Clean Air Partnership

Briefing Note

March 2024

High Performance Buildings Costing Studies

Introduction

1. The buildings where we live, work, and play impact our health and the environment. Increasing energy efficiency and decarbonizing our building stock needs to be a priority climate action for all levels of government as buildings produce about half of community of greenhouse gas emissions. Addressing emissions from our buildings, especially existing buildings, also presents an enormous economic development and job creation opportunity.

2. High performance buildings are designed to be energy-efficient, reduce environmental impacts, and ensure a healthy space for occupants. These modern structures have lower operational costs and are more resilient to extreme weather events.

Benefits of High Performance Buildings

3. **Energy efficiency**: High performance buildings minimize energy consumption without impacting occupant comfort. This is achieved both through passive design and building orientation, as well as using building automation and smart technologies that increase efficiency in heating, ventilation, lighting, and other building systems. Efficient use of energy and water in buildings can reduce operational costs.

4. **Environmental impact:** High performance buildings use sustainable materials and generate lower emissions by using fossil fuel-free heating systems. Energy, water, and waste are efficiently managed throughout the lifespan of building. These buildings have a tighter envelope and are more resilient to disruption caused by climate impacts.

5. **Healthy indoor environment**: A high performance building offers a healthy, comfortable, and productive environment for occupants. This is achieved by lower noise levels, better ventilation and indoor air quality, and using materials with low levels of volatile organic compounds.

Economic Opportunities of High Performance Buildings

6. **Green Jobs**: Building and managing higher performance buildings offers new employment prospects across a range of occupations and skill sets, including roles such as property managers, designers, HVAC technicians, building science experts, building inspectors, and more throughout the supply chain to construct and manage these buildings.

7. **Education and Training Programs**: Constructing and managing high performance buildings offers opportunities to develop innovative training approaches to address skill shortages, such as micro credentials, training programs, and on-the-job training.

8. **Reduced impact on existing municipal infrastructure:** Energy and water efficiency features of high performance buildings reduce strain on municipal electricity and water infrastructure, thus, reducing costly maintenance and upgrades to this infrastructure.

9. **Enhanced Building Resilience**: High performance buildings demonstrate a higher capacity to withstand natural disasters. As a result, communities are able to realize direct economic benefits, such as lower insurance premiums and less disruption and damage from adverse weather events.

Analysis of Recent High Performance Buildings Costing Studies

10. Construction Cost Analysis of High Performance Multi-Unit Residential Buildings in British Columbia (2021).

    This study looked at seven buildings across four different municipalities in BC. Key outcomes include:

    - Two all-electric buildings were constructed for considerably less than the baseline electric and fossil fuel heated buildings in the same municipality. It is possible to construct high performance (Step 4), all-electric buildings for less than a similar fossil fuel heated code-minimum building.

- The projects with the lowest construction costs and best results relative to the baselines were constructed by developers who used an integrated design approach during the design phase before construction began. This integrated design approach broke down siloes across the design and construction teams and likely played a factor in reduced construction costs.

- A lack of availability of components, materials and other construction products used for Net-Zero Energy-Ready (NZER) buildings resulted in higher supply costs for some of the projects. A better supply chain due to growing demand for materials will reduce these costs.

- A recurring theme among builders was the lack of familiarity with cost-effective NZER approaches. It is expected that with more experience, both designers and builders will become more familiar with the cost-effective approaches to construct NZER buildings.

- While there are differences in the building envelope and mechanical systems between a building constructed to code and a high-performance building, it doesn't always lead to higher costs for high performance buildings.

11. Decarbonizing Canada's Large Buildings: Summary Report, Canada Green Building Council (2021)

    As part of this study, key financial metrics were evaluated for retrofit measures, including net present value (NPV), internal rate of return (IRR), incremental capital cost (ICC), and the cost of carbon abatement (CCA) – assessed over a 40-year time horizon, using a five percent discount rate for the cost of capital, and accounting for increasing carbon prices. The results demonstrated positive NPV values for 17 out of 50 archetypes and that the CCAs generally aligned with industry norms. Additionally, positive IRRs were achievable for 45 out of 50 archetypes, and business cases will further improve over the long term due to federal carbon price increases. Some other notable findings include:

    - Almost all archetypes could realize energy reductions greater than 70 percent, yielding significant operational savings.

    - Decarbonizing investments yield a partial return for almost all studied archetypes. In most cases where the models returned a negative NPV, the IRR was positive (i.e., between 0% and 5%). So, currently, the owners would see a positive financial return but less than the estimated cost of capital or borrowing rate. While deep carbon retrofits for some specific archetypes might not be financially attractive today, owners can conduct a lifecycle-cost analysis on a building-by-building basis to optimize the timing of improvements as the cost of carbon escalates.

    - Carbon price increases will continuously improve the business case for high performance buildings, making decarbonization retrofits even more financially attractive.

12. Advances Toward a Net-Zero Global Building Sector, Annual Review of Environment and Resources (2020)

    This study summarized outcomes from high performance building costing studies from various jurisdictions in Canada, the US and the UK to support zero emission building policy development. Key findings include:

    - The City of Boston in the USA released their *Guidebook for Zero Emission Buildings* in 2020 which assessed the incremental cost of zero emission buildings. The findings indicate that the total construction cost increases are less than 2.5% before rebates and incentives are considered. Rebates and incentives can potentially reduce construction costs, with additional long-term operational savings.

    - The City of Toronto Zero Emissions Buildings Framework demonstrated that the incremental construction costs associated with the highest levels of performance were less than those for somewhat less ambitious levels. For example, the cost premiums for Toronto Green Standard (TGS) Version 3.0 Tier 3 was 6% and for TGS Version 3 Tier 4 was 3.6%. In all cases, the overall capital cost premiums for higher performance buildings ranged from 0% - 6%.

    - The City of Vancouver anticipated a small increase in construction costs to result from the increased performance requirements in their building code but instead experienced a cost decrease of 1%.

    - These examples demonstrate that net-zero or near net-zero energy buildings have been implemented at cost parity or at a single-digit percentage cost premium over conventional buildings. Growing market demand and experience, will narrow this cost gap.

- Data from many jurisdictions illustrate that highly efficient low-carbon buildings can be the most affordable option when designed and built. There may be a small increase in design and construction costs, but operational savings more than compensate.

13. Making the Case for Building to Zero Carbon, Canada Green Building Council (2019)

 The study found that Zero Carbon Buildings (ZCB) are both technologically feasible and financially viable. Over a 25-year lifecycle, ZCB archetypes provided a positive financial return of 1%, and require a modest 8% capital cost premium. As the cost of carbon pollution rises over time, these financial returns will improve.

 A sensitivity analysis was performed to determine the relative impact that changes in initial capital costs, baseline and ZCB energy costs (consumption and price), and the cost of carbon on the lifecycle cost. Mid-rise office and low-rise Multi-Unit Residential Building (MURB) archetypes were examined in three different communities. Key insights include:

- For mid-rise offices, other larger buildings and buildings with higher energy costs, lifecycle costs are much more sensitive, overall, to energy costs than to either capital costs or the cost of carbon.
- For smaller buildings, or those that have lower energy costs (ex. low-rise MURB), capital costs become more important. The cost of energy also remains important, especially in markets with higher energy costs.
- The cost of carbon has a small impact in low-carbon grids, but a much more impact in higher- carbon grids where emissions are substantially higher.
- The closer to net-zero energy the ZCB is (i.e. the more onsite renewable energy is generated), the less sensitive the lifecycle costs are to energy costs.
- When sensitivity to energy costs decreases, sensitivity to capital cost rises. This is illustrated by the heightened sensitivity to capital costs in the low-rise MURB, as compared to in the mid-rise office.
- Likewise, when the baseline building's energy cost decreases, sensitivity to capital costs rises.
- A similar sensitivity analysis should be repeated on all projects when making long-term economic decisions. Variation ranges for different factors must also be explored. For example, a higher range of variability could be considered for energy costs than for initial capital, as the design-build team have greater control over the capital costs as compared to the future price of energy.

Key Conclusions

14. Recent cost-benefit studies examining high performance buildings indicate that the capital cost premium ranges from 0% to 7% of construction expenditures. Some projects have successfully constructed a higher performance building at lower costs as compared to code-minimum baseline buildings. Most of these studies are conservative in their estimate of benefits because they have not examined the full economic, social and environmental benefits associated with higher performance buildings, particularly impacts on municipal infrastructure.

15. Higher efficiency homes are cheaper to operate. These operational savings should be considered by banks and other lenders when assessing mortgage creditworthiness, offsetting the premium for a high performance home.

16. Conducting a sensitivity analysis for the projects can help determine the relative impact that changes in initial capital costs, baseline and energy costs (consumption and price), and the cost of carbon.

17. These studies highlight the importance of policy development, market demand, and incentives in reducing the cost premium associated with high performance and net-zero energy buildings. With supportive policies, incentives, and an increase in market demand, the construction cost gap between high performance and conventional buildings can narrow. Additionally, operational savings and the potential for reduced construction costs through innovation in design, construction methods, and materials further enhance the affordability and appeal of high performance buildings.

Other Relevant Studies and Resources:

18. Making the Case for Building to Zero Carbon, Canada Green Building Council (2019)
19. Simulation Study for Working Group-Costing: PCF1527 – Impact Analysis (2019)
20. Canmet ENERGY, PCF-1617 Impact Assessment (2019)
21. The Evaluation and Costing of the Proposed Energy Star for New Multi-Family Buildings, Program for Ontario, Sustainable Buildings Canada (2018)
22. The City of Toronto Zero Emissions Buildings Framework (2017)
23. Cost/Benefit Analysis of Proposed Energy Efficiency Requirements for the Toronto Green Standard, from Sustainable Buildings Canada (2012)
24. Toronto Green Development Standard Cost Benefits Study, Ted Kesik and Anne Miller, U of T (2008)

Contact: **Devanshi Kukadia**, Communications Manager.
Email: dkukadia@cleanairpartnership.org