reThink green
Low Carbon Retrofit Project

Green Buildings in Greater Sudbury

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Date: 31 March 2021

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Introduction

This report is a companion document for the preliminary feasibility study for reThink Green's Low Carbon Retrofit Project. It provides an overview of types of green buildings, the benefits they provided, and the need for Greater Sudbury to adopt more sustainable building practices.

Additionally, highlights from ASHRAE's design guide for Achieving Zero Energy buildings are included at the end of the report to provide readers with a general understanding of strategies to keep in mind when working on low carbon building projects.

Defining Green Buildings

The World Green Building Council defines a **'green' building** as, "a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts on our climate and nature environment."[1]

Specific types of green buildings include:

Low Carbon Buildings (LBCs) - buildings designed with the intention of reducing greenhouse gas emissions.

Net Zero Energy Buildings (NZEBs) - buildings that produce as much energy on site as they consume each year.[2]

Zero Carbon Buildings (ZCBs) - buildings that demonstrate a zero-carbon balance in their operations.[3]

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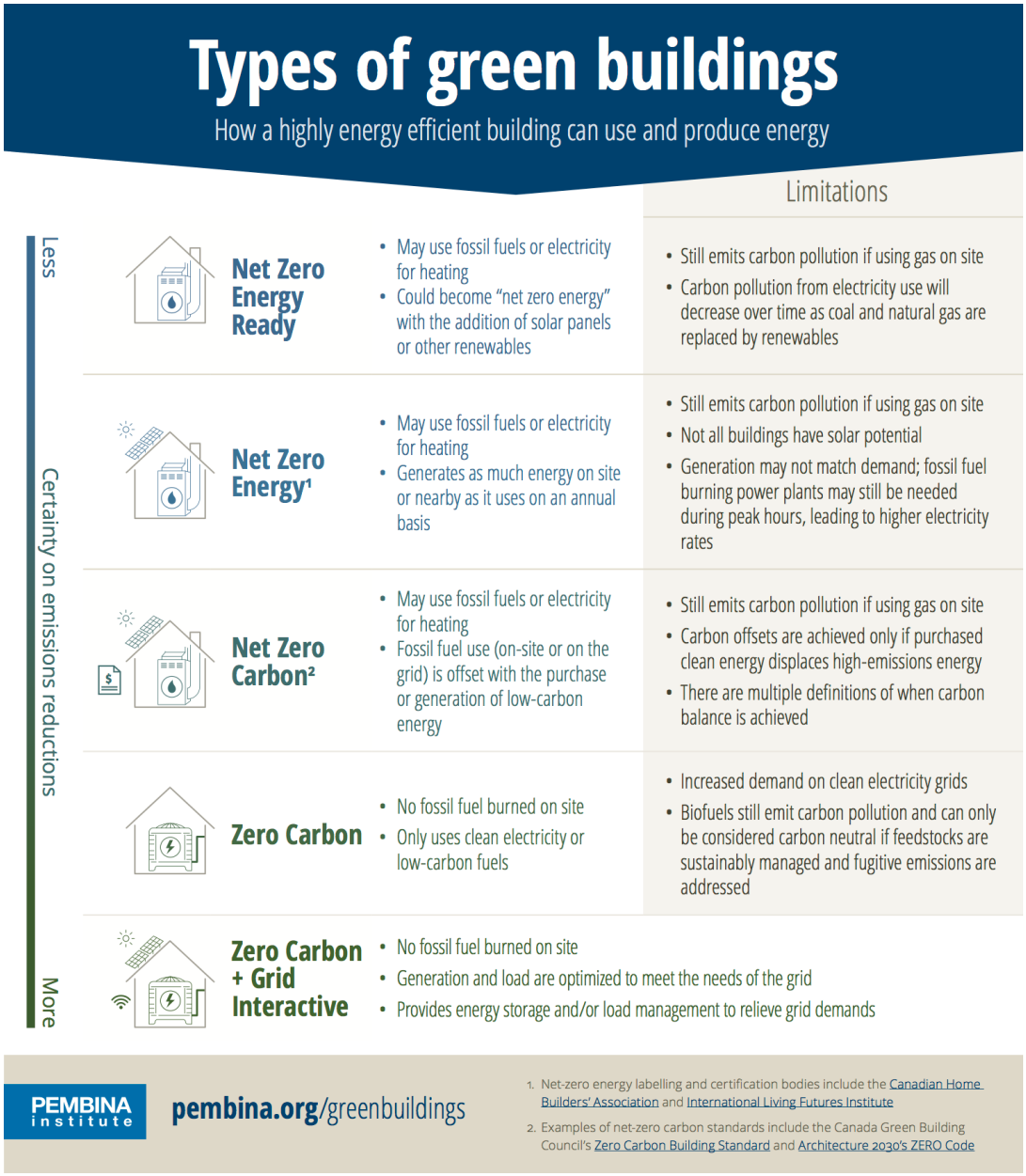
[1] World Green Building Council, About Green Building, https://www.worldgbc.org/what-green-building

[2] The exact definition of this term varies, usually in terms of whether it is refers to site or source, For further information see: https://www.wbdg.org/resources/net-zero-energy-buildings energy.

[3] Canada Green Building Council, Making the Case for Zero Carbon Buildings, February, 2019. pg.6.

This infographic prepared by the Pembina Institute provides a useful illustration on the difference between net zero energy and zero carbon buildings.[4]



[4] This infographic is available for download at https://www.pembina.org/pub/green-buildings-infographic

The Benefits of Green Buildings

This section provides an overview of the numerous benefits of green buildings.

Environment

1. Reduced GHG Emissions & Electricity Use

Through passive design strategies, energy efficient appliances, and the use of renewable technology GHG emissions and electricity use can be reduced.

2. Promotion of Responsible Material Use

When combined, infrastructure and construction account for approximately 50% of global usage of virgin materials.[5] Frameworks and certification standards that encourage material reuse, waste diversion, and closing resource loops, help to reduce the amount material extracted from the earth and the associated emissions.

3. Greater resiliency during emergencies

Green buildings designed with resiliency in mind demonstrate a higher degree of passive survivability. **Passive survivability** is the ability of a building to provide critical life-support conditions in the event of extended loss of power, heating fuel or water.[6]

Health and Happiness

4. Improved Occupant Comfort

Energy efficient buildings, like Passive House, are designed to maintain a comfortable indoor temperature, improving occupant thermal comfort by avoiding the problem of "hot spots" or "cold spots" within the building.

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[5] Global Alliance for Building and Construction, "2020 Global Status Report For Buildings and Construction: Towards a zero-emissions, efficient and resilient building and construction sector." 2020. pg.48. https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf

[6] Wilson, Alex, Building Green, "Passive Survivability" https://www.buildinggreen.com/op-ed/passive-survivability

5. Access to nature

Many green building standards and certifications attempt to introduce access to nature through requirements for daylight, views, plants, natural features, or the inclusion of outdoor space.

6. Increased Cognitive Functioning

Research has shown that workers in well ventilated areas have demonstrated increased cognitive functioning.[7]

7. Healthier Air Quality

Sustainable buildings aim to promote healthier air quality by implementing measures to reduce the amount of air pollutants that enter the building, avoiding the use of materials that contain harmful substances, advocating for effective ventilation, and encouraging a safe cleaning protocol.[8]

8. Better sleep

Green buildings often include provisions to ensure occupants have access to adequate daylighting and views. The American Academy of Sleep Medicine found that people who have windows in their office slept an average of 46 minutes more per night.[9]

Economy

9. Lower utility costs

By reducing energy demand and/or producing energy on site the amount of utilities a building is required to pay is minimized. Natural Resource Canada states that buildings that undergo deep environmental retrofits can save up to 60% in energy costs.[10]

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[7]Harvard T.H. Chan School of Public Health / Syracuse University Center of Excellence / SUNY Upstate Medical School, 2015. Cited on World Green Building Council, "About Green Building." https://www.worldgbc.org/benefits-green-buildings

[8] World Green Building Council, "Clean Air Building." https://worldgbc.org/clean-air-buildings

[9] American Academy of Sleep Medicine, 2013. Cited on World Green Building Council, "About Green Building." https://www.worldgbc.org/benefits-green-buildings

[10]Natural Resources Canada, "Retrofitting." https://www.nrcan.gc.ca/retrofitting/20707

10. Reduced absenteeism

A side effect of improved occupant health, green buildings are said to reduce rates of absenteeism and the rate of sick days.[11]

11. Increased Productivity

Better indoor air quality can also lead to performance improvements, reportedly of up to 8 percent. [12]

12. Asset Value

In some markets, green buildings may be able to charge a rent premium or maintain a higher resale value.[13]

13. Job Creation

According to the Delphi Group and the Canadian Green Building Council, in 2014 Canada's green building industry generated $23.45 billion in GDP and represented nearly 300,000 full-time jobs.[14] From a global perspective, the International Finance Corporation expects green buildings to be one of the largest investment opportunities of the next decade, valuing it at $24.7 trillion by 2030.[15]

14. Reduced demand on municipal infrastructure

Green building projects can reduce demand for municipal water supply, storm water management, sewage treatment, and solid waste management.[16]

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[11] Green Building Council Australia, "Why working a green building." https://www.gbca.org.au/green-star/why-work-in-a-green-building/

[12] Park and Yoon, 2011. Cited on World Green Building Council, "Clean Air Building." https://worldgbc.org/clean-air-buildings

[13] World Green Building Council, "The Business Case for Green Building: A Review of the Costs and Benefits for Developers, Investors, and Occupants." https://www.worldgbc.org/news-media/business-case-green-building-review-costs-and-benefits-developers-investors-and-occupants

[14] Canada Green Building Council / The Delphi Group, 2016.

[15] Global Alliance for Building and Construction, "2020 Global Status Report For Buildings and Construction: Towards a zero-emissions, efficient and resilient building and construction sector." 2020. pg.7. https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf

[16] City of Burlington, Staff report on Corporate Sustainable Building Policy, 2010. https://www.burlington.ca/en/live-and-play/resources/Environment/Corporate_Sustainable_Building_Report.pdf

Buildings and Climate Change

Across the globe, buildings have been identified as a leading cause of carbon emissions with nearly 40% of total global energy-related CO_2 emissions coming from the construction and operation of buildings.[17]

Within Canada, the energy used to heat and cool buildings, and the emissions from producing that energy, account for 17% of total emissions. The third highest sector in terms of emissions, following industry and transportation.[18]

Likewise, here in Sudbury, the Community Energy and Emissions Plan, released in the last quarter of 2020, identified buildings and transportation as the top contributors of local emissions at 22% and 43% respectively.[19]

What these numbers show is that building related emissions are a significant issue at a global, national, and local level.

They also represent one of the largest opportunities for positive change.

By taking measures to reduce the embodied and operational carbon of buildings, communities like Greater Sudbury can significantly reduce their total emissions. Indeed doing so will be necessary in order to meet community, national, and global reduction targets.

Fortunately, many of the tools and techniques we will need to get buildings to net-zero carbon emissions already exists and are available on the market.

What's needed is action.

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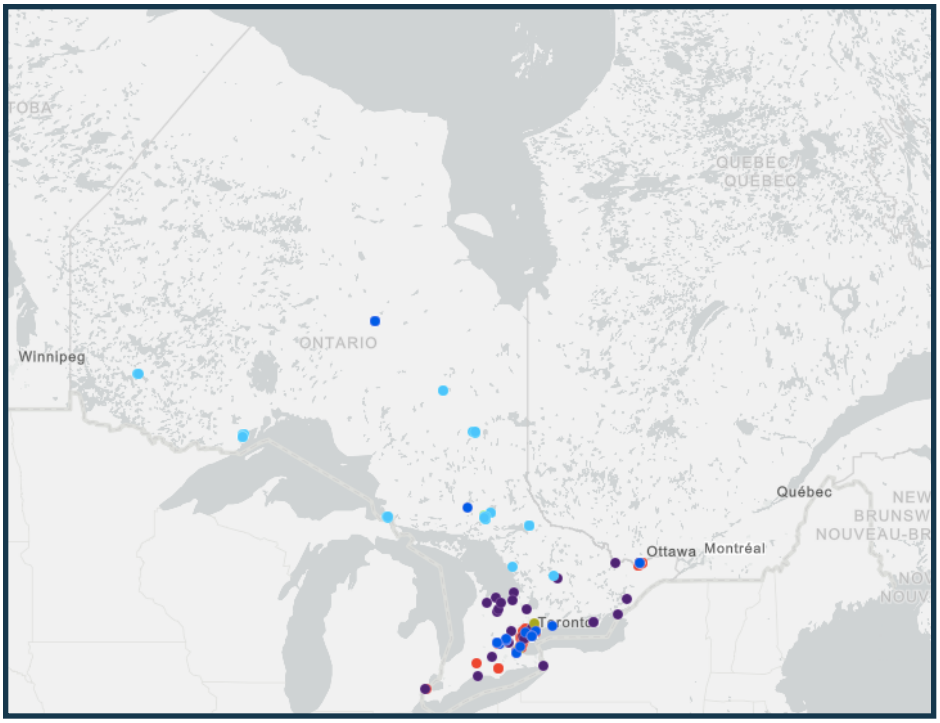
[17] Global Alliance for Buildings and Construction, 2020 Global Status Report for Buildings and Construction: Towards a zero-emissions, efficient and resilient buildings and construction sector. 2020 pg. 4. https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf

[18] Based off 2014 emission data. Government of Canada, "Pan-Canadian Framework on Clean Growth and Climate Change: Canada's Plan to Address Climate Change and Grow the Economy." 2016. pg. 14, https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html

[19] City of Greater Sudbury, "Community Energy and Emissions Plan." 2020. pg. 23, https://www.greatersudbury.ca/sudburyen/assets/File/Comms/FINAL%20Greater%20Sudbury%20CEEP.pdf

The Existing Context of Green Buildings in Northern Ontario

Though necessary to reduce our environmental impact and a key component of increasing community resiliency, green building projects remain an anomaly in northern Ontario. In fact, in our review of six well known green building standards, we were able to identify only 43 buildings in all of northern Ontario that have achieved certification.[20]



Click here to view an interactive map of green buildings in northern Ontario.

Those 43 buildings represent 1.65% of the total 2,606 projects in Ontario that have achieved certification from one of the following six standards: LEED, Zero Carbon Building, Passive House, Living Building Challenge, BOMA Best, and Energy Star.[21]

[20] For the purpose of this analysis, northern Ontario was defined as the districts of Algoma, Cochrane, Kenora, Manitoulin, Nipissing, Parry Sound, Rainy River, Sudbury (including the City of Greater Sudbury), Thunder bay, and Timiskaming.

[21] To arrive at this number we combined data from the Canadian Green Building Council Database (which covers Zero Carbon and LEED buildings), the Passive House Canada Project Database, the Living Building Challenge Case Studies database, the BOMA Canada Certified Project List and the National Resource Canada Registry of ENERGY STAR certified buildings. Further details regarding methodology are describe in the Green Building Master list excel file included in the appendix.

Number of Certified Green Buildings

Certification Standard	Ontario	Northern Ontario
LEED	1,407	37
Zero Carbon Building (ZCB)	10	0
Living Building Challenge (LBC)	2	0
BOMA Best	1,071	6
ENERGY STAR	114	0
Passive House	2	0
TOTAL	2,606	43

Only 11 (0.42%) of the 2,606 projects are located in Greater Sudbury, none of which are a commercial office building in which reThink Green could occupy space.

This means that for reThink Green, or any other business or organization that rents office space in Greater Sudbury, there is currently no opportunity to rent space in a certified green building.

Despite the apparent lack of supply, the 2018 report, **Building a Low-Carbon Future for Sudbury and Manitoulin**, prepared by reThink Green and Workforce Planning for Sudbury and Manitoulin, found that the skills exist, albeit in limited supply, for those who want and can afford to build a low carbon building in Sudbury.

Nonetheless, the report also notes that there are significant gaps in the locally available skills and training programs required for green buildings operations and energy management. As low carbon building becomes an environmental and regulatory necessity, Greater Sudbury will need to take steps in order to ensure that the workforce is equipped with the necessary skills. Failure to do so could result in mistakes during construction leading to higher costs and lower emission reductions.

Certified Green Buildings in Greater Sudbury

Building Name	Address	Certification Year	Certification Level	Certification Standard	Project Size	Project Type
Nickel Rim South Mine Administration Building	3259 Skead Road	2010	Gold	LEED Canada for New Construction and Major Renovations	5,500	Mixed-use
Xstrata Nickel Sustainable Energy Centre	1400 Barrydowne Road	2012	Gold	LEED Canada for New Construction and Major Renovations	2,145	Lecture Hall / Classroom
Target - T3677: Sudbury	1485 LaSalle Blvd	2013	Certified	LEED BD+C: Retail	11,543	Retail
The Ben Avery Active Living Centre	Ben Avery Physical Education Building, 935 Ramsey Lake Road	2013	Certified	LEED Canada for New Construction and Major Renovations	4,647	Sports Facility
Vale Living with Lakes Centre	935 Ramsey Lake Road	2014	Platinum	LEED Canada for New Construction and Major Renovations	2,720	Laboratory
The Lodge Home Areas for Residents with Dementia	960 Notre Dame Avenue	2014	Silver	LEED Canada for New Construction and Major Renovations	5,232	Nursing home/ Extended care facility
Confidential Project		2017	Silver	LEED Canada for New Construction and Major Renovations	3,745	Public Safety (firehall, police station)
Taxation Data Centre	1050 Notre Dame Ave.	2018	Gold	BOMA Best		
New Sudbury Centre	1349 Lasalle Blvd	2018	Gold	BOMA Best		
Sudbury FFMC Building	6150 Skyline Drive	2018	Silver	LEED Canada for Commercial Interiors	3,234	Public Safety (firehall, police station)
Government of Canada Building	19 Lisgar St.	2019	Gold	BOMA Best		

Decarbonizing Greater Sudbury's Built Environment

In order to achieve the ambitions of Greater Sudbury's Community Energy and Emissions Plan (CEEP), the community will need to see the number of low carbon buildings increase dramatically in the coming decades.

Goals 2, 3, and 4 of the CEEP pertain to efficient buildings:

Goal 2: Periodically increase the energy efficiency of new buildings until all new buildings in 2030 onward are Passive House energy efficiency compliant.

Goal 3: The existing building stock is retrofit for 50% increased energy efficiency by 2040 and large buildings are routinely recommissioned.

Goal 4: Achieve net-zero emissions in City buildings by 2040.

To accomplish these goals, Greater Sudbury will need to address the specific challenges of the local community, including:

- Perceived (or real) lack of consumer demand for green buildings
- High construction costs
- Material and labor shortages
- A cold climate

Addressing these challenges will likely require a mix of incentives, regulations, training programs, and infrastructure upgrades. More importantly, there will have to be a commitment to equity and resiliency.

What is the Community Energy and Emissions Plan?

Adopted in 2020, the CEEP is a community mitigation plan designed to work in parallel with the City's climate change adaptation planning efforts. It outlines 18 goals which, if achieved, will enable Greater Sudbury to achieve net zero greenhouse gas emission by 2050. The 18 goals are divided into 8 strategy sectors, the second of which is Efficient Buildings.

What does it say about buildings?

Like many Canadian cities, transportation and the residential sector are the largest users of energy. Thus, greater efficiency in these areas, particular residential buildings, represent the largest opportunities for reducing emissions.

Within the building sector specifically, space and water heating are the largest culprits. Primarily using natural gas, they account for 65% of Greater Sudbury's 2016 building emissions.

With Sudbury's annual temperature expected to continue to rise, alongside increasing precipitation, it is expected that the number of heating days will decrease, lowering heating related emissions, but potentially increasing the the space cooling emissions as cooling days rise.

To reduce the emissions associated with buildings the City is promoting a Reduce-Improve-Switch paradigm:

Reduce: Build efficient and low-carbon new buildings

Improve: Upgrade to energy efficient light systems. Perform energy retrofits for existing buildings.

Switch: Source energy from renewable sources.

COVID Recovery and Building Back Better

The pandemic has had a devastating impact on local and small business, especially in Greater Sudbury's downtown. The business and the individuals who have lost their livelihoods as a result of the pandemic, will need help to regain their strength.

As in the past, it is likely that governments will turn to the construction industry to help restart the economy. This is because the construction industry's connections to local value chains serves as an effective channel for injecting money back into the economy. For instance, estimates predict that for every million dollars invested in building retrofits or efficiency measures between 9 and 30 jobs would be created in manufacturing and construction.[22]

While we "build back better" we will need to remember that climate change also disproportionally affects the health and financial stability of the must vulnerable members of our society. As the City of Greater Sudbury works on lowering emissions and mitigating the effects of climate change, attention must be given to ensuring all buildings are retrofitted, including those of the community's most vulnerable members.

> "Beyond improving individual buildings, coordination among the private sector, the government, and the public is crucial to align business priorities and the government's socioeconomic goals. **Hardening one property to survive the effects of a storm means little if public transit fails and neighbouring businesses are flooded – the district as a whole remains vulnerable.** If all stakeholders incorporate climate resilience into their collective game plans, cities will experience transformative progress that can be sustained over time."
>
> Building Climate Resilience in Cities Worldwide, Urban Land Institute and Centre for Liveable Cities, 2020, pg. 26.

[22] Global Alliance for Buildings and Construction, 2020 Global Status Report for Buildings and Construction: Towards a zero-emissions, efficient and resilient buildings and construction sector. 2020 pg. 26. https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf

Certification Standards

Alongside building codes, certification standards can be a helpful tool for improving the sustainability of buildings. While it is certainly possible to build a highly sustainable building without pursing certification, standards provide guidance to developers and contractors on how to reduce the building's environmental impact and signal to the public that the building should be performing at a certain level of sustainability. The achievement of certification, also lends credibility to a project and allows it to stand apart from other buildings.

That said, each certification standard has its own unique set of requirements and process for measuring and scoring building performance. They also take on different focuses, many prioritizing energy efficiency above all else, but others focusing on health or taking a most holistic approach to sustainability.

Themes addressed by various certification standards:

- Energy Efficiency
- Air Quality
- Water Use
- Food/Nourishment
- Light
- Movement
- Thermal Comfort
- Sound
- Healthy Materials
- Mind/Health
- Community/Equity
- Innovations
- Resilience
- Location / Habitat
- Access to Nature
- Beauty

The variety of standards, coupled with different degrees of stringency, makes understanding each one, and determining the validity of the standard's sustainability claims, an onerous task for members of the public. Without a basic level of understanding and trust in a certification standard, the ability for it to serve as a market signal may be compromised.

Certification standards have also received criticism for awarding certifications based off design (how the building should function) not performance (how the building actually functions). To address this, many standards are now requiring buildings to monitor their performance for a 12-month period before awarding

Moving forward, real time monitoring and transparent reporting of building data are likely to play an increasingly important role in establishing the credibility of a project's sustainability achievements.

Certification is thus only the beginning of a project's sustainability journey. Constant monitoring and maintenance will be needed to ensure the building's systems continue to perform optimally. As well, occupants will need to be educated on the functioning of the building and how their actions are influencing the building's performance.

Well Known Certification Standards Related to Green Buildings:

Zero Carbon Building Standard
"With ZCB Standard v2, focus is on the carbon balance of a building across its life-cycle, including construction and operation. It is applicable to all buildings except homes and small multi-family residential buildings." - Canada Green Building Council

FitWel
"Fitwel is the world's leading certification system committed to building health for all. Generated by expert analysis of 5,600+ academic research studies, Fitwel is implementing a vision for a healthier future where all buildings and communities are enhanced to strengthen health and well being." - Fitwel

Passive House
"Passive House (Passivhaus) buildings consume up to 90 percent less heating and cooling than conventional buildings. Applicable to almost any building type or design, the Passive House high-performance building standard is the only internationally recognized, proven, science-based energy standards in construction. Certification ensures that designers and consultants are expertly qualified to design buildings to meet the standard." - Passive House Canada

WELL
"The WELL Building Standard is a vehicle for buildings and organizations to deliver more thoughtful and intentional spaces that enhance human health and well-being. Backed by the latest scientific research, WELL includes strategies that aim to advance health by setting performance standards for design interventions, operational protocols and policies and a commitment to fostering a culture of health and wellness." - WELL

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Living Building Challenge
"The Living Building Challenge is a philosophy, certification, and advocacy tool for projects to move beyond merely being less bad and to become truly regenerative. - Living Future Institute

LEED
"LEED, or Leadership in Energy and Environmental Design, is the most widely-used green building rating system in the world, available for virtually all building, community, and home-project types." Canada Green Building Council

ENERGY STAR
ENERGY STAR is a certification for energy efficiency buildings. "It's import to rely on proven methods to ensure that buildings are designed for top energy efficiency and that they actually perform as intended once they're operational. That's why ENERGY STAR complements top green building certification systems such as LEED and Green Globes." - ENERGY STAR

BOMA BEST
"With more than 7,000 buildings obtaining certification or recertification since its inception in 2005, BOMA BEST is Canada's largest environmental assessment and certification program for existing buildings. It is a unique voluntary program designed by industry for industry; it provides owners and managers with a consistent framework for assessing the environmental performance and management of existing buildings of all sizes. - BOMA Canada

Choosing a Certification Standard

Which certification standard a project pursues will depend on several factors, including the:

- Organization's understanding of sustainability and desired sustainability targets
- End-use of the building
- Financial and technical resources
- Supply of labour and materials
- Local building codes and planning context
- Site and climate conditions

Regardless of which standard is selected, attention needs to be given to the building's energy efficiency and life-cycle carbon emissions in order to effectively address climate change.

As previously mentioned, we were able to identified 11 buildings in Greater Sudbury that have achieved a green building certification.[23] Three achieved certification through the BOMA BEST program and the remainder through LEED.

Significantly, Goal 2 of the Community Energy and Emissions Plan specifically identifies Passive House as the baseline for 2030 onwards.

Goal 2: Periodically increase the energy efficiency of new buildings until all new buildings in 2030 onward are Passive House energy efficiency compliant.

Passive House buildings emphasize energy efficiency, thermal comfort and affordability. In Central Europe, where the method become popular, they have demonstrated space heating and cooling related energy savings of up to 90% compared with typical building stock and over 75% compared to average new builds.[24]

> "A **Passive House** is a building, for which thermal comfort (ISO 7730) can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions – without the need for additional recirculation of air."
>
> - PassivHaus Institut

[23] Please note, it is possible that there are certified buildings that we were unable to identify or that have achieved certification through a standard we did not collect data for. Additionally, there may sustainable or energy efficient buildings that choose not to go through any certification process.

[24] Passive House Institute. https://passiv.de/en/02_informations/01_whatisapassivehouse/01_whatisapassivehouse.htm

The construction method is based five basic principles:

1) Passive House Windows
2) Thermal Insulation
3) Airtightness
4) Thermal Bridge Free Design
5) Ventilation with Heat Recovery

Built with super insulation and a tight building envelope, Passive House buildings use ventilation systems to supply the building with fresh air from outdoors and simultaneously use this air as a source of heating. This is only possible with buildings with sufficient insulation. (You can explore Passive House in detail here.)

Passive House buildings reduced energy needs also mean that they will require less renewable energy (e.g. solar panels) in order to become net zero energy buildings.

However, in colder climates like Greater Sudbury, achieving the necessary level of insulation to maintain a comfortable temperature during the winter months can be challenging and requires technical know-how and experience.

As this is the standard the city has identified in the Community Energy and Emissions Plan, it presents as a logical chose of certification standard for projects in the community. Achieving Passive House Certification would support the objectives of the CEEP and help to building community understanding and knowledge of Passive House standards.

The Cost of Certification

Certification standards generally require payment in order to register and certify a project and come with a construction premium. The premium will depending on the type of certification being pursued, the experience level of the project team, the length of the lifecycle period being considered, as well as the building size, shape, location, and use.

For example, in the Canada Green Build Council's 2019 report, Making the Case for Zero Carbon Buildings, they identified the cost premium for zero carbon buildings as 8% over a twenty-five year lifecycle.[25]

Cost premiums generally decline as companies gain experience and the price of the necessary technology decreases. The Pan-Canadian Frame on Clean Growth and Climate Change found that the costs of construction for a net zero energy building have dropped by 40% in the past decade.[26]

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[25] Canada Green Building Council, Making the Case for Zero Carbon Buildings, February, 2019. pg.6.

[26]Government of Canada, "Pan-Canadian Framework on Clean Growth and Climate Change: Canada's Plan to Address Climate Change and Grow the Economy." 2016. pg. 15, https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html

Deep Environmental Retrofits

In addition to ensuring that all new buildings are built according to low carbon standards, reducing greenhouse gas emissions will require retrofitting the existing building stock for increased energy efficiency. Retrofits play important role in reducing emissions for two main reasons: embodied carbon and long-life spans.

Embodied Carbon

Historically, building standards focused on reducing the amount of energy used while the building was in operation. For example, from lights, heating systems, and plug loads. However, these emissions represent only a portion of a building's life-cycle emissions.

Prior to being an operational building, materials first had to be extracted from the earth, processed, manufactured, transported and installed at the building site - contributing to global emissions along the way. Embodied carbon measures the emissions from throughout this supply chain process. Together with operational carbon it informs a deeper understanding of a building's environmental impact.[27]

Retrofitting an existing building instead of building a new one helps to minimize a project's embodied carbon by reducing the need for virgin materials, avoiding the development of a greenfield site and preventing the unnecessary waste or down-cycling of materials.[28]

Long Life-spans

Unlike other products that are discarded after a single use, buildings are used for several decades. **As a result, more than 75% of Canada's 2030 building stock will be**

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[27] Depending on the boundary considered during the life-cycle analysis, the embodied carbon may be calculated differently, e.g. from cradle to site (extraction to use) or cradle to grave (extraction to end-of-life). Measuring embodied carbon can be a difficult tasks but new resources are available to assist with this process, for an example see: https://www.mckinsey.com/business-functions/operations/our-insights/data-to-the-rescue-embodied-carbon-in-buildings-and-the-urgency-of-now#

[28] As the 2020 Global Status Report on Buildings and Construction highlighted, buildings and infrastructure use approximately 50% of resources extracted globally and result in an enormous amount of waste. For instance, 25-30% of the waste generated in the European Union comes from construction and demolition. pg 48 https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf

be composed of buildings that already exist today.[29] If these building are not retrofitted for increased energy efficiency, they will continue to be a source of greenhouse gas emissions in the future.[30]

Retrofits

Retrofits can encompass a variety of energy reduction measures and are typically categorized as minor, major, and deep retrofits.

In order to achieve Goal 3 of the CEEP the existing building stock in Greater Sudbury will need to undergo deep energy retrofits..

Goal 3: The existing building stock is retrofit for 50% increase energy efficiency by 2040 and large buildings are routinely recommissioned.

According to Natural Resource Canada, deep building retrofits have energy saving of 40% or more[31] and may include measures such as[32]:

- reconfiguring the interior
- replacing the roof
- adding or rearranging windows for increased daylight
- Replacing the heating, ventilation and air-conditioning system with a renewable technology like a ground-source heat pump

As a result of greater efficiency, deep retrofits can save you up to 60% of your energy costs.[33]

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[29] Government of Canada, "Pan-Canadian Framework on Clean Growth and Climate Change: Canada's Plan to Address Climate Change and Grow the Economy." 2016. pg. 15, https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html

[30] Much of the focus of retrofits centres on energy efficiency but using less water and being able to filter water onsite is also an important consideration to keep in mind.

[31] Natural Resource Canada, "Major Energy Retrofit Guidelines for Commercial and Institutional Builings." 2016. pg. 1 https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oee/buildings/pdf/RetrofitGuidelines-e.pdf

[32]Natural Resources Canada, "Retrofitting." https://www.nrcan.gc.ca/retrofitting/20707

[33] Natural Resources Canada, "Retrofitting." https://www.nrcan.gc.ca/retrofitting/20707

Highlights from ASHRAE's Achieving Zero Energy Design Guide

For information and techniques for building energy efficient buildings, The ASHRAE Design Guide, Achieving Zero Energy, is an excellent resource. Designed for Zero Energy projects, many of the recommendations are applicable to any low carbon building project be it a new build or retrofit.

Below are some of the helpful recommendations included in the report.

Key Steps in the Building Process . . .

- Establishing zero energy as a goal
- Selecting the right contracting process and the right team
- Selecting the energy performance target for the building
- Highlighting the energy goal in all project descriptions and documents
- Quantifying the impact of all design decisions on the energy performance in an iterative process throughout design
- Incentivizing the team to continue to reach for or exceed the goal throughout the process
- Transitioning the energy performance from a design goal to an operational reality
- Setting up a system of ongoing checks and alignments to realize this success over the life of the building

  (pg. 27)

For Project Communications . . .

- Develop a clear but flexible communication strategy to help create a culture that believes achieving your energy goal (while staying within your project's budget) is possible. (pg.16)

- Use your communication strategy to connect the benefits to each stakeholder group. (pg.16)

- Ensure that you have champions to drive the project forward. (pg.18)

Building Strategies . . .

- Through building simulation, assess the following variables:
  - Climate
  - Form and Shape
  - Window-to-wall ratio
  - Shading
  - Envelop
  - User Behaviour
  - Equipment schedules and loads
  - Lighting
  - Natural Ventilation
  - Infiltration
  - Daylighting
  - Heating and Cooling Loads
  - Mechanical Systems Comparisons
  - Renewable Energy Systems
    (pg. 47)

- Adhere to a hierarchy of energy related criteria (or loading order) in order to evaluate energy efficiency strategies and measures. (pg.19)

- Compact building forms (like cubes) are often effective in cold climates. (BP3)

- For optimal solar orientation orient the building such that a rectangular footprint is elongated along the east-west axis. Depending on the location, the axis can vary up to 20° of south without substantial energy impacts. (BP7)

- Windows should be located in south-facing surfaces, where solar radiation can be controlled with proper overhangs. However, northern climate zones may experience problems with glare from winter light. (BP8)

- If you are aiming for zero energy in climate zones 6-7 expect to need an area for photovoltaics that is equivalent to 24-27% percent of gross floor area. (BP14)

- Thermally massive elements (like masonry, stone, rammed earth, concrete and water) will dampen variation in space mean radiant temperature, improving comfort even with significant changes in space air temperatures. (EN10)

- The window-to-wall ratio has a significant effect on building energy performance and can be one of the most important variables in delivering a

cost-effective zero energy building. A window-to-wall ratio of 30% is generally consider a good starting point and should be adjusted according to other design considerations (EN16)

- In colder climates select fenestration to avoid condensation and frosting to avoid the issue of radiant asymmetry which can cause significant thermal comfort challenges even when indoor air temperature is satisfactory (EN18)

- Design the interior according to daylight methodology e.g. place corridors not workstations along windows to provide a buffer for occupant glare and heat control. (DL1)

- Floor-plate depth should be minimized in order to increase access to daylight and views. The floor plate depth is often a challenge for existing buildings which prevents easy retrofits for daylighting, views or natural ventilation. (DL2)

- Redirecting devices can assist daylighting by directing sunlight upwards to create luminous ceiling that helps provide ambient lighting. (DL6)

- Conduct a plug load inventory to validate the maximum plug load required. To reduce plug loads select equipment with lower power demands and control equipment so that it is off when it is not in use. (PL1)

- Using lighting controls to minimize lighting to the time and quantity that it is needed. Lighting controls can range from manual switches to advanced controls. (LC2)

- Reduce water consumption through low-flow fixtures and select appropriately sized, energy efficient systems. (WH2 and WH3)

- Similarly, select an appropriate HVAC system and size for the building (HV32)