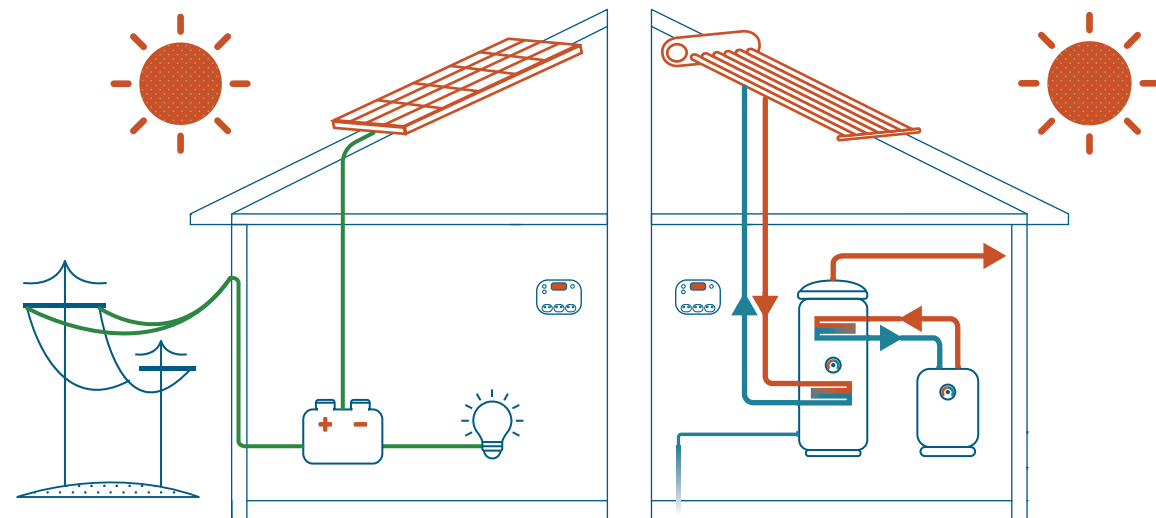


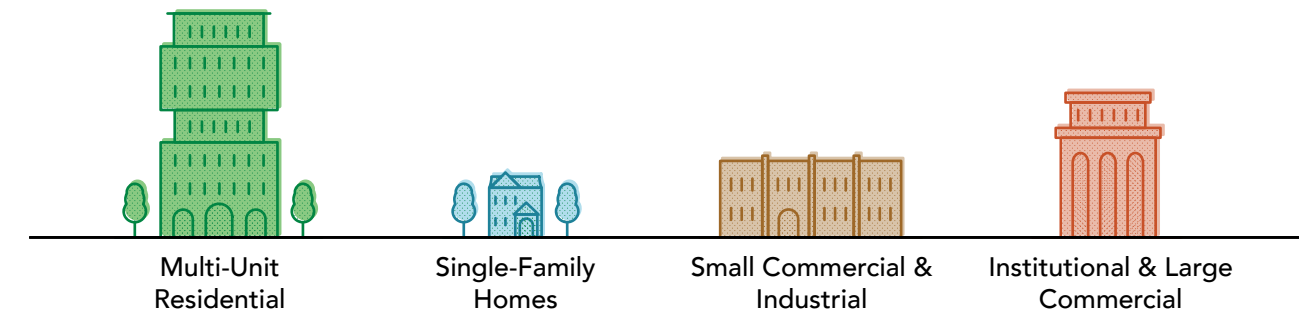
Net Zero Building Retrofit Guides

Solar and Batteries

Technology Companion Guide



Applicable to:



Co-benefits

Resilience



Indoor Air Quality



Occupant Comfort



Property Value



Impacts

Emissions Reduction



Utility Savings



Capital Cost



Maintenance Requirements

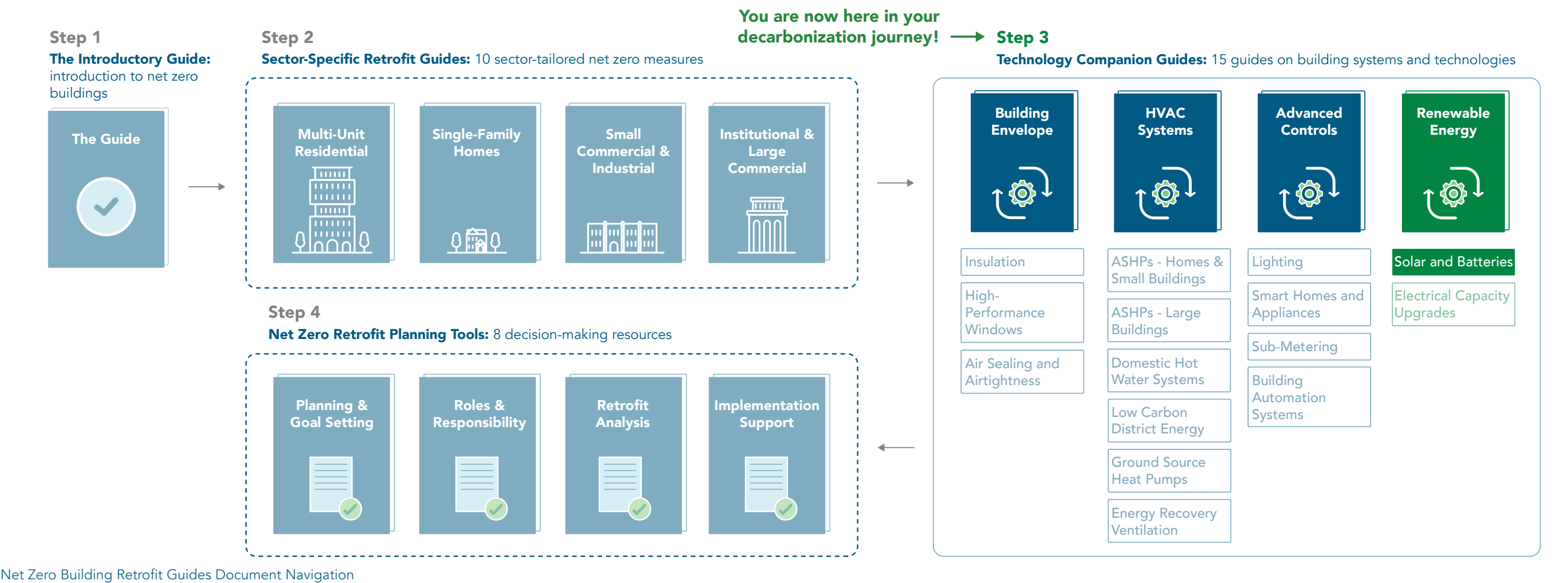


Navigating the Net Zero Building Retrofit Guides

Reducing Greenhouse Gas (GHG) emissions is a journey. It's also an opportunity to make your building more comfortable, healthier, valuable, and resilient to extreme weather events. Successfully arriving at your net zero destination requires careful planning and the right travel companions to ensure a smooth trip.

The City of Toronto's **Net Zero Building Retrofit Guides** include a range of documents designed to support home and building owners reduce GHG emissions from their buildings.

- 1. **The Introductory Guide** introduces the topic of "net zero buildings." The guide's goal is to familiarize all home and building owners with Toronto's net zero goals and concepts.
- 2. **The Sector-Specific Retrofit Guides** highlight net zero measures tailored to each building sector and type. These guides provide guidance to plan and implement retrofit projects specific to your building.
- 3. **The Technology Companion Guides** provide technical information about building systems and technologies related to net zero measures and retrofits.
- 4. **The Net Zero Retrofit Planning Tools** provide decision-making resources to help home and building owners prioritize their retrofit projects. The tools include needs assessments, checklists, and support for contractor selection.



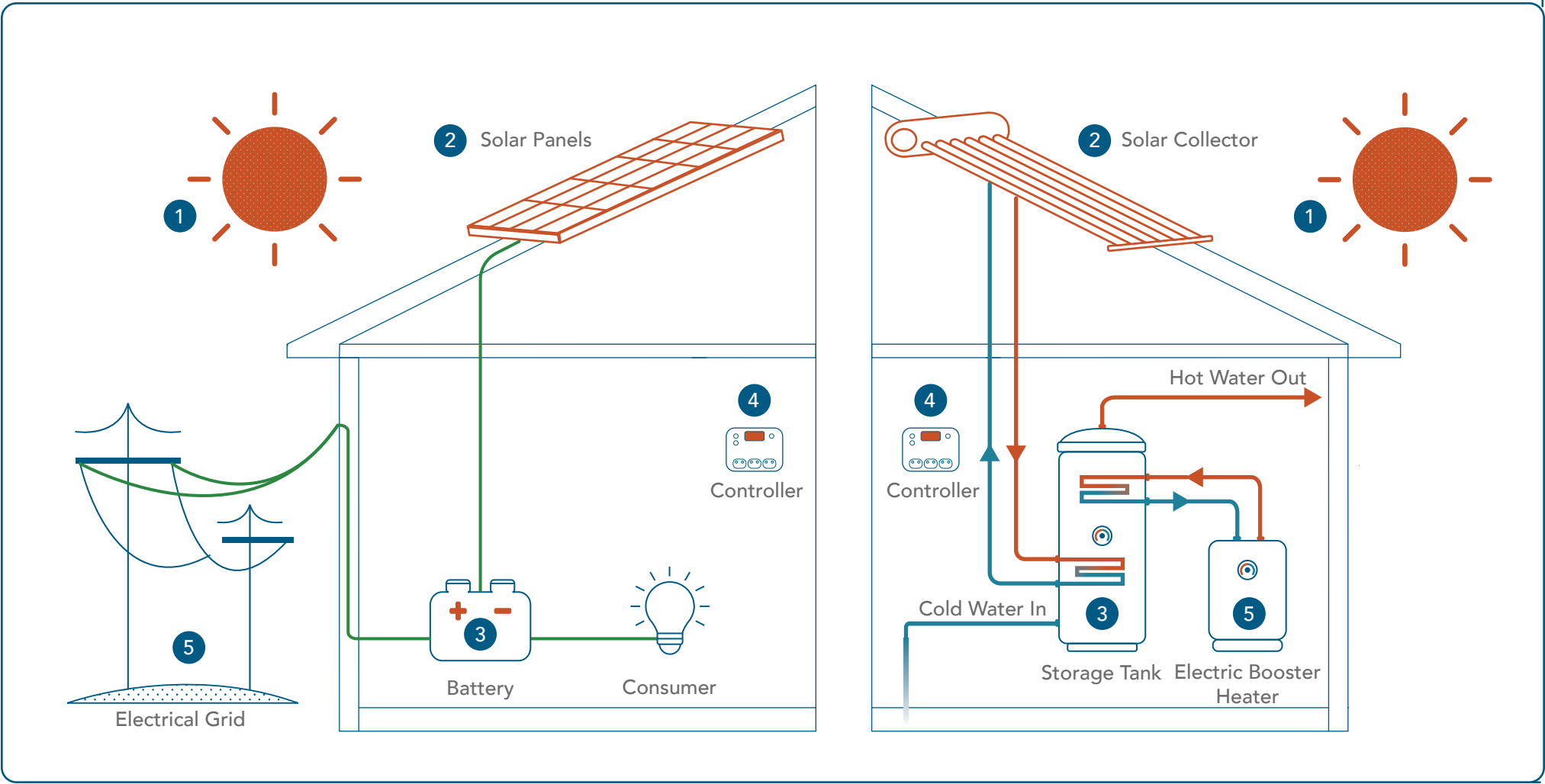
Solar and Batteries

What Is This Technology

Solar energy is radiant light and heat from the sun that is harnessed for a variety of uses. It is a renewable, zero emissions resource.

Solar panels, also known as solar photovoltaics or solar PV, convert solar radiation into electricity. Solar energy is intermittent, meaning that it is not always available at full capacity, like at night or in overcast conditions. Optional batteries can serve as energy storage units, holding excess solar energy produced during the day. This stored energy can then be used later, such as at night or during cloudy periods when solar panels aren't generating electricity.

Solar thermal collectors capture radiant heat from the sun in fluid filled pipes. This heat can then be used to supplement domestic water systems or swimming pool heating. Excess hot water can be stored in an insulated tank, also known as thermal battery, for later use.



How Solar and Batteries Work

Solar technology can provide electricity as shown on the left or capture thermal energy for domestic hot water as shown on the right.

- 1 The sun provides light, radiation, and heat.
- 2 From sunlight exposure, solar panels convert radiation to electricity, while solar collectors capture thermal energy
- 3 Excess electricity can be stored in a battery system or discharged to the electricity grid. Thermal energy can be stored in storage tanks, also known as thermal batteries.
- 4 A controls system makes sure that energy is generated, used, stored, or sent to the grid in an efficient manner.
- 5 Solar energy isn't always available to meet the needs of the building. The electrical grid can provide reliable electricity when solar panels are not generating enough electricity. An electric booster heater can be used to add additional heat to solar-thermal systems to meet building needs.

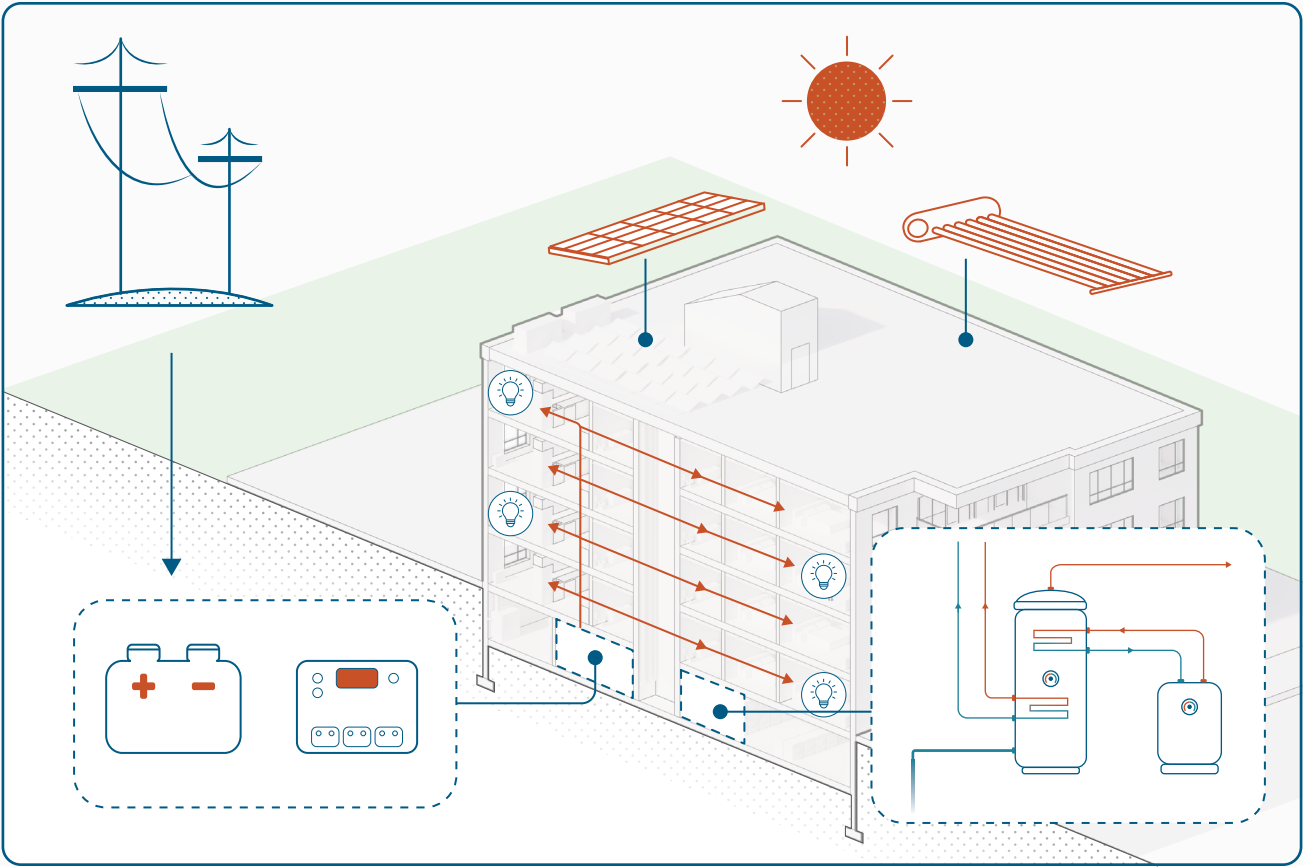
Retrofit technology explained.

When to Retrofit This System

Solar energy can be used to complement your existing building systems and electrical demands. Solar PV can be used to reduce your utility bills. Solar thermal is best used when you have a large, year-round hot water demand, such as a swimming pool, or a large number of residential units. Consider installing solar if you are planning roof or structure upgrades, or if you want to generate renewable electricity to supplement your building’s electrical needs.

Why Retrofit This System

Harnessing energy from the sun can reduce utility peaks and can contribute to a more resilient power grid. Buildings with high energy use, time-of-use electricity billing, and good sun exposure can benefit from renewable solar energy. Once the systems are installed, they will generate free, zero emissions electricity for the life of the equipment. Batteries can add resilience to your electrical system and help mitigate the effects of blackouts. By reducing energy consumption, you can decrease reliance on utilities and protect yourself from rising energy costs, all while lowering GHG emissions.



Typical locations in a building associated with this technology

Below are co-benefits and impacts to help you better understand this technology.

Co-benefits

- Resilience:** Solar energy generation and battery storage reduce a building’s reliance on the electrical grid, increasing its ability to withstand shocks and stresses like blackouts.
- Indoor Air Quality:** The installation and use of solar and batteries does not impact indoor air quality.
- Occupant Comfort:** The installation and use of solar and batteries does not impact occupant comfort.
- Property Value:** The presence of on-site solar energy can generate interest from environmentally conscious buyers and tenants. In addition, reduced energy costs and increased resiliency can also result in higher property values.

Impacts

- Emissions Reduction:** Solar energy is emissions-free. Using solar energy over traditional electricity sources saves emissions associated with the electrical grid.
- Utility Savings:** The energy generated by solar equipment is free. Excess energy can be sent to the electrical grid and can reduce your utility costs through net metering.
- Capital Cost:** Installing the equipment for solar energy generation is affordable. Larger systems or systems that include energy storage may require complex upgrades to the electrical system.
- Maintenance Requirements:** Solar energy equipment requires regular maintenance to keep it functioning efficiently. With few moving parts, they are relatively simple to maintain.

Types of Systems and Retrofit Solutions

There are a variety of technologies available to capture and utilize solar energy. The following technologies have unique characteristics that make them suitable for a variety of applications and uses.

Here are some possible solar retrofit solutions:

Solar PV

Solar PV uses solar panels to capture and convert sunlight into electricity, which can then be used to power your building.

Best Suited For: Buildings that have roof space or open outdoor areas.

Energy Storage: Lithium-ion (rechargeable) batteries, like those found in electric vehicles.

Solar Thermal

Solar thermal uses the heat from the sun to heat fluid in a pipe, which is then used to heat buildings.

Best Suited For: Buildings that have a need for hot water, such as a pool or large domestic hot water demand.

Energy Storage: Thermal batteries, which are large, insulated tanks that store warm water for later use.

Building Integrated Photovoltaics (BIPV)

Solar PV technology is integrated into architectural components of the building. Serving a dual purpose, BIPV function as customizable architectural components as well as electricity generators, which balance performance with aesthetics.

Best Suited For: Buildings with large facades that get a lot of south and west-facing sun, such as event spaces, places of worship, community centers, and apartment buildings.

Energy Storage: Lithium-ion (rechargeable) batteries, like those found in electric vehicles.

Solar Air Preheat

This system uses the sun’s radiant heat to warm building materials that absorb sunlight, such as dark metal cladding. Outdoor air is directed over those building materials, where it picks up heat. This pre-conditioned air is then heated further by the building HVAC system to ventilate spaces, reducing the heating load for ventilation air.

Best Suited For: Buildings with large facades that get a lot of south-facing sun, such as warehouses, large institutions, and apartment buildings.

Energy Storage: Not available.

How to Implement

Before starting, refer to the **seven-step roadmap to net zero** in the **Introductory Guide** and in your **Sector-Specific Retrofit Guide** to ensure your retrofit aligns with your overall strategy and goals. Here are a few steps to get you started with a solar energy generation and storage retrofit:



1. Search your address on the SolarTO map on the City of Toronto website to get a preliminary estimate of the potential of your building for solar generation.
2. Consider space requirements for solar energy generation.
 - o Do you have open roof space?
 - o Do you have unobstructed south and west-facing walls?
3. Determine the best ways to use the solar energy you will generate, and whether you will need energy storage.
 - o Will you need batteries to store energy for later?
 - o Does your building use large amounts of hot water, i.e. for a swimming pool? If so, consider solar thermal.
4. Reach out to qualified solar installers – see the list on the City of Toronto SolarTO website for guidance. These experts can help you understand your building’s needs and capabilities. They will also assist with system design and connection to the grid.
5. Explore financial incentives offered by the City of Toronto and federal Government (refer to City of Toronto resources noted at end of this guide).
6. Install and commission the system.
7. Start producing solar energy and sign up for net-metering with Toronto Hydro to get paid for any electricity you generate that you don’t use.

What is Net-Metering?

Net-metering measures the amount of energy added to the grid and gives you credits on your utility bill. When you are producing more electricity than you can use, the extra energy can be given back to the grid for other buildings to use.



Opportunities

Evaluate how this retrofit can be integrated with the following building systems to maximize potential synergies and optimize overall performance.



Building Controls and Automation Systems

Solar energy management systems optimize the generation, use, and storage of energy. They can work with your current building controls to improve efficiency.



Heating Systems



Domestic Hot Water



Gas Appliances

Adding solar panels and batteries can help lower your electricity required from the grid, particularly useful as you electrify your building.



Building Envelope



Lighting



HVAC Systems



Appliance Upgrades

Consider the timing of this retrofit with envelope upgrades such as façade upgrades and roof replacement.

Improving energy efficiency of building systems like lighting and HVAC will mean that any solar generation will be able to meet a greater amount of your needs.

Challenges and Solutions

Adding a solar and battery system to your building can be challenging. Below are some common challenges you may face and how to solve them.

Challenge 1: Solar Availability

Solution: Solar energy depends on sunlight availability, which varies throughout the day and across seasons. Remain connected to the grid to access electricity as needed.

Challenge 2: Power Management

Solution: Properly design your system to switch between solar, batteries, and the electrical grid at the correct times to meet your building’s needs.

Challenge 3: Space and Clearance

Solution: Plan your project with your service provider. Review competing uses for the space to make sure there is enough space for your solar equipment and other building equipment. Optimize the location of your equipment, including considerations for roof slope. South-facing roofs will have the best energy output.

Challenge 4: Roof and Structure

Solution: Consider your roof age and condition, as well as its structural capacity. It is not recommended to install solar on a roof that is over 10 years old (depending on the condition). A professional structural analysis of your roof will help you avoid structural problems.



Toronto’s Climate Considerations

Due to Toronto’s climate, there are a few things to consider before implementing solar and batteries.

Cold Performance

Toronto’s cold climate is not a deterrent to installing a solar system. Solar PV works better in cold temperature than in hot weather.

Cold weather can affect the performance and efficiency of batteries. Batteries should be located in a warm space or insulated from the cold.

Snow and Ice Buildup

Solar energy systems should be kept free of snow and ice for optimal performance.

Hours of Daylight

In Toronto, winter days are short. This will impact the amount of energy generated in the winter. On the contrary, long summer days will mean lots of opportunities for energy generation.

Ready!

You should now have a better idea of what **Solar and Batteries** are, their co-benefits and impacts, and how to implement them in your building given potential synergies and challenges!

Also check your building **Sector-Specific Retrofit Guide** for steps to achieve net zero and visit the other **Technology Companion Guides** to learn more about retrofit measures.

Other guides in the Renewable Energy Technology Companion Guides:

- Electricity Capacity Upgrades

Other resources in the Net Zero Building Retrofit Guides:

- The Introductory Guide
- Sector-Specific Retrofit Guides
- Net Zero Retrofit Planning Tools

For more information, please refer to these other City of Toronto resources:

- Net Zero Existing Building Strategy
- Transform TO Net Zero Strategy
- Toronto Green Standard
- Better Buildings Partnership
- Better Homes: Green Resources for Residents
- Energy & Water Reporting for Buildings
- SolarTO

Prepared for:



Prepared by:



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For larger buildings, condominiums and businesses, contact: bbp@toronto.ca

For homes and duplexes, contact: BetterHomesTO@toronto.ca homeenergyloan@toronto.ca

