THE CITY OF EDMONTON

Affordable Housing Sustainability Guidebook

Prepared in Fall 2024 by:

FINE POINT WRITING / EDITING

PLUMBHEAVY DESIGN

enbix ecotrust

Technical renderings produced by 5468796 Architecture with Office In Search Of

The creation of this guide was funded by:

Edmonton

CMHC SCHL

Housing Accelerator Fund

Land Acknowledgement

The City of Edmonton acknowledges that we are on Treaty Six Territory, the traditional land of the First Peoples, Métis, and Inuit. We thank the Indigenous Peoples whose ancestors have cared for this land, including the Cree, Dené, Saulteaux, Nakota Sioux, and Blackfoot. This is the Métis' homeland and home to one of the largest Inuit communities south of the 60th parallel. Edmonton welcomes people from around the world who make it their home. Together, we draw on our shared traditions to build a great city for today and future generations.

Contents

Introduction

6 Making a Financial and Ecological Investment
8 ROI of Energy Efficient Design

Myth Busting

10 Common Misconceptions About Sustainable Design

Energy Efficient Design

13 Planning for High-Performance Affordable Housing
15 The Three Pillars of Sustainable Design
39 The Sliding Scale of Energy Efficient Design
45 Key Design Strategies for Energy Efficiency

Building Form and Architecture

47 The Principles of Sustainable Architecture
49 Passive Design Strategies

Mechanical Systems and Renewable Energy

56 Mechanical Systems
59 Electrical Systems
63 Practical Applications in Affordable Housing Development

Conclusion

Appendix

70 Grace Village
71 Parkside North
72 Defined Terms

Disclaimer

The City of Edmonton is providing the information in the Affordable Housing Guidebook (the "Information") as a guide for both new and experienced non-profit and for-profit housing executives, project managers, and faith groups involved in affordable housing development in Edmonton. While the City of Edmonton shares this Information to offer a roadmap for affordable housing projects, the City of Edmonton is not liable for any risks, outcomes, or issues that may arise from the Information provided. The City of Edmonton does not warrant or guarantee, either expressed or implied, the accuracy, completeness, reliability, or suitability of the Information for any purpose. All persons, companies, and entities accessing this Information are advised not to rely on the Information and to seek their own professional advice for any particular purpose. All persons, companies, and entities accessing this Information shall not represent that the City of Edmonton has endorsed or approved a particular affordable housing development without the express written notice of the City of Edmonton. In no event shall the City of Edmonton and its employees, members, agents, contractors, and suppliers be liable for any loss or damages of any kind arising in any way out of any use of the Information. Organizations are encouraged to conduct their due diligence before entering into any affordable housing projects.

External website references and links within the Information are provided as a convenience and do not constitute an endorsement by the City of Edmonton of the content, policies, or products of the referenced website. The City of Edmonton does not control the referenced external websites and is not responsible for the accuracy, legality, or content of the referenced websites.

The baseline *energy modelling* and related *Energy Conservation Measures* (*ECMs*) presented in this guidebook are intended as examples only. While they illustrate potential impacts on energy use and long-term value, they should not be used in isolation to guide development or design decision-making. *Energy modelling* is a complex and nuanced process that varies significantly based on building type, site conditions, and specific project goals. The outcomes of *energy modelling* are highly dependent on multiple factors that are unique to each development.

To ensure accurate and effective results, developers should consult with a local energy professional who can tailor the modelling to the specific requirements and conditions of their project. The examples provided here are not a substitute for professional advice, and it is strongly recommended that developers engage qualified experts to inform their design and energy strategy decisions.

1

Introduction

The **Affordable Housing Sustainability Guidebook** helps **multi-family affordable housing developers** make informed decisions about **sustainable design practices** early in the development process. By considering energy efficiency and *sustainability* from the start, developers can lower construction costs, avoid late-stage changes, and keep housing affordable by reducing operating expenses. Additionally, using *resilient* design—durable, efficient materials and systems from the outset—can minimize long-term maintenance and repair costs.

For clarity, acronyms and technical terms used throughout this guide are indicated in *italics*, and defined in the Appendix on page 72.

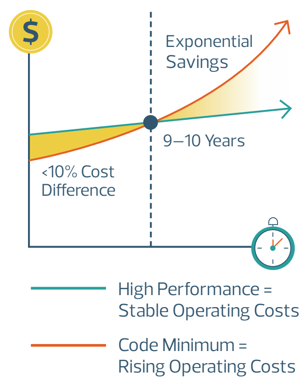
Making a Financial and Ecological Investment

Edmonton's climate creates unique challenges and opportunities for building energy use. This **sustainable design supplement** to the City of Edmonton Affordable Housing Guidebook provides developers with the tools and resources to pursue *sustainability* on their own terms. The guide demonstrates how small design changes can significantly improve energy efficiency and cut long-term costs, whether you're minimizing upfront expenses, planning for future adaptability, or aiming for emissions-neutral projects. It also outlines pathways toward more ambitious *sustainability* goals.

Each project is different, and what works for one may not suit another. This guide evaluates practical and achievable measures based on their impact on energy use, ease of construction, and initial costs. With this information, developers and their design teams can find the right balance between *sustainability* goals and affordability, considering both upfront investment and long-term operational savings.

Why Invest in Energy Efficient Development in Edmonton?

We all recognize the importance of addressing *climate change* and the construction industry's role in reducing its impact. However, sustainable development doesn't mean sacrificing Return on Investment (ROI). This guide illustrates how climate-*resilient* buildings can be more comfortable, durable, and cost-effective, while also offering better financial returns over time.



While some **additional capital investment** may be needed, many energy efficient and sustainable design choices deliver strong long-term benefits by lowering operating, maintenance, and replacement costs—which often surpass initial expenses. These savings are especially important for multi-family and affordable housing developers, where securing ongoing operational funding can be more challenging than covering initial project costs. Two notable examples of energy efficient affordable housing in Edmonton, Grace Village by the Salvation Army and Parkside North by HomeEd, showcase how investing in green energy and sustainable building design can lead to substantial operational savings and improved financial *sustainability*. See Appendix on pages 70-71 for more information on these case studies.

Benefits of Environmentally and Financially Sustainable Building Practices

For Rental Housing Developments	
For Tenants	✓ **Lower operating costs:** Energy efficient buildings reduce utility bills. ✓ **Energy security:** These buildings will experience greater *insulation* from rising energy prices. ✓ **Comfort and well-being:** Tenants enjoy enhanced thermal comfort, improved air quality, and quieter living spaces due to better acoustic performance.
For Investors, Developers, and Building Owners	✓ **Utility cost recovery:** Potential to reduce organizational operating costs through *renewable energy* generation. ✓ **Low maintenance costs:** These projects deliver high durability and climate *resilience*. ✓ **Reputation and market position:** Sustainable buildings appeal to environmentally conscious tenants, increasing demand, reducing turnover, and lowering vacancy rates. ✓ **Increased asset value:** Energy efficient buildings often command higher rents and benefit from increased asset value. ✓ **Access to funding and financing:** Additional funding streams or favourable financing options are available for projects with a *sustainability* focus.

For Condominium and Townhouse Developments	
For Buyers and Developers	✓ **Enhanced reputation:** *Sustainability* features can attract buyers, improving sales. ✓ **Market niche:** Developers can tap into a growing market for environmentally friendly housing. ✓ **Future-proofing:** Energy efficient buildings reduce dependency on fluctuating energy costs and increased reliability of grid power. ✓ **Increased asset value:** Energy efficient buildings are more desirable, leading to higher sale prices. ✓ **Access to funding and financing:** Green condo and townhouse developments may qualify for additional funding streams or favourable financing options.

ROI of Energy Efficient Design

Potential upgrade costs:	Future value:
Design and *energy modelling* ***Insulation*** value and type **Higher level of *airtightness*** (requires careful detailing and construction) **Mechanical systems*** (ultra high efficiency systems typically require use of the local Electricity Grid) **Renewable systems** (solar *PV*) and monitoring equipment	**Utility Recovery / Revenue Stream** Reliable energy performance resulting in financial benefits. ***Resilience*** Longer lasting building with reduced maintenance costs. **Market Awareness** Enhanced reputation, niche market positioning, lower turnover, reduced vacancy, and the potential for higher rents. **Future-Proof** Protection against future building code changes, rising energy distribution costs, energy market fluctuations, and advances in technology. **Financing** Access to transferable long-term CMHC financing.

* *Some projects have seen lower mechanical system costs when 'right size' designed for a high-performance envelope.*

Common Misconceptions About Sustainable Design

Many developers hesitate to prioritize energy efficiency, often due to misconceptions. However, sustainable design is becoming the new standard in construction, and as building codes evolve, energy efficiency is increasingly mandated. By embracing sustainable building practices now, developers can access valuable funding, such as the **Affordable Housing Investment Program** while positioning their projects for long-term success.

Four common myths about sustainable design in affordable housing development are described below.

Myth 1: **Too Expensive**

One of the most common misconceptions is that sustainable design is prohibitively expensive. While energy efficient construction can increase capital costs by 0 to 10%, depending on the approach, these upfront expenses can and should be viewed as an investment. Many tools are available to calculate the **Return on Investment** (ROI) based on operational savings. Throughout this guide, we outline various strategies that can be customized to meet your project's energy goals and budget.

For example, adopting **High-Performance Envelope and Mechanical Systems** may increase initial costs by 5%, but can reduce total ownership costs by **30 to 40%** over the building's life. This could result in millions of dollars in savings over time.

> *"Adopting Passive House techniques can increase initial costs by approximately 5%, the total ownership costs will drop by 30 to 40%. So, for example, a new building that costs $1 million to construct but only meets the minimum building code will typically have a total cost of building ownership (TCBO) of between $8 to $10 million. By choosing Passive House design, that same building will cost $1.05 million upfront, but the overall savings will be $2.4 to $4.0 million or between $40,000 to $66,000 per year. These savings exceed costs by five or six years from the completion of construction."* (**source**)

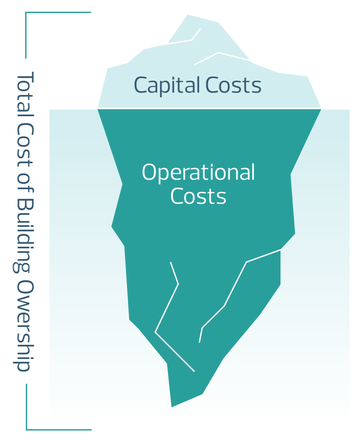
Many low-cost measures—such as passive building planning, window placement, improved *insulation*, smart thermostats, and energy efficient lighting—can be incorporated early in the design phase, avoiding the higher costs of retrofitting after occupancy. The key is to make decisions early, as energy efficiency is most cost-effective when integrated from the start.

Myth 2: **Too Complex to Build**

The construction industry is evolving quickly, with more contractors gaining experience in building high-performance, energy efficient structures. As sustainable design becomes more mainstream, the availability of **low-carbon products** and high-performance systems is increasing. With proper planning, building to these standards should not add complexity or extend construction timelines.

Investing in thoughtful design from the outset is critical. As one expert noted, **design costs typically account for just 1% of the total cost of building ownership**, so optimizing the design phase can lead to significant long-term benefits. (**source**)

Myth 3: **Does Not Save Money**



Another misconception is that sustainable buildings don't offer financial returns. In reality, a building's **life cycle costs**—including operational costs, maintenance, and replacement—far exceed the initial capital cost. High-performance buildings last longer, require less maintenance, and generate significant savings on utility bills. With a long-term investment mindset, small increases in capital costs can lead to substantial paybacks over the building's lifetime, especially as energy prices continue to rise.

A typical building's capital cost represents only **10% of its total cost of ownership**, meaning the bulk of expenses arise from operational and maintenance costs (**source**). By investing in energy efficient systems upfront, developers can reduce these long-term costs, ultimately saving more money over time.

Myth 4: **Not a Major Selling Point for Tenants/Buyers**

While some developers may believe that energy efficient or "green" features aren't a selling point, studies show otherwise. **Green features** can command a rent premium of **5 to 15%** and increase asset value (**source**). These features also appeal to tenants who want to reduce their energy costs and environmental impact, helping lower vacancy rates and turnover.

For developers, exceeding basic energy codes offers a competitive edge. Building with *sustainability* in mind not only reduces costs but also strengthens your brand as a forward-thinking, responsible builder.

3

Energy Efficient Design

Planning for High-Performance Affordable Housing

Achieving **high-performance affordable housing** requires a collaborative approach from the outset of the project. Making design changes late in the process, after key decisions have been made, can lead to costly and time-consuming revisions. Engaging your entire team early—including architects, engineers, and energy consultants—helps ensure energy efficiency is a core part of your project's DNA.

A critical tool for this is ***energy modelling***. By using energy models at each stage of the design process, developers can see how different decisions will impact the building's overall energy performance. Combining this analysis with **cost estimates** and energy pricing creates a more accurate business model, allowing you to weigh capital and operational costs to make informed decisions.

Key Milestones in the Design Process

Key stages in the design process where energy efficiency can be maximized:

Initial Planning

Before diving into the design, assess the property's zoning and site conditions, including building typology (e.g., townhomes, three-storey walk-ups, or apartments) and how the building's *massing* (form) and solar orientation will impact energy use.

Schematic Design

At this stage, combine ***energy modelling*** with ***Energy Conservation Measures*** **(*ECMs*)** to test various design options. Decisions about the building's envelope (*insulation*, *airtightness*) and mechanical systems (heating, cooling, ventilation) can be weighed against costs to find the best balance between performance and budget.

Design Development

As the design becomes more detailed, ensure mechanical systems are right-sized for the space to avoid overbuilding, which can lead to unnecessary costs. Consider future-proofing the design to accommodate later upgrades like solar photovoltaic (*PV*) systems or additional *insulation*.

Principles of Energy Efficient Design

Make it Tight	Focus on creating an airtight *building envelope* to reduce energy loss and improve efficiency.
Insulate Right	Choose appropriate *insulation* for Edmonton's climate and the building type to optimize thermal performance.
Size for the Space	Ensure heating, cooling, and ventilation systems are properly sized to meet the building's needs without overconsumption.
Make Up the Difference	Integrate *renewable energy* systems like solar photovoltaic (*PV*) systems or geothermal systems where possible to reduce dependence on non-*renewable energy* sources.

For additional information, see the City of Edmonton's **Change Homes for Climate Guide**.

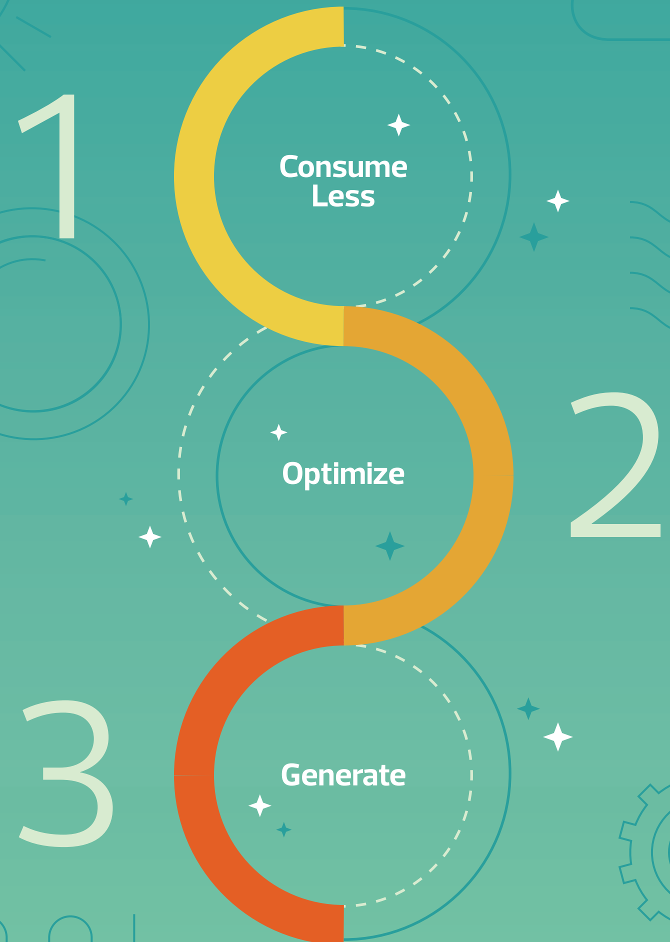
Energy and Cost Considerations

Once your development is occupied, energy consumption becomes a daily reality. This includes everything from heating and cooling to lighting and appliance use. In Alberta, where energy prices fluctuate based on demand and source, understanding the long-term impact of your energy choices is essential.

Electricity Costs	The price of electricity can vary significantly, with recent averages ranging between ($0.07-$0.18 / kWh).
Natural Gas Costs	Natural gas is subject to price increases, increases to carbon taxes, and future availability concerns. Recent averages range between ($0.6-$4.3 / GJ).

While Alberta's shift away from coal-fired electricity generation has reduced *greenhouse gas emissions*, the province still relies heavily on natural gas. As the global supply of natural gas diminishes, new buildings may need to operate without it in the next 50 years. Fortunately, *renewable energy* is on the rise, with up to 30% of Alberta's electricity expected to come from renewable sources like solar and wind by 2030 (**source**).

The Three Pillars of Sustainable Design



1. Consume Less

Energy conservation is the cornerstone of sustainable design, and the best way to save energy is by minimizing the need for it in the first place. By designing buildings to consume less energy, we reduce the overall environmental impact while lowering operational costs for residents.

Minimize Energy Loss in Operations

Efficient building operations are vital for long-term energy savings. Strategies such as high-performance *building envelopes* and energy-conscious design play a critical role in minimizing unnecessary energy waste. Whether in heating, cooling, or lighting, the goal is to ensure energy consumption is as low as possible without compromising comfort or functionality.

Reduce Solar Heat Gain in Summer

Edmonton is experiencing hotter summers, and extreme heat periods are expected to increase. Excessive solar heat gain can dramatically increase cooling loads, leading to higher energy use and costs. Design elements that reduce heat gain are critical to maintaining a comfortable indoor environment.

Strategies for reducing solar heat gain:	
***Insulation* Levels**	High levels of thermal *insulation* in the *building envelope* prevent unwanted heat from entering the building, ensuring interior spaces remain cool with minimal air conditioning.
Window Size and Placement	Careful consideration of window size and placement can significantly impact solar heat gain. South-facing windows can capture sunlight during the winter but should be limited or shaded in summer to prevent overheating.
Window Performance	High-performance windows with low-emissivity (*low-E*) coatings and triple glazing help control the amount of heat entering the building while allowing for natural daylight, which can reduce the need for artificial lighting.
Overhangs and Shading Devices	Overhangs, louvers, and other shading devices can block direct sunlight during peak hours in summer, reducing cooling demands. These *passive design* elements effectively control solar heat gain without relying on mechanical systems.

Reduce Heat Loss in Winter

In colder months, minimizing heat loss is critical for keeping energy consumption low.

Key design strategies to ensure heat retention:	
***Insulation* Levels**	*Insulation* is vital for keeping warm air inside the building during winter. A well-insulated *building envelope* with minimal *thermal bridging* reduces the demand on heating systems by preventing energy loss through walls, roofs, and floors and leading to a more stable indoor temperature.
Envelope *Airtightness*	Air leakage through gaps and cracks in the *building envelope* can lead to significant heat loss, driving up energy use and costs. Ensuring the *building envelope* is properly sealed and airtight helps maintain the building's thermal integrity, reducing the need for supplemental heating.

Use Fewer Materials in Construction

In addition to optimizing energy efficiency during operation, reducing the amount of materials used in construction is another crucial component of sustainable design. While it may receive less attention than operational energy efficiency, material efficiency plays an important role in minimizing a building's environmental footprint.

Consider Material Efficiency

Reducing material waste and focusing on building smaller, more efficient spaces can lead to significant *sustainability* gains. By using fewer materials, we reduce the demand for resources and decrease the overall environmental impact of the construction process.

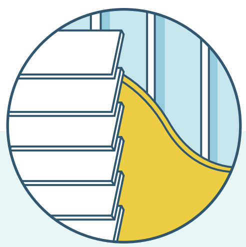
Considerations for material efficiency:	
Less Waste	Careful construction planning can reduce material waste. Techniques like prefabrication, careful cutting, and accurate design calculations all contribute to material efficiency.
Build Small	Smaller, more efficiently designed buildings require fewer materials, resulting in a lower *carbon footprint* (refer to Building Form and Compactness on page 50).

Choose Low-*Carbon Footprint* Materials

As operational energy efficiency improves, the *embodied carbon* of building materials—the greenhouse gas (*GHG*) emissions associated with producing and transporting materials—becomes increasingly important. Although operational emissions still dominate in Alberta, selecting low-carbon materials for construction can significantly reduce the project's overall environmental impact.

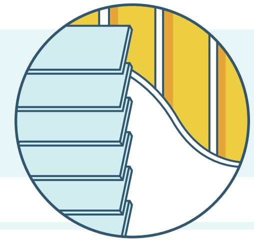
Reducing your building's *carbon footprint* doesn't have to be complex. Simply asking designers and suppliers about the low-carbon options for common building materials is an effective way to make environmentally conscious choices that easily obtain up to 50% reductions in emissions utilizing common, affordable, and readily available material choices.[1]

When selecting materials, it's important to consider not just the *carbon footprint* and costs, but also long-term performance and durability. Additionally, when choosing *insulation*, evaluate its effectiveness in retaining heat. Materials with a higher *R-value* per inch require less thickness to achieve the same total *R-value*. This can reduce the amount of material needed and increase usable interior space, further contributing to the efficiency and practicality of the design.



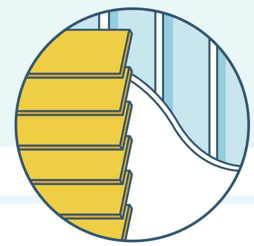
Common Continuous Board *Insulation* Materials[1]
Ranked by *GHG* Emissions ($kgCO_2e/10m^2$, R10)
$ · $$ · $$$

Wood Fibre Board (European imports) (R3.6/inch)	–36	$$$
GPS Foam Board (EPS w/ Graphite) (R4.7/inch)	49	$
Polyiso Foam Board (R6.5/inch)	50	$$
Mineral Wool Board (R4.3/inch)	51	$$$
EPS Foam Board (Type II) (R4/inch)	66	$
NGX Foam Board (New XPS) (R5/inch)	143	$$
XPS Foam Board (R5/inch)	987	$$



Common Wall Cavity *Insulation* Materials[1]
Ranked by *GHG* Emissions ($kgCO_2e/10m^2$, R10)
$ · $$ · $$$

Straw bale (R3.3/inch)	–128	$$
Hempcrete (R2.1/inch)	–76	$$$
Wood Fibre Batt (R3.8/inch)	–19	$$$
Cellulose Blown In (R3.7/inch)	–13	$$
Fibre Glass Batt (R3.6/inch)	12	$$
Mineral Wool Batt (R3.8/inch)	23	$$
Closed Cell Spray Foam (HFO) (R6.6/inch)	73	$
Closed Cell Spray Foam (HFC) (R6.6/inch)	232	$



Common Cladding Materials[1]
(industry standard material thickness)
Ranked by GHG Emissions ($kgCO_2e/10m^2$)
$ · $$ · $$$

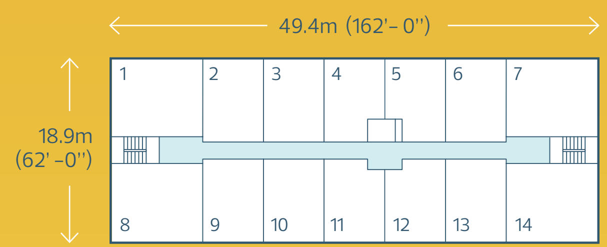
Wood Siding (spruce, pine, fir)	12	$$$
Wood Siding (western red cedar)	17	$$$
Engineered Wood Siding	28	$$$
Acrylic Stucco	35	$
Vinyl Siding	54	$$$
Traditional Stucco	96	$
Corrugated Metal Cladding (Steel)	150	$$
Fibre-Cement Panels	170	$$$
Aluminum Composite Panels	195	$$$
Traditional Brick Veneer Masonry	472	$$$

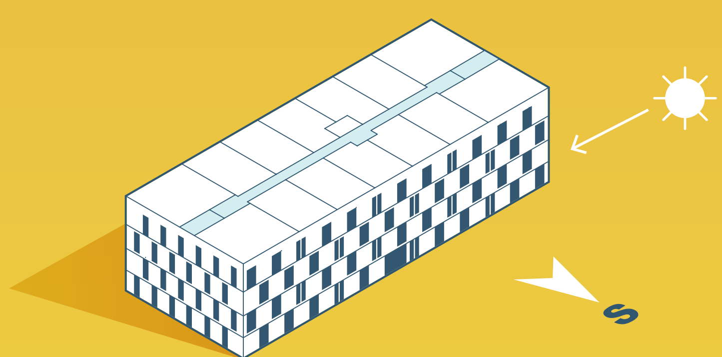
1 *Achieving Real Net-Zero Emission Homes: Embodied carbon scenario analysis of the upper tiers of performance in the 2020 Canadian National Building Code.*

Baseline Building and *ECM* Testing

To better understand the impact of different energy efficient design strategies, we've established a **baseline building model** that reflects current code minimums for energy performance (NECB 2020). This building is a conventional double-loaded corridor **four-storey multi-family residential development** with **55 units** and a floor area of **933 square meters per floor**. It serves as a typical example of the kind of developments this guidebook targets.

Baseline Building Model Parameters	
Roof *U-Value*	0.121 (R47)
Above Ground Walls	0.215 (R26.4)
Ground Floor	0.757 (R7.5)
Windows and Doors	1.73 (R3.3)
Infiltration	0.8 m³/h/m² @ 4Pa (1.5 L/s/m² @ 75Pa)
HVAC	Single zone, with gas boiler, and packaged dx
Window to Wall Ratio	28.6%





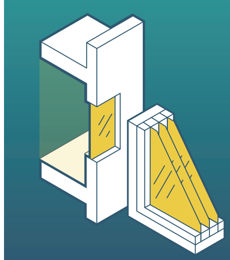
By using this baseline, we can systematically test various ***Energy Conservation Measures* (*ECMs*)**—such as increasing *insulation* levels, improving window performance, enhancing *airtightness*, and optimizing building orientation or *massing*—one change at a time. Each *ECM* has been evaluated for its effect on energy use and its subsequent long-term value to the project, giving developers a clear sense of which improvements deliver the most significant operational savings and environmental benefits.

However, it's important to note that the results of each *ECM* test reflect its impact **in isolation**. The effect of any individual change may not be as pronounced when combined with other upgrades. Changes are **not cumulative**, meaning the combined impact of multiple *ECMs* may differ from the sum of their individual effects. To fully understand the collective benefits of multiple changes, **bundles of *ECMs*** should be tested simultaneously to assess their overall contribution to energy savings and performance. This approach provides developers with a flexible and clear framework for optimizing energy efficiency based on the unique needs and goals of each project.

Below is a sample of the *ECM* Card that will appear throughout this guide:

Energy Conservation Measure

IMPROVE WINDOW PERFORMANCE



***ECM* 1.7**
Upgrade windows to triple-glazed low-conductivity U-0.96 (R-5.9)

TOTAL ENERGY: **EUI -11%**

HEATING/ COOLING: **TEDI +16%**

Description:

Basic change to baseline building.

Impact on Energy Use:

A **negative percentage** indicates **decreased energy use** (more efficient).

A **positive percentage** indicates **increased energy use** (less efficient).

***Energy Use Intensity* (EUI)** refers to the total energy use

***Thermal Energy Demand Intensity* (TEDI)** is the energy used for heating and cooling only

Considerations for Sustainable Development

Explore Thermal *Insulation*

Effective thermal *insulation* is essential for maintaining comfortable indoor temperatures and reducing energy consumption in buildings.

1. **Rigid Board *Insulation*** See page 24
2. **Cavity *Insulation*** See page 24
3. **Blown in *Insulation*** See page 24
4. **Effective *R-values*** See page 26

Minimize *Thermal Bridging*

Minimizing *thermal bridging* is crucial for maintaining energy efficiency and preventing moisture problems.

5. **Strategies to Minimize *Thermal Bridging*** See page 26

Airtightness

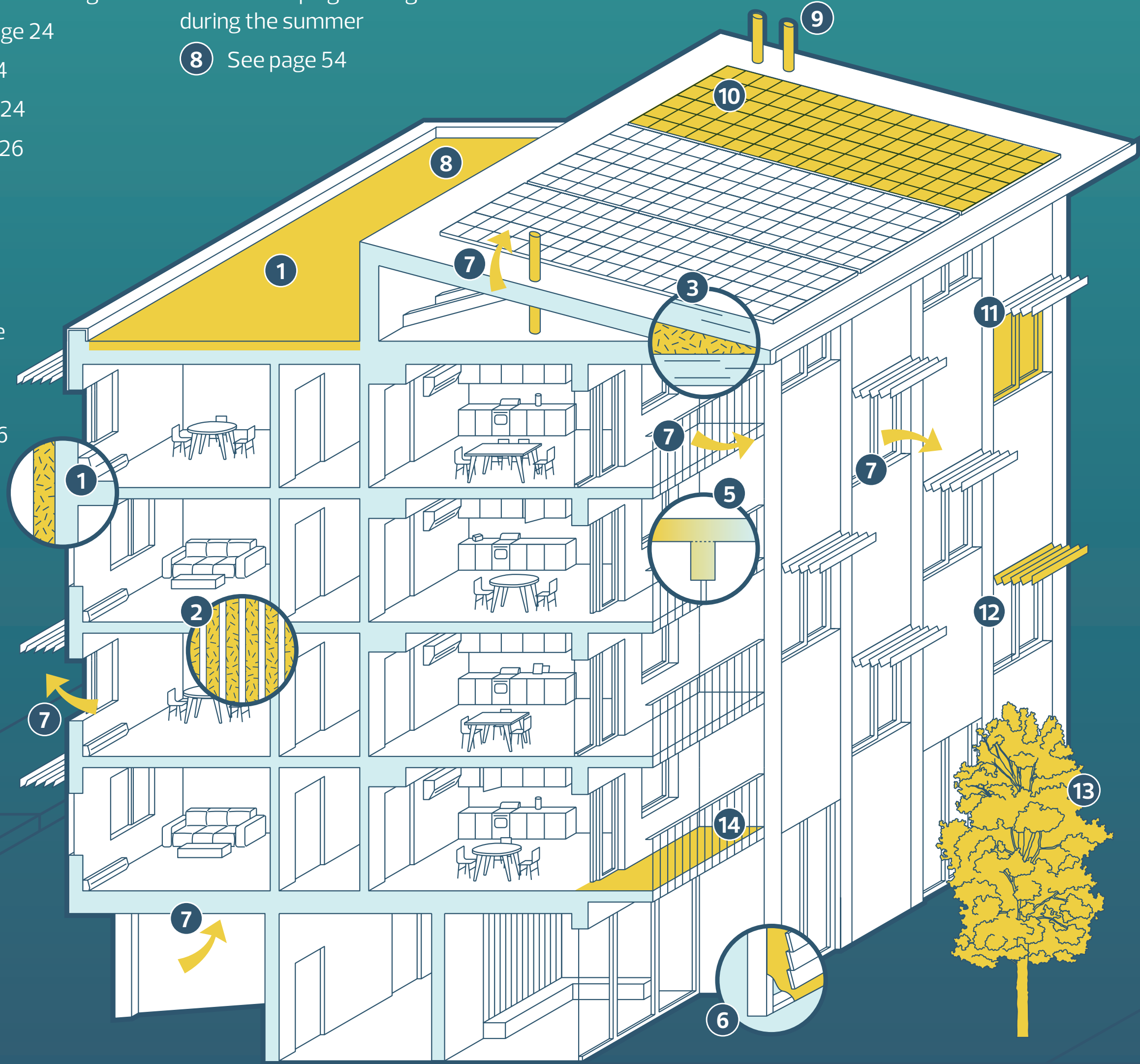
Airtightness is critical for preventing unwanted energy loss through *building envelopes*.

6. **Types and Placement of Air Barriers** See page 27
7. **Typical Problem Areas** See page 27

Green Roofs

Green roofs act as insulators, reducing heat transer through the roof and keeping buildings cooler during the summer

8. See page 54



Generate Solar Power

Solar *PV* systems are highly effective in Alberta due to the province's abundant year-round sunlight and ever rising and fluctuating electricity prices.

9. **Be Solar Ready** See page 60, 61
10. **Solar *PV* Array** See page 37

Doors and Windows

Often the weakest points in a building's thermal envelope. Proper design and placement are essential to minimize their impact on energy efficiency.

11. **Choose High-Performance Windows** See page 28

Utilize Solar Shading

Use shading devices to reduce cooling loads and maximize beneficial *solar gain*.

12. **Solar Shading** See page 30
13. **Landscape Design** See page 30

Balconies and Projections

To minimize energy loss, consider using insulated balcony systems, thermally broken supports, or thermally isolated supports.

14. **Recessed Balconies** See page 30

Explore Thermal *Insulation* Options

Effective thermal *insulation* is essential for maintaining comfortable indoor temperatures and reducing energy consumption in buildings.

Here's an overview of the types of *insulation*, their benefits, and key considerations:

Exterior wall *insulation*:	
Cavity *Insulation* Batts or Blown-In Fibres	Installed within wall cavities, batts, blown-in, or cellulose *insulation* fills gaps between studs. Cavity *insulation* effectiveness is impacted by studs (thermal breaks) and is often difficult to place, especially around utilities. Its effectiveness may be further reduced if compressed or if there's excessive blocking in the wall design. Cavity *insulation* is the most common *insulation* type in typical residential construction.
Exterior *Insulation* Semi-Rigid and Rigid Board	Applied to the exterior surface of sheathing, continuous exterior *insulation* improves thermal performance by minimizing *thermal bridging* (when carefully designed) and reducing the risk of condensation by keeping sheathing warm. Rigid boards offer higher *insulation* values per inch and are suitable for new construction or renovations where cladding is removed.

Roof *insulation*:	
Blown-In Sloped Roofs with Attics	Similar to cavity *insulation*, blown-in *insulation* effectively fills attic spaces, providing excellent coverage and reducing heat loss. If space allows, it can be easily upgraded by adding more *insulation* on top of the existing layer.
Cavity *Insulation* Batts in Sloped Roofs with Attic Rafters	Pre-cut batts placed between rafters are easy to install and work well in attics with standard rafter spacing.
Rigid Board Flat Roofs	Flat roofs benefit from rigid board *insulation*, which offers continuous thermal performance and integrates seamlessly into flat roofing systems.

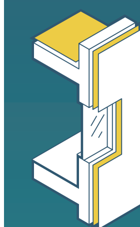
ADD *INSULATION* TO ENVELOPE

ECM 1.0
Add R-5 to Walls

TOTAL ENERGY: EUI -1%
HEATING/COOLING: TEDI -2%

ECM 1.1
Add R-10 to Walls

TOTAL ENERGY: EUI -2%
HEATING/COOLING: TEDI -5%



ECM 1.2
Add R-10 to Roof

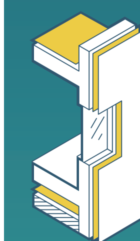
TOTAL ENERGY: EUI -1%
HEATING/COOLING: TEDI -1%

ECM 1.3
Add R-20 to Roof

TOTAL ENERGY: EUI -1%
HEATING/COOLING: TEDI -2%

ECM 1.4
Add R-40 to Roof

TOTAL ENERGY: EUI -1%
HEATING/COOLING: TEDI -3%



ECM 1.5
Add R-10 under Slab

TOTAL ENERGY: EUI -11%
HEATING/COOLING: TEDI -20%

NOTE: *As current energy codes become more stringent, the impact of increased insulation levels on energy use is minimized. In most cases, adding insulation to walls and roofs provides diminishing returns as the R-values increase. Thermal resistance increases by 100% from R1 to R2 as doubling the resistance halves the heat flow through the assembly. By contrast, energy savings from R39 to R40 is only 2.5%.*

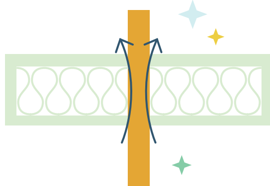
Up to 20% of total heat loss can occur through the floor surface in contact with the ground, especially in large floor area shallow foundations common in multi-family construction. Here, increased insulation levels exceeding the NECB can have a major impact on long-term energy use.

Most often, greater impact can be had by ensuring insulation is placed effectively, reducing condensation risks and limiting thermal bridging.

Value of *insulation*:	
***Insulation* Value** (*R-Value*)	Each *insulation* type has a specific *R-value* (or metric *U-value*) indicating its thermal resistance. Higher *R-values* provide better *insulation*. Choose the appropriate *R-value* based on the building's design, climate, thermal needs, and carbon emissions.
Optimizing Thickness	Increasing *insulation* thickness improves thermal performance, but with diminishing returns. Balance cost and performance by optimizing thickness to achieve effective *insulation* without unnecessary expense.
Effective *R-Values* R_{eff}	Structural components like studs, strapping, and cladding connections can reduce the overall effectiveness of *insulation*. Proper design and installation ensure that the intended *R-value* is achieved by minimizing interruptions. All *insulation* values listed in the Energy Code now reflect "effective" *R-values*, which account for the negative effects of *thermal bridging*.

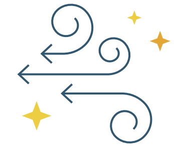
Minimize *Thermal Bridging*

Thermal bridging happens when materials with high thermal conductivity allow heat to flow around *insulation*. This can significantly reduce *insulation* effectiveness, leading to higher energy consumption and potential condensation issues. Minimizing *thermal bridging* is crucial for maintaining energy efficiency and preventing moisture problems.



Strategies to minimize *thermal bridging*:		
Use continuous *insulation* layers, preferably on the outside of all structure and moisture barriers.	Incorporate materials with low thermal conductivity, such as wood instead of steel and concrete.	Design structural elements so that they do not serve as thermal pathways.

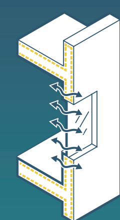
Check for *Airtightness*



Airtightness is critical for preventing unwanted air leakage, which can account for up to 30% of energy loss through *building envelopes*.

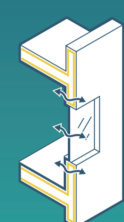
Considerations for *airtightness*:	
Continuous Structurally-Supported Air Barrier to Control Leakage	Implement a continuous air barrier to control air leakage. This can be achieved through various methods: · **Polyethylene (Poly) Barriers:** These are common, cost-effective, and suitable for many projects. · **High-Performance Options:** These include self-adhered barriers on sheathing, integrated sheathing with tapes, and liquid-applied barriers for superior air sealing.
Placement of Air Barrier	Ensure the air barrier covers all parts of the *building envelope* without gaps, focusing on seams and joints for maximum effectiveness.
Typical Problem Areas	Pay special attention to sealing overhangs, garages, canopies, balconies, and penetrations where air leakage is most likely to occur.

INCREASE *AIRTIGHTNESS*



***ECM* 2.0**
Increase *airtightness* to 0.78 ACH50

TOTAL ENERGY: EUI -7%
HEATING/COOLING: TEDI -13%



***ECM* 2.1**
High-performance *airtightness* to 0.6 ACH50

TOTAL ENERGY: EUI -11%
HEATING/COOLING: TEDI -19%

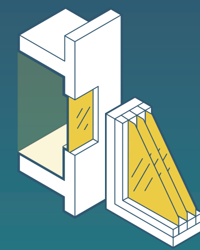
Consider the Type and Position of Windows and Doors

Windows and doors are often the weakest points in a building's thermal envelope, acting as thermal bridges if not properly designed. **Think of windows and doors as thermal bridges**. Proper design and placement are essential to minimize their impact on energy efficiency. See also Window to Wall Ratio on page 52.

Choosing high-performance windows:	
Operable vs. Fixed Windows	**Operable window** options like awning and casement windows provide ventilation, improving indoor air quality while maintaining energy efficiency. **Fixed windows** offer better thermal performance by eliminating gaps and reducing heat transfer.
Frame Type	Choose frames made from materials with low thermal conductivity, such as vinyl, fibreglass, or wood, to improve energy efficiency compared to metal frames. Ensure metal frames are thermally broken.
Glass Type	While dual pane meets code minimums, **triple glazing** provides better thermal and acoustic *insulation* with improved interior comfort for occupants. ***Low-E* reflective coatings** reduce heat gain in summer and heat loss in winter. **Gas-filled units** (argon or krypton gas between panes) enhance *insulation*. **Sealed unit spacers** affect thermal performance by minimizing heat transfer between panes.

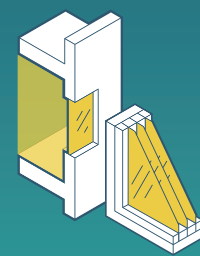
Optimizing window locations:	
Thermal Centre Placement	Position windows at the thermal centre of walls to maximize their effectiveness. Proper detailing and exterior *insulation* integration enhances window performance.

IMPROVE WINDOW PERFORMANCE



***ECM* 3.0**
Upgrade windows to triple-glazed low-conductivity U-0.96 (R-5.9)

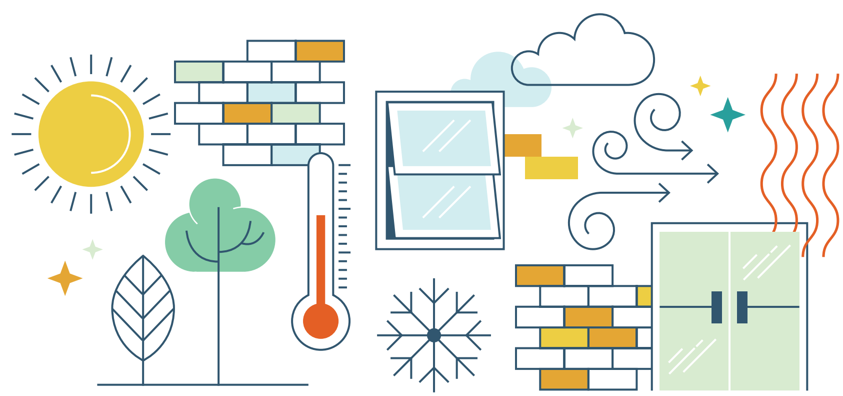
TOTAL ENERGY: EUI -11%
HEATING/COOLING: TEDI -19%



***ECM* 3.1**
Revise windows to provide an increased *Solar Heat Gain Coefficient* of 0.36 to 0.61, while maintaining triple-pane windows (U 0.96)

TOTAL ENERGY: EUI -14%
HEATING/COOLING: TEDI -29%

NOTE: *Considering Edmonton is currently a heating dominant location, EUI is reduced when more of the sun's heat is let in through the glazing during colder months.*



Utilize Solar Shading

Types of solar shading:	
Designed Solar Shading	Use shading devices like overhangs, louvers, or blinds to block high summer sun while allowing low winter sun to enter. This reduces cooling loads and maximizes beneficial *solar gain*.
Landscape Design	The strategic placement of trees and shrubs can provide natural shading, complementing built-in shading solutions and enhancing overall energy efficiency.

See also Section 4, Window to Wall Ratio, on page 52.

Consider Balconies and Projections

Balconies and projections can create thermal bridges, leading to energy loss if not properly addressed.

Thermal Bridging

Balconies often introduce thermal bridges due to their structural connections. To minimize this effect, consider using insulated balcony systems, thermally broken supports, or thermally isolated supports.

Options to minimize *thermal bridging* on balconies and projections:	
Insulated Balconies	Incorporate *insulation* within balcony structures to reduce heat transfer.
Thermally Isolated Structure	Consider supporting stacks of balconies on their own independent structure, thermally decoupling them from the primary building structure.
Thermally Broken Supports	Use materials or design techniques that interrupt thermal pathways, such as using insulating materials between balcony supports and the main structure.
Projecting Balconies	Place balconies fully outside of the envelope. Recessed balconies can dramatically increase the area of *building envelope* while creating new roof and soffit conditions, which require complex detailing for thermal, air, and water management (see *ECM* 4.0).

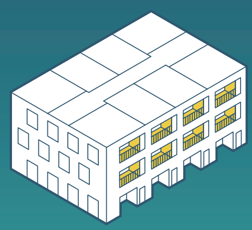
The balconies of **Ralph Erskine's Barberaren Building** in Sandviken, Sweden, are a creative solution to minimize *thermal bridging*, featuring a unique design that detaches the balconies from the main structure.

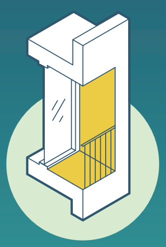
Supported independently, this approach preserves energy efficiency while maintaining architectural character, addressing a common challenge in cold-climate housing.

IMAGE CREDIT: © Arvid Rudling 2013

RECESSED BALCONIES

***ECM* 4.0**
Incorporate one 2.4m (8') x 1.8m (6') balcony into each suite by recessing it and articulating the building enclosure accordingly.





TOTAL ENERGY: EUI +19%

HEATING/COOLING: TEDI +35%

2. Optimize

Mechanical Design: Optimizing HVAC Systems for Energy Efficiency

Energy efficiency in HVAC systems is critical to reducing operational costs and minimizing the environmental impact of multi-family residential buildings. The following principles focus on optimizing system performance and maximizing energy efficiency through strategic mechanical design.

Right Size Design

An HVAC system that is too large for the building's needs will result in energy waste, while an undersized system will struggle to maintain comfort. Optimizing the system's size to fit the specific requirements of the building ensures efficiency, longevity, and cost-effectiveness. Properly sizing systems based on factors such as *building envelope* performance, occupancy, and usage patterns can prevent oversizing, which leads to higher upfront costs and unnecessary energy consumption.

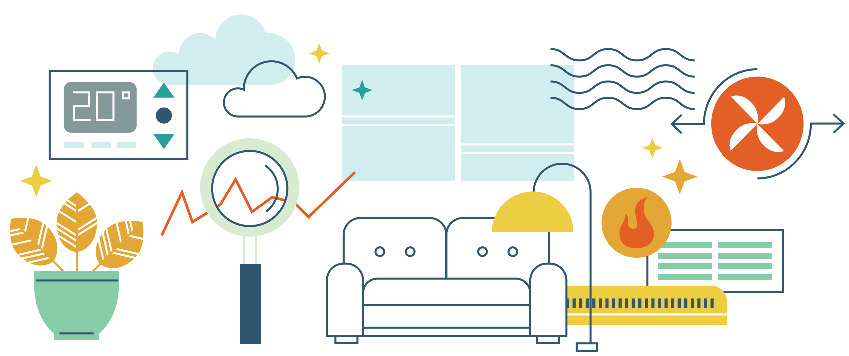
Key considerations for right sizing:		
Obtain accurate, software-verified load calculations from your mechanical, electrical, and energy consultants.	Account for the building's *insulation*, *airtightness*, window size, and orientation.	Consider the building's occupancy patterns and peak usage times.

High-Performance Systems (High *Coefficient of Performance – COP*)

The *coefficient of performance* (*COP*) measures the efficiency of heating and cooling systems. A *COP* greater than 1.0 means the system provides more energy output than it consumes, making it highly efficient. Choosing high-performance systems with a high *COP* can significantly reduce energy consumption over the lifespan of the building.

Performance examples of common systems:	
Electric Baseboard Heating (*COP* ~1.0)	Baseboard heating is simple to install but relatively inefficient compared to other systems. For every unit of energy consumed, it produces an equal amount of heat.
High-Efficiency Gas Furnace (*COP* ~0.9)	This type of furnace is a common option in cold climates, providing almost 90% of the fuel's energy as heat. Although efficient, it's less environmentally friendly than electric systems and cannot be powered by on-site renewables.
Air Source Heat Pump (*COP* ~ 2.0 or higher)	*Heat pumps* are among the most efficient systems, especially cold-climate models designed for Edmonton. They deliver more than twice the heating energy and often five times the cooling energy they consume, offering significant energy savings over time.

By investing in a high *COP* system, developers can ensure greater energy savings, especially in Alberta's colder climate.



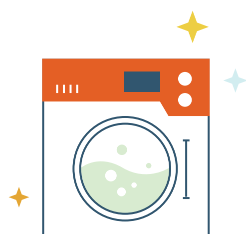
Heat Recovery Systems

Ventilation is essential for maintaining healthy indoor air quality, but it can lead to energy loss if not managed efficiently. Heat recovery systems capture waste heat from exhaust air and transfer it to incoming fresh air, minimizing the energy needed for heating or cooling.

Types of heat recovery systems:	
***Heat Recovery Ventilators* (*HRV*)**	Recover heat from exhaust air and transfer it to fresh air, reducing the heating load in colder months.
Energy Recovery Ventilators (ERV)	Recover both heat and moisture, offering better humidity control while reducing heating and cooling loads.

In Edmonton's climate, E/*HRV*s are particularly valuable, as they reduce the heating burden in winter without compromising indoor air quality.

Energy Efficient Appliances

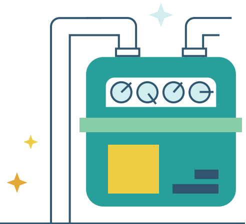


Beyond the HVAC system, energy efficient appliances play a surprisingly important role in reducing the overall energy consumption of a multi-family building. Selecting **Energy Star-rated appliances** for common areas and individual units can lead to substantial energy savings.

Considerations for energy efficient appliances:		
Install energy efficient refrigerators, dishwashers, and laundry equipment in both individual units and shared facilities.	Use LED lighting and low-energy ventilation fans.	Opt for high-efficiency water heaters, especially in conjunction with hot water recovery systems.

Reducing water usage conserves a vital resource, while also lowering operational costs and reducing the energy required for water heating. Low-flow fixtures, such as faucets, showerheads, and toilets, are simple yet highly effective measures that can significantly decrease water consumption. By minimizing water waste, these fixtures provide long-term environmental benefits and help make developments more sustainable and cost-effective.

Individual Metering



Individual energy metering can have a significant impact on energy consumption in multi-family buildings. When tenants are directly responsible for their energy use, they tend to be more aware of consumption and are likely to adopt energy-saving habits.

Benefits of individual metering:		
Encourages accountability for energy use.	Provides clear feedback to residents, helping them understand their usage patterns.	Reduces overall building energy usage as tenants become more mindful of their impact.

This approach ensures that the mechanical (HVAC) design not only enhances comfort and health but also optimizes energy efficiency in small to medium-scale multi-family housing developments.

3. Generate

Once you've optimized your building's energy consumption, the next step toward achieving **Net Zero** is generating *renewable energy* on-site to offset the remaining energy use. This is typically done through solar photovoltaic (*PV*) systems and/or *ground-source heat pumps* (geothermal systems), both of which provide sustainable, long-term solutions for reducing operational costs and greenhouse gas (*GHG*) emissions.

Shifting Away from Fossil Fuels

The key to maximizing the *sustainability* of a multi-family development is transitioning the heating and energy systems away from fossil fuels. By shifting to low-carbon alternatives, such as renewable electricity and *geothermal energy*, buildings can drastically reduce their environmental footprint. This transition becomes easier once the building's overall energy consumption has been minimized through high-performance design and energy efficiency measures.

Geothermal Systems (*Ground-Source Heat Pumps*)

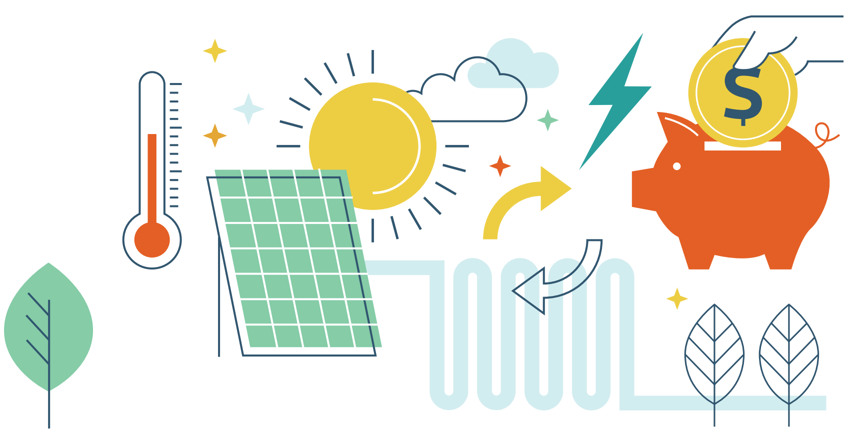
Ground-source heat pumps are one of the most efficient ways to generate renewable heating and cooling. These systems take advantage of the relatively constant temperature below the earth's surface, transferring heat to and from the ground.

Benefits of *ground-source heat pumps*:	
Energy Efficiency	Geothermal systems can produce three to four units of heating or cooling for every unit of energy consumed, resulting in an impressive *Coefficient of Performance* (*COP*) greater than 3.0. This makes them an excellent option for reducing energy use and providing reliable heating and cooling in cold climates like Edmonton's.
Long-Term Savings	Although geothermal systems require a higher initial investment, they offer significant operational cost savings over time due to their high efficiency and long lifespan.
Reduction of *GHG* Emissions	Geothermal systems can be powered by renewable electricity, reducing reliance on natural gas or other fossil fuels and contributing to lower carbon emissions.

Solar Photovoltaic (*PV*) Systems

Solar *PV* is one of the most widely adopted forms of on-site *renewable energy* generation for multi-family developments. It captures sunlight and converts it into electricity, which can be used to power building systems or exported to the grid.

Benefits of solar photovoltaic systems:	
Rooftop Solar	Installing solar panels on unused roof space is a cost-effective way to generate clean electricity. In addition to reducing grid electricity consumption, solar *PV* can significantly lower long-term operating costs by offsetting utility bills.
Decreasing Costs, Increasing Returns	As the cost of solar *PV* systems decreases and utility rates for grid-produced electricity rise, the financial benefits of solar are becoming increasingly attractive. The payback period for solar installations is shrinking, while the long-term savings continue to grow.
Scalability	Solar *PV* systems are highly scalable, making them a good fit for both small (five-unit) and medium-scale (100-unit) multi-family developments. Developers can size the system according to available roof space, energy needs, and budget.
Utility Recovery	With affordable utility costs covered directly by tenants, developers are free to utilize a whole building solar *PV* grid as operating income, ensuring long term stability and encouraging further affordable housing developments.



Considerations for Renewable Energy Integration

To maximize the effectiveness of *renewable energy* systems, consider the following:

Site-Specific Feasibility	The potential for *renewable energy* generation depends on site-specific factors such as roof orientation, shading, and available space for geothermal wells. Conducting an initial feasibility assessment will help determine the best approach for each development.
Grid Connectivity	Ensure your building can easily connect to the grid. A well-designed system can balance on-site renewable generation with grid energy use seamlessly.

Long-Term Benefits of *Renewable Energy*

Incorporating *renewable energy* systems, such as solar *PV* and geothermal, offers both environmental and financial advantages:

Lower Operating Costs	*Renewable energy* systems help insulate the building from fluctuating energy prices, leading to more predictable and lower operational costs over the long term.
Increased Property Value	Buildings equipped with *renewable energy* systems often command higher property values due to their lower utility costs and environmentally friendly features.
Resilience* and *Sustainability	On-site *renewable energy* generation enhances the building's *resilience*, reducing dependence on external energy sources and contributing to a more sustainable urban fabric.

Making the Shift to Net Zero

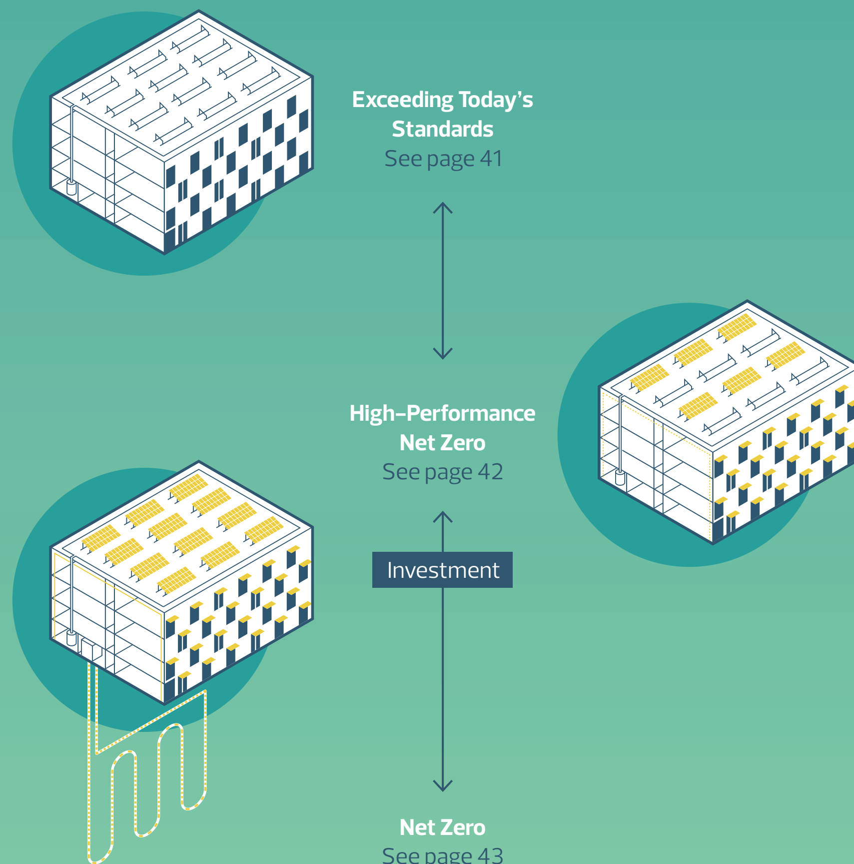
By optimizing energy consumption and generating *renewable energy* on-site, small to medium-scale multi-family residential developments can take significant strides toward achieving Net Zero energy performance. Transitioning away from fossil fuels and investing in systems like **solar *PV*** and **geothermal *heat pumps*** not only reduces the building's *carbon footprint* but also provides long-term economic benefits through reduced energy costs and increased property value. As *renewable energy* technology continues to advance, the opportunity to build cost-effective, energy efficient, and sustainable housing will only grow.

For considerations about the sequencing of building design and execution, see page 14: "Key Principles to Building an Energy Efficient Development."

The Sliding Scale of Energy Efficient Design

Energy efficiency doesn't have to be an all-or-nothing investment. The sliding scale of green building allows developers to choose how much they invest in energy efficient measures based on their budget and long-term goals. While the upfront investment for a Net Zero building might not be feasible for all developers, taking smaller, incremental steps toward improved energy performance can still yield significant financial and ecological benefits.

Every new building in Alberta must meet energy performance minimums as outlined in the **Alberta Building Code**—NBC(AE) 9.36 for smaller Part 9 buildings and the **National Energy Code for Buildings** (NECB) for larger Part 3 buildings. Developers can choose to meet or exceed these standards based on their goals and available capital.



Incorporating the City of Edmonton's Energy Efficiency Standards

The **City of Edmonton Affordable Housing Investment Program** emphasizes the importance of energy efficiency and *sustainability* in all new affordable housing developments. Projects must adhere to specific energy performance standards to qualify for funding, with additional benefits for developments that exceed these minimum requirements.

Minimum energy efficiency standards:
New developments comprising apartments and/or large buildings must achieve at least a 15% improvement over the baseline tier 1 of the 2020 National Energy Code for Buildings.
New developments comprising single-detached housing, semi-detached housing, and/or row housing using Section 9.36 of the National Building Code (Alberta Edition) must achieve energy performance equivalent to a 15% improvement over the baseline tier 1 of the 2020 National Energy Code for Buildings. • Must also abide by requirements related to City Policy C627 (Climate Resilience), if and when applicable. These requirements apply to new construction projects that are greater than 600 metres in gross floor area, anticipated to be greater than $3 million in total capital project costs, and where the requested funding from the City will be at least 33% of the total capital construction costs of the project (excluding land costs). Where so applicable, the projects must have the future installation of renewable energy systems considered in the design process.
Rehabilitation developments must be designed to achieve a minimum 25% decrease in energy consumption and Greenhouse Gas (GHG) emissions relative to pre-rehabilitation ("base case") performance.

1. Meeting and Exceeding Today's Minimum Energy Code Standards (20% Better than Code)

At the most basic level, developers can set a target for buildings that are designed to meet **20% better than code** requirements. This can be achieved through relatively simple, cost-effective measures, such as improving *insulation* levels, using energy efficient windows and doors, and optimizing HVAC systems.

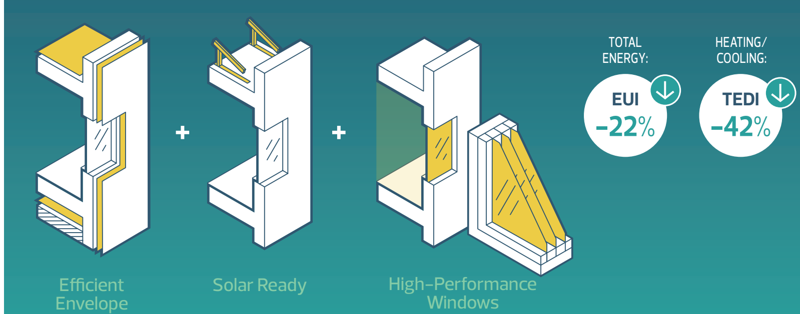
National Energy Code for Buildings (NECB) – Two Primary Paths:	
Prescriptive Path	The prescriptive path follows a checklist of requirements (e.g., *insulation*, window *U-values*, etc.) that must be met for compliance. This approach is straightforward and requires fewer design adjustments but may not fully optimize the building's energy performance.
Performance Path	The performance path allows for more flexibility by modelling the entire building's energy use. This approach enables developers to make trade-offs (e.g., using higher *insulation* in some areas to offset lower performance elsewhere) and potentially achieve better energy savings.

For developers willing to go beyond the prescriptive path, *energy modelling* can show how different design choices impact energy use and costs. *Energy modelling* allows for a more informed, customized approach to achieving energy savings.

ENTRY LEVEL GREEN *ECM* BUNDLE

***ECM* 5.0**

Add R-5 to walls, add R-10 to roof, add R-10 to ground floor slab, use triple-pane low conductivity windows (U-0.17)



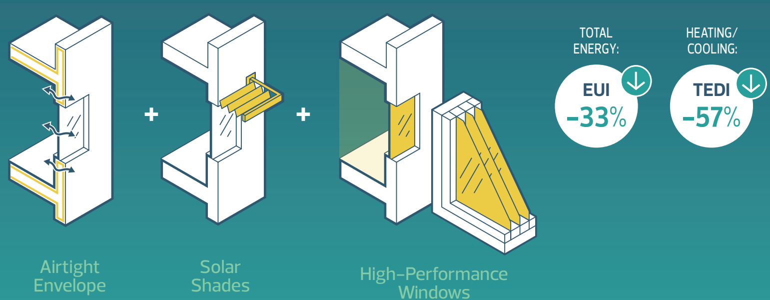
2. High-Performance, Net Zero-Ready Building

For those looking to invest in a **Net Zero-ready** building, future upgrades must be considered in the design phase. A high-performance *building envelope*, improved *insulation*, *airtightness*, and energy efficient systems can dramatically reduce energy consumption, positioning the building to eventually achieve Net Zero with the addition of *renewable energy* sources.

Considerations for a net-zero ready building:	
Enhanced Envelope	Focus on superior *insulation*, high-performance windows, and minimizing *thermal bridging* to reduce heating and cooling needs.
High-Efficiency Systems	Select mechanical systems like *heat pumps* and energy recovery ventilators to lower energy use and improve indoor air quality.
Adaptability	Even if the budget doesn't allow for immediate investment in renewables, designing a building with the infrastructure (e.g., conduits for solar *PV*, space for *heat pumps*) enables easy future upgrades as renewable technology becomes more affordable.

HIGH-PERFORMANCE ENCLOSURES PATH *ECM* BUNDLE

***ECM* 6.0**
Add R-10 to walls, add R-20 to roof, add R-10 under slab, improve *airtightness* to 0.78 ACH 50 / 0.7 Eff *HRV*.



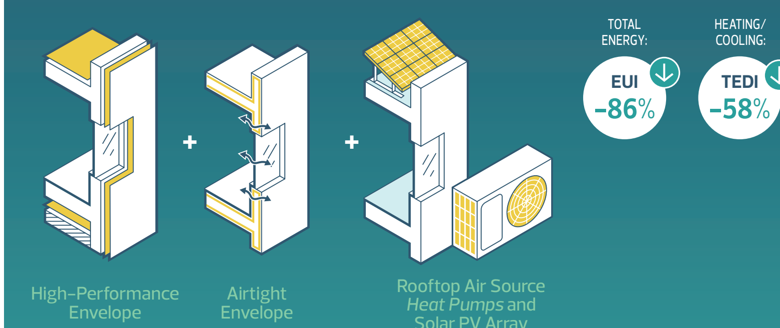
3. Going All the Way to Net Zero

At the highest level of performance, **Net Zero** buildings generate as much energy as they consume over the course of a year. This is achieved by energy efficiency with *renewable energy* generation like solar *PV* and/or geothermal.

Considerations for a net-zero building:	
Net Zero Envelope	These buildings maximize thermal performance with a near airtight *building envelope*, minimizing heat loss and reducing the need for mechanical heating and cooling.
On-Site *Renewable Energy*	Integrating systems such as solar *photovoltaic panels* and geothermal *heat pumps* helps offset remaining energy needs, ensuring the building generates as much energy as it consumes.
Future-Proofing	Net Zero buildings are not just environmentally responsible—they also protect developers and owners from rising energy costs over time.

NET ZERO ENCLOSURE + RENEWABLES PATH *ECM* BUNDLE

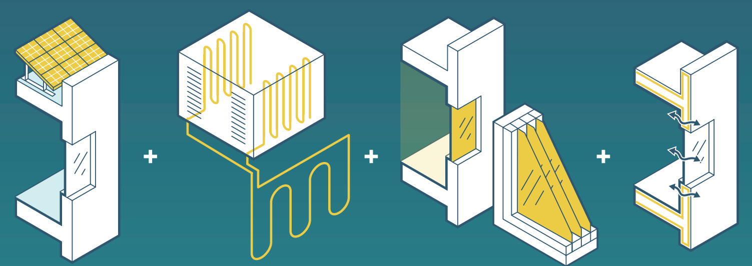
***ECM* 7.0**
Same as *ECM* 2.1 with electric air source heat pump and 540 m^2 of rooftop solar *PV* (10° Angle).



***NOTE:** EUI is at 24 (kWh/m^2/yr) in this example. One limitation to achieving true "Net Zero Energy" (EUI at 0) is building size to roof area for potential solar PV generation. In testing, a three-storey version of this building with the same total floor area achieves Net Zero with the same enclosure and systems but a 33% increase in available rooftop area for solar PV.*

NET ZERO RENEWABLES ONLY PATH *ECM* BUNDLE

***ECM* 8.0**
Minimal enclosure upgrades with *ground-source heat pump* and rooftop solar *PV* (10° angle), baseline wall, roof and slab *insulation* with triple pane windows and good *airtightness* (0.8 ACH50).



NOTE: *This option shows how total energy expenditure can be dramatically reduced by compensating with a renewable heating/cooling system like a ground-source heat pump. Capital that is normally put into high insulation levels can be used to invest in the geothermal system and rooftop solar PV. Once a high performance (high COP) mechanical system is considered, the impact of additional insulation is further diminished. This system relies on onsite renewable energy generation rather than conservation and optimization through enclosure design.*

TOTAL ENERGY: EUI -83%

HEATING/COOLING: TEDI -19%

Positioning Developments for Future Success

Choosing the right entry point on the sliding scale of green building allows developers to balance capital investment with long-term savings. Whether meeting basic code requirements or investing in Net Zero, every step toward energy efficiency benefits both the environment and the building's financial performance. By considering long-term adaptability and future energy demands, developers can ensure their buildings are positioned for *sustainability* in an evolving energy landscape.

Key Design Strategies for Energy Efficiency

To meet or exceed these standards, developers should consider these energy efficiency measures:

Improved *Building Envelope*

- High-performance ***insulation* and air sealing** to reduce heat loss.
- Use of **energy efficient windows** with low *U-values* and proper shading to manage solar heat gain.

1

Efficient Mechanical Systems

- Install **high-efficiency HVAC systems**, such as air-source *heat pumps* or ***ground-source heat pumps*** (geothermal).
- Incorporate **energy recovery ventilators** (ERVs) or ***heat recovery ventilators*** (*HRVs*) to maximize energy savings.

2

Renewable Energy Integration

- Design buildings with **future *renewable energy* installations** in mind, such as solar *PV* systems.
- Utilize **geothermal systems** to achieve significant long-term energy savings, particularly when paired with high-performance mechanical systems.

3

Energy Modelling

- Conduct ***energy modelling* early in the design process** to identify cost-effective ways to reduce energy use and ensure compliance with performance requirements. Projects that use performance path methods rather than prescriptive approaches allow for more design flexibility and optimization.

4

4 Building Form and Architecture

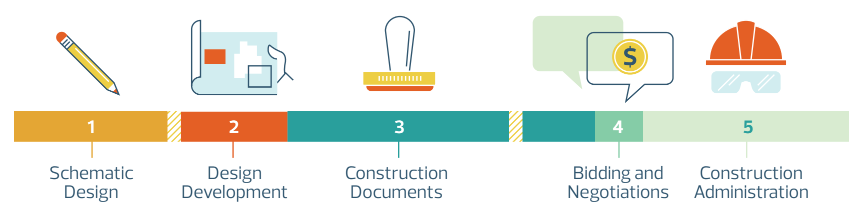
The Principles of Sustainable Architecture

The form and architecture of a building play a pivotal role in determining its energy efficiency. By using *passive design* measures—strategies that optimize natural environmental factors like sunlight, wind, and *thermal mass*—developers can significantly reduce a building's heating and cooling loads, ultimately lowering energy use. Importantly, these measures are best considered early in the design process, where they can be seamlessly integrated without adding significant costs.

Timing is Critical: Designing with the Future in Mind

***Passive design* strategies** that optimize building form and architecture offer some of the most cost-effective ways to reduce energy use in multi-family residential developments. The design and integration of passive strategies should happen **early in the project timeline**—ideally at the concept or schematic design stage—when decisions about building form, orientation, and *massing* are made. Retrofitting these design elements later can be challenging and cause significant disruption. For example, altering window placements or adjusting the building's shape post-construction would involve costly and invasive renovations, often requiring tenant displacement.

Project TImelines:



Potential additional time for net zero energy / high-performance buildings and associated certification processes.

Phased Implementation and Adaptability

For projects not aiming for **Net Zero** or ***Net Zero Ready*** performance at the outset, it's important to consider which energy efficient design strategies need to be locked in early and which can be modified or upgraded later. The building form, orientation, and passive strategies should be **established from the beginning**, as they have the most impact on long-term energy use and are difficult to alter post-occupancy.

However, other features—such as HVAC systems or *renewable energy* installations—can potentially be added or enhanced at a later stage. Even in these cases, it's crucial to plan ahead for future adaptations. For instance, designing a building with the infrastructure for **future solar panel installation**—such as wiring conduits and roof structure reinforcement—facilitates upgrades to energy performance without major disruptions.

Post-Occupancy Considerations

Modifying *passive design* elements after occupancy **can significantly impact tenants**. Renovations may require tenants to vacate their homes temporarily, leading to rent loss for building owners and increased vacancy rates if the disruption is severe. Additionally, post-occupancy alterations can lead to higher renovation costs compared to incorporating these features from the outset. Therefore, implementing smart, *passive design* strategies early ensures both **lower operational costs** and **greater tenant satisfaction** in the long run.

Passive Measures as Essential Design Tools

By implementing the following ***passive design* strategies**, developers can significantly reduce the energy consumption of multi-family residential buildings while also improving occupant comfort and lowering operational costs. When integrated early in the design process, these measures are cost-effective and provide long-term benefits. Balancing building orientation, form, window placement, and ventilation strategies allows developers to create energy efficient buildings that are both sustainable and adaptable to future needs.

Passive Design Strategies

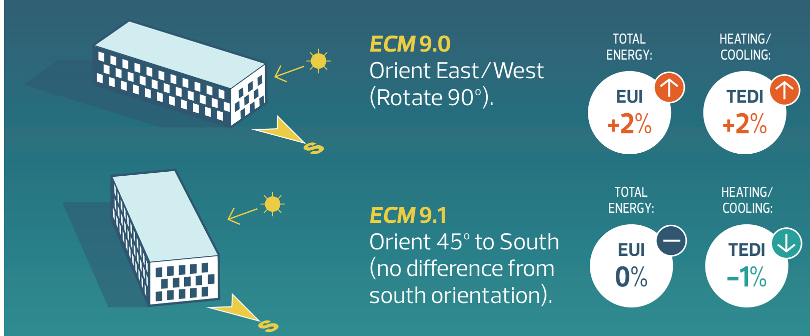
Incorporating *passive design* strategies is one of the most effective ways to reduce energy use in multi-family residential buildings. These strategies leverage environmental factors—such as sunlight, airflow, and *thermal mass*—to minimize reliance on mechanical systems, thus lowering energy consumption and operational costs. Below are some key ***Energy Conservation Measures* (*ECMs*)** that can be implemented to optimize building performance. Although each *ECM* is presented independently, note that the effectiveness of each strategy may be reduced when combined with other performance upgrades.

Orientation

While urban sites often dictate a building's orientation, developers should prioritize positioning units to maximize southern exposure wherever possible. This orientation allows buildings to take advantage of **passive solar heating** in colder months.

- **Energy Comparison:** A building oriented **due south** or **45 degrees south** can significantly reduce winter heating needs compared to one with primary windows oriented **due north**, leading to noticeable reductions in energy consumption.

ORIENTATION



NOTE: *In general, the impact of orientation will be site and project-specific. In this instance, the base building has extensive and equal glazing facing north and south, so rotating the building 180° has zero impact. In some instances, rotating 45° to south can optimize heating, cooling, and access to natural light. Rooftop solar PV optimization should also be considered when orienting a building, especially with sloped roofs.*

Building Form and Compactness

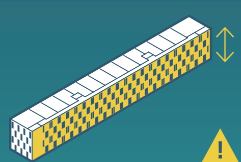
The **area-to-volume ratio (A/V)** and **surface-area-to-volume ratio (SAR)** are critical factors in determining the energy efficiency of a building. A compact building form that minimizes exterior surface area reduces heat loss through the envelope, especially in cold climates like Alberta's.

Considerations for building form and compactness:	
Efficient *Building Envelope*	The less exterior surface area a building has relative to its volume, the less opportunity for heat loss. This is why compact multi-family buildings are more energy efficient compared to sprawling forms. However, designers must balance compactness with **quality of life**, as overly dense units may sacrifice comfort or limit natural light and ventilation.
Net Zero Challenges	Higher-density developments with small units face challenges in achieving **Net Zero** due to limited roof space for *renewable energy* systems like solar *PV*. For example, in the **Grace Village** projects, density limited the potential for solar installations, making it difficult to balance remaining energy loads. Lower-density developments with larger roof areas per unit are often better suited for Net Zero, as they provide more space for solar energy generation.

BUIDING FORM AND COMPACTNESS

***ECM* 10.0**
Single loaded exterior corridor (use corridor as shading device)

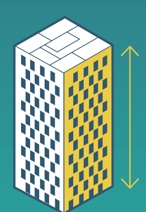
TOTAL ENERGY:	HEATING/COOLING:
EUI +9%	TEDI +14%



***ECM* 10.1**
Make two-storeys with same number of units and same overall building area.

TOTAL ENERGY:	HEATING/COOLING:
EUI +11%	TEDI +21%

NOTE: *With code minimum under slab insulation level (R-7.5), the larger footprint created by reducing the base building to two storeys while keeping the total area the same, the energy use is dramatically larger.*



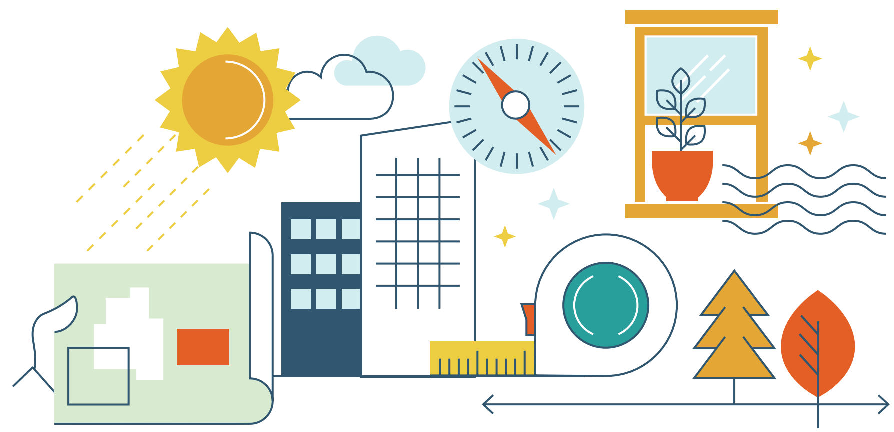
***ECM* 10.2**
Make 12-storeys same number of units, same overall building area.

TOTAL ENERGY:	HEATING/COOLING:
EUI +27%	TEDI +51%

Building Efficiency and Structural Optimization

Optimizing a building's structure can significantly reduce both construction costs and energy use. **Minimizing spans** in structural design increases building efficiency and reduces the *carbon footprint* by requiring fewer materials. Efficient designs, such as **three-storey walk-ups** with exterior corridors, can approach 100% efficiency, as they avoid the need for heating, cooling, and maintaining non-rentable or non-sellable spaces like large common areas and corridors.

Considerations for building structure:	
Efficient Use of Space	Compact building designs with minimized structural spans and fewer conditioned common areas lower both upfront costs and long-term operational energy use. This also contributes to reducing the overall *carbon footprint* of the building.

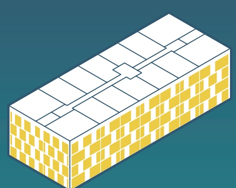


Window-to-Wall Ratio (*WWR*)

The ***Window-to-Wall Ratio* (*WWR*)** is a key factor in determining the thermal performance of a *building envelope*. Since windows are typically the weakest link in thermal efficiency, the amount and performance of glazing can greatly impact energy use.

Considerations for *window-to-wall ratio*:	
Optimal *WWR*	Achieving a balanced *WWR* is essential for minimizing energy loss while still providing adequate natural light and views. Too little glazing can reduce opportunities for daylighting, while too much glazing makes it difficult to achieve thermal efficiency, leading to over-reliance on mechanical heating and cooling systems. A *WWR* of **40-50%** is generally considered optimal for high-performance buildings, while buildings with a *WWR* exceeding **65%** become overly reliant on active systems and are sometimes referred to as **"high-cholesterol buildings".**
Thermal Performance	For buildings aiming for high-performance energy efficiency, the overall envelope should achieve a minimum thermal performance of **R7.5**, including windows. This balance can be achieved through investing in high-performance windows rather than excessively increasing wall *insulation*. A higher-performing window system often delivers better results than simply focusing on opaque wall performance.

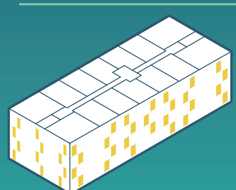
WINDOW TO WALL RATIO



***ECM* 11.0**
Double window to wall ratio increasing to 65%.

TOTAL ENERGY: EUI +15%

HEATING/ COOLING: TEDI +23%



***ECM* 11.1**
Half window to wall ratio decreasing to 16.25%.

TOTAL ENERGY: EUI -7%

HEATING/ COOLING: TEDI -11%

Natural Ventilation and Daylighting

Natural ventilation is an important passive strategy for reducing reliance on mechanical ventilation and cooling systems. Well-placed operable windows allow for natural airflow and cross-ventilation, helping to cool spaces in warmer months without relying on energy-intensive air conditioning systems. Natural ventilation also improves indoor air quality, which contributes to occupant comfort and well-being.

Daylighting is another powerful passive strategy that reduces the need for artificial lighting. By designing for maximum natural light exposure during the day, buildings can lower their electricity consumption and create healthier living environments.

Considerations for daylighting:	
Balance Between Heat Loss and Daylight	While windows provide daylighting, they also increase heat loss, particularly in winter. Therefore, it is crucial to carefully place windows to balance daylighting benefits with minimized heat loss. South-facing windows can provide both daylight and passive solar heating, while limiting large windows on the north side reduces unnecessary heat loss.

Shading Devices and Overhangs

Incorporating **shading devices**, such as overhangs, louvers, or even landscape elements, can significantly reduce solar heat gain during summer months, helping to maintain indoor comfort without over-relying on air conditioning. Shading can block high-angle summer sun while allowing lower winter sunlight to pass through, providing natural heat in colder months.

Considerations for shading devices:	
Shading Strategy	Fixed or adjustable shading devices should be considered at the design stage to optimize their effectiveness. These passive measures not only reduce cooling loads but also enhance the overall *sustainability* of the building.

Key *Passive Design* Strategies to Reduce Energy Use

1. Building Orientation and Shape

Orientation: Maximizing winter sunlight and minimizing summer heat can cut heating and cooling needs. In northern climates like Edmonton, south-facing windows enable passive solar heating.

Compact Shape: Compact forms reduce wall exposure, minimizing heat loss and improving efficiency, especially in multi-family developments with shared walls.

2. *Thermal Mass*

Materials: Concrete, brick, or stone regulate indoor temperatures by absorbing daytime heat and releasing it at night, reducing heating and cooling demands.

3. Window Placement and Size

***Window-to-Wall Ratio*:** Carefully sizing and placing windows balances daylight, heat gain, and heat loss, maximizing winter sunlight while minimizing unwanted heat impacts on north and west sides.

High-Performance Glazing: Double or triple-glazed windows with *low-E coatings* enhance efficiency and comfort.

4. Natural Ventilation

Cross Ventilation: Operable windows and vents promote natural airflow, cutting energy use and improving air quality.

5. Shading and Overhangs

Shading Devices: Overhangs and fins minimize summer heat while allowing winter sunlight, keeping interiors comfortable year-round and minimizing heating and cooling costs.

6. Green Roofs and Vegetation

Green Roofs: Green roofs insulate, reduce cooling needs, and mitigate the urban heat island effect.

5

Mechanical Systems and Renewable Energy

Mechanical Systems

Mechanical systems play a vital role in the overall energy performance of multi-family residential buildings. Thoughtful selection and design of heating, cooling, ventilation, and water heating systems can greatly reduce energy consumption and make it easier to transition to *renewable energy* sources, setting the foundation for long-term *sustainability*.

Heating

The heating system you choose will depend on the building's envelope, configuration, and energy goals. While many developments still use traditional **fossil fuel-based systems** (like natural gas), minimizing their use through **airtight, well-insulated enclosures** can save energy and money while preparing buildings for future *renewable energy* integration.

Natural Gas

Natural gas is still an attractive option in Alberta because it is currently cheaper than electricity. However, for high-performance buildings with optimized envelopes, some developers opt for **all-electric systems**, especially to avoid the high upfront costs of installing natural gas infrastructure and monthly delivery charges. With **solar *PV* micro-generation**, buildings can offset electric heating and occupancy costs.

Hybrid Systems

Hybrid systems or **dual-fuel systems** are also common in cold climates. These systems use a **high-efficiency air-source heat pump** for most of the year, switching to **natural gas furnaces** during extreme cold. This approach balances the benefits of both systems and is suitable for high-performance buildings. While a supplemental heating system is often thought of as a deterrent to electric heat pump systems, in today's climate, most new developments utilizing all natural gas systems will have secondary equipment for cooling purposes. The hybrid system does so with the added benefit of very high efficiency and added *resilience* through built-in redundancy.

When a building is well-insulated and designed for passive heating, all-electric heating and cooling systems can be considered. While **traditional baseboard electric heaters** are simple and inexpensive to install, they are only 100% efficient and only do heating. Electric **air-source *heat pumps*** are a better all-electric option for low heating and cooling demands, with efficiencies of 250% in winter and over 500% in summer.

An Additional Consideration: Individual Systems vs. Centralized Systems

When choosing heating systems for multi-family units, it's important to weigh the benefits and drawbacks of individual systems—where each unit has its own heating setup—versus centralized systems, which distribute heat to all units from a single source. Each option distinctly impacts installation, efficiency, and long-term maintenance.

Individual vs. centralized systems:	
Individual Systems	Individual systems are less complex and easier to install, with lower upfront costs, but are often oversized for high-performance buildings. Their short lifespan may require more frequent replacements. They often require additional *building envelope* penetrations, making high levels of *airtightness* more difficult to achieve.
Centralized Systems	Centralized systems are more efficient over time due to longer equipment lifespans and fewer units, but they are more complex to install and maintain. Centralized systems can be distributed to optimize energy performance across multiple units, but their replacement can impact several suites simultaneously.

Cooling

Avoiding mechanical cooling through ***passive design* strategies** is the best way to reduce energy use. However, as summer temperatures rise in Alberta, cooling systems are becoming more common in multi-family housing.

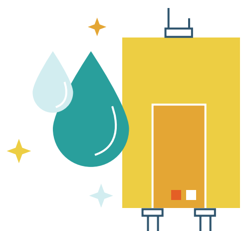
Types of cooling systems:	
Cooling-Only Systems	Central air conditioning, mini-splits, and multi-splits are common choices for multi-family buildings. While effective, they are often separate from heating systems, adding to operational complexity, maintenance, and replacement costs.
Heating and Cooling Systems	**Air-source and *ground-source heat pumps*** offer both heating and cooling, making them an attractive option for year-round performance. However, **air-source *heat pumps*** may struggle in extreme cold, and **ground-source systems** require significant upfront investment but deliver high efficiency.

Ventilation and Heat Recovery

Ventilation is essential for maintaining healthy indoor air quality, but it can be a significant source of energy loss. Traditional systems exhaust conditioned air without capturing its energy. **Heat recovery systems**, such as ***heat recovery ventilators*** (*HRVs*) or **energy recovery ventilators** (ERVs), capture waste heat from exhaust air and use it to preheat incoming fresh air.

Considerations for ventilation and heat recovery:	
ROI	Heat recovery systems typically pay back their initial costs within 5-10 years and provide great energy savings for new residential buildings.
Individual vs. Centralized Systems	Centralized heat recovery systems are more efficient but impact multiple suites if maintenance is required. Individual systems are easier to manage but may be less energy efficient overall.

Water Heating and Conservation



Water heating is another significant energy load in multi-family buildings. Options include **centralized** or **individual water heating systems**.

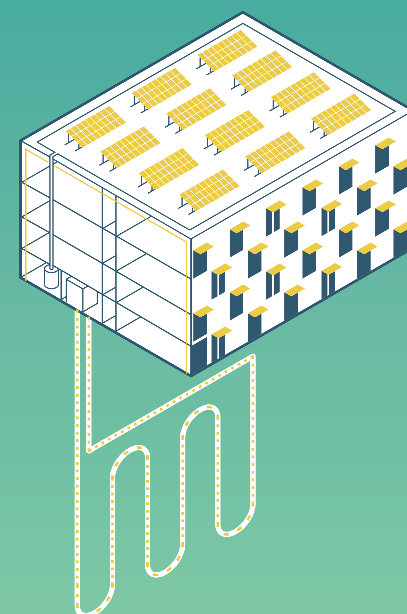
Considerations for water heating and conservation:	
Heat Pump Technology	Available for domestic hot water heaters at the individual or centralized scale. While slightly larger than conventional tanks and difficult in tight spaces due to air requirements, heat pump water heaters come with a nearly 400% efficiency boost year round.
Water Heaters	Solar Domestic Hot Water (SDHW) and tankless water heaters help reduce energy consumption.
Water Conservation Measures	Efficient fixtures and rainwater harvesting, can **cut water use by up to 40%**, further reducing energy demand.

Electrical Systems

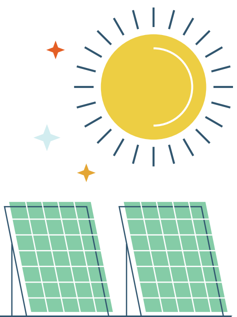
Electrical consumption, including **lighting, appliances, and plug loads**, accounts for 18-20% of total energy use in multi-unit residential buildings. Conversion to **LED lighting** and the use of **occupancy sensors** in corridors and common areas can reduce lighting energy use by an additional **40%**. **Energy efficient appliances** can reduce in-suite electricity consumption by **9-25%**.

Renewable Energy Integration

Renewable energy integration is becoming an essential consideration for affordable housing developments in Alberta, especially as the province transitions to a cleaner energy grid. For multi-family residential buildings, the most practical *renewable energy* sources are **solar photovoltaic** (*PV*) **systems** and **geothermal exchange** (***ground-source heat pumps***). These technologies offer substantial long-term savings on energy costs while reducing greenhouse gas (*GHG*) emissions.



Solar *PV*



Solar *PV* systems are highly effective in Alberta due to the province's abundant year-round sunlight, which ranks among the highest in Canada. With Alberta's rising electricity prices and the desire to reduce *GHG* emissions, rooftop solar arrays have become a viable option for affordable housing developments. Ground arrays require more space and costly infrastructure, making rooftop solar the preferred option for urban settings with limited space.

Design considerations for solar *PV*:	
Be Solar Ready	It is crucial to plan for future solar *PV* or Solar Domestic Hot Water (SDHW) installations early in the design process. Incorporating these design considerations at the outset allows for seamless integration later, even if the project isn't installing solar panels immediately.
Orientation	South-facing roofs capture the most sunlight, though east-west orientations can also work.
Angle	The angle of the solar panels affects energy production. For peaked roofs, the natural slope may be suitable. Flat roofs need tilted panels, which add costs, but lower slopes are generally more efficient and cost-effective.
Conduit and Wiring	Ensure the building has the appropriate conduit for wiring (*PV*) or piping (SDHW) installations.
Space in Electrical Room	Allocate space for inverters, controls, and ensure electrical panels are sized appropriately for the additional load solar *PV* will bring.
Clear Roof Space	Ensure roof penetrations and roof-top equipment are coordinated to be outside of space allocated for panels.
Structural Considerations	Roof structures should be designed to handle the additional dead load of solar arrays, which typically requires designing for a load of at least **0.24 kPa (5 psf)**.

Multi-Family vs. Single-Family Solar *PV* Systems

In multi-family residential buildings, the size and configuration of solar *PV* systems differ significantly from single-family homes. For multi-family buildings, considerations such as **unit density** and **available roof space** are critical. Compact, high-density buildings may face challenges in generating enough solar energy to meet the building's total energy load, especially when roof space per unit is limited.

Design Considerations for Solar *PV*

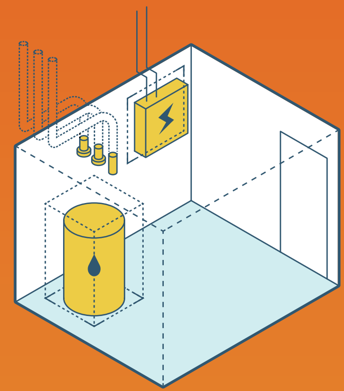
Be Solar Ready

It is crucial to plan for future solar *PV* or Solar Domestic Hot Water (SDHW) installations early in the design process. Incorporating these design considerations at the outset allows for seamless integration later, even if the project isn't installing solar panels immediately.

Space in Electrical Room

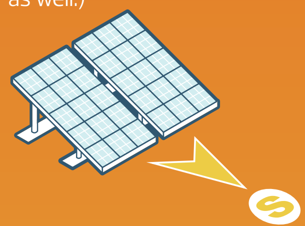
Allocate space for inverters, controls, and ensure electrical panels are sized appropriately for the additional load solar *PV* will bring.

1. **Future solar system control** (91.4 x 91.4 cm)
2. **Future SDHW tank** (91.4 x 91.4 x 182.9 cm)
3. **Solar conduits**



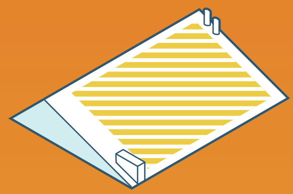
Orient South

When possible (East/West will work as well.)



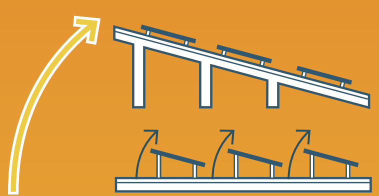
Roof Space

Keep large areas clear of obstructions.



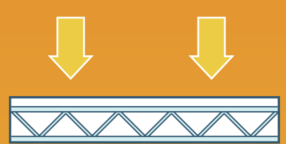
26-56° Ideal Angle

Be mindful of shadowing.



Structural

Design for at least 0.24kPa (5psf).



Geothermal Exchange (*Ground-Source Heat Pumps*)

Geothermal exchange systems utilize relatively stable underground temperatures to provide heating and cooling. They work by circulating a fluid through underground pipes (either vertical or horizontal) that absorbs heat from the earth in the winter and transfers heat back into the earth in the summer.

Vertical vs. field designs in geothermal systems:	
Vertical Boreholes	In tight urban sites with limited land, vertical boreholes can be drilled deep into the ground, allowing the system to tap into *geothermal energy* without requiring a large surface area.
Field Designs	In more spacious rural or suburban developments, horizontal field systems are often more cost-effective, using shallow trenches spread over a larger area.

Why Consider Geothermal

Geothermal systems have a ***Coefficient of Performance*** (***COP***) of 3 to 5, meaning they generate three to five times more energy than they consume. This makes them one of the most efficient heating and cooling systems available.

Benefits of geothermal:	
Energy Efficiency	While geothermal systems have higher upfront costs, they offer significant energy efficiency and long-term savings. In Net Zero designs, geothermal systems are so energy efficient that they can offset heat loss through the *building envelope*. This allows developers to reallocate some of the budget typically set aside for upgrading the *building envelope* toward installing the geothermal system.
Design Flexibility	Geothermal designs can be fine-tuned to meet specific energy goals, including Net Zero readiness. For tighter sites, deeper boreholes can increase energy output, maximizing the system's efficiency without requiring additional space.

The Co-Benefit of Geothermal

One of the significant advantages of geothermal systems is their **high-efficiency cooling capability**. With the same system, geothermal can provide both heating in the winter and cooling in the summer, making it a versatile and energy efficient solution for year-round climate control.

Practical Applications in Affordable Housing Development

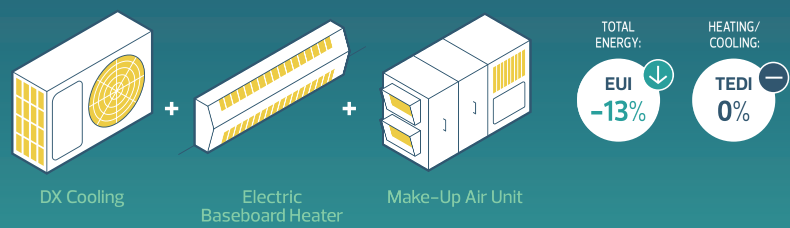
System Selection

When selecting mechanical systems for affordable housing developments, it's important to balance **upfront capital costs** with the long-term operational costs of the systems. The goal is to choose equipment that delivers both immediate savings and long-term efficiency while aligning with the project's *sustainability* objectives.

Key factors to consider in system selection include:	
Energy Type	Choosing between electric, natural gas, or *renewable energy* sources significantly impacts both the upfront costs and operational expenses of the system. While natural gas systems may be less expensive initially, they are subject to rising costs and carbon taxes. Electric systems, especially those paired with *renewable energy*, have higher upfront costs but may offer more savings in the long term, especially as Alberta's grid transitions toward more *renewable energy* sources.
Energy Consumption	Energy consumption is a critical driver of operational costs. High-performance mechanical systems, such as **air-source *heat pumps*** or **geothermal exchange systems**, offer substantial energy savings over time compared to traditional fossil fuel-based systems. These systems may also align better with a **Net Zero** or ***Net Zero Ready*** development.
Maintenance Costs	Centralized systems, while more complex, typically have lower per-unit maintenance costs compared to individual systems. However, individual systems offer flexibility for tenant management and easier replacements when needed. The long-term maintenance demands and the cost of service contracts should be part of the evaluation.
Replacement Costs	The lifespan of mechanical systems can vary significantly. Centralized systems may have longer lifespans, reducing the frequency of replacement. Conversely, individual systems, while potentially easier and cheaper to replace, often have shorter lifespans and require more frequent updates, impacting overall *lifecycle costs*.

LOW CAPITAL COST RESISTANCE ELECTRIC – MECHANICAL SYSTEM ONLY

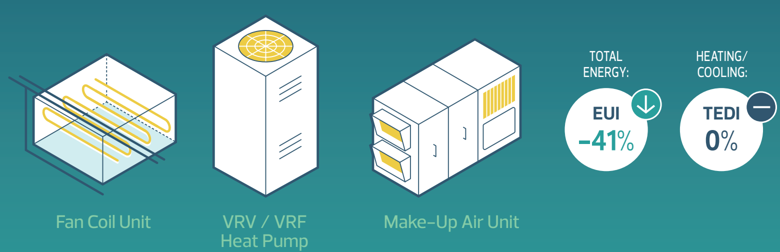
***ECM* 12.0**
Replace baseline natural gas heating with electric resistance baseboard heat (*COP* = 1.0). Cooling unchanged from baseline.



NOTE: *While often the most affordable electric heating system to install, this option improves energy use by 13% compared to the gas boiler baseline. However, due to current electrical costs in Alberta, without enclosure improvements, this system is likely several times more expensive to operate.operate.*

HIGH-PERFORMANCE ELECTRIC – MECHANICAL SYSTEM ONLY

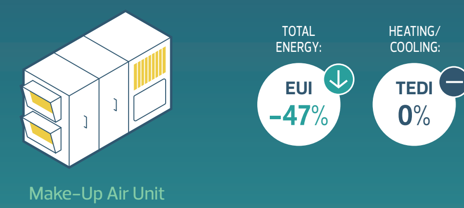
***ECM* 13.0**
Replace baseline natural gas heating and DX packaged cooling with high-performance electric air-source heat pump (heating *COP* = 2.35, cooling *COP* = 4.1), Improved performance heat recovery (70%).



NOTE: *Even without enclosure improvements, the high efficiency of modern air source heat pumps can offset price discrepancies between Edmonton electricity and natural gas. With careful planning and improvements to the enclosure, implementing this system should pay back before replacement while ensuring long-term energy and climate resiliency. Just as natural gas heating systems require a supplemental cooling system, with current technology, the ASHP will require a supplemental heating system for the coldest months (typically below -15°C to beyond -30°C, depending on the system specifications).*

HIGH-PERFORMANCE GEOTHERMAL MECHANICAL SYSTEM ONLY

***ECM* 14.0**
Replace baseline natural gas heating and DX packaged cooling with high-performance *ground-source heat pump* (heating *COP* = 3.7, cooling *COP* = 5.2), improved performance heat recovery (70%).



NOTE: *When correctly designed, GSHPs are typically more efficient than ASHPs in both heating and cooling. However, due to the heat source staying warm throughout the coldest months of the year, a GSHP does not need a supplemental heating system. When combined with adequate solar PV, a well designed geothermal exchange system can even hit Net Zero energy without a high-performance enclosure (see ECM4.3 - Net Zero Renewables Only Path - ECM Bundle).*

Consider Future Cost Trends

When evaluating system selection, it's crucial to consider potential future changes in energy costs, such as the impact of **carbon taxes** on non-*renewable energy* sources. Fossil fuel systems, which might seem cost-effective now, are likely to become more expensive as carbon pricing increases, making renewable or electric-based systems more attractive for long-term savings.

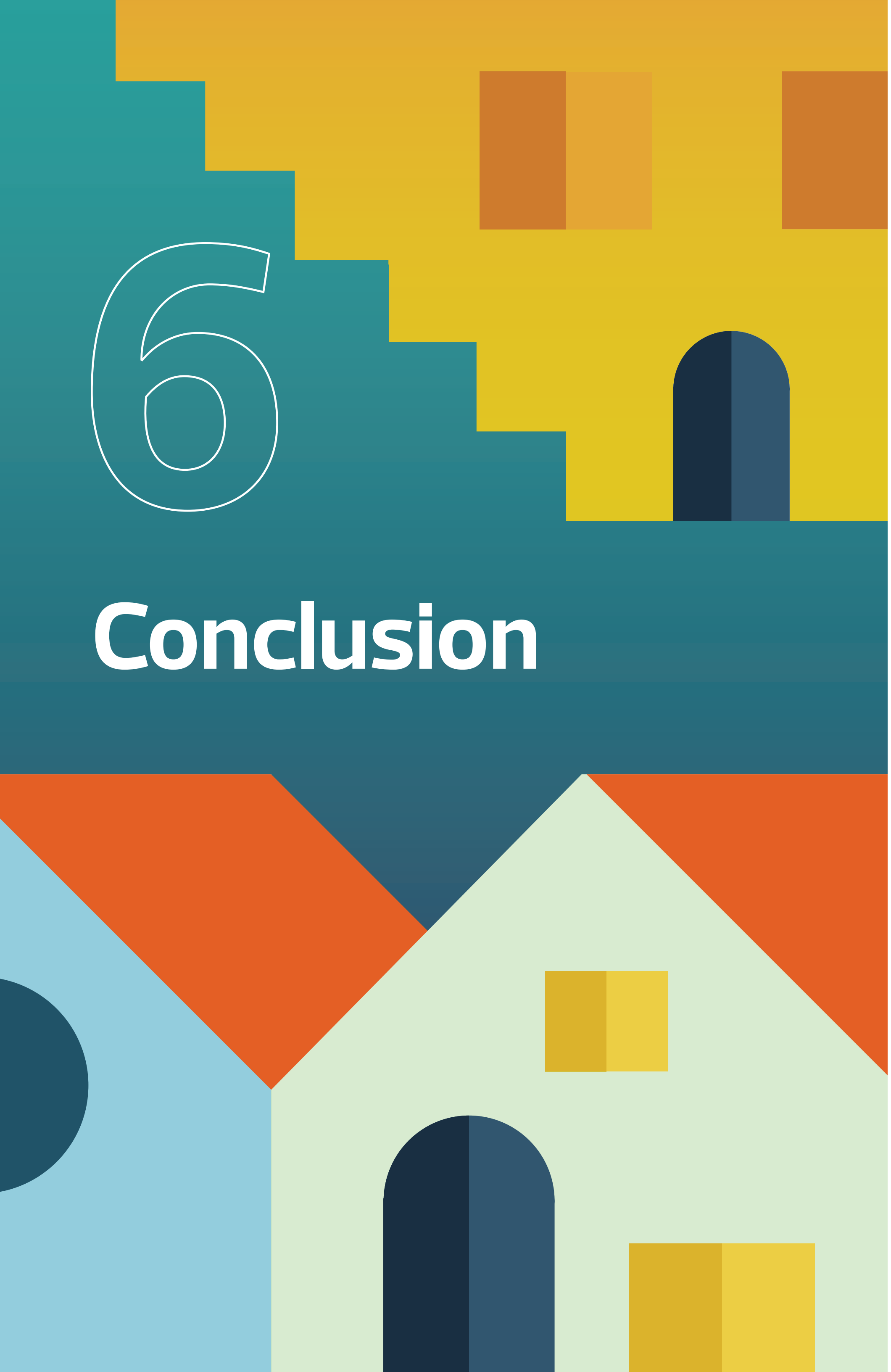
Early Design Collaboration

To make an informed decision, it's essential that the project team—including architects, engineers, and energy consultants—collaborate early in the **design development stage**. They should explore different system options and use energy performance modeling to evaluate the total operational costs of each. This tailored analysis allows the project team to identify the best mechanical system for the building, balancing short-term capital investment with long-term operational efficiency.

Energy performance modelling is particularly valuable because it assesses how each mechanical system interacts with your specific building's design and climate conditions, providing a more accurate picture of total energy use, *lifecycle costs*, and *carbon footprint*. This approach ensures that the selected system aligns with both the project's immediate budget and long-term *sustainability* goals.

An Integrated Design Process (IPD) takes a holistic approach to building design and construction. By involving the entire project team early and collaboratively, it ensures energy efficiency, *renewable energy*, and sustainable features are seamlessly incorporated throughout the project. More information on IPD can be found through **Natural Resources Canada.**

6 Conclusion



As the affordable housing sector continues to grow, incorporating energy efficient and sustainable design strategies into new construction is no longer optional—it's essential. Every development, regardless of whether it targets Net Zero or high-performance standards, can benefit from thoughtful planning that considers energy efficiency from the outset. This approach not only reduces long-term operational costs but also future-proofs buildings against rising energy prices and the ongoing impacts of *climate change*.

Throughout this guide, we've discussed key principles such as *passive design* strategies, high-performance mechanical systems, and *renewable energy* integration. When incorporated early in the design phase, these elements can dramatically improve the energy performance of multi-family residential buildings while enhancing occupant comfort and reducing *greenhouse gas emissions*.

The message is clear: **start early**. The most impactful energy-saving measures come from decisions made at the outset of the design process. Early collaboration between architects, engineers, and energy consultants can lead to more informed choices, ensuring systems are right-sized and integrated seamlessly into the overall building design.

Affordable housing developers are in a unique position to lead the way in sustainable development. By prioritizing energy efficient systems, *passive design* measures, and *renewable energy* integration, developers can not only meet the needs of today's tenants but also ensure long-term affordability and environmental responsibility.

How to Begin

For affordable housing developers, the challenge of creating more energy efficient buildings presents a significant opportunity. Start by incorporating energy efficiency into your project's vision from day one. Collaborate with your team to explore design alternatives and energy performance models, ensuring that your building is not only financially viable but also environmentally sustainable. By doing so, you contribute to a more *resilient* housing sector and a more affordable and sustainable future for everyone.

7 Appendix

Affordable Housing Case Studies

Sustainable Design in Practice

The following case studies highlight affordable housing developments in Edmonton that have successfully integrated sustainable design principles. These projects demonstrate how prioritizing eco-friendly features from the outset can lead to long-term cost savings, improved energy efficiency, and enhanced environmental performance. By showcasing practical examples, this section illustrates the impact of sustainable design choices and provides inspiration for future developments.

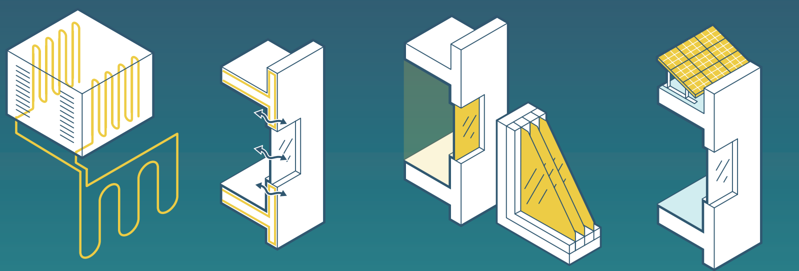
Grace Village

PROJECT TYPE	Supportive Housing with Addictions Support (New Construction)
DEVELOPER	Salvation Army
ADDRESS	12430 140 Ave NW
STATUS	Complete

Grace Village is a prime example of affordable housing integrating energy efficiency and *sustainability*. The development, designed as Net Zero Energy-Ready, incorporates a high performance envelope, geothermal heating and cooling, solar panels, and energy recovery ventilators (ERVs) to drastically reduce energy consumption. These energy-saving features lead to estimated annual savings of $240,000 and a total of $6 million over the building's lifespan—critical for non-profits like the Salvation Army, where operational funding is often more difficult to secure.

Remarkably, these energy-efficiency upgrades only increased the capital costs by 2%, demonstrating that *sustainability* can be cost-effective while providing significant long-term financial benefits. This approach allows non-profit housing providers to reduce operational costs, making developments like Grace Village more financially *resilient*.

Key Energy Efficiency Features:



- **Geothermal and Ground-Source *Heat Pumps*** – Heating and Cooling
- **High-Performance *Building Envelope*** – R44 walls (nominal), Exceptional *Airtightness*
- **High-Performance Windows** – Triple Pane
- **Rooftop Solar *PV*** – 512 Modules, 236 kW System*

**The project fell just short of achieving Net Zero Energy, primarily due to limited roof space for solar PV. While building small and reducing material use is environmentally beneficial, higher-density developments often face challenges in generating sufficient on-site renewable energy due to limited roof area for solar installations. This highlights the trade-off between density and the ability to meet remaining energy needs with solar power.*

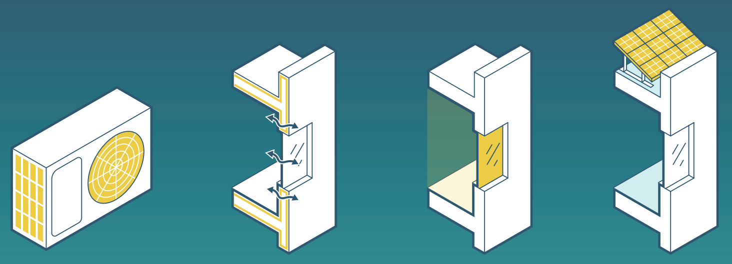
Parkside North

PROJECT TYPE	Mixed Market and Affordable Townhomes (New Construction)
DEVELOPER	HomeEd
ADDRESS	6409 Laubman St
STATUS	Under Construction (at time of publishing)

The Parkside North development by HomeEd focuses on delivering highly energy efficient homes that directly benefit tenants. The units feature well-insulated walls, high *R-value* windows, and energy efficient appliances, all of which help significantly reduce energy consumption. Air-source heat pump heating, cooling, and domestic hot water make efficient use of electric power. Tenants are responsible for paying their electricity (which includes heating/cooling) and water through consolidated utility bills, keeping costs low due to the building's superior energy performance. As Jonathan Lay, VP of Projects at HomeEd, explains, the key benefit of the Net Zero Energy design is that "the units are really energy efficient," ensuring that tenants enjoy lower utility costs while living in comfortable, sustainable homes.

This will be a model for HomeEd's future projects. Each unit is sub-metered so tenants pay their own electricity and water. Sub-metering provides feedback on energy and water consumption, which can alter habits, reduce energy and water end use by 12-15%, and keep utility bills affordable. Rooftop solar *PV* feeds power back directly to the grid, permitting HomeEd the economic benefit of selling the power to offset future operational costs.

Key Energy Efficiency Features:



- **Air-Source Heat Pumps** – Heating/Cooling, Domestic Hot Water
- ***Airtightness*** – Near Passive House Level
- **High-Performance Fiberglass Windows** – Low Window to Wall Ratio (21.6%)
- **Rooftop Solar *PV*** – 1,200 Panels (540W each) = 586,000 kWh per Year

Defined Terms

This section explains key terms and acronyms to help you better understand and apply the concepts in this guidebook.

Airtightness	The measure of how well a building prevents air from passing through the envelope, critical for minimizing energy loss and maintaining indoor air quality.
Annual Fuel Utilization Efficiency (AFUE)	*AFUE* is the measurement of the thermal efficiency of combustion equipment, such as hot water heaters, furnaces, and boilers. A higher *AFUE* means a higher efficiency.
Blower Door Test	A test that measures the airtightness of buildings by using a fan to pressurize or depressurize the structure, identifying leaks that could lead to energy loss.
Building Envelope	The physical separator between the interior and exterior of a building, including walls, roof, foundation, windows, and doors, responsible for maintaining indoor thermal conditions.
***Coefficient of Performance* (COP)**	A measure of the efficiency of heating and cooling systems, indicating how much heat or cooling is generated for each unit of energy consumed. Higher values indicate greater efficiency.
Carbon Footprint	The amount of carbon dioxide and other greenhouse gases emitted into the atmosphere from human activities, such as the consumption of fossil fuels. In buildings, carbon is typically emitted from heating, cooling, electricity use (if the electricity is generated by fossil fuels), and hot water use.

City-Funded Buildings	Projects that are funded by the City in the form of grants, or loans that are provided by the City for up to 33% of the total capital cost of the building project (i.e. land costs if applicable are not included).
Climate Change	A change in global weather patterns, in particular a change apparent in recent decades, attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.
Climate Change Adaptation	Actions that reduce the negative impacts, or take advantage of positive impacts of a changing climate. With expectations of sudden rainfalls that result in overland flooding, hotter summer temperatures, and increases in high winds and convective storms, it is important that one's home and yard is prepared for gradual changes and projected weather extremes.
Climate Change Mitigation	Actions taken to reduce *greenhouse gas emissions*. Reducing *greenhouse gas emissions* is expected to slow global temperature increases.
Cogeneration	A combined heat and power plant uses an engine to generate power while simultaneously using the waste heat for heating purposes. Using the waste heat and creating electricity on-site makes the system more efficient than a traditional boiler paired with grid electricity. These systems are best suited for buildings that have a constant need for heat, otherwise the heat is wasted. Typically, this application works better in larger commercial, institutional, or mixed-use buildings than single-family homes.
Embodied Carbon	The total of all *greenhouse gas emissions* that result from the manufacture and supply of construction products and materials, as well as the construction process itself.
Energy Conservation Measure (ECM)	Specific actions or design strategies implemented to reduce energy consumption in buildings, such as upgrading *insulation*, improving windows, or optimizing mechanical systems.

Energy Modelling	A simulation used to predict a building's energy performance, evaluating the impact of design decisions such as *insulation* levels, glazing, and mechanical systems on overall energy use.
Energy Poverty	Refers to the inability of a household to maintain access to energy services necessary to meet basic health and well-being needs at a reasonable cost.
Energy Use Intensity (EUI)	The sum of the building's annual energy use divided by its floor area, usually in $kWh/m^2 \cdot y$.
Form-Factor	Refers to the ratio of a building's surface area (walls, roof, and floor) to its internal volume. A lower form factor, achieved through compact designs with less exterior surface relative to the interior space, reduces heat loss, improves energy efficiency, and minimizes material usage, making it a key consideration in sustainable building design.
Geo-Exchange	Low-temperature earth energy commonly used for heating and cooling a building with a heat pump. The stable temperature of the earth just below the surface can be used as a heat source or sink to generate free earth energy for a building.
Geothermal Energy	Energy derived from the heat in the interior of the earth.
Greenhouse Gas (GHG) Emissions	Gases such as carbon dioxide, methane, and nitrous oxide, which contribute to global warming and are produced by burning fossil fuels, industrial processes, and building operations.
Ground-Source Heat Pump (GSHP)	A central heating and/or cooling system that pumps heat to or from the ground. It uses the earth as a heat source in the winter or a heat sink in the summer. This design takes advantage of the moderate temperatures in the ground to boost efficiency and reduce the operational costs of heating and cooling systems. Also known as a geo-exchange system.

Heat Pump	A mechanical system that extracts heat out of a cold space into a warmer one, such as out of the air or the ground and into a home. *Heat pumps* can also be used for cooling and typical examples of this are air conditioning units and refrigerators. The relative energy and cost savings for installing a heat pump depend on your heating system and the current cost of energy. By running a heat pump you will use less natural gas, but you will use more electricity to run the pump.
Heat Recovery Ventilator (HRV)	A fully ducted system that delivers fresh-filtered outside air into the house, while moving stale air out. As the fresh air passes the stale air (in separate chambers), the heat from the hot stale air is passed to the cool fresh air, pre-warming it before it is heated. This action reduces the amount of energy it takes to heat the home.
Insulation	Materials used in the walls, roof, and floors of a building to reduce heat transfer, keeping the building warm in winter and cool in summer.
Lifecycle Cost	The total cost of ownership of an asset over its life. *Lifecycle cost* takes into account all costs of acquiring, owning, operating, maintaining and disposing of an asset in order to maximize return on investment and achieve the highest, most cost-effective performance.
Low-Emissivity (Low-E) Coating	A microscopic coating applied to glass that helps reduce heat loss or gain by reflecting infrared light, improving the energy efficiency of windows.
Massing	An architectural term used to describe the size of the building, as well as the general shape and form.
MURB	Multi-Unit Residential Building
Net Positive	Describes a building that will generate surplus energy annually.

Net Zero Energy Building	A building that produces as much energy as it consumes over the course of a year, typically through *renewable energy* sources such as solar panels or geothermal systems.
Net Zero Ready	A building that is designed with very low energy consumption but does not yet have its on-site energy generation systems installed. This is sometimes done due to limited funding (solar can be added later) or in anticipation of solar panel prices dropping.
On-Demand Hot Water Heater	On-demand or tankless hot water heaters can be between 19 and 53% more energy efficient than conventional storage tank water heaters; however, they typically cost more to install. The greatest potential improvements are in homes that use the least hot water—typical hot water heaters continually use energy to heat water all day long, even when not being used.
Passive Design	*Passive design* is key to green building design. It's an approach that maximizes the use of free, renewable sources of energy, such as sun and wind, to provide household heating, cooling, ventilation, and lighting. This reduces or removes the need for mechanical heating or cooling. Using *passive design* can reduce temperature changes, improve indoor air quality, and make a home drier and more enjoyable to live in.
Passive Solar Gain	Heat energy that is gained from the sun through the building's windows. *Solar gain* helps heat the building in the winter but increased load on cooling systems in the summer.
Peak Oil	The point in time when the maximum rate of global petroleum extraction is reached, after which the production rate enters terminal decline.
Photovoltaic (PV) Panels	Solar panels designed to convert sunlight into electricity, often installed on rooftops to reduce reliance on grid electricity and lower *greenhouse gas emissions*.

R-Value (insulation)	A measure of thermal resistance used to evaluate the effectiveness of *insulation* materials; higher *R-values* indicate better insulating properties.
Renewable Energy	Energy generated from natural resources that are replenished on a human timescale, such as solar, wind, and geothermal power, used to reduce reliance on fossil fuels.
Resilience/Resilient	The concept of *resilience* covers the proactive capacity of public, private, and civic sectors to withstand disruption, absorb disturbance, act effectively in a crisis, adapt to changing conditions including climate change, and grow over time.
RSI	*RSI* stands for "Résistance Système International," meaning it measures the R-value of an insulating material, but uses the international metric system of units. Converting one to the other requires some simple math.
R-Value (US)	*RSI* multiplied by 5.678 or *RSI* (SI) = *R-value* multiplied by 0.176.
Solar Gain	The increase in temperature in a space, object, or structure that results from solar radiation. The amount of *solar gain* increases with the strength of the sun and with the ability of any intervening material to transmit or resist the solar rays. This concept is also referred to as solar heat gain or *passive solar gain*.
Solar Heat Gain Coefficient (SHGC)	A number indicating how much solar radiation passes through a window and contributes to heating a building. A lower *SHGC* reduces heat gain in hot climates, while a higher *SHGC* allows for beneficial heat gain in cooler climates.
Sustainability	The ability to be maintained at a certain rate or level; can also be referred to a process that is self-perpetuating. In the context of this publication, *sustainability* refers to maintaining environmental, social, and financial balance by avoiding the exploitation of natural resources and considering future scenarios.
TCBO	Total Cost of Building Ownership

Thermal Bridging	Occurs when materials that are poor insulators, such as steel or concrete, provide a path for heat to escape through the building envelope, reducing overall energy efficiency.
Thermal Energy Demand Intensity (TEDI)	The sum of the building's annual energy used for space and ventilation heating. It represents a measure of efficiency of the building's envelope and ventilation systems. Usually expressed in $kWh/m^2 \cdot yr$.
Thermal Mass	The ability of a material to absorb and store heat energy. Buildings with high *thermal mass* can store heat during the day and release it at night, improving energy efficiency.
U-Value	A measure of how much heat is lost through a material, such as a window or wall. Lower *U-values* indicate better *insulation* and less heat loss.
Window-to-Wall Ratio (WWR)	The proportion of window area to total wall area in a building. A higher ratio can increase natural light but also lead to greater heat loss, requiring careful balancing for energy efficiency.

www.edmonton.ca/affordablehousingdevelopers

Affordable Housing and Homelessness
Social Development Branch

18th Floor, Edmonton Tower
10111 104 Avenue NW
Edmonton AB T5J 0J4