

# Energy renovations and radon

CARST Annual Conference

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Dr. Anne-Marie Nicol, MES PhD Faculty of Health Sciences

Knowledge Translation Scientist, National Collaboration for Environmental Health

Scientific Director, BC Lung Foundation- Healthy Indoor Environments Program



National Collaborating Centre  
for Environmental Health

Centre de collaboration nationale  
en santé environnementale



Canada is warming faster than many parts of the world

# 2021 heat dome linked to climate change, could become once-in-10-year event: study



By **Simon Little** • Global News  
Posted November 30, 2022 5:25 pm



It claimed hundreds of lives and now we're learning the full impact of June's heat dome. Dr. Sarah Henderson, Scientific Director of Environmental Health at the BC Centre for Disease Control explains - Sep 18 2021

**Outcomes: Death, disease, displaced citizens, decline in mental health, property damage...**

# Canadians and Canadian Cities are being significantly impacted

## Opinion: One year after Sumas Prairie flood, BC real estate still at risk

Guest Author | Nov 8 2022, 3:41 pm



A residential neighbourhood in Abbotsford backdropped by flooding and a building fire in November 2021. (Shutterstock)



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## Net-Zero Emissions by 2050

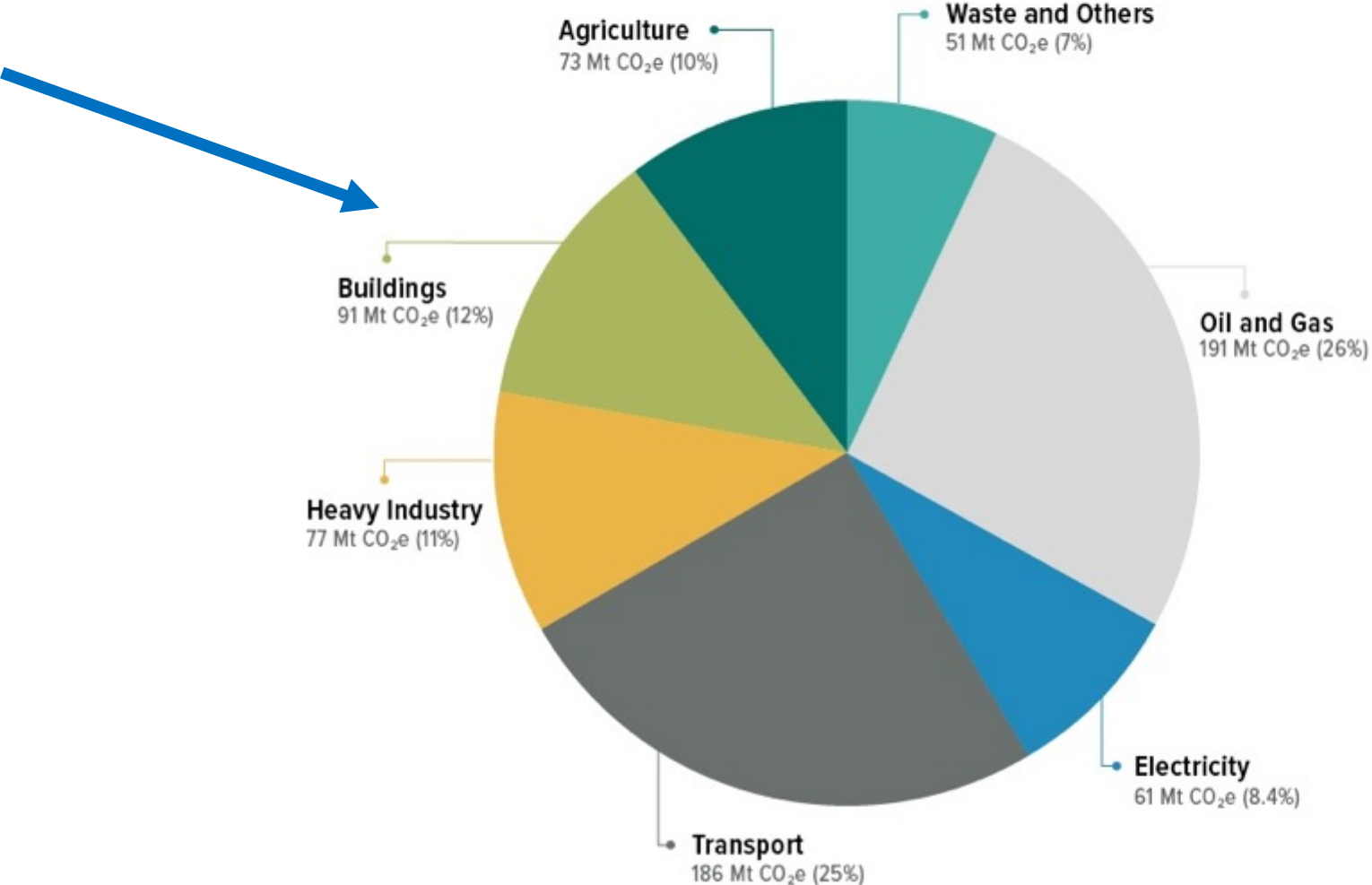


The transition to a cleaner, prosperous economy needs to be both an immediate priority and a sustained effort over the years and decades ahead. Canada must keep innovating to meet this long-term goal, strengthening and building on existing measures that fight climate change and transform the economy.

To avert the worst impacts of climate change, the Government of Canada is committed to achieving net-zero emissions by 2050.

This goal will require support and engagement from all parts of society, including provinces and territories, cities, Indigenous Peoples, youth, and businesses.

# BREAKDOWN OF CANADA'S GREENHOUSE GAS EMISSIONS BY ECONOMIC SECTOR (2019)



GHG savings from building retrofits **can be realized more quickly than GHG reductions from other sectors**, and either deliver net cost savings or are cost-effective when compared to other mitigation measures.



Regular paper |  Free to Read

## **Ambitious deep energy retrofits of buildings to accelerate the 1.5°C energy transition in Canada**

Christina E. Hoicka , Runa Das

First published: 22 June 2020 | <https://doi.org/10.1111/cag.12637> | Citations: 5



# Canada Greener Homes Grant

## Helping you save energy and make your home more comfortable

We want to help Canadians make where they live more energy efficient. The Canada Greener Homes Initiative will help homeowners save money, create new jobs across Canada for energy advisors and fight climate change.

**NOTE:** This information is for applicants residing in: Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Northwest Territories, Prince Edward Island, Saskatchewan and Yukon.

- [Ontario applicants](#)
- [Quebec applicants](#)
- [Nova Scotia applicants](#)

## Need a loan for your retrofit?

The Canada Greener Homes Loan is an interest-free loan of up to \$40,000 with a repayment term of 10 years, open to homeowners who have an active application (at the pre-retrofit stage) with the Canada Greener Homes Grant.

Learn more about how to apply for the Canada Greener Homes Loan.

## B.C.'s climate change targets

Using 2007 as the baseline, B.C. is committed to greenhouse gas (GHG) reductions of:

- 16% by 2025
- 40% by 2030
- 60% by 2040
- 80% by 2050

In March 2021, to help meet provincial GHG targets, the Province established new [2030 emission reduction targets for four sectors](#), with 2007 as a baseline:

- Transportation, 27-32%
- Industry, 38-43%
- Oil and gas, 33-38%
- Buildings and communities, 59-64%



Rebates ▾ Self-serve res

### Rebate Search Tool

Find rebates specific to your home energy project by answering a few questions.

#### ← Energy upgrades (Step 3 of 4)

Which type(s) of home energy upgrades are you interested in? (Choose one or more)

Home heating (heat pumps and more)

Hot water

Windows, doors and draftproofing

Ventilation (airflow)

Insulation

Appliances and energy kits

Wind, solar or geothermal

Show all



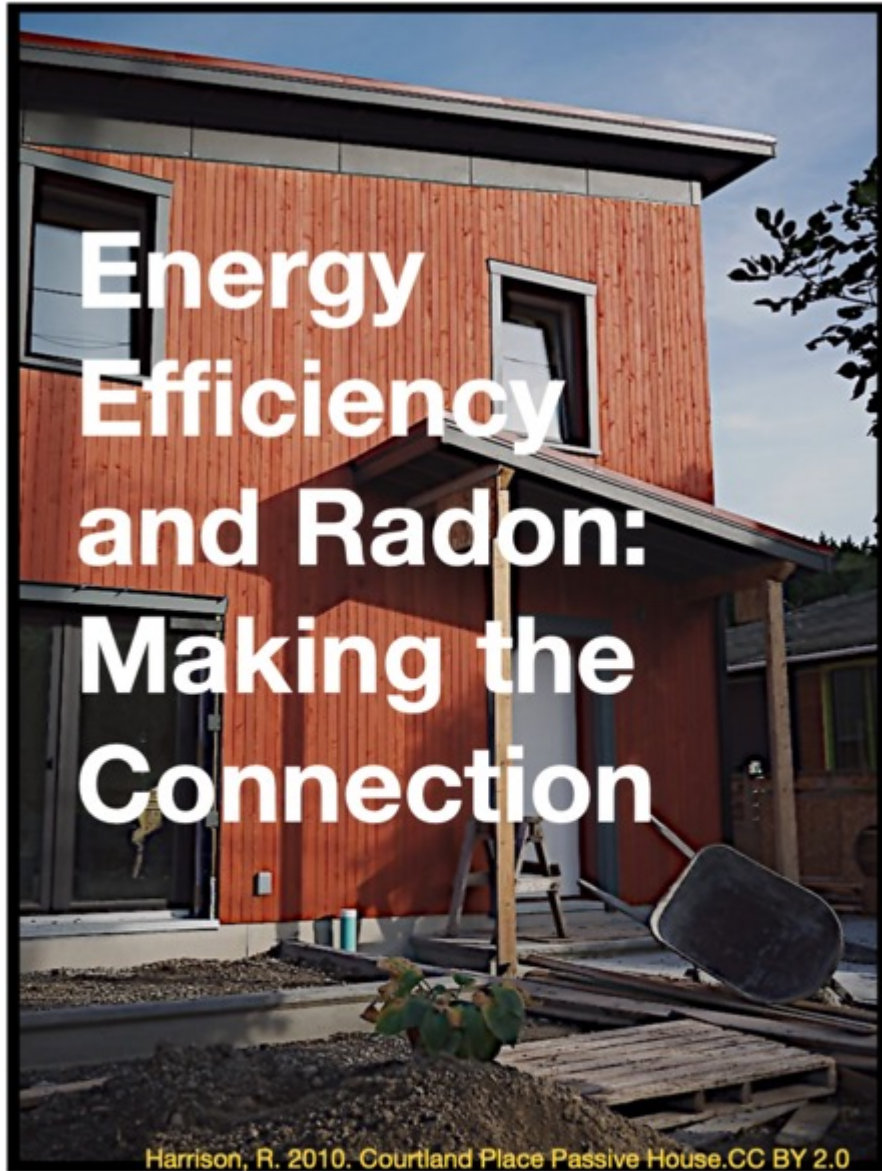


# Energy Efficiency impacts indoor air quality

BC Lung Report:

What are the impacts of  
energy retrofits on IAQ?





Harrison, R. 2010. Courtland Place Passive House. CC BY 2.0



**Lead Author:** Anne-Marie Nicol, MES, PHD. Faculty of Health Sciences, Simon Fraser University.  
Completed pro bono for the Healthy Indoor Environments Program, British Columbia Lung Foundation.

**Further contributions:**

Dr Rodrigo Mora and Abila Hours, Building Sciences Program British Columbia Institute for Technology (BCIT).

Date: October 5, 2022

To cite: Nicol, A.-M.. 2022. Energy Efficiency and Radon: Making the Connection. BC Lung Foundation.

To find project documents, visit BC Lung's website on Radon and Energy Efficiency, at <https://bclung.ca/radon-and-energy-efficiency>

**About our program.** The BC Lung Foundation's Healthy Indoor Environments program is focused on providing education, resources, and policy options for addressing priority indoor air pollutants in British Columbia. Canadians spend 90% of their day indoors, with about 70% at home and 20% at work or school. The air we breathe indoors can contain particulates, gases, allergens and fumes that can significantly affect our health in both the short and long term. Knowing the main indoor air pollutants, their sources, and how to reduce them are key to reducing harm to our health. Radon has been identified as the leading environmental carcinogen in Canada. For more information visit our website at <https://bclung.ca/programs-initiatives/healthy-indoor-environments-program>

Funding for this project was made possible by:



# Impact of reduced airflow and radon: old news

LBL-13415  
Preprint



**Lawrence Berkeley Laboratory**

UNIVERSITY OF CALIFORNIA

## ENERGY & ENVIRONMENT DIVISION

Submitted to Health Physics

**RADON CONCENTRATIONS AND INFILTRATION RATES  
MEASURED IN CONVENTIONAL AND ENERGY-EFFICIENT  
HOUSES**

A.V. Nero, M.L. Boegel, C.D. Hollowell,  
J.G. Ingersoll, and W.W. Nazaroff

September 1981

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Egert GW, Kathren RL, Cross FT, Robkin MA. The effect of home weatherization on indoor radon concentration. Battelle Press, Columbus, OH (United States); 1992 Dec 31.

### Abstract

In an effort to reduce energy consumption costs, increasing numbers of homeowners are weatherizing their homes to minimize the loss of heated and cooled air to the outside. These house-tightening measures decrease the natural infiltration rate of fresh air into the house, potentially increasing the concentration of indoor pollutants, including the radioactive gas, radon. We measured radon concentrations with track-etch detectors in 17 wooden frame homes for a period of 3 months before and after weatherization. An additional 42 homes that were not weatherized were also sampled; they constituted the control group. The measured concentrations in the weatherized homes, the control group, and in both groups combined were described by log-normal distributions. The differences between final and initial concentrations approximate both a log-normal and a normal distribution. Student's t-test and the Wilcoxon Rank Sum Test of both log-normal and normal-data distributions at the 0.05 significance level show an increase in the indoor radon concentration following home weatherization of 40% and 60%, respectively. This suggests that standard weatherization techniques may increase indoor radon levels by approximately 50%.

# What factors increase radon levels?

## Activities that seal up homes

- Double glazing
- Sealing- Weatherstripping
- Insulation

## Increasing Air tightness influences gases

### Switzerland (Meyer et al 2019, Yang et al. 2020)

- Radon levels  $\sim 2x$  in retrofitted homes ( $p < 0.05$ )
- Impacts of retrofits greater in high radon regions

### UK (Symonds 2019, Daraktchiev, 2021)-

- Double glazed windows- most impact on radon levels
- The more EE options used, the higher the radon levels
- Retrofitted homes have more measurement variation between rooms

Great Review: Fisk WJ, Singer BC, Chan WR. **Association of residential energy efficiency retrofits with indoor environmental quality, comfort, and health: A review of empirical data.** Building and Environment. 2020 Aug 1;180:107067.



# USA Weatherization Assistance Program Research

## US Department of Energy (DOE) researched Weatherization Assistance Program (WAP)

- Targeted at low-income housing
- Average energy cost reduction: \$283.00
- Support local employment

### Review of program (Pigg et al 2018)

- 514 homes across USA radon zones
- Pre- and post- weatherization measurements
- Control homes included
- Short term (7-day) radon measurements

### Results

- Small but statistically significant impact on radon levels after weatherization (avg 0.44 PiC/l)
- Greater impacts in higher radon regions



### BUILDING SHELL MEASURES

- Install insulation where needed
- Perform air sealing
- Repair/replace windows and doors
- Install window film, awnings, and solar screens
- Repair minor roof and wall leaks prior to attic or wall insulation.

[https://www.energy.gov/sites/default/files/2021/01/f82/WAP-fact-sheet\\_2021\\_0.pdf](https://www.energy.gov/sites/default/files/2021/01/f82/WAP-fact-sheet_2021_0.pdf)

ORNL/TM-2020/1769

# Building Assessment of Radon Reduction Interventions with Energy Retrofits Expansion (The BEX Study): Final Report



Approved for public release.  
Distribution is unlimited.

Paul W. Francisco  
Stacy Gloss  
Jonathan Wilson  
Yigang Sun  
Sherry L. Dixon  
Zachary Merrin  
Jill Breysse  
Ellen Tohn  
David E. Jacobs

September 2020

Article

## Association of residential energy efficiency retrofits with indoor environmental quality, comfort, and health: A review of empirical data

June 2020 · *Building and Environment* 180(4):107067

DOI:10.1016/j.buildenv.2020.107067

Authors:



William J. Fisk



Brett Craig Singer

Lawrence Berkeley National Laboratory



Wanyu R. Chan

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[Citations \(36\)](#)

[References \(67\)](#)

### Abstract

This paper reviews empirical data from evaluations of the influence of residential energy efficiency retrofits on indoor environmental quality conditions and self-reported thermal comfort and health. Data were extracted from 36 studies described in 44 papers plus two reports. Nearly all reviewed studies were performed in Europe or United States. Most studies evaluated retrofits of homes with low-income occupants. Indoor radon and formaldehyde concentrations tended to increase after retrofits that did not add whole-house mechanical ventilation. Study-average indoor concentrations of nitrogen dioxide and volatile organic compounds other than formaldehyde increased and decreased with approximately equal frequency. Average indoor temperatures during winter typically increased after retrofits, usually by less than 1.5 °C. Dampness and mold, usually based on occupant's reports, almost always decreased after retrofits. Subjectively reported thermal comfort, thermal discomfort, non-asthma respiratory symptoms, general health, and mental health nearly always improved after retrofits. For asthma symptoms, the evidence of improvement slightly outweighed the evidence of worsening. There was insufficient evidence to determine whether changes in thermal comfort and health outcomes varied depending on the type of energy efficiency retrofit. The published research has numerous limitations including a lack of data from retrofits in warm-humid climates and minimal data on changes in objective health outcomes. Suggestions for future research are provided.



**Indoor Air Quality (IAQ)**

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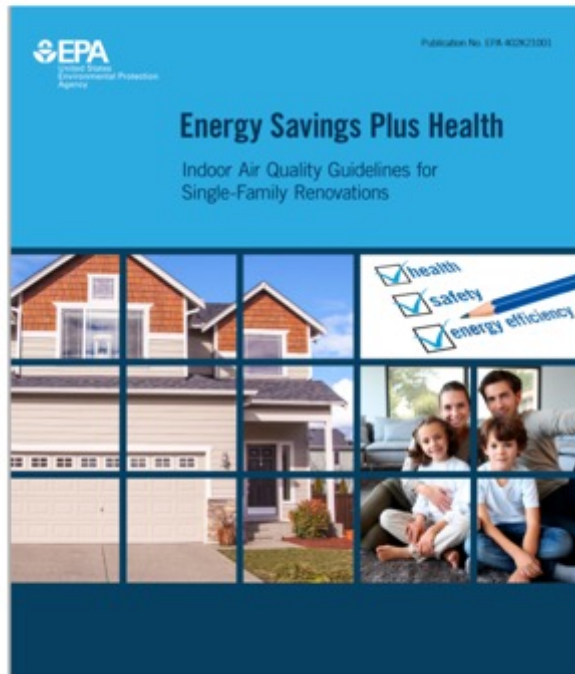
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# Energy Savings Plus Health: IAQ Guidelines for Single-Family Renovations



This page contains the EPA-developed Energy Savings Plus Health: IAQ Guidelines for Single-Family Renovations, a PDF guide that provides a set of best practices for improving indoor air quality in conjunction with energy upgrade work in homes.

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<https://www.epa.gov/indoor-air-quality-iaq/energy-savings-plus-health-iaq-guidelines-single-family-renovations>

# Take Home Messages

Decarbonizing the housing stock is underway

Many financial incentives...

IAQ impacts of tightly sealed homes needs to be considered....

It IS possible to be greener AND have better indoor air quality



**We have the opportunity to advocate for including radon testing during energy retrofits, but it needs to happen now**





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## Peer-Reviewed Canadian Radon Literature

- [A Summary of Residential Radon Surveys and the Influence of Housing Characteristics on Indoor Radon Levels in Canada. Health Physics \(Chen, Sept 2021\)](#)  
This **article**, based on more than 21,000 radon measurements taken in Canada, found that having a basement more than doubled the average radon exposure indoors. Homes with private wells also tended to have higher radon levels.
- [Regional cost effectiveness analyses for increasing radon protection strategies in housing in Canada. Journal of Environmental Radioactivity. \(Gaskin et al, Dec 2021\)](#)  
This **article** provides compelling evidence in support of building code changes that prevent radon ingress in new homes. This work also found that efforts to remediate older homes was cost effective in higher radon regions across the country.
- [Contribution of Childhood Indoor Radon Exposure to Lung Cancer Incidence among Young Adults: A Population-Based Ecological Study in Canada. Radiation environment and medicine \(Chen et al, Feb 2021\)](#)  
This **article** suggests that cumulative exposure to radon during childhood may be a leading cause of lung cancer in young adults and later in life.
- [Younger North Americans are exposed to more radon gas due to occupancy biases within the residential built environment. Scientific reports \(Simms et al, Mar 2021\)](#)  
This **article** found that younger people who live in newer homes were receiving higher doses of radiation from radon gas. This exposure scenario is likely to lead to a greater future burden of lung cancer due to radon exposure.
- [A comparison of consumer-grade electronic radon monitors. Journal of Radiological Protection \(Warkentin et al, May 2020\)](#)  
This **study** examined the accuracy and precision of consumer grade electronic radon detectors available in Canada
- [A comparative study of radon levels in Federal buildings and residential homes in Canada \(Whyte et al, 2019\)](#)  
This **study** provides information about the Canadian government's radon testing program in federal workplaces. The results are compared to residential radon results from other federal research initiatives.
- [Radon exposure is rising steadily within the modern North American residential environment, and is increasingly uniform across seasons \(Stanley et al, 2019\)](#)  
This **study** of Canadian homes illustrates how housing characteristics can impact radon levels and examines radon variability.
- [Indoor Radon in Microgeological Setting of an Indigenous Community in Canada \(Sarkar et al, 2017\).](#)  
This **paper** explores radon measurements in an Inuit community in Labrador.

<https://ncceh.ca/environmental-health-in-canada/health-agency-projects/radon>

Have Ideas?

Want to be involved?

anicol@sfu.ca



### Radon and Energy Efficiency



Energy efficiency upgrades to homes and workplaces can make radon levels worse. Efficiency improvements are a key plank in addressing climate change, but we want to make sure lung health is protected. Our research analyzes the problem and offers solutions.

Our scientific advisor, Dr. Anne-Marie Nicol, has an in-depth blog post on balancing energy retrofits and indoor air quality. [See the post here.](#)

#### Health & Air Quality

[Annual BC State of the Air Report](#)

[Healthy Indoor Environments Program](#)

[Radon and Lung Health](#)

[Wildfire Smoke and Lung Health](#)

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