the federal energy efficiency program, and was the first to actively promote the uptake of these programs through member organizations in cities and towns across Canada.

The Residential Energy Efficiency Project (REEP) has been a member of GCC since 2005. REEP serves people in the Waterloo Region by giving information and advice on energy conservation and efficiency, renewable energy and sustainable development. As the local delivery agent for the federal government's ecoENERGY Retrofit — Homes program, REEP provides home assessments and recommends changes that will save energy for homeowners. As well, REEP conducts community workshops that help educate people with respect to cost-effective energy efficiency measures and healthy indoor air.

TowerWise tries to promote deeper measures that might have a longer investment timeline and, therefore, might be less likely to be undertaken, but where eventual payback on an investment might be higher. The advisor focuses on convincing people to take advantage of the available incentives. In its promotional work, TowerWise does not address environmental health-related issues such as the possible presence of mould or lead paint.

6.4 Summary

Many of the energy efficiency programs sponsored by governments and available in Ontario are in transition, ended in 2010 or will end in 2011.

The federal ecoENERGY Retrofit — Small and Medium Organizations and the popular federal ecoENERGY Retrofit — Homes are being phased out, while the other two federally funded programs, the Social Housing Renovation and Retrofit Program and the On-Reserve Housing Retrofit Initiative, are limited to two years under Canada's Economic Action Plan and are ending in 2011.

The federal government estimates that about 400,000 homes across Canada have benefited specifically from the ecoENERGY Retrofit — Homes program and almost one million homes across Canada have been rated for energy efficiency under this program and its federal forerunners. Between the two federal ecoENERGY Retrofit programs (for homes and buildings) there has been a projected reduction in greenhouse gas emissions of 0.4 megatonnes. As well, a wide range of educational materials has been created and is available online from these and other provincially based programs.

Despite the elimination of the federal programs, with which most provincially based programs in Canada were integrated, the Ontario Home Energy Savings Program is continuing. And while Ontario's utility-based programs, offered by Enbridge Gas, Union Gas and OPA are finishing, new programs are under development to replace them that may include delivery of new programs by other Ontario local electric distribution companies. Of particular importance will be the adoption of energy efficiency measures in Ontario, such as within the new OEB-mandated programs which should include low-income households, and under development within the gas and electric utilities, partially in response to recent Directives issued by the provincial Minister of Energy. Significant economic, health and environmental benefits are possible as these programs expand to a province-wide mandate and focus on deep measures such as insulation.

In general, although ventilation and air exchange issues are effectively integrated into energy efficiency programs in Canada, other potential indoor air and/or environmental health concerns are not systematically identified or addressed. Asbestos and mould may be identified during the audit process, but other concerns such as lead, PCBs and radon, or warnings about the high levels of toxic contaminants that can be present in renovation dust, are usually not mentioned during energy audits or included in auditors' advice and recommendations for implementing energy efficiency measures. Beyond warnings and advice about hiring professionals to address asbestos risks, and limited warnings about lead risks in old paint, these additional contaminant issues are rarely if ever integrated into the implementation of energy efficiency measures, educational materials or follow-up assessments.

There is also little information available or emphasis on the choice of materials used for energy efficiency retrofits, and their potential impact on environmental health. The increased risks associated with using chemicals, tobacco or pesticides in the home after renovations have tightened the building are almost never addressed under any energy efficiency programs.

With the upcoming development of new energy efficiency programs there is an opportunity to incorporate environmental health concerns in this next generation of initiatives.

7. Results of the Online Survey of Energy Efficiency Professionals

An online survey was conducted to assess the knowledge of, and knowledge transfer between, the frontline contacts for energy efficiency programs and the homeowners, building owners and managers who are their clients for energy efficiency audits/projects. For most of the programs reviewed for this report, energy auditors were the main professional frontline contacts. The survey focused on this segment but also included consultants, builders, renovators and others working in the field of energy efficiency.

A key finding was that the energy efficiency industry, as seen through the eyes of energy auditors and other energy efficiency professionals, has the opportunity to integrate more indoor environmental health information into their activities. Many felt that this integration could be carried out at the program design phase.

The majority of energy auditors completing the survey felt that training specifically geared to auditors would be the most appropriate means to educate and reach their clients with respect to indoor environmental health concerns. They reported that the overall indoor environmental health knowledge of the home/building owner is quite low. Many respondents also indicated that they rely on CMHC as their primary source of information for indoor environmental health issues.

This chapter provides a detailed overview of the survey results, including respondents' views on existing opportunities and challenges to addressing environmental health concerns in the context of energy efficiency auditing.

7.1 Overview of Survey Participants

7.1.1 Energy advisors

Of the 70 people that filled out the survey, 75.7% were energy auditors (they may also be referred to as energy advisors, energy evaluators or energy assessors). The majority of these advisors have been working in the field for one to two years (32%), with the next largest group (28.8%) having worked in the field for two to five years. The third largest group (11.5%) had seven to ten years' experience (see Figure 1).

The data indicate that many of the energy professionals surveyed have worked only with the federal government's ecoENERGY Retrofit — Homes program. A very small percentage worked in the energy audit business before the start-up of this program when Green Communities Canada (GCC) delivered its predecessor — the EnerGuide for Houses program. The overall number of energy auditors increased dramatically when the ecoENERGY Retrofit — Homes program opened to the general market in 2007 and replaced the previous GCC-only model.

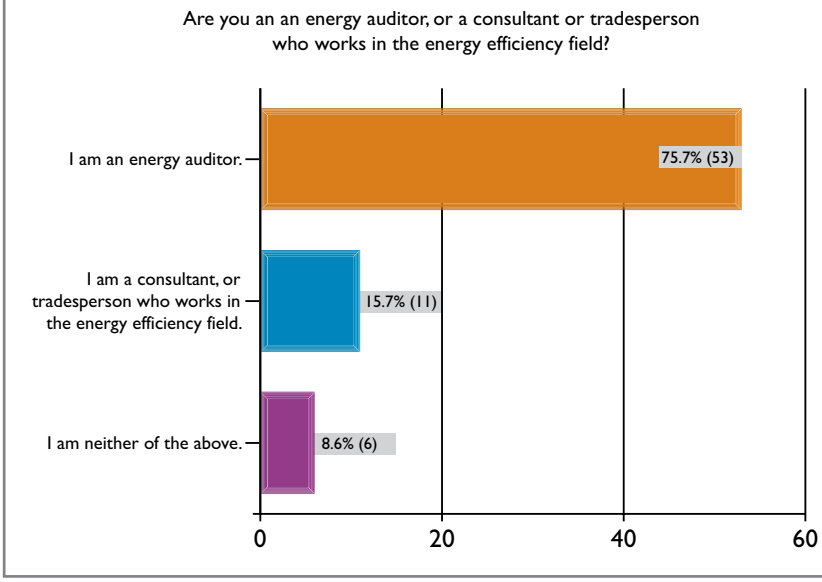
7.1.2 Contractors and consultants

Among all respondents, 15.7% were tradespeople or professionals who work in related energy efficiency fields and/or consultants, such as green building consultants, designers or engineers, who are not certified energy advisors. Of this group, most came with significant experience, with the largest percentage having worked in the field for more than ten years (40%), followed by those with seven to ten years' experience (30%). These results indicate that the majority of those working on energy efficiency projects have been in the field since some of the earliest energy efficiency programs began in Canada.

7.1.3 Respondents' Provincial, Employment and Program Affiliations

Given that the overall project is focused there, it is not surprising that most of the respondents were from Ontario (89.7%). However, people from Nova

Figure 1 *Survey Respondents*



Scotia, British Columbia and New Brunswick also filled out the survey.

The energy auditor and contractor sectors, for the most part, comprise self-employed or contract workers in smaller organizations. Most respondents are self employed (40.7%), followed closely by those working in the non-profit sector (35.6%) with somewhat fewer in the private sector (18.6%). A small percentage (5.3%) worked for government or as consultants for government programs.

As shown in Figure 2, the majority of respondents worked on the ecoENERGY Retrofit — Homes program (81.0%). Over 62% had worked with the former EnerGuide program. After these two, the program employing the next highest percentage of respondents (39.7%) was the commercial program, ecoENERGY Retrofit — Small and Medium Organizations.

Many of the energy auditor respondents also work on new construction and energy efficiency programs associated with that industry segment, including Energy Star, EnerGuide for New Homes, LEED for Homes, R-2000 and the Build Green program based in Alberta and British Columbia. Therein, fully 36% of the auditors work under Energy Star for New Homes, and 19% work under LEED for Homes.[150] Both of these new construction programs, which originated in the United States and have been modified for Canadian construction practices, showed a greater adoption than other Canadian programs for new construction; for example only 8.6% of respondents had worked on R-2000. Energy efficiency programs for new construction are not addressed in this report.

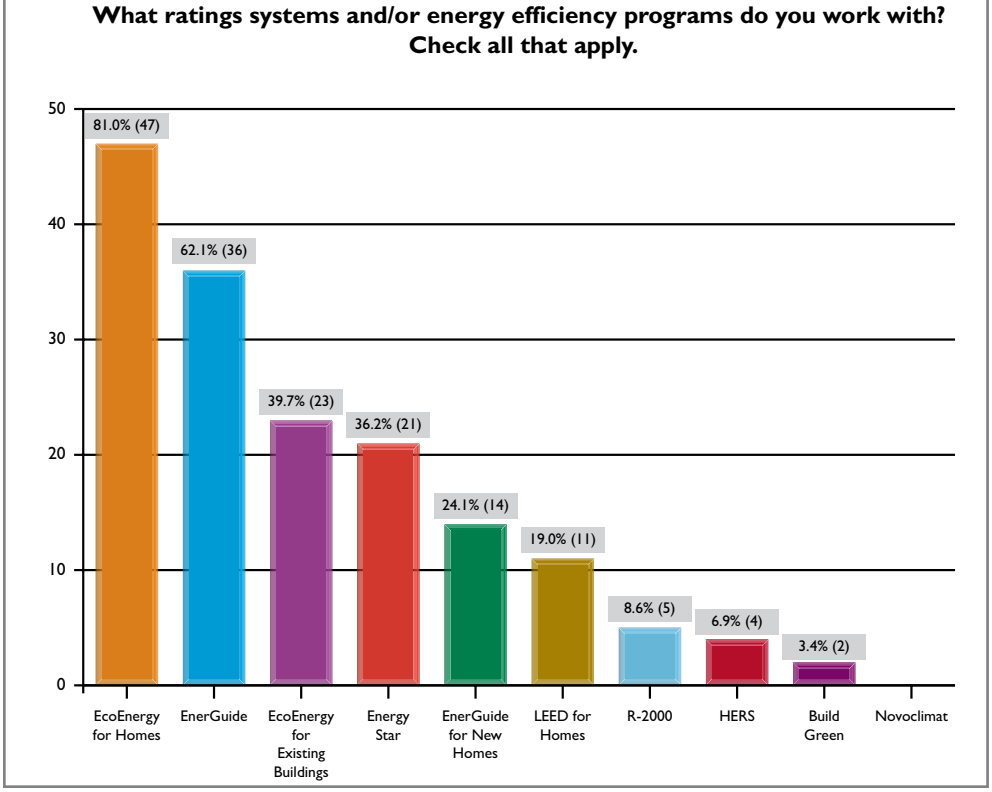
The vast majority of respondents work on existing buildings (72.4%) where this work "is greater than 75% of their scope." The majority of respondents work on evaluating and retrofitting single-family homes (71.4%), which consume more than 75% of their focus. These figures indicate the main drivers of energy efficiency programs and efforts are in the existing building market.

7.2 Indoor Environmental Health Training and Knowledge

7.2.1 Indoor environmental health training/screening

Auditor training that addresses indoor environmental health issues associated with energy efficiency programs is outlined in Section 6.1 (see specifically Box 1). The survey explored whether the energy advisors have other ancillary and relevant training beyond their programs' requirements. Only 29 people responded to this question, indicating that many of the energy efficiency professionals do not have relevant indoor environmental health training beyond what is offered in their energy efficiency program training. Those that did comment noted that the CMHC's Indoor Air Quality (IAQ) program was the most popular, with ten of the 29 respondents indicating that they had taken either the initial introductory course (Build and Renovate to Avoid Mould) or the entire Indoor Air Quality Investigator Course. The rest of the indoor environmental health training came from a range of sources such as the Heating, Refrigeration and Air Conditioning Institute of Canada, which is a trade association that provides heating, ventilation and air conditioning (HVAC) training to those in the

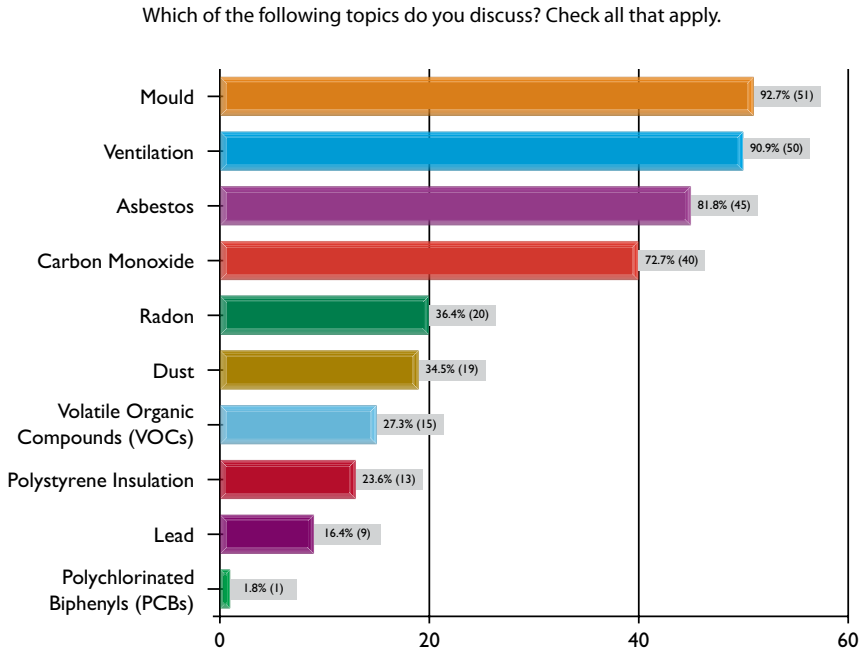
Figure 2 **Rating systems and/or energy efficiency programs used**



industry. Two respondents had some training through their home inspection training, as it is common for energy auditors to also serve as home inspectors.

The survey also asked whether the energy efficiency professionals carried out any indoor environmental screening or testing. To clarify, screening is the qualitative analysis of a potential environmental concern to determine its presence or absence, while testing is a quantitative analysis of the same concern to determine actual levels present. An example of this would be the use of squeeze tube kits, available at paint stores, to screen for presence of lead, while sending a paint chip to a lab or using an onsite analysis tool such as an X-ray fluorescence (XRF) analyzer would provide a quantitative measure of the level of lead in paint, generally in parts per million. Of those surveyed, 64.3% do not do any indoor environmental screening or testing. However, a small number of those surveyed do test or screen for mould (23.2%), asbestos (21.4%), carbon monoxide (12.5%) and radon (10.7%).

Figure 3 *Indoor environmental health topics discussed with clients*



7.2.2 Discussion of environmental health issues with clients

Less than half of the respondents (45.6%) initiate discussions of indoor environmental health issues with homeowners, occupants and/or tenants, while 38.6% only discuss indoor environmental health topics when a potential issue is discovered during an audit. Nearly 9% of respondents discuss environmental health issues only when asked, and 7% do not discuss indoor environmental health issues at all.

As shown in Figure 3, of the issues discussed, mould is the most common (92.7%), followed closely by ventilation (90.9%), then asbestos (81.8%), and carbon monoxide (72.7%). It should be noted that all of these issues are covered within the training and the homeowner's manual, *Keeping the Heat In*, distributed as part of the ecoENERGY Retrofit — Homes program.

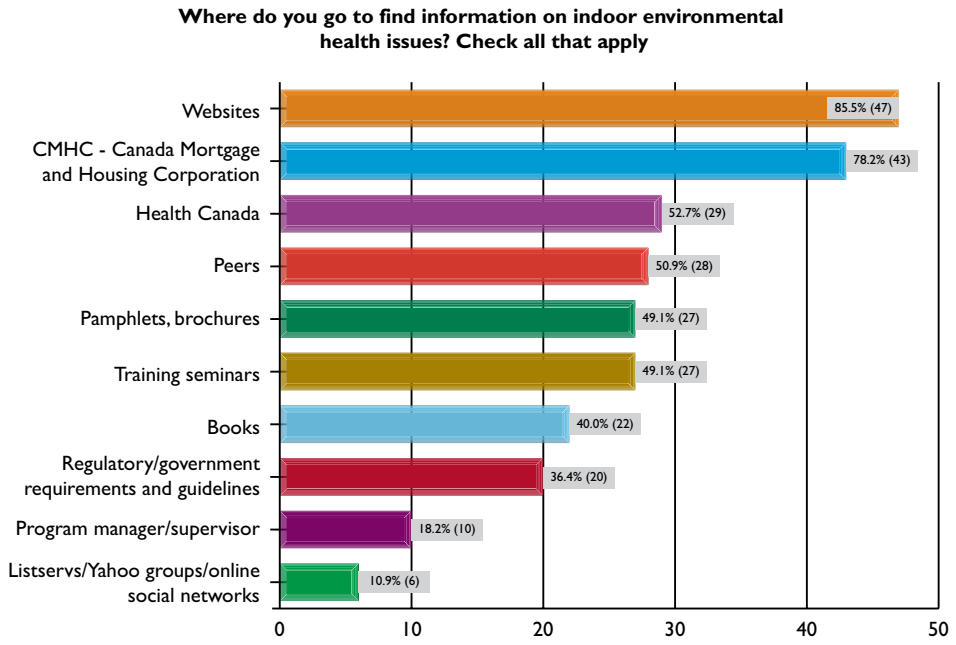
7.2.3 Reasons why indoor environmental health issues are not discussed with clients

Energy efficiency professionals who responded to the survey reported a number of reasons why they do not discuss indoor environmental health issues with their clients:

- Don't feel qualified/lack of sufficient knowledge and experience (41.5%)
- Training did not cover these issues/elements (41.5%)
- Concerns about personal and/or professional liability (41.5%)
- Not part of their job (31.7%)
- Felt that they didn't have enough time (26.8%)
- Felt they did not have appropriate information resources to provide the client (29.3%).

Additional written comments suggest that auditors feel pressure to conduct the audit quickly with limited time for data collection, and that processing the grant application takes up a large percentage of their time. Some commented on their lack of training on indoor environmental health issues and/or their professional responsibility to stay within the scope of the program they are serving. A couple of comments suggested that some homeowners are having the audit done for the grant money and want little, if anything, to do with the learning process that the auditors can provide. These comments along with the response results above indicate that

Figure 4 *Auditors sources of information on indoor environmental health*



auditors may be pressured to stick to the details of the program and not address additional indoor environmental health issues.

7.2.4 Indoor environmental health resources used

Online environmental health resources are the most popular information source for energy efficiency professionals (85.5%), followed by CMHC (78.2%), Health Canada (52.7%), peers (50.9%) and training seminars and pamphlets (both at 49.1%) (see Figure 4, below). Combined with the fact that CMHC's IAQ seminar series was the most common training among respondents, these data suggest that CMHC is the predominant source of information on indoor environmental health for energy efficiency professionals.

Of all respondents, 89% were interested in further training so as to be better able to address indoor environmental health issues with their clients, however, in their written comments some noted concerns about time constraints and potential liabilities.

7.3 Indoor Environmental Health Knowledge of Clients

This section of the survey asked for information from the energy efficiency professionals about their clients. Although this is second hand questioning, it was felt that the opinions of energy efficiency experts about their clients' knowledge, based on their experiences, are relevant to the success of indoor environmental health education and knowledge transfer.

7.3.1 Frequency of indoor environmental health questions asked by clients

More than half (54.4%) of energy efficiency experts responding to the survey reported that they experience "infrequent" questions about indoor environmental health issues from clients, and 35.1% report that they are "sometimes" asked such questions by clients.

A small percentage of respondents (7%) are asked questions about environmental health "frequently," and 3.5% of respondents reported never being asked questions about indoor environmental health by their clients.

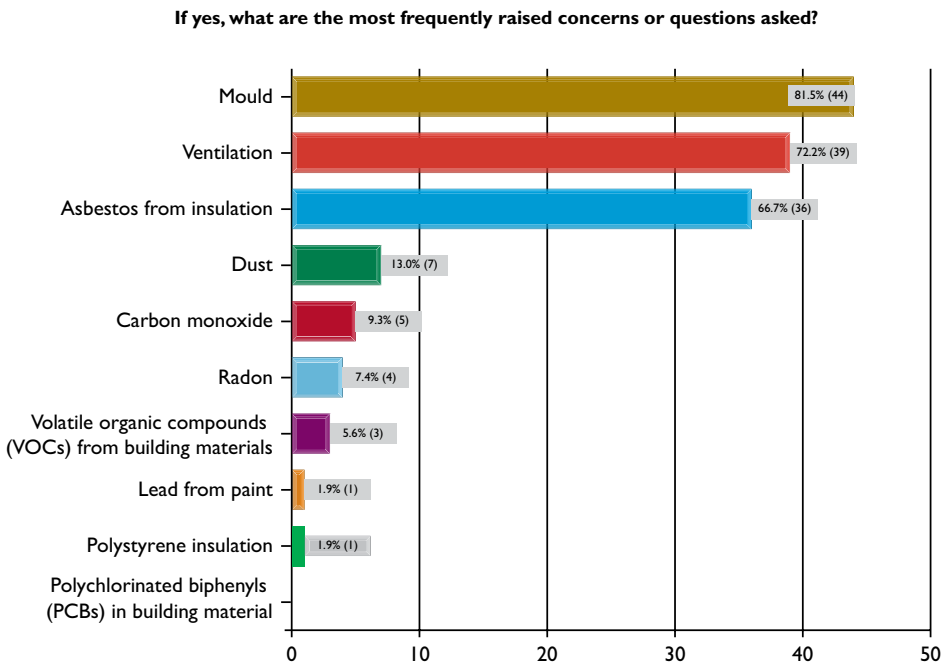
7.3.2 Most common Indoor environmental health questions asked by clients

When clients ask indoor environmental health questions of energy efficiency professionals, 81.5% of the questions are about mould, 72.2% are about ventilation and 66.7% are about asbestos from insulation. Other indoor environmental concerns are rarely raised (see Figure 5).

7.3.3 Why clients rarely ask about indoor environmental health issues

When respondents were asked to guess why the average energy efficiency client does not ask about indoor environmental health issues, 81.5% stated it was due to a lack of awareness of potential health-related concerns. Of these, 48% reported that clients likely feel that energy efficiency upgrades have no relevance to indoor environmental health, while 38.9% suggested that clients do not feel that occupants (their tenants or their own families) will be affected by these issues. About one in five respondents (20.4%) felt that homeowners/managers/tenants lacked sufficient confidence in their own knowledge of the topic to feel comfortable asking questions.

Figure 5 *Most frequently raised indoor environmental health issues*



7.4 Integrating Indoor Environmental Health into Energy Efficiency Programs

Energy efficiency professionals surveyed, many of whom have experience delivering multiple energy efficiency programs, were asked about the most effective ways to implement and integrate indoor environmental health issues into energy efficiency programs.

7.4.1 The potential for integrating indoor environmental health issues into current programs

Most of those surveyed (72.2%) felt that indoor environmental health issues could be integrated into the main energy efficiency program they were working on. Respondents did raise concerns, however, such as information overload on the part of clients and increases in cost, time and training requirements for the professional. Many recommended that these issues be the focus of a separate program, and one contractor was concerned that homeowners might react negatively to raising all of these concerns and the perceived added costs of addressing them. Of the 25 respondents who commented, many agreed there is a connection between the energy efficiency and indoor environmental health of a house. This understanding was attributed to having received training that addressed the concept of house as a system, whereby every element, system and operation interacts with all other elements in the home.

7.4.2 Ways to effectively integrate indoor environmental health issues into programs

Respondents were asked to comment on the effectiveness of various methods of integrating indoor environmental health issues into their primary energy efficiency program.

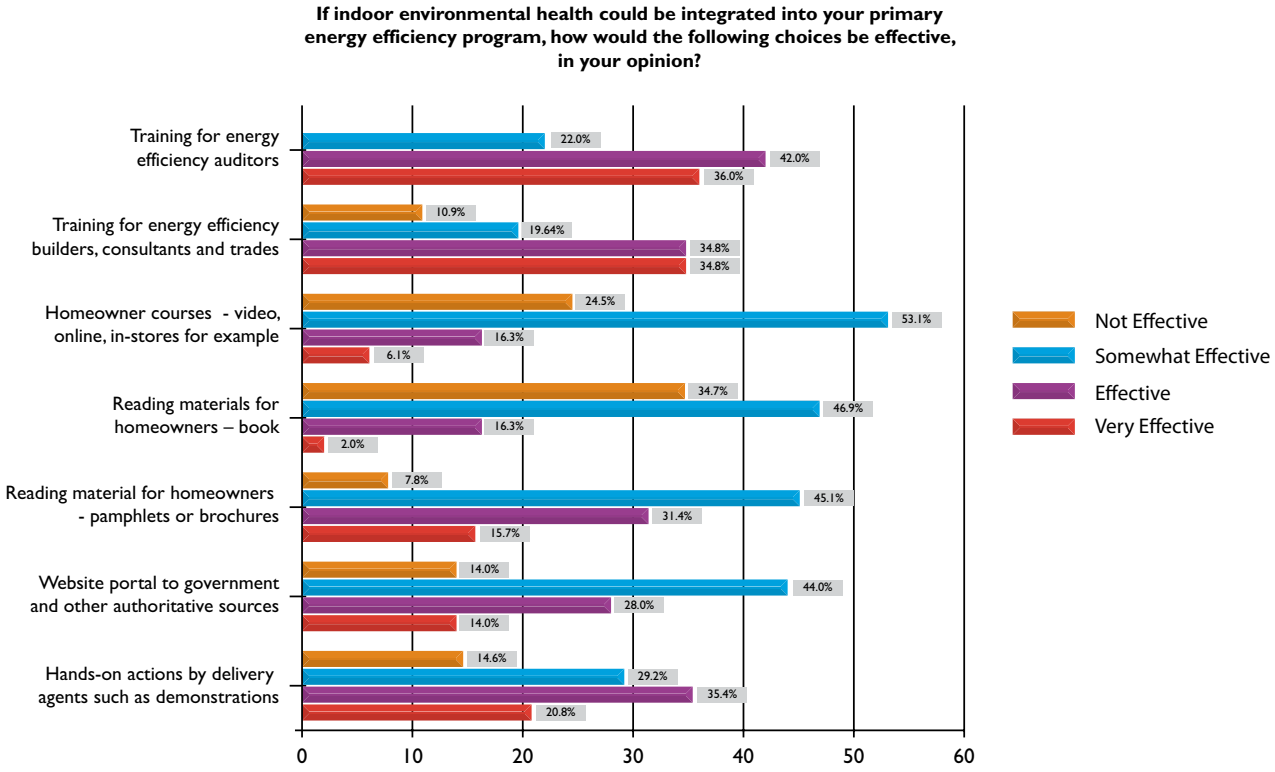
As shown in Figure 6, all survey respondents felt that providing training for energy efficiency auditors would be an effective action, with no respondents choosing the "not effective" option. Respondents varied in how effective they felt that training for energy efficiency auditors would be, with 22.0% considering it somewhat effective, 42.0% considering it effective and 36% considering it very effective.

Nearly 70% of respondents felt that providing training for energy efficiency builders, consultants and tradespeople would be either effective (34.8%) or very effective (34.8%), while 19.6% of respondents felt it would be somewhat effective and the remaining 10.9% felt it would not be effective to train builders, consultants and tradespeople.

Approximately 75% of respondents felt that homeowner courses — via instructional videos, online seminars and in-store workshops — would be effective, to varying degrees. Fifty-three percent thought that homeowner courses would be somewhat effective, 16.3 % felt they would be effective and 6.1% felt they would very effective. Nearly one in four respondents (24.5%) felt that these approaches to educating homeowners would not be effective.

Reading materials for homeowners, such as books or brochures, were also considered potentially effective. There was greater support for brief materials, such as a brochure, as compared to book material. Approximately 65% felt that a book would be effective to varying degrees, however 47% of respondents rated a book as likely to be only "somewhat effective." More than 92% of respondents thought a pamphlet or brochure

Figure 6 *How should indoor environmental health information be integrated*



would be effective; of these, 45% suggested such materials would be "somewhat effective," 45% rated them as "effective" and 16% thought they would be "very effective." Only 7.8% of respondents felt that a brochure or pamphlet for homeowners would not be effective. This question was asked specifically as it relates to the current practice of giving clients the book *Keeping the Heat In*.

Of those surveyed, 86% considered government or other authoritative website sources of indoor environmental health information and guidance to be effective, to varying degrees, for educating energy efficiency professionals. Most (44%) felt that governmental information sources are only somewhat effective, 28% feel they are effective, and 14 % feel they are very effective. Fourteen percent felt that such sources are not effective.

Finally, hands-on actions by the delivery agent such as showing how to do remediation work or screening for concerns such as lead were considered effective by the majority of respondents, with 20.8 % rating them as very effective, 35.4% rating them as effective, and 29.2% rating them as somewhat effective. Nearly 15% of respondents rated hands-on actions by delivery agents as not effective.

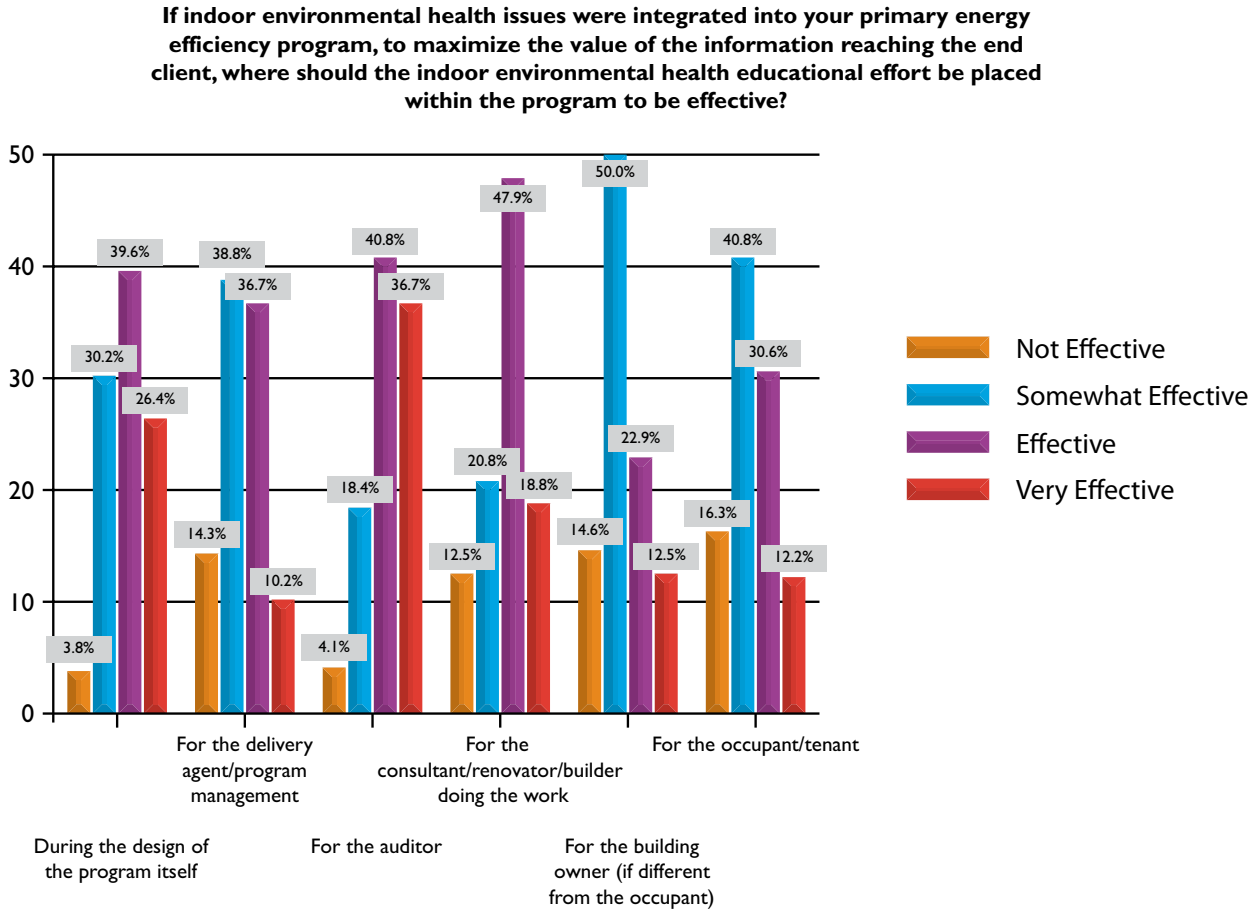
7.4.3 The placement of indoor environmental health education within a program

Energy efficiency professionals were asked to offer insight as to where they might place an indoor environmental health education effort within an energy efficiency program to maximize the effectiveness of the information transfer (see Figure 7).

Of the respondents, the majority felt that integration of indoor environmental health efforts should be done during the design of the program itself, with only 3.8% disagreeing with that statement. Nearly 40% felt that incorporating environmental health issues into program design would be an effective choice, with 30.2% feeling it would be somewhat effective, and 26.4% believing this was the best way to implement change and rating it as very effective.

There was less, yet still significant, support for focusing on the delivery agent/program management area. Approximately 39% of respondents felt that it would be somewhat effective to focus on the delivery agent/program management area, closely followed by 36.7% rating this as effective, and 10.2% feeling it would be very effective. As a counterpoint, 14.3% felt it would not be effective to take this tack.

Figure 7 *Placement of indoor environmental health issues within programs*



Just over 40% of respondents felt that directing indoor environmental health educational efforts to the auditor would be effective, with nearly the same number (36.7%) rating this approach as very effective. Approximately 18% felt it would be somewhat effective and only 4.1% felt that focusing on the auditor would not be effective.

Nearly nine out of ten respondents felt that focusing on the consultant/renovator/builder doing the work would be effective, to varying degrees. Of these, 47.9% of respondents felt this approach would be effective, 20.8% felt it would somewhat effective, and 18.8% rated it as very effective. Approximately 12% responded that it would not be effective.

The majority of respondents expressed support for focusing on the building owner, although 50% felt it would be only somewhat effective. This approach would be effective according to 22.9% and very effective according to 12.5% of respondents. Nearly 15% of respondents felt that it would not be effective to focus on the building owner (14.6%).

Similar to the results for the focus on the homeowner, focusing on the occupant/tenant would also be somewhat effective at (40.8%) followed by 30.6% considering it effective, and 12.2% choose very effective. Again, a similar percentage, 16.3% felt it would not be effective.

The comments in this section were similar to other areas, in that they felt indoor environmental health is important, but reaching the overloaded client could be difficult. It was perceived that this would drive the costs of the audits up. Government assistance or the addition of more reading materials would be helpful to make it more readily adoptable.

8. Analysis and Recommendations

The following observations, analysis and recommendations stem from a year-long process of gathering information and insights from the literature, from governmental and non-governmental websites, from the online survey of energy efficiency professionals summarized in Chapter 7, and from direct interactions with numerous colleagues and stakeholders, including the members of the Project Advisory Committee, the key informants interviewed during the preparation of this report, and the participants in the Stakeholder Roundtable convened by CPCHE/CELA on November 16, 2010 in Toronto.

8.1 Integration Can and Should Occur

This work summarizes robust research findings that energy efficiency measures can reduce energy use, bring down the cost of utility bills, contribute to the warmth and comfort of housing, and reduce significant health risks associated with energy insecurity. These are population-wide benefits that are of particular importance to low-income families, as they typically spend a disproportionate amount of their income on energy costs and their children can be at greater risk of health effects associated both with energy insecurity and with greater exposure to indoor environmental contaminants.

Potential health benefits, however, can depend on how energy efficiency measures are implemented. Well-executed energy efficiency upgrades can create a healthier environment by making a home warmer, improving ventilation, reducing moisture and condensation, and reducing contaminants such as mould, dust and carbon monoxide.

On the other hand, energy efficiency measures may also increase the risk of harm by creating hazards during the renovation work itself, or by increasing concentrations of contaminants, especially if a house is tightened without providing adequate air exchange. The greater risks faced by children from environmental contaminants on a daily basis, and the potential for increased exposures from renovation activities, underscore the need for greater awareness and policy response.

The solutions are reasonably straightforward and a "win–win" proposition. This research has revealed various opportunities for better integrating indoor environmental health protection into efforts to improve energy efficiency. Moreover, it reveals a growing surge of interest in linking these two streams of effort in the interest of improving the health and living circumstances of families in Canada while taking meaningful action on climate change.

With the phase-out of federal energy efficiency grant programs for homeowners, businesses and others, an opportunity exists to assess progress and recommend changes for the future. Likewise, Ontario-based programs need to adjust to the shrinking federal role and move forward to implement new requirements flowing from *Ontario's Green Energy Act* (GEA). Important progress can occur in Ontario's utility-operated programs since these will expand province-wide and will include a suite of deeper measures, particularly with respect to improving insulation of low-income residences.

This evolving situation represents an opportunity to look at the entire approach to encouraging and supporting the adoption of energy efficiency measures. Integration of key indoor environmental health issues can occur within the training of energy auditors and in educational materials generated by government or others for use by auditors and their clients. As well, additional policy measures can support continued adoption of a more integrated approach to energy efficiency and indoor environmental health issues, as outlined in the recommendations offered below.

This research has revealed various opportunities for better integrating indoor environmental health protection into efforts to improve energy efficiency. Moreover, it reveals a growing surge of interest in linking these two streams of effort in the interest of improving the health and living circumstances of families in Canada while taking meaningful action on climate change.

8.2 Strengths of Existing Programs

The federal government, through NRCan, has set the framework, designed key programs, developed valuable and trusted training modules that have been used to train energy efficiency auditors across the country, and been a major motivator for a high level of energy retrofit activities across Canada. Despite the recent termination of federal grant programs, this infrastructure continues to provide a valuable foundation for energy efficiency programming in Canada. The ongoing advocacy, expertise and hands-on activities within community-based groups like Green Communities Canada have similarly contributed to the delivery and uptake of energy efficiency

incentive programs. In Ontario, programs for low-income residents arose from the activities and advocacy of groups within the Low Income Energy Network (LIEN), work that has also ensured their expansion province-wide and into deeper retrofit measures.

Other federal agencies, most notably the CMHC and Health Canada, have mandates and information/guidance relevant to indoor environmental health concerns. Survey respondents noted that the most widely used online professional resources were the CMHC and Health Canada websites.

The existing concept of addressing buildings as a system provides a valuable basis for the integration of indoor environmental health issues. Agencies such as CMHC, utilities such as Union Gas, the LEED Canada initiative and others already stress the importance of considering the whole building, rather than its individual components. It is especially important that this concept be broadened to consistently include issues that arise from legacy contaminants, such as lead and asbestos, which are often present in older buildings.

8.3 Opportunities for Improvement

The research, interviews and survey conducted for this report indicate that the way in which federal and Ontario-based energy efficiency programs have been designed and implemented varies considerably in the degree of attention paid to indoor environmental health concerns.

The following sections address the five areas — program design, auditor training, program coverage, educational activity and supportive policy — in which opportunities exist to integrate indoor environmental health concerns into energy efficiency programs and activities in Canada. Specific recommendations are made in Section 8.4 to address these issues.

8.3.1 Program design

The online survey and key informant interviews conducted for this report and the discussions during the November 2010 Stakeholder Roundtable suggest that a majority of people working in the energy efficiency field agree that the most effective way of integrating environmental health concerns into energy efficiency activities would be through the design of government programs. The objectives, grant/rebate criteria, professional training and implementation strategies of such programs should be designed to support the integration of environmental health protection measures into home energy efficiency improvement projects. In particular, many survey respondents supported the inclusion of a broader range of indoor environmental health issues into the suite of parameters routinely addressed by auditors during site visits.

A number of stakeholders noted, in particular, the opportunity for advancing the integration of indoor environmental health and energy efficiency efforts within Ontario's new energy efficiency retrofit program for low-income housing coming online in 2011 (see Box 5).

In addition to government-sponsored energy efficiency incentive programs, the design of voluntary building standards programs are also relevant. Stakeholders noted the need to address the assumption that LEED-certified buildings are healthier than non-certified buildings. They pointed to the need for LEED and other programs outside of government to more comprehensively integrate environmental health issues into their certification process. In this context, stakeholders reiterated the need for supportive policy measures to ensure that important issues such as old lead paint are uniformly, rather than optionally, addressed.

8.3.2 Auditor training

NRCan-sponsored training has helped to create a cadre of energy efficiency auditors across the country. The research conducted for this report, however, suggests that most auditors lack sufficient expertise and training on many indoor environmental health concerns, with lead being the most surprising and significant gap.

The majority of survey respondents and other stakeholders noted their need for, and interest in, additional training to more comprehensively address indoor environmental health issues beyond those addressed under the NRCan-sponsored training of auditors or the CMHC air quality training. Without further training, they noted the unlikelihood of discussing key environmental health issues with clients. Respondents also identified the training of energy auditors as an effective way to integrate environmental health issues into energy efficiency programs.

In addition to auditors, training that would increase the knowledge and capacity of builders, renovators and other energy efficiency professionals to address environmental health concerns was also seen as desirable. Many also were in favour of youth training in this area, via apprenticeship programs and updating curriculum materials in vocational programs. To reach some of these audiences it was suggested that contact be made with vocational colleges, municipal and provincial departments that licence independent contractors, the renovation council of the Ontario Home Builders Association,

Box 5 ***Stakeholder Advice for Ontario's New Energy Efficiency Retrofit Program for Low-Income Housing***

To ensure environmental health protection measures are effectively integrated into the design and implementation of Ontario's new program for low-income housing, experts suggested the following:

- Create a full-service program that adds environmental health information and activity to the existing approach of conducting energy audits and providing energy efficiency upgrades.
- To reach low-income residents, recognize the need to work through established contacts in social service networks where trust relationships exist; prepare these agencies with adequate information to be able to provide advice and support.
- Recognize that, in order to participate, tenants may need assistance to contact and work with landlords who may be reluctant to acknowledge and address energy efficiency and/or indoor environmental health issues.
- Match subsidy programs to retrofit programs, e.g., within Ontario Works (OW). If an individual is in arrears for energy costs, when OW provides money to pay the shortfall, the OW service provider should concurrently provide information about the availability of low-income retrofit programs and/or the CMHC RRAP. Such action would recognize constraints on low-income individuals, i.e., that they can only seek coverage of energy cost arrears once a year. OW service providers need to take advantage of this timing and connect low-income individuals with programs whereby they access energy retrofit measures to improve their circumstances over the longer term.
- Introduce "pre-qualifying criteria" to avoid up-front expense of audit; include basic information about how to qualify for assistance in outreach materials.
- Add environmental health training for auditors, such as including an environmental health checklist in the audit process.
- Add training and certification for contractors and seek means of employing people in targeted communities (e.g., Winnipeg BUILD project described in Section 4.1).
- Ensure adequate ventilation is addressed by the retrofits, given that poor ventilation can contribute to excess humidity or moisture, particularly in low-income circumstances (as described in Section 5.2.1).
- Include information about lead plumbing issues in older homes and include referrals to municipal lead pipe replacement programs, where they exist.

and industry associations for home inspectors. Others noted the importance of also educating real estate agents, appraisers and lenders as part of the overall chain of participants who interact with homeowners.

The energy auditors play an extremely important role in evaluating the home or building and in determining whether indoor air quality and environmental health concerns are addressed. The training of energy auditors was identified through the on-line survey and stakeholder consultations as an effective way to integrate environmental health issues into energy efficiency programs.

The survey results and discussions at the stakeholder workshop also indicated that recognition of the health risks of lead and related training to address this problem are particularly lacking. Some noted the need for specific tools to identify lead risks and guidance on control and remediation. Many stakeholders noted that lead risks will not be addressed in training or in practice unless there are legal requirements to do so. A key informant further stated that such training and policy guidance must apply equally to any renovation activity, not just those done in the context of energy efficiency programs.

8.3.3 Program coverage of environmental health issues

As discussed in Chapter 5, the main indoor environmental health issue currently addressed by energy efficiency programs in Canada and in Ontario is air exchange; the overall objective is to ensure that tightening the building envelope for the sake of energy savings does not create or worsen indoor air quality problems. Within this focus, contaminant exposure is generally limited

Box 6 ***Stakeholder Advice for Ensuring Consistency and Quality of Auditor Services with the Phase-out of Federal Programs***

- NRCan training is trusted and credible. It needs to continue and be expanded to include more indoor environmental health issues.
- Existing NRCan-trained auditors are the best choice for helping homeowners deal with the existing or an expanded range of indoor environmental health issues; if they don't have a purpose or a program, this valuable human resource will disappear.
- There is a need to ensure that energy auditors gain additional credentials to reflect the broader scope of indoor environmental health issues on which they have been trained, and that this expanded certification be kept current.
- Any new or revised training program should be non-profit and should also be built into vocational training programs for energy auditors and contractors; certification should be above or in addition to college training.
- Greater integration of activities and information is necessary across federal departments (CMHC, NRCan, Health Canada).
- Target training to home inspectors.
- Introduce to Canada the Building Performance Institute, a US-based program that could provide accreditation for energy auditors and renovation contractors.
- The Canadian Residential Energy Services Network (CRESNET), an existing auditor association, was noted as "stagnant" but it could be revived.

to ensuring proper venting of carbon monoxide or other combustion gases from fuel-burning appliances or furnaces or as a result of chimney backdrafting. Mould may also be addressed. Most auditors have knowledge and provide advice, generally obtained from CMHC or Health Canada, about ensuring energy retrofits do not contribute to excess humidity or moisture. They may also refer homeowners to qualified professionals (or in some cases other government programs) if an existing mould problem is apparent.

The management of asbestos risk is also included in auditor training. It is standard practice that homeowners who may have vermiculite insulation or other asbestos sources be given the advice provided by Health Canada and the CMHC, i.e., to leave undisturbed asbestos alone or to otherwise hire a specialized professional.

Attention to other environmental health concerns is uneven and often lacking. Energy efficiency training programs for energy auditors do not include consideration of indoor environmental contaminant issues such as lead, PCBs, radon, VOCs, or the exposure risks to children from contaminants in ordinary house dust or the much higher levels of contaminants present in renovation dust. Survey results indicate that most auditors do not generally screen or test for environmental health-related problems unless they take the initiative themselves.

Children's exposure to lead is one of the most significant health concerns not integrated into energy efficiency programs.

Lead-based paint in an older building can become a greater health risk during any renovation when it is disturbed, particularly for the developing fetus and child. Even though public information materials produced by the federal government urge homeowners to be careful, potential exposure to lead from paint is not covered in energy auditor training, and auditors are unlikely to point it out during their audit or include it in their reports. Only 7.1% of energy professionals surveyed reported screening or testing for lead. The survey results also showed that, for 93% of the auditors and renovators/contractors who do talk about environmental health issues with their clients, lead is not high on the list. Only about one in six (16 %) identified it as an issue that they discuss with their clients.

One workshop attendee who had been in the "green" building industry for 25 years stated that he knew lead was hazardous but noted surprise and concern that he had never heard that old paint was a lead exposure risk. He also stated his intention to become much more informed and proactive on lead remediation and exposure prevention in his work.

Although literature distributed by federal and provincial energy efficiency programs alerts homeowners to the existence of lead in paint, messages about lead in paint that originate from the federal government are overly complicated, are inconsistent, and downplay the risk in some

homes (as discussed further in Section 8.3.4 below).

Stakeholders also noted that the federal government is actively reviewing the latest scientific evidence about low-level lead exposure and, like other countries, is considering lowering the blood-lead intervention level. They further noted that strong support for such federal action should be recommended in this report.

There is no information available in Canada on PCBs in caulking as a potential problem during energy efficiency renovations.

This issue is recognized in the scientific literature and is being addressed in guidance material under development by the US EPA, but is not recognized in Canadian training, educational or guidance materials. As a result, procedures around removing and replacing old caulking materials likely to contain PCBs are not considered in the audit process and no advice is given to homeowners or building managers.

Radon is another important indoor air quality issue that is often not considered under energy efficiency programs.

Just 10% of the energy professionals surveyed for this report screened or tested for radon. Auditors in certain areas where radon has previously been identified in federal surveys may recommend radon testing to homeowners. Otherwise, the evaluation of radon potential in Canadian homes is not part of energy efficiency programs.

In the US, radon testing is required in some states and municipalities prior to a home purchase, and disclosure is also required to potential buyers as to radon levels and potential concerns within the building. Both Health Canada and the CMHC recommend that all houses be tested for radon but this advice is not integrated with information about energy efficiency retrofits. As an example, it is not mentioned in *Keeping the Heat In*, the key document consulted by most auditors and homeowners.

Information is not readily available to assist homeowners and contractors/renovators in choosing safer building materials and products.

Many products used as home building materials, including insulation and caulking, contain known toxic substances, such as solvents, flame retardants and biocides. Information on the toxicity of building materials and less toxic alternatives is not always readily available, either through rating systems or on product labels. Energy efficiency programs rarely give guidance to homeowners, auditors or building professionals on the toxicity of materials that may be used for retrofits, aside from the need to follow pertinent hazard or warning labels and product use instructions. These factors make it difficult for homeowners or building contractors to identify and choose less toxic materials.

The NRCan guide, *Keeping the Heat In*, urges some caution for homeowners doing their own energy retrofit work. For example, they are advised to protect themselves from solvent fumes in caulking materials and harmful vapours from certain types of insulation by using face masks and ventilating the work area.

In addition, some delivery agents of energy efficiency programs such as GreenSaver have chosen to use insulation materials such as cellulose that are less likely to release hazardous chemicals into the building's air.[151]

Household activities that may result in higher concentrations of contaminants after a house is more tightly sealed are generally considered beyond the scope of energy efficiency programs.

Auditor training on indoor air quality issues focuses on ventilation issues with very limited or general coverage of ongoing sources of indoor air contamination. For example, if auditors identify odours from poorly stored volatile materials, they may give advice to the homeowner on how to improve the situation or refer the homeowner to a qualified professional.[152] Generally, other sources of indoor air contamination from products and materials used in the home are not addressed.

Energy audits usually involve an envelope airtightness test from which building air exchange rates are inferred. These estimates of air exchange are notably imprecise. However, it is true that a building retrofitted to be tighter will almost always have a reduced air exchange rate following the retrofit. Tight buildings, damp buildings and buildings with high occupancy will usually benefit in the heating season from the additional air provided by a mechanical ventilation system. If homeowners or building managers try to save energy by turning off the ventilation system, a build-up of contaminants from indoor sources, such as mould, VOCs or pesticides, may ensue.

The opportunity to address the needs of residents with environmental sensitivities was raised by some stakeholders as another dimension of increased integration between indoor environmental health and energy efficiency upgrades. It was suggested that CMHC should formally recognize environmental sensitivities as a disability, so that grant monies available under the Residential Rehabilitation Assistance Program could be used to address mould or

other contaminants that are debilitating for environmentally sensitive individuals.

8.3.4 Educational activity

At all stages of the energy efficiency activity, energy professionals such as auditors, delivery agents and, to a lesser extent, renovators or building contractors were viewed as potentially effective messengers for conveying environmental health information to homeowners and building managers. Auditors, in particular, were seen as being well-situated to educate homeowners and other clients and guide them towards proper prevention and remediation of environmental problems in their homes. Stakeholders also noted that local public health departments are increasingly focusing on the built environment and can be important participants in ongoing work to better integrate indoor environmental health protection into efforts to improve energy efficiency. Stakeholders also repeatedly noted the crucial role of building supply retailers in reaching contractors and the public since they are a pivotal contact point for purchasing of materials and many provide educational materials and activities about home renovations, including energy efficiency measures.

A wide range of educational materials and activities about energy efficiency and indoor environmental health issues, respectively, has been developed by federal and provincial agencies and utilities as well as non-profit organizations and retailers. Integration between education on energy efficiency and that addressing environmental health, however, has yet to be achieved.

Education for homeowners and building owners/managers was identified as a key way in which environmental health concerns could be better integrated with energy efficiency improvement efforts.

The overall knowledge of indoor environmental health issues among homeowners and building owners was regarded as quite low by survey respondents, although some respondents reported interest in such issues among their clients. Where individual homeowners do their own energy efficiency work, their knowledge of indoor environmental health concerns, the availability of relevant materials and the level of care to be taken during renovations become the critical factors in how well energy efficiency measures are implemented and how well children's health is protected.

Reading materials and homeowner courses — video, online and in-store workshops — were seen as good ways to educate homeowners about environmental health issues related to energy efficiency measures. Stakeholders further

noted that the more the public is educated, the more informed questions they will ask of energy auditors and contractors.

Stakeholders noted the challenges associated with convincing some landlords and building owners/managers to undertake energy efficiency and indoor environmental health improvements. Rather than focusing solely on potential financial savings, it was suggested that outreach efforts should emphasize the reasons for making the changes. Environmental and health benefits, in addition to financial considerations, should be addressed.

Workshop participants and key informants emphasized the need to direct education efforts to retailers in the building supply industry including training of retail staff. This sector is seen as a key player in reaching the public and contractors, particularly smaller operators and do-it-yourself homeowners. Point-of-sale information, increased training for sales personnel and on-site workshops are some of the ways in which retailers can improve public and contractor education. Many also noted a corresponding need for improved labelling of products by manufacturers.

Non-governmental organizations are also recognized by stakeholders as continuing to have an instrumental role in increasing public awareness and fostering the adoption of appropriate environmental health protection measures during home renovation projects.

Survey responses and discussions about the value of various educational tools produced mixed results. The survey results noted in Section 7.5.3 suggested that auditor training and direct hands-on activity along were favoured, along with strong support for credible online resources and general support for printed literature. Some workshop participants said "brochures, posters and slide presentations" are not effective, noting instead that personal relationships and word-of-mouth information sharing are more relevant and effective. Other stakeholders supported the

Box 7 | ***Examples of Stakeholder Advice for Education Work in Phase 2 of This Project***

Stakeholders at the November 2010 meeting and other key informants provided CPCHE/CELA with valuable advice that will inform Phase 2 outreach activities. Phase 2 will build upon and respond to the gaps and opportunities identified during the research-oriented Phase 1 of the CPCHE/CELA Healthy Retrofits Project. Following is a summary overview of suggestions made for Phase 2:

- **Lead:** Raise awareness about lead risks; fix the unclear messaging from Health Canada and CMHC to indicate that lead can be present in homes built prior to a single year (1978); provide clear guidance and training about how to prevent/mitigate lead exposure; gain policy support, otherwise nothing will happen, particularly by landlords who own older, sub-standard buildings where lead risks are most common.
- **Radon:** Raise awareness about radon risks; provide clear guidance about how to test homes and what to do if radon levels are high; note the potential benefit of increased home value and ways homeowners can demonstrate measures taken to reduce radon risks.
- **VOCs:** Raise awareness about risks; link to clear information about potential health effects (e.g., acute vs. chronic); provide clear advice on what individuals can do; include information about product choices; provide information at retail point-of-purchase; advocate for improvements to product labelling requirements.
- **Mould:** Provide information about identifying the problem and how to remediate; advocate for certification programs so that people can find and trust qualified contractors; counter the misinformation pushed by some people marketing unproven or unnecessary "solutions" that prey on people's fears.
- **Ventilation:** Emphasize the concept of the house as a system ("build tight, ventilate right"); use point-of-sale brochures, video and vocational training.
- **Builders/Renovators:** Offer more education to this key audience, especially about legacy contaminants like lead and potential current contaminants like radon; emphasize self-protection against occupational exposures and the potential for take-home exposure to their own families; note the ability to increase revenue from value-added safe renovation practices; ensure awareness of any expanded or updated content in CMHC or other trusted materials; provide information at point of licensing, municipal waste sites and through the Workplace Hazardous Materials Information System (WHMIS); educate about green/healthier product alternatives but also recognize that contractors use trusted products as means of providing a warranty on their work; use conferences, webinars, TV home renovation programs, iPhone apps (GreenBuilder in US), and other tools to reach and/or bring people together.
- **Interior Designers:** Offer more education to this key audience, especially about legacy contaminants like lead; raise awareness about the risks associated with "shabby chic" as a decorating style in old buildings since rough/unfinished surfaces of old wood, concrete or brick can be highly contaminated with old and peeling lead paint and lead-bearing dust.
- **Landlords/Residents:** Find ways to education these key audiences as they are typically unaware of the issues; interest landlords in the potential increased marketability of healthier units and the value of long-term investment, but start small by taking on one or two issues to stay manageable; add to buyer-beware information available to homeowners; encourage tenants to become educated and ask questions of landlords but recognize the power imbalance in these relationships.

use of videos as well as partnering with or at least influencing the content of the many home renovation programs on television.

Low-income people are often tenants who rarely have control over how renovations are done. They also need to obtain information from trusted sources.

Stakeholders noted that recommendations for public education efforts need to recognize that low-income tenants have limited control over renovations done in their homes and they are unlikely to receive information from landlords or may not trust that information. Consideration should be given to reaching them through, for example, local service organizations where a relationship of trust already exists.

Educational materials produced by the federal government are dispersed across multiple departmental websites; information can be hard to find on-line and some contain inconsistent information.

Survey results indicated that respondents rely heavily on federal government publications and websites including NRCan, Health Canada and CMHC. In particular, energy auditors tend to rely on CMHC and Health Canada websites for indoor environmental health issues. For energy efficiency issues, the overwhelming favourite source is the NRCan guide *Keeping the Heat In* that has been given to all homeowners participating in the federal ecoENERGY Retrofit — Homes program. However, during the research for this report, and according to key informants and stakeholders, it was apparent that the work and information products of these relevant federal agencies is not well integrated, making it difficult for homeowners, contractors and others to fully benefit from the available information.

Federal government guidance on lead downplays exposure risks, is overly complicated and is at times inconsistent.

Literature distributed by federal and provincial energy efficiency programs alerts homeowners to the existence of lead in paint. However, the messages originating from the federal government are overly complicated, inconsistent and downplay the risk in some homes. For example, in educational materials from Health Canada and the CMHC, a distinction is made between lead in paint in buildings built before 1960 and those built between 1960 and 1990. The advice notes that pre-1960 paint can contain high levels of lead but that "for homes built between 1960 and 1990, small amounts of lead may be in some of the paint used."[153,154] The same advice is given in a booklet for First Nations communities where lead is inaccurately included in a section about indoor air.[155] In NRCan's *Keeping the Heat In* document, the year 1950 is used to note lead hazards.[156]

While these materials make useful and necessary recommendations about taking precautions when working with older (pre-1960/pre-1950) paint, the risk in homes built after 1950 or 1960 is inappropriately downplayed. Clear and irrefutable scientific evidence indicates serious health risks from exposure to very low levels of lead. Until 1978, most paints sold in North America contained lead in levels up to 5,000 parts per million, levels that are known to be extremely hazardous, as is clear from the most recent regulatory action taken in the US and Canada to reduce the allowable level of lead in paint to 90 parts per million.

The Canadian approach to advice about what paint is hazardous is in contrast to the US where the advice is simply and unambiguously linked to the year 1978 when regulations were established to limit the lead content of paint to 600 parts per million. Moreover, US regulations are in place to control lead dust in housing during renovations that explicitly use the year of 1978 to address the risks to children and pregnant women from lead dust during renovations. As of April 22, 2010, the US Renovation, Repair and Painting rule requires all contractors performing work on pre-1978 homes that disturbs painted surfaces to be certified by the US EPA. Educational materials in the US are also unambiguous about using the single year of 1978 to advise the public about the risks of lead in paint.

Finally, voluntary action by industry to further reduce lead in paint in Canada was not taken until the early 1990s, Canada waited until 2005 to match the US regulation (established in 1978) of 600 parts per million of lead in paint, and both countries have further reduced the allowable level to 90 parts per million. It is thus prudent to take precautionary action with any dust arising from paint in Canadian homes.

Box 8 ***Controlling Children's Exposure to Lead Paint is Cost-Effective***

Lead paint and the related dust and chips are one of the most significant remaining legacy sources of lead exposure for children. A systematic review of multiple studies conducted in the US during the 1990s indicates low-cost, lead hazard controls produce a modest, but significant decline in the proportion of children with elevated blood lead concentrations.[157]

A more recent study done in the US on the benefits of controlling household lead and children's exposures found that every dollar invested in controlling the hazard of lead paint resulted in a return of between $17 and $221 in health benefits.[158] These benefits included increased IQ, higher lifetime earnings, tax revenue, reduced spending on special education and reduced criminal activity, amounting to a savings of $181 to $269 billion. An earlier study found that strict enforcement of housing policies to prevent childhood blood lead elevation results in cost savings through reduced medical and educational costs and increased productivity for protected children.[159]

8.3.5 Supportive policy

Across the issues addressed in the preceding four sections, a range of supportive policy measures are necessary. The various recommendations provided in Section 8.4 below assume a very broad definition of "policy." Hence, policy can include a wide range of measures extending from a decision by the federal government to update its existing educational materials and the design of government energy efficiency programs to issues that may be more typically considered as policy including the passage of laws and regulations or supporting guidance on their implementation.

Box 9 ***Stakeholder Advice for Ensuring the Risk of Lead in Older Buildings is Effectively Addressed, Via Clear Policy Measures***

- Lead in old paint, during any renovation activity, including energy efficiency retrofits, needs to be addressed via mandatory requirements akin to the approach followed in the US.
- There is no need to reinvent the wheel and Canada should use the same training, certification and lead remediation rules as used in the US.
- This issue requires mandatory training and certification programs, with inspectors to ensure work is done properly.
- Recognizing the jurisdictional authority and the need for detailed implementation to occur at the provincial level, a consistent practice must be established across the country for the adoption of lead remediation requirements.
- Lead awareness and remediation requirements should be integrated into the NRCan training program for energy auditors.
- A national education campaign (for the public and contractors) is necessary; schools and child care facilities can be used to send letters home to parents; the federal mailing list for the Child Tax Credit can also be used.
- Reach associations of interior designers and schools for interior design with this information to eliminate, in particular, the practice in older or "heritage" buildings of leaving wood, brick, cement or other previously painted surfaces in a rough, dusty or otherwise unfinished condition (the so-called "shabby chic" look).
- Focus activity on low-income circumstances in recognition of knowledge about greater risks.
- Enact a complete ban on lead in plumbing solder to prevent its misuse by do-it-yourself individuals or others who may be unaware or indifferent to the fact that the Ontario ban only applies to its use on incoming plumbing.

8.4 Recommendations

The following recommendations derive from the research and stakeholder consultation conducted for this report. The overall objective of these recommendations is to seek the integration of the two broad issue areas discussed in this report – indoor environmental health and energy efficiency retrofits - by identifying specific opportunities for improvement.

The recommendations are directed to the following diverse groups or individuals as they engage in energy efficiency issues and activities:

- government agencies, energy companies/ utilities and others responsible for the design of energy efficiency programs
- energy efficiency auditors and other energy efficiency professionals
- energy efficiency program delivery agents
- builders, contractors, renovators and interior designers, including their industry or trade associations
- educators involved in vocational training and apprenticeship programs for builders, contractors, renovators and interior designers
- retailers supplying the home building and renovation industry
- home inspectors, real estate agents and loan/ financial institutions involved in real estate transactions
- landlords, building owners and managers
- municipal public health and waste management departments
- non-governmental organizations

Design of Energy Efficiency Programs:

1. Government agencies, energy companies and others responsible for the design of energy efficiency programs should make indoor environmental health an integral part of program objectives and deliverables.

2. Program design improvements should include

    - expansion of the "whole building" or "building as a system" concept in energy audits to more comprehensively address energy, safety and environmental health concerns
    - allowance for a portion of energy efficiency program funding to be applied to health and safety hazards encountered during audits, particularly within programs designed for low-income housing.

3. The federal government should renew and expand the scope of its ecoENERGY programs by integrating the multiple indoor environmental health issues raised in this report, and developing national sectoral targets, for example, reaching a level of 15% of all Canadian homes retrofitted by 2015, including 130,000 low-income households, by investing $1.25 billion over five years, as recommended by the Green Budget Coalition.[160]

4. The Ontario Energy Board, the Ontario Power Authority, and Ontario's utilities should ensure that program design currently underway for a province-wide weatherization program for low-income families integrates the multiple indoor environmental health issues raised in this report.

Auditor Training:

5. The federal government's NRCan training module for energy efficiency auditors is a trusted resource for energy auditors that should be expanded to include the following:

    - A module explaining the greater vulnerability and exposure of children to environmental contaminants, particularly indoors, with an emphasis on indoor particulate matter and dust as primary exposure media for children. The module should emphasize the potentially dangerous exposures that can arise from renovation and retrofit activities.
    - A module explaining the potential sources, indoor exposure pathways and prevention/ control options for indoor environmental health concerns beyond those already addressed in NRCan training, including lead in paint, PCBs in old caulking, radon, and VOCs in new building materials.

Effectively Reaching Diverse Audiences:

6. A national focal point for healthy and energy efficient housing should be designated. A key role for this entity would be to integrate and make accessible to building professionals and the public all existing government information, guidance and regulations pertaining to indoor environmental health concerns as well as energy efficiency measures. The national focal point could be within a federal department (e.g., CMHC) or a designated, federally supported non-governmental entity.

7. A consolidated set of protocols, encompassing both regulations and guidance, should be developed for Canada, similar to the US EPA's draft Healthy Indoor Environment Protocols for Home Energy Upgrades.

Improved Training, Guidance and Requirements for Specific Contaminants

Lead Paint Remediation:

8. Drawing on elements of the US Renovation, Repair and Painting Rule, and in collaboration with the Provinces and Territories, mandatory requirements should be established across Canada for the training, certification and conduct of lead paint remediation activity, with these requirements applicable to all renovation activities, including but not limited to energy efficiency retrofits.

9. Diverse federal government educational materials addressing lead in paint should be reviewed and updated to provide a single and unambiguous message about the danger of lead in any paint applied prior to 1978, accompanied by educational materials about safe lead remediation practices that draw upon excellent resources already available in the US and from CMHC.

10. The federal government should immediately lower the blood-lead intervention level to recognize current scientific consensus that there is no safe level of lead exposure for fetuses and young children.

Mould Remediation:

11. CMHC should expand its Indoor Air Quality training program to provide certification for contractors so homeowners have a more reliable means of evaluating the credentials of those offering indoor air quality or mould remediation services.

Handling of Caulking Material Likely to Contain PCBs:

12. To control exposure to PCBs, Canada should issue guidance, similar to that of the US EPA, on the proper maintenance, removal, and disposal of caulking materials likely to have been installed prior to 1978.

Radon Safety:

13. Canada should integrate into energy efficiency training and programs educational outreach activities about home radon testing and corrective measures.

14. Retailers should make cost-effective radon testing kits more widely available and use Health Canada's educational materials to promote them at point of sale.

Raising Awareness and Improving Labelling Requirements for Products Containing Toxic Substances:

15. The federal government should revise the *Hazardous Products Act*, or its replacement provisions contained in the *Canada Consumer Product Safety Act*, once that law is in force, to expand the information required on product labels to include listing of substances known to be associated with chronic toxicity, including cancer and developmental and reproductive harm.

16. In addition to improved labelling, government, manufacturers and retailers all have roles to play in enabling contractors, builders and do-it-yourself homeowners/residents to make more informed choices, including choosing safer alternatives, when surface coatings, adhesives and other building/renovation materials. Point-of-sale information on product hazards, information sessions for contractors and do-it-yourselfers, and product rating schemes are among the possible measures that would support informed purchasing and use of building/renovation materials.

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