DECARBONIZATION READINESS GUIDE FOR AFFORDABLE MULTIFAMILY HOUSING

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Seattle Office of Sustainability & Environment

HOUSING DEVELOPMENT consortium

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Acknowledgements

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The mission of Seattle's OSE is to ensure a clean and healthy environment for every resident of Seattle. OSE provided leadership, funding, and policy guidance that shaped the direction and scope of this Guide, ensuring alignment with local climate goals and regulatory requirements.

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Case study projects featured in this Guide draw on contributions from O'Brien 360 and Ecotope, Inc., reflecting their experience and technical work in improving building performance, designing energy systems, and reducing building emissions.

Together, these partners contributed complementary perspectives that made this Guide more comprehensive. Their shared commitment to reducing greenhouse gas emissions while supporting healthy, resilient, and affordable housing is reflected throughout this document.

Executive Summary

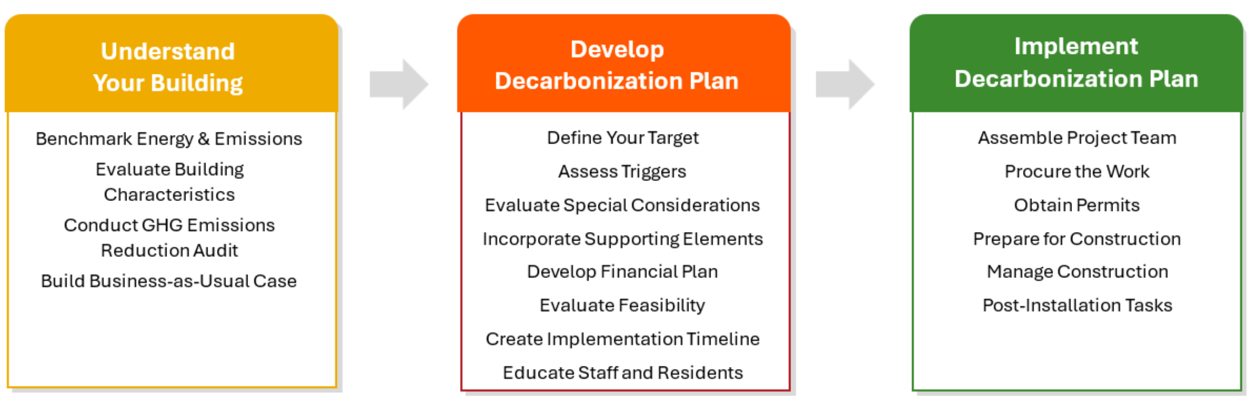
Multifamily building owners and operators across King County and the City of Seattle are entering a new era of building decarbonization—one shaped by evolving energy codes, performance standards, and growing expectations for healthier, more-resilient, and more-equitable housing. This Readiness Guide is designed to help multifamily property owners, asset managers, and property managers understand what decarbonization means for existing buildings, what is required under current regulations, and how to plan and carry out an effective, phased approach to reducing their buildings' greenhouse gas emissions.

Decarbonizing multifamily buildings offers multiple benefits:

- improved comfort and health for residents
- lower and more predictable energy costs
- streamlined building operations
- reduced carbon pollution that supports community-wide climate goals

For building owners, proactive decarbonization helps with future compliance with the City of Seattle's Building Emissions Performance Standard (BEPS) and Washington State's Clean Buildings Performance Standard (WA CBPS), while providing a structured pathway to modernize building systems over time.

This Guide outlines a three-step decarbonization process:



For each step, the guide outlines practical details and best practices, linking tasks to relevant WA CBPS and Seattle BEPS requirements and timelines.

Equity is embedded throughout the Guide, recognizing that decarbonization efforts must benefit the residents most affected by energy burdens, air quality challenges, and climate-related risks. Recommendations include strategies for resident engagement, minimizing cost burdens, supporting local workforce development, and preventing displacement during retrofit work.

Because each building is unique—and because Seattle and Washington State offer multiple compliance pathways, the Guide emphasizes the need for tailored planning supported by qualified professionals, including energy auditors, engineers, contractors, and benchmarking experts. It also links to key resources, including utility incentives, technical assistance programs, and compliance support offered by local and state agencies.

This document is not a substitute for legal or regulatory guidance. Instead, it serves as an accessible starting point to help multifamily building owners understand what decarbonization entails, what steps are required for compliance, and how to begin preparing their teams, residents, and capital plans for a low-carbon future. By following the framework and recommendations provided, owners can reduce risk, optimize investments, and ensure their buildings remain resilient, efficient, and healthy for decades to come.

Glossary

1,000 British Thermal Units (kBtu): the amount of heat needed to raise one pound of water by one degree Fahrenheit. It is a standard measure used to compare energy consumption across different fuel sources – gas, electricity, etc.

1,000 British Thermal Units per Hour (MBH): the measure of how much heat or cooling HVAC equipment can produce in an hour. For example, a 100 MBH furnace produces 100,000 British Thermal Units per hour.

Annual Fuel Utilization Efficiency (AFUE): the measure of a furnace or boiler's efficiency representing the percentage of fuel that is converted to usable heat vs. wasted energy.

CO_2e (carbon dioxide equivalent): a common metric to assess the total climate effect of all GHGs (like methane, nitrous oxide) alongside CO_2.

Coefficient of Performance (COP): the measure of heating and cooling equipment's performance. A higher coefficient indicates greater efficiency.

Energy Efficiency Ratio (EER): the measure of an air conditioner's cooling efficiency at a specific peak operating condition (95°F outside and 80°F inside).

Energy Use Intensity (EUI): the measure of how efficiently a building uses energy, expressed as kBtu/SF/yr. A lower value indicates more efficient energy use.

Greenhouse Gas Intensity (GHGI): a measurement of a building's greenhouse gas emissions from its energy use relative to its size. A building's GHGI is the sum of each energy fuel source consumed in one year multiplied by the emissions factor of that fuel, divided by the gross floor area of the building. GHGI is measured as a value of kgCO_2e units per square foot per year (kgCO_2e/SF/yr). A lower value indicates a building emits less GHG per square foot.

Greenhouse Gas Intensity Target (GHGIT): a target that limits a building's GHGI under a building performance standard, such as Seattle's Building Emissions Performance Standard (BEPS). GHGIT is reported as a value of kgCO_2e units per square foot per year (kgCO_2e/SF/yr).

Heating Seasonal Performance Factor (HSPF): the measure of an air-source heat pump's efficiency over a typical heating season.

Kilowatts (kW): the standard unit of measure for electricity produced at any moment in time, equal to 1,000 watts.

Kilowatts per Hour (kWh): the amount of electricity consumed over an hour.

LED: light-emitting diode; a highly efficient technology used in modern lighting fixtures and other electronic equipment.

Measurement & Verification (M&V): a formal, planned process for quantifying the energy savings generated by an energy efficiency measure within a building.

Seasonal Energy Efficiency Ratio (SEER): the measure of an air conditioner or heat pump's efficiency during a normal cooling season.

Thermal storage: technology that captures, stores, and then releases thermal energy (heat or cold) for later use.

Weather normalized energy use: a calculation that adjusts a building's actual energy consumption to reflect what it would have used under normal (average) weather conditions, removing the impact of exceptionally hot or cold weather.

Section 1. Building Decarbonization Overview

Intended Purpose and Audience of This Guide

This guide is designed to help multifamily building owners, property managers, and asset managers understand the overall steps, available resources, and compliance pathways for decarbonizing their existing properties in King County, Washington, in alignment with City of Seattle and Washington State building performance standards. Although some multifamily properties include commercial spaces, this guide is intended solely for the residential portions of those buildings. Commercial tenant readiness involves requirements and considerations beyond the scope of this document.

This guide to address new construction requirements or how to design a new zero-carbon building; its purpose is to inform owners and managers of **existing** buildings about how to reduce and eventually eliminate greenhouse gas emissions from their buildings to help them comply with applicable laws. Where buildings aren't required to fully decarbonize, this guide provides useful information for owners who want to go beyond the mandates to create healthier environments for their residents and a healthier planet.

Each building has distinct characteristics, opportunities, and constraints that require tailored approaches to implementing decarbonization measures. Thus, this guide is not intended to serve as a universal solution. Although it attempts to provide comprehensive information on the decarbonization process, along with references to additional resources, this guide should be regarded as an entry point—a starting framework for your decarbonization efforts. All building owners and managers will need additional resources—such as technical documents, qualified consultants, and experienced retrofit contractors—to support them through each subsequent step.

What is Building Decarbonization?

Building decarbonization is the process of reducing and ultimately eliminating greenhouse gas emissions from buildings. Building decarbonization can broadly include greenhouse gas emissions associated with all phases of the building lifecycle (i.e., from design to construction to operations to demolition).

Video: https://www.youtube.com/watch?v=m3qgftmaeS8

Strategies to Decarbonize Buildings

Strategies to decarbonize a building generally fall within the following four categories.

Energy-efficiency (EE) measures

Energy-efficiency measures are strategies intended to reduce the energy consumed from space conditioning, lighting, water heating, etc., while maintaining comfort, health, and safety for residents. They are often the most cost-effective way to reduce energy consumption and in turn lower utility expenses. The complexity and cost of EE measures vary depending on the energy reduction and other outcomes to be achieved. Most EE measures involve some form of technology upgrade, retrofit, or change to how a building is operated, although some involve only readjusting the settings of equipment or control systems. Many of the upgrades are eligible for financial incentives through local, state, and utility programs, which offset some or all of the implementation costs. Common EE measures include:

- Upgrading lighting systems to highly efficient light-emitting diode (LED) fixtures
- Sealing cracks and openings to minimize air leakage
- Replacing windows with higher-efficiency models
- Installing insulation in walls, floors, and attics to improve thermal performance and reduce heat loss
- Optimizing building systems through retro-commissioning[1] to ensure equipment operates efficiently
- Adjusting thermostat and central heating, ventilation, and air conditioning (HVAC) equipment set points
- Installing lighting controls and occupancy sensors
- Implementing a building automation system to manage lighting, heating, and cooling based on real-time conditions

Implementing the efficiency measures described above help to reduce the building's energy load the amount of energy it needs to operate effectively. Lowering the energy load provides several benefits:

- A tighter, better-insulated building envelope reduces the heating and cooling demands placed on HVAC and hot water systems, allowing these needs to be met with smaller, more efficient equipment.

[1] The systematic process of evaluating, analyzing, and optimizing the performance of an existing building's systems to improve energy efficiency and occupant comfort.

- It frees up capacity for the building's existing electrical service, which may help avoid the need for costly electrical service upgrades when switching from fossil-fuel systems to electric equipment.
- It helps mitigate potential peak-demand charges during periods of high electricity use by keeping overall system demand lower and more stable.

Enabling activities and infrastructure readiness

To enable more-complex decarbonization measures in some buildings, retrofits may need to be made to the building's infrastructure and components, such as:

- Electrical panel upgrades required for high-efficiency electrical equipment
- Structural reinforcement for rooftop solar or other equipment
- Creating space for heat pumps and heat pump water heaters

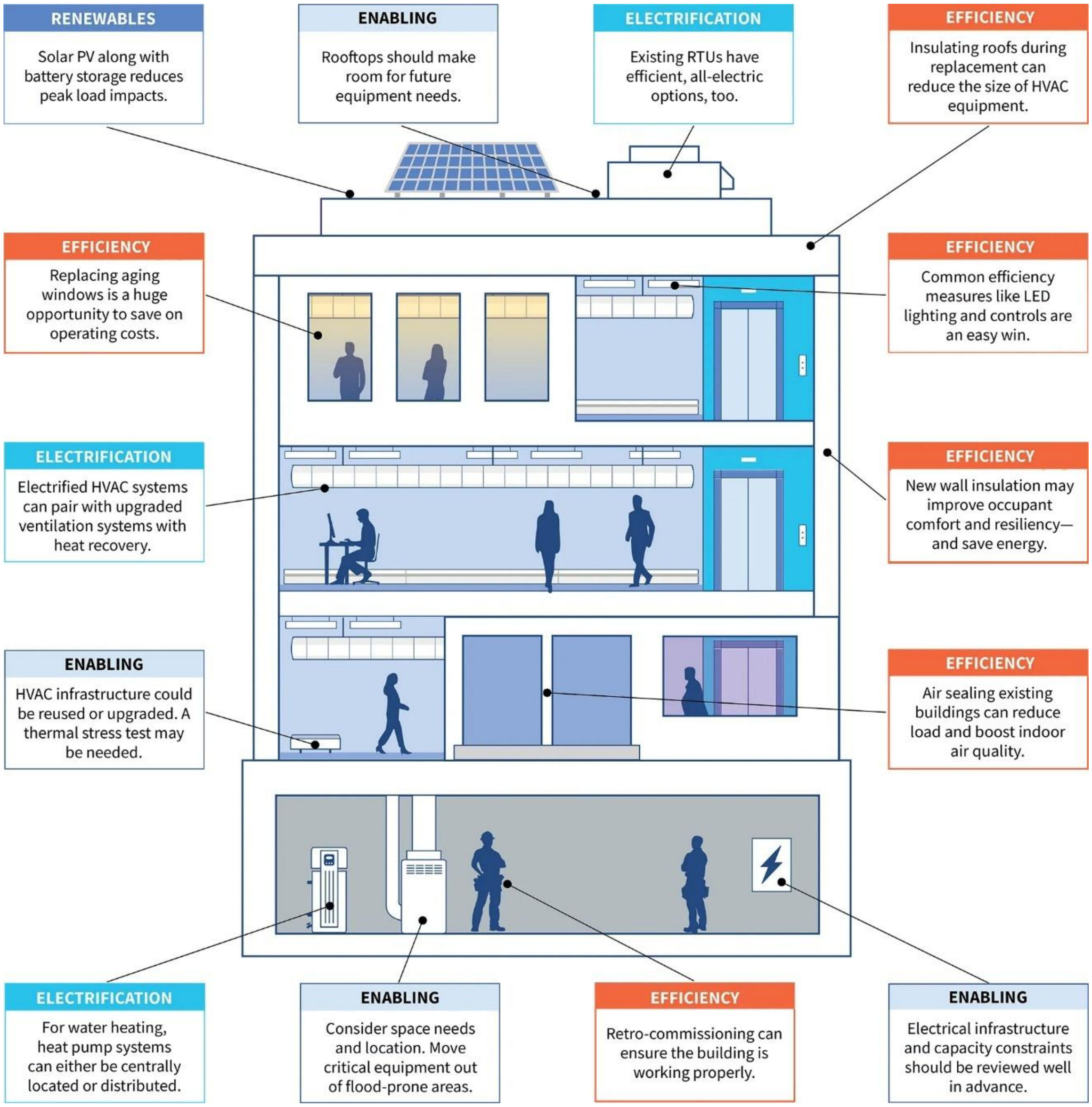
Electrification of combustion systems

Transitioning HVAC and water-heating equipment, clothes dryers, and stoves from fossil fuels to electricity is a critical step in decarbonizing buildings, particularly in a region like Seattle/King County where the electricity that is provided by local utilities is or soon will be carbon-free[2] [3]. Electrification enables the use of energy generated from renewable sources, aligning with the goal of eliminating greenhouse gas emissions. If switching to electric systems and appliances results in measurable energy or cost savings, or avoids the volatility of some non-electric fuels, it may be beneficial to make the transition even before renewable energy procurement is in place.

Renewable energy and storage

The last step to fully decarbonizing your building is to ensure that all electricity supplied to it comes from renewable energy. You can install renewable energy systems such as solar on site and/or you can procure electricity from local utilities that is generated from renewable sources such as hydropower and wind. Including on-site battery storage can protect your building from outages, as well as enable you to store electricity during times of day when electricity is cheaper and then discharge it during times of day when electricity is more expensive.

[2] Seattle City Light's energy mix (https://www.seattle.gov/city-light/energy)
[3] Washington State's "Clean Energy Transformation Act (CETA)," which requires Washington's electric utilities to eliminate carbon emissions from their energy resources by 2045.



Source: https://www.buildinghub.energy/what-components-are-needed-to-decarbonize

The Benefits of Decarbonization

For Residents

Decarbonizing buildings doesn't just reduce greenhouse gas emissions—it also provides direct and tangible benefits to residents.

Lower energy costs

Energy-efficient upgrades—such as modern heat pumps, induction stoves, and improved insulation—can lower household utility bills by reducing the amount of energy needed for heating, cooling, cooking, and clothes drying. While savings vary based on household energy use, building conditions, and local utility rates, many residents can expect more stable and predictable energy costs over time as buildings do the same or more with less.

Reliable heating and cooling

A major benefit of decarbonization comes from the installation of electric heat pumps, which provide both heating and cooling in a single system. Unlike older systems that may falter in extreme temperatures, modern heat pumps deliver reliable air conditioning during hot summers, which addresses a critical public health issue in the Pacific Northwest, particularly during extreme heat events or when air quality is poor due to wildfire smoke. Today's heat pumps also offer effective and efficient heating during cold winters, ensuring year-round comfort and reducing risks related to heat stress or cold exposure.

Enhanced indoor comfort

Decarbonization projects often pair new systems with building envelope improvements, such as upgraded insulation, high-performance windows, and enhanced ventilation. These upgrades help eliminate drafts, reduce indoor noise, and maintain even indoor temperatures, creating a more comfortable living environment throughout the day and across all seasons.

Improved health and safety

Transitioning away from combustion-based appliances eliminates indoor pollutants like carbon monoxide, nitrogen dioxide, and particulate matter, which are common byproducts of gas stoves and furnaces. Cleaner indoor air is especially important in multifamily housing, where ventilation may be limited. These upgrades reduce risks of respiratory issues and carbon monoxide poisoning while also lowering fire hazards associated with outdated equipment. In short, decarbonization creates healthier, safer homes that directly benefit residents' well-being.

Improved resilience

Energy-efficient and electrified multifamily buildings provide greater protection and comfort for residents during extreme weather and power disruptions. Decarbonization measures—such as air sealing, improved insulation, upgraded electrical systems, and renewable energy or battery storage—help maintain safe, healthy living conditions during heat waves, wildfire smoke events, cold snaps, and unexpected outages.

For Building Owners

Reduced energy use and costs

Upgrading to energy-efficient systems and appliances can lower overall building energy consumption, leading to reduced utility expenses. Actual savings depend on factors such as building size, occupancy patterns, local utility rates, and who pays the bill. Over time, these upgrades can improve operational budgets and reduce exposure to rising energy prices, as well as keep properties competitive within the rental market.

Simplified utility management

Decarbonization often enables better control and integration of building energy systems. This can streamline utility billing by consolidating multiple accounts, reducing administrative burden, and making energy costs more predictable.

Higher resident satisfaction and retention

Enhanced comfort, consistent heating and cooling, and better indoor air quality make units more attractive to both current and prospective residents. Satisfied residents are more likely to stay longer, which reduces turnover, vacancy periods, and the costs associated with re-leasing.

Easier compliance with building performance standards

Upgraded systems and building improvements make it easier to meet local and state energy and building performance standards and decarbonization mandates (see section below). Proactively decarbonizing with well-structured plans and realistic timelines helps avoid costly penalties for non-compliance.

For the Community

Reduced greenhouse gas (GHG) emissions

Building decarbonization helps communities cut greenhouse gas emissions—the main drivers of climate change. Transitioning to clean, electric systems powered by renewable energy sources improves local air quality and moves communities closer to their climate goals.

Improved resilience

Energy-efficient and electrified buildings are better prepared for extreme weather and power disruptions. Decarbonization efforts often include air sealing, better insulation, upgraded electrical systems, and renewable energy or battery storage. These measures all help to keep neighborhoods safe and comfortable during heat waves, poor air quality events due to wildfire smoke, cold snaps, or power outages.

Job creation

Investing in building upgrades creates local jobs in construction, electrical work, HVAC installation, and energy management. These projects can also support workforce development and training opportunities, particularly in the clean energy and green building industries.

Health & safety

Modern, electric systems reduce risks of fires, gas leaks, and carbon monoxide exposure. When multiple buildings in a neighborhood are upgraded, these safety benefits extend beyond individual homes—contributing to safer, healthier communities overall.

Decarbonization Mandates

Greenhouse gas emissions contribute significantly to adverse climate impacts, including rising global temperatures and more frequent extreme weather events. These environmental changes, in turn, pose serious risks to public health, safety, economic stability, and social well-being. To address these impacts, local and state governments have implemented mandates aimed at reducing greenhouse gas emissions. For buildings, these mandates typically fall into three main categories.

Types of Mandates

Benchmarking	Energy and/or Emissions Performance Standards	Energy Codes
Existing Buildings		**New Construction & Substantial Alterations**
Measuring a building's energy use and GHG emissions and comparing it to the energy use of similar buildings, its own historical usage, or a reference performance level.[4]	Policies that require building owners to meet performance targets by actively improving their buildings over time, often with interim targets.[5]	Energy codes are a subset of building codes, which establish baseline requirements and govern building construction.[6] Some retrofits may be subject to energy codes.

Legislative overview

Benchmarking: Energy and GHG benchmarking laws require building owners or managers to track a building's annual energy use and emissions and submit the results to the governmental body. Benchmarking ordinances are generally implemented in phases, with the largest buildings required to comply first. Benchmarking of larger multifamily buildings

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[4] https://www.epa.gov/statelocalenergy/benchmarking-and-building-performance-standards-policy-toolkit

[5] https://www.epa.gov/statelocalenergy/benchmarking-and-building-performance-standards-policy-toolkit

[6] https://www.energycodes.gov/why-building-energy-codes

is required for both the State of Washington under the Clean Building Performance Standard Tier 2 requirements and the City of Seattle's Energy Benchmarking Law.

Performance targets: Mandates like Performance Standards set targets for buildings to achieve within a period of time, but don't prescribe how a building will achieve that target. These targets can be metrics such as a building's annual energy use intensity (EUI) expressed in kBtu per square foot, like the Washington Clean Building Performance Standard (WA CBPS), or its annual greenhouse gas intensity (GHGI) expressed in $kgCO_2e$ per square foot, like the Seattle Building Emissions Performance Standard (BEPS). Targets vary based on the type of activity(ies) within the building. The time periods generally span multiple years, and targets become more stringent over time. [7] [8]

Compliance pathways: Mandates typically offer multiple compliance pathways to accommodate the diverse characteristics of buildings—such as type, use, and existing conditions—and to support equitable implementation across different contexts. For example, Seattle's BEPS offers three distinct compliance pathways to achieve its GHGI targets and offers extensions for affordable housing buildings, as well as prescriptive compliance options.

Measurement and reporting processes: To ensure consistency in measuring and reporting of a building's performance in comparison to the targets and to make capturing and tracking easier, mandates often require specific reporting tools such as the U.S. Environmental Protection Agency's ENERGY STAR® Portfolio Manager®. Benchmarking mandates, like the one in place since 2010 for buildings in Seattle, typically require regular self-reporting of energy and/or emissions performance data to the governing body. Performance Standards impose further requirements to ensure that the data is verified or validated independently.

Energy codes: Although predominantly focused on new construction, some elements of local energy codes may apply to existing buildings when replacing HVAC systems that burn fossil fuels. Any potential "like-for-like" replacement of an aging fossil-fuel-burning system in a building should be carefully evaluated against code requirements and the building's future decarbonization compliance dates.

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[7] kBtu = 1,000 Btu's. Btu (British thermal unit) is a measure of the heat content of fuels or energy sources. One Btu is the quantity of heat required to raise the temperature of one pound of liquid water by 1° Fahrenheit (F) at the temperature that water has its greatest density (approximately 39° F).

[8] $kgCO_2e$ = 1,000 grams of CO_2e. CO_2e is the unit of measurement for the warming effect of greenhouse gas emissions.

Key Stakeholders in Decarbonizing Buildings

At the national, state, regional, and local levels, governments play a pivotal role in advancing decarbonization and setting performance targets, as outlined in the preceding section, "Decarbonization Mandates." Collaboration with stakeholders as those governments draft legislation is essential to ensure that standards are both practical and ambitious, driving meaningful outcomes while remaining achievable and equitable, so that the benefits of decarbonization are distributed fairly across all communities.

At the individual building level, building owners are the ultimate decision makers for when and how to decarbonize their properties. However, consultation and collaboration with a diverse range of stakeholders here, too, can provide valuable insights and practical guidance, enabling owners to make informed decisions that best align with their building's unique circumstances. Key consultants and collaborators include, but are not limited to, those listed in the table below.

Stakeholder	Relevance/Role
Property Owner	Property owners, in consultation with others, define the goals and the measures to meet those goals.
Property Manager	Property managers understand the opportunities and challenges of the building and the relationships with residents.
Facilities/Maintenance Staff	Facilities and maintenance staff provide information on the existing systems, input on what measures make sense given their experience with the building, and an assessment of the team's capabilities to manage new technologies.
Residents	Depending on the decarbonization strategies selected, residents can play an influential role in ensuring the strategies achieve their goals.
Contractors	Knowledgeable, trained contractors can provide a wealth of information on the equipment and measures that are most appropriate for a building.
Local Government	Seattle established emissions targets for existing buildings and the pathways for compliance (BEPS).
State Government	Washington State established energy-efficiency targets[9] and the pathways for compliance (WA CBPS); choices that building owners make as they work toward complying with

[9] As of publication of this guide, these targets are voluntary, but targets may become mandatory at some point in the future. See the CBPS Tier 2 Compliance webpage for the current requirements.

	these energy-efficiency targets can support their decarbonization goals.
Housing Development Consortium/DAHN	HDC and DAHN provide resources and opportunities for peer-to-peer information sharing on decarbonization efforts.
Utilities (Seattle City Light, Puget Sound Energy, small public utilities)	Utilities provide data that informs the pre- and post-decarbonization energy usage and costs. They also are often the administrators of energy-efficiency incentives that can fund decarbonization measures.
Financing Institutions	Banks, credit unions, community development financing institutions, and the like can offer financing to help pay for decarbonization measures.
Community and Faith-based Organizations	Community and faith-based organizations can provide support in engaging residents and help ensure that decarbonization efforts are equitable.

Section 2. Equity Considerations

Why Equity Matters

Building decarbonization has the potential to deliver significant environmental and economic benefits, but without intentional planning upfront, these benefits may not be distributed equitably. Marginalized communities - particularly low-income households and communities of color - often live in older, less-efficient buildings and pay a larger portion of their income towards energy costs. Without targeted interventions, these communities are at risk of being left behind or even harmed by decarbonization efforts, such as through increased housing costs or displacement, or by having to pay a higher proportion of the costs of stranded utility assets like gas pipelines as wealthier customers leave the gas system.

A truly equitable decarbonization strategy will ensure that no one is left behind. It will center the voices and needs of those most impacted by climate change, and by energy and housing insecurity, and it will actively work to dismantle systemic barriers. The goal of equitable decarbonization is a just transition - one that not only reduces emissions but also promotes social, economic, and environmental justice for all communities.

Key Equity Considerations

To help ensure equity is prioritized when planning your decarbonization efforts, consider the following suggestions.

Community voice

Community members know their needs best. They should be involved in shaping, planning, and implementing decarbonization projects. Early and ongoing engagement with residents and community-based organizations builds trust and ensures solutions are culturally relevant, transparent, and equitable.

Affordability

To the extent possible, decarbonization efforts should lower, not raise, costs for residents. It is recommended to evaluate potential measures and equipment for their financial impacts on the property overall and residents before finalizing decarbonization plans.

Access

All residents—no matter their income, housing type, or ownership status—deserve access to energy-efficient upgrades and clean energy technologies. This includes renters, multifamily residents, and homeowners in under-resourced communities. When planning for decarbonization in a building, ensure that all units are addressed. If decarbonizing a portfolio of properties, consider prioritizing buildings based with vulnerable or under-resourced residents.

Health benefits

Many older or lower-income buildings have poor indoor air quality, drafts, or heating and cooling problems, compounding the health harms experienced by vulnerable communities, who also have less access to healthcare and live in areas that are disproportionately polluted and climate-burdened. Decarbonization plans that include replacing gas or oil systems with clean electric options can improve indoor air quality, reduce pollutants, and help manage moisture and reduce mold. Replacing gas-burning equipment located within residences with electric equipment will have the greatest impact on indoor air quality and residents' health, so if all other factors are equal, prioritize these replacements. These upgrades create safer, healthier homes for residents and families.

Jobs and training

The shift to clean energy creates local jobs in construction, electrical work, and building maintenance. As you develop your plans for decarbonization, consider incorporating equity-focused elements that invest in training and hiring workers from communities that have been historically excluded from these opportunities, helping them build long-term careers in the green economy.

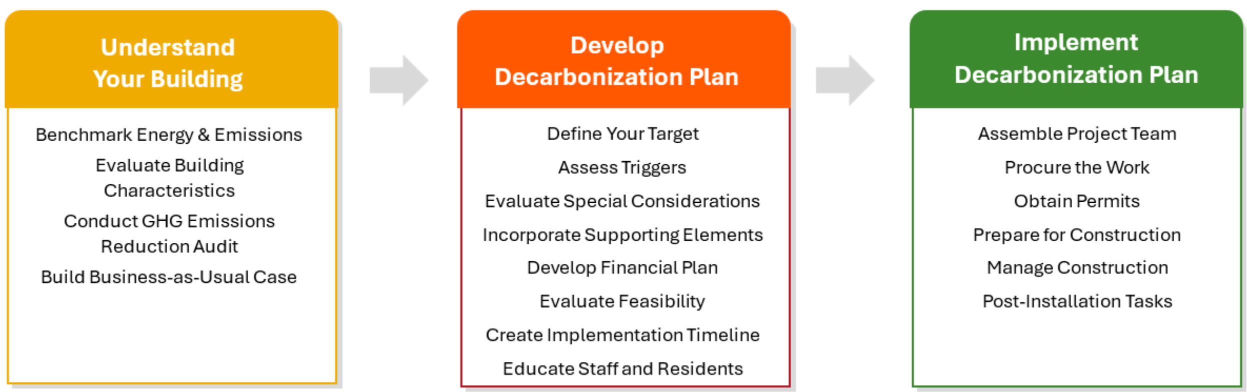
Preventing displacement

As neighborhoods improve, there is a risk that long-term residents may be priced out. This is why many grant programs to decarbonize buildings include strong resident protections and affordable housing preservation so that residents can stay in their homes and benefit from the changes to their buildings. When using external funding sources to support your decarbonization efforts, be sure to review any associated requirements—such as affordability covenants or rent ceilings—to ensure your project remains in compliance.

Section 3. Building Decarbonization Process

Overview

The primary workflow of building decarbonization revolves around three steps.



1. Understand the current status of your building. Measure its energy use and emissions, build your "business as usual case," and audit your building to find the barriers and opportunities to decarbonization. Report under energy benchmarking requirements if mandated, as in the City of Seattle.
2. Build your plan. Develop your decarbonization and non-energy objectives and align a capital plan with important triggers to decarbonization, such as the availability of financial incentives and planned maintenance activities. Then establish a timeline for implementing your plan.
3. Implement your plan and evaluate your progress. Assemble your team and make it happen, then evaluate how it went so you (and perhaps others) can learn from it. Were the expected decarbonization outcomes achieved? Is the building healthier for occupants and more resilient? What did you learn that will make things easier when you decarbonize the next building in your portfolio? Can you share your story to help others?

Each step is discussed in more detail in the following sections.

Step 1. Understand Your Building (Within the Context of Building Decarbonization)

1A. Benchmark Your Building's Energy and GHG Emissions

If any of your properties are within the City of Seattle and are greater than 20,000 square feet, you are already familiar with benchmarking energy and GHG emissions. If you aren't already benchmarking your non-Seattle buildings, the WA CBPS will require you to benchmark all buildings that are greater than 20,000 square feet.[10] Benchmarking is the first step to identifying opportunities to reduce energy use and save on utility bills and is an important tool to help determine whether a building is on track to meet its energy and emissions performance goals.

The data you derive from benchmarking your building can be used to compare energy, emissions, and cost performance year-over-year, to compare a building's performance to similar buildings, and to better identify when a property is underperforming relative to a performance standard. Reviewing your benchmarking data regularly will allow you to understand where there are opportunities to improve performance when energy consumption and/or emissions exceed expectations.

If you have not yet started benchmarking your building and aren't familiar with the process, it is explained in more detail below along with example benchmarking reports and tools you can utilize. For those who are already benchmarking, you can skip to the next section.

Benchmarking process

1. **Choose a person to act as the benchmarking lead within your organization.** The benchmarking lead either coordinates or performs data collection and entry and interprets results for management. If you decide to work with a benchmarking service provider, the benchmarking lead serves as the primary internal point of contact with the service provider to streamline information flow. The property manager might fill the benchmarking lead role, or an energy or sustainability manager if one exists. NOTE: Before selecting an internal staff member for this role, consider whether the data will need to be verified as part of a compliance process (see Step 4). Although the person preparing the data does not need specific credentials, the verifier does. Therefore, if you have the option, assign the benchmarking lead role to someone *without* the required verification credentials so that the qualified staff member can later serve as the verifier.

[10] Washington State CBPS Tier 2 Compliance

2. **(Optional) Choose a benchmarking service provider.** All benchmarking tasks can be performed in-house; however, an organization can choose to contract with an external service provider to do the work on their behalf to reduce internal labor or leverage a service provider's expertise.

3. **Gather and enter data.** Collect data on your building and enter it into ENERGY STAR® Portfolio Manager®. The benchmarking lead might do this by themselves or coordinate with internal and external partners such as building managers and maintenance teams, accounting staff, or benchmarking service providers. Data usually comes in two forms: whole-building descriptive data such as gross square footage and use type, and energy-use data, which often comes in the form of utility bills or directly from a utility data portal. **TIP:** The City of Seattle's Energy Benchmarking How-to Guide explains the steps needed to obtain energy meter usage data directly from Puget Sound Energy and Seattle City Light.

4. **Verify data is correct.** Some benchmarking or decarbonization ordinances require a professional with credentials to verify a building's data periodically. For example, Seattle's BEPS requires benchmarking verification every 5 years by a Qualified Person, starting in 2027 for the largest buildings. Even if not mandated, verifying data is a best-practice and helps ensure that benchmarking results are accurate. For Seattle BEPS and WA CBPS, an employee of the building owner can verify the benchmarking data if they have the necessary credentials and weren't the one who prepared it.

5. **Report and interpret results.** Once data entry is complete, benchmarking tools automatically generate results that compare a building's performance to similar properties. However, to ensure accurate reporting, and to verify compliance with the Seattle and State of Washington building performance standards, certain settings must be adjusted, such as selecting "Weather Normalized Site EUI" for the building's energy-use intensity, choosing weather-normalized metrics for all fuels used by the building, and applying the correct GHG emissions factors of the local utility's electric generation. Therefore, it is important to engage a professional who meets the Qualified Person definition for the verification process. The definition of a Qualified Person can be found in the State of Washington's Roles and Responsibilities Guidance Document and Seattle BEPS FAQs.

Sample Energy Star® Portfolio Manager® Energy Usage Report

Report results internally to the management team and follow applicable reporting guidance for Seattle BEPS and WA CBPS to ensure compliance.

Tools/Resources

- ENERGY STAR Portfolio Manager
- Conduct a Greenhouse Gas Emissions Reduction Audit
- GHG Emission Factors Hub | US EPA
- Emissions & Generation Resource Integrated Database (eGRID) | US EPA
- Cambium | Energy Systems Analysis | NREL
- Homepage | GHG Protocol
- Seattle Building Emissions Performance Standard (BEPS)
- Seattle's Energy Benchmarking How-to Guide
- WA Clean Building Performance Standard (WA CBPS) for multifamily buildings (Tier 2)

1B. Evaluating Building Characteristics

Your building's path to decarbonization will depend on existing components—such as whether heating and cooling systems are centralized or decentralized, the type of HVAC system in place (e.g., gas furnace, electric resistance, or individual heaters), the condition and layout of ductwork, and other structural characteristics. Some buildings are more readily adaptable to high-efficiency electric systems like air-source heat pumps, while others may require significant reconfiguration of existing infrastructure to support such upgrades.

Individual building vs. Portfolio of buildings

If you are decarbonizing a single building or just a few, your process can begin with a building-level assessment, where an audit team evaluates key characteristics to inform your strategy. However, if you manage a portfolio of buildings, it is important to prioritize which properties require the most attention to meet decarbonization mandates. In this case, starting with a portfolio-level pre-assessment of building characteristics is the most effective approach.

Data collection

For an assessment of a single building, the audit team's pre-assessment data collection will involve notating building and equipment characteristics and obtaining copies of utility bills for the previous 12 months.

A portfolio-level assessment requires a more coordinated effort to gather and analyze the information mentioned above across multiple properties. A consultant can support this process by facilitating data collection and performing calculations such as energy use intensity (EUI) for each building. Below is a list of building characteristics that are typically captured.

Considerations for Steps 1B and 1C

These steps outline analyses that will help you evaluate your building and inform the development of a decarbonization plan. Although these activities share similarities with requirements in the Washington CBPS and Seattle BEPS, they are not mandated by either standard, nor do they replace any of the specific compliance obligations of those laws.

Washington CBPS reporting requirements

- Benchmarking data via ENERGY STAR® Portfolio Manager®
- Energy Management Plan outlining how the building will monitor and improve energy use.
- Operations and Maintenance plan detailing the maintenance of building systems to ensure efficiency.

Seattle BEPS reporting requirements

- Verification of ENERGY STAR® Portfolio Manager® benchmarking data (in addition to meeting annual Seattle benchmarking requirements)
- GHG Report that includes current GHGI and targets, and building equipment, and outlines plan to meet future GHGITs. See page 59 for more details.

Building envelope

- Wall type (masonry, wood frame, metal frame, SIP)
- Wall insulation (area with type and R-value)
- Attic/roof type (sloped, flat, ventilated/non-ventilated attic cavity, R-value, air-tight rating/estimate, area)
- Basement wall or crawlspace wall (area, height, type, and insulation)
- Bottom floor (basement, crawlspace, slab-on-grade, area, type, and insulation)
- Windows (type, air-tight rating/estimate, R or U value, area or window/wall ratio estimate)
- Doors (type, quantity, weather stripping/sweeps, storm doors, R or U value)

Space heating/cooling equipment

- Type of equipment (boiler, furnace, baseboard heaters, central AC, window AC, PTAC/HP)
- Type of fuel (natural gas, propane, fuel oil, electric)
- Efficiency (COP, AFUE, SEER/EER, HSPF)
- Equipment size (MBH, ton, kBtu, kW)

Water heating equipment

- Type of equipment (unitary or split boiler, auxiliary heat exchanger, unitary or split HPWH, central or individual, quantity)
- Type of fuel (natural gas, propane, fuel oil, electric)
- Efficiency (UEF, EF, COP, AFUE)

Appliances

- Range/oven/cooktop: fuel type
- Clothes dryer: fuel type

Identifying trends and groupings

To take advantage of efficiencies of scale for a portfolio, it is important to identify trends or groupings across the portfolio, such as buildings that have a higher EUI and have similar characteristics. Recognizing these patterns can help streamline planning and implementation. For example, a portfolio-level assessment may reveal opportunities to scale contractor engagement or bulk-purchase equipment.

The table below is a sample portfolio analysis.

The Typology ID identify groupings based on type of HVAC system (F=Furnace, B=Boiler)

The value in each cell of the first three Decarbonization Opportunity columns represents the prioritization score for that opportunity across the properties. Higher values (darker shading) indicate stronger opportunities for decarbonization.

The properties are ordered by their total Decarbonization Opportunity score

Property Address[3]	Typology ID	Decarbonization Opportunity				Water Efficiency Opportunity
		Energy Efficiency	Electrification	Solar	Decarbonization Opportunity[4]	
Property 1	F2	5.0	5.0	2.5	12.5	5.0
Property 2	F1	4.2	3.3	3.3	10.8	5.0
Property 3	F2	1.7	5.0	3.3	10.0	0.0
Property 4	F1	5.0	0.0	5.0	10.0	0.8
Property 5	F2	3.3	5.0	1.7	10.0	2.5
Property 6	F2	5.0	3.3	1.7	10.0	4.2
Property 7	F1	3.3	3.3	3.3	9.9	1.7
Property 8	F1	3.3	3.3	3.3	9.9	5.0
Property 9	F2	4.2	5.0	0.0	9.2	3.3
Property 10	B1	5.0	1.7	1.7	8.4	2.5
Property 11	B1	5.0	1.7	1.7	8.4	4.2
Property 12	F1	0.8	1.7	5.0	7.5	1.7
Property 13	F1	0.8	3.3	3.3	7.4	5.0
Property 14	B1	1.7	1.7	3.3	6.7	5.0
Property 15	F2	0.0	3.3	3.3	6.6	0.0
Property 16	B1	0.8	3.3	1.7	5.8	0.0
Property 17	F1	2.5	0.0	3.3	5.8	0.0
Property 18	F2	0.8	1.7	3.3	5.8	4.2
Property 19	F2	0.0	5.0	0.0	5.0	0.8
Property 20	B1	0.0	1.7	3.3	5.0	0.8
Property 21	F1	0.8	1.7	1.7	4.2	2.5
Property 22	B2	0.0	0.0	3.3	3.3	0.0
Property 23	B1	0.0	3.3	0.0	3.3	0.0
Property 24	F3	0.8	1.7	0.0	2.5	0.8

As the table demonstrates, properties with the same typology may score similarly, such as the Energy Efficiency score for properties 12 and 13. In other cases, building-specific circumstances may result in significantly different scores even when properties share the same type of HVAC system, as seen with properties 1 and 3.

Identifying potential barriers

The graphic below offers insights into the characteristics of buildings that could pose notable challenges during retrofitting. Building characteristics highlighted in orange or red do not mean those buildings would be impossible to retrofit; rather, they suggest a higher level of difficulty to implement (primarily based on costs) compared to those in green, which will be more cost efficient. Certain characteristics also may be more or less challenging depending on how a project is being financed or what funds are being leveraged. The insights below assume that projects must be cost effective and that incentives are limited.

Building characteristics aligned with decarbonization

- Central heating and cooling systems
- Fully insulated
- Updated electrical service panels
- Existing or potential space for HVAC with minimal impact to current space functionality
- Energy usage history recorded for past 2 years
- No health and safety concerns

Building characteristics that may be challenging for decarbonization

- No central cooling
- Minimally insulated
- Electrical service upgrade needed
- Non-critical health and safety concerns
- No existing electrical supply in common areas

Building characteristics that will be challenging for decarbonization

- No existing duct work
- Boilers for space heating
- No existing heating or cooling equipment
- Equipment updated within past few years
- Severe health and safety concerns

Identifying potential opportunities

Programs that offer financial and technical assistance, such as those through your utility's energy efficiency programs or city or county incentive programs, can provide valuable resources for planning and implementing your decarbonization efforts. Connecting with program administrators early will help ensure that you are able to take advantage of all resources available. In the box to the right are a few websites to start your search for relevant offerings.

- Seattle City Light Multifamily Energy Solutions
- Seattle City Light Multifamily Weatherization Program
- Seattle City Light Clean Heat Program
- Seattle Office of Housing HomeWise Program
- Seattle Office of Housing - Other Funding Opportunities
- Seattle Building Emissions Navigator Decarbonization Grants
- King County Energize – Multifamily Homes Program
- Puget Sound Energy – Multifamily Programs
- The Switch is On

1C. Conduct a GHG Emissions-Reduction Audit

A GHG emissions-reduction audit is an energy audit, with additional information to inform decarbonization efforts. The audit will document current conditions of your building in terms of energy usage, the performance of the building's envelope and equipment, and sources and levels of GHG emissions. Based on the information gathered, the audit team will outline upgrades to achieve greater energy efficiency and reduced GHG emissions.

Key steps

1. Data Collection: The audit team collects data about the building's general characteristics and energy usage from the relevant utilities and building owner/property manager.
2. Onsite Inspections: The audit team conducts a site visit to assess the condition and performance of building systems and evaluate the potential for upgrades.
3. Analysis and Reporting: The audit team performs analyses to determine potential measures to reduce energy usage and cost and GHG emissions. For each of the identified measures, they estimate the level of reductions and potential cost of the upgrades. The team then outlines groupings of measures that can be undertaken together in phases to achieve emissions reduction goals. This step culminates in an audit report containing the detailed analysis and proposed phases and groupings of measures.

Audit scope

Preliminary Walkthrough

Before conducting a detailed audit, the audit team should perform a preliminary walkthrough with building representatives—such as the owner, property manager, or facility manager—to gain a comprehensive understanding of the building's layout and any areas requiring special attention. It is also beneficial for the team to engage with residents to gather insights on issues such as thermal comfort, indoor air quality, and safety concerns.

Health and safety

Health and safety issues can pose significant risks to both construction crews and occupants during decarbonization retrofits. To avoid these risks, the audit team identifies potential hazards and presents them to building owners for remediation before any decarbonization activities begin. The following is a non-exhaustive list of potential hazards that the audit team may uncover during an assessment.

- Air quality issues (lead, CO_2, particulates)
- Absence of, or failure in, smoke or carbon monoxide detectors/alarms
- Structural components (drywall, ceiling, joists, fasteners)
- Radon
- Mold
- Asbestos
- Absence of fire extinguishers
- Pest infestation

System and Envelope Evaluations

To evaluate a building's energy efficiency performance, the audit team will conduct visual inspections of key components, including but not limited to the following.

Spaces
- Attic space
- Crawl spaces
- Basements
- Attached garages

Equipment
- Major appliances
- Exhaust fans

Structural Components
- Exterior walls
- Concrete slabs
- Foundation walls

Fenestration
- Windows
- Doors
- Skylights

Energy Systems
- Domestic hot water systems
- Heating systems
- Mechanical ventilation systems
- Cooling systems

They will also perform field tests to assess actual system functionality and identify the existence and severity of any health and safety hazards associated with building systems and appliances.

Field Tests Conducted During Audit	
Typical Energy Assessment	
Blower door test	Tests the building's air tightness
Ambient CO testing	Tests the air in the building for carbon monoxide levels
Gas leak testing	Tests for leaks in natural and propane gas piping
Spillage testing	Tests for proper chimney operation
Infrared thermography	Identifies areas of temperature variation, indicating potential air leakage
Detailed Energy Assessment	
Worst case depressurization testing	Tests for proper chimney operation
Heating appliance CO testing	Tests for proper chimney operation
Oven testing	Test ovens and stovetops for normal operations
Certified Energy Assessments (BPI or HERS)	
Duct leakage testing	Test ducts for air leaks
Pressure diagnostic testing	Tests for pressure variations in buildings

Electrical service evaluation

Switching from equipment fueled by gas, oil, or propane to high-efficiency systems fueled by electricity, such as heat pumps, will increase the property's electricity demand. For older buildings with limited capacity to handle increased demand, electrical service upgrades will likely be needed unless significant energy-efficiency measures are undertaken to reduce demand from other systems, such as lighting replacements. To evaluate the existing system's capability to handle electrification measures, the audit team will:

- Determine existing loads using actual maximum meter demand data from the past year
- Assess the nameplate capacity (i.e., the amperage) of the service entrance equipment and review one-line diagrams
- Assess the size and condition of electrical piping and wiring - identify deficiencies in existing electrical components versus current code requirements
- Analyze future load demands
- Identify load reduction measures that can offset increased demand
- Verify there are available breaker spaces on your service panel for future load or the ability to expand the panel, and that compatible breakers are available on the market.

If the audit team identifies that to decarbonize, the building will have more load on its electrical service than the current service's capacity, the customer must complete an application for electric service with the utility. The utility will determine if the existing electric infrastructure, such as transformers, can support the increased electrical load and will create a cost estimate for the upgraded service.

Special considerations:

- If a transformer replacement is required, the building may be responsible for covering the costs related to the replacement.
- Properly sizing equipment and designing efficient operation sequences can significantly influence both the scope and cost of electrical system upgrades. For a variety of reasons, existing systems may be either oversized or undersized for the building's needs. When selecting new equipment, reassess its appropriate sizing to avoid unnecessary costs or operational issues. In addition, plan for a qualified contractor to establish set points and operation sequences to ensure the new equipment operates at optimal efficiency.
- If weatherization measures are planned for the building, ensure that their effects are incorporated when designing decarbonization measures. For example, a building that is poorly insulated and has single-pane windows, which currently needs an oversized heating system to compensate for its thermal losses but for which significant envelope upgrades are planned, will not need the same heat output from its decarbonized heating system replacement.

Audit report

The audit report will outline the following:

- Types, age, models, and fuel sources for equipment and systems
- Condition of structural components, equipment, and systems
- Analysis of energy usage and costs
- Estimated GHG emissions
- Results of field testing (if applicable)
- Any health and safety concerns
- Recommended energy efficiency, load reduction, electrification, and renewable energy measures
- Estimated installation cost, energy savings, and GHG emission reductions for recommended measures
- Potential funding sources for measures (where applicable)

Resources

- See Appendix C for a sample GHG Emissions Audit Report

- The National Renewable Energy Laboratory's fact sheet on Greenhouse Gas Emissions Accounting in Buildings provides background information on sources of GHG emissions, the different types of emissions, and how GHG emissions are calculated.
- The U.S. Department of Energy's GHG Emissions Reduction Audit webpage offers further information to help plan and conduct an audit, including a link to an audit checklist with step-by-step information.

1D. Build a Business-As-Usual Case

Process

Conduct a Capital Needs Assessment

- From the information collected during the GHG Emissions Reduction audit described above, review the condition of existing HVAC, lighting, hot water, major equipment, windows, walls, structure, and roof to determine remaining useful life and estimate cost for repair or replacement of equipment.
- Review condition and capacity of electrical infrastructure and physical size of spaces housing major components of HVAC and DWH systems to assess capacity for expansion.

Capital Cost Estimation

- Create a 10- to 20-year timeline of what equipment and systems will need to be replaced based on the equipment's current condition and estimated useful life.
- Estimate the cost for business-as-usual investments over the specified timeline which include operational utility costs, maintenance of equipment, and planned renovations and equipment replacements at their end of life.

Energy Usage and GHG Emissions Projections

- Project the building's energy usage and GHG emissions based on current equipment and systems and the replacements planned within the 10- to 20-year timeline.

Timeframe

The timeframe for your business-as-usual case will depend on several factors:

- Capital planning and external funding cycles
- State and local decarbonization compliance deadlines
- Target dates for organizational goals

Tools/Resources

The U.S. Department of Housing and Urban Development (HUD) provides an overview and tool for conducting a Capital Needs Assessment which can be used as a primer for establishing a business-as-usual case.

- Capital Needs Assessment Tool | HUD.gov / U.S. Department of Housing and Urban Development (HUD)

Step 2. Develop a Decarbonization Plan

A building's decarbonization plan serves as a strategic roadmap that outlines the key issues to address, prioritizes them based on critical factors, identifies potential solutions, and details the implementation timeline, associated costs, required resources, and anticipated outcomes.

A decarbonization plan should be tailored to your building. Just as no two buildings have the same purpose, occupants, or capital planning considerations, the same decarbonization plan won't work for every building. A plan should meet both the technical and financial needs of your specific site, carrying out measures all at once, in batches, or spread out over time depending on your needs and goals.

The best plans allow for flexibility while still having a clear plan of action. A plan will set an order of implementation that includes prerequisite measures and key milestones. That way, any measures you add will be augmenting a solution that you can confidently say meets the optimal needs of your building.

This section discusses key components of decarbonization and how they contribute to a holistic plan. But remember that even though these steps will get you started on a plan, your building is unique. Depending on the opportunities and constraints of the site and the building, you may need to bring in more-comprehensive design and engineering support to execute certain elements of the plan once you're underway.

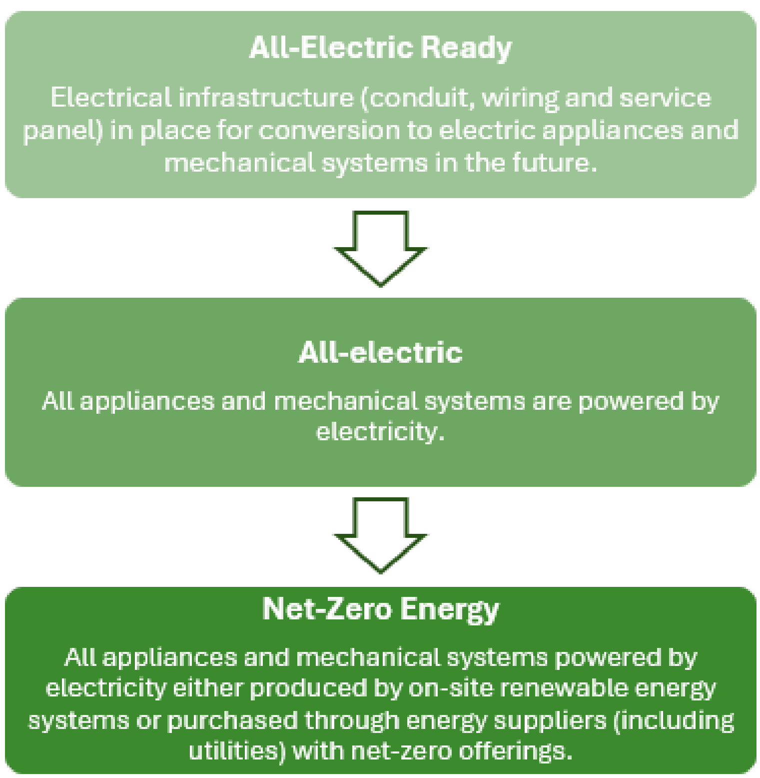
Tools/Resources

- Retrofit Playbook's Resource Efficient Decarbonization Guide
- Stewards of Affordable Housing for the Future's (SAHF) Multifamily Portfolio Carbon Emissions Roadmap Tool

2A. Define Your Target

If your buildings fall within the scope of the City of Seattle's Building Emissions Performance Standard (>20,000 square feet), greenhouse gas intensity targets are the minimum targets for decarbonizing your building and the City's energy code will apply to most equipment installations. However, building owners may choose to set more ambitious goals that surpass these performance standards. Doing so can lead to greater energy savings, enhanced resident satisfaction and retention, and further reductions in greenhouse gas emissions.

For those outside the City of Seattle, two ways to think about defining your decarbonization target are 1) as a percentage of current energy use or 2) by stages of decarbonization, such as all-electric ready, all-electric, and net-zero.



Seattle BEPS for Multifamily Housing

Pathways:

- Emissions Target: Meet the multifamily GHGIT emissions target at each five-year compliance interval.
- Prescriptive: Convert hot water or HVAC equipment to heat pump or in-unit electric resistance (per code). An option can only be used for one compliance interval.
- BEPS Custom Decarbonization Plan: For buildings that apply for and meet certain eligibility criteria, a custom decarbonization plan to reach net-zero by 2050 may be submitted.

For more information, visit the BEPS website.

Extensions:

Extension of GHGIT target timeline for owners of low-income housing, human service use, and low-rent housing obligations for 2031–2035. Still must do Benchmarking Verification and create a GHG Report.

2B. Watch for Opportune Timing

Several key events commonly prompt investment in building upgrades. These include:

- Refinancing or recapitalization
- Multiple simultaneous lease expirations
- Planned updates or renovations
- Needed equipment and system replacements and upgrades
- Compliance deadlines for local mandates

When developing your decarbonization plan, assess which of these occurrences might apply to your buildings. Engage relevant stakeholders to understand the timing and any constraints that could influence the scope or feasibility of your plan.

- **Refinancing and recapitalization** can unlock capital to support more comprehensive decarbonization efforts.
- **Coordinating in-unit decarbonization measures with resident turnover** can reduce or eliminate the need for costly resident relocations.
- **Planned renovations involving structural elements**—such as floors and walls—can create opportunities to implement measures like insulation that might otherwise be cost-prohibitive. It's also a chance to incorporate planning for mechanical equipment replacements that may have structural implications, such as relocating equipment on rooftops or within mechanical rooms.
- Your business-as-usual case should have outlined the anticipated timelines for **replacing equipment and systems as they reach the end of their useful life**, helping to align decarbonization efforts with existing capital planning.

2C. Evaluate Special Considerations

Equipment

Heat Pumps

- *Replacing existing ductless systems:* For existing ductless systems (hot water or steam boilers), replacement with ductless mini split heat pumps (DMSHP) is recommended. Interior components of DMSHPs are available in high-wall, low-wall, and cassette versions. Each head has its own blower, thermostat, etc. and should be programmed as an independent zone. Resident education is advised to ensure proper operation of the unit.
- *Replacing ducted systems:* For existing ducted (forced air) systems, replacement with an air-source heat pump (ASHP) is recommended. Ductwork may need to be modified to achieve the level of airflow needed for optimal performance.

- *Right-sizing:* Proper sizing of HVAC equipment is essential—not only for managing costs but also for minimizing unnecessary electrical load. HVAC contractors should perform a Manual J calculation[11], incorporating planned weatherization measures, to ensure the replacement heat pump system is appropriately sized for the building's needs.

Heat Pump Hot Water Heaters (HPWHs)

- *Placement of HPWHs:* HPWHs should not be installed near common living space (living rooms or other heavily used rooms) or near bedrooms, because they remove heat from the ambient space. They can also be quite noisy when running in heat pump mode, which can negatively impact occupant comfort. Heat pump systems operate best at a low-and-slow pace, so having plenty of storage capacity to respond to times of high demand is important. Several HPWHs are available with equipment components installed indoors, outdoors, and some mixed indoor/outdoor systems. The physical interior and exterior site constraints will drive the decision of which system arrangement is most compatible for your building.
- *Four options for HPWHs:* Replacements of existing hot water systems with heat pump water heaters can be configured in four different ways.
  - In-unit gas or electrical replaced by in-unit HPWH
  - In-unit gas or electrical replaced by central HPWH
  - Central gas or electrical replaced by in-unit HPWH
  - Central gas or electrical replaced by central HPWH

There are advantages and drawbacks to in-unit systems vs. centralized systems.

HPWH Type	Pros	Cons
In-unit	• Failures affect only one unit rather than the entire building • No need for large central mechanical room • Heat is generally better maintained through the in-unit distribution system (pipes)	• Heat pump water heaters draw heat from the surrounding room, increasing heating loads and potentially raising resident utility bills in winter • May require in-unit electrical upgrades • Central systems typically maintain stored water temperature more effectively than in-unit systems

[11] HVAC load calculation that determines the size of equipment needed to heat and cool a building

HPWH Type	Pros	Cons
		• Total cost of outfitting each unit individually may exceed that of a centralized system
Central Unit	• Avoids potential increase in resident heating loads and utility bills during winter months; applicable only to an in-unit to central-unit conversion • Any needed electrical upgrades are typically limited to the central location • Centralized systems generally maintain stored water temperature more effectively than in-unit systems	• May require substantial changes to hot water distribution system (pipes); applicable only to in-unit to central-unit conversion • Owner is responsible for water-heating energy costs • Requires significant space in a central mechanical room with adequate ventilation and heat-rejection pathways • Greater heat loss through long hot-water distribution system (pipes)

- *Centralized Hot Water Systems:* As mentioned in the table above, distribution efficiency is more important in a centralized system—long pipe runs can lead to higher heat loss—so additional insulation or recirculation strategies may be required to maintain temperature and minimize wasted energy. Because a failure in a centralized system affects the entire building rather than a single unit, design teams should plan for redundancy and maintenance access.

Induction Cooktops

Although induction stove tops are more efficient than standard electric stoves, they require cookware that contains iron and can function with the magnetic process used by induction stoves. Fortunately, nearly all new cookware, even inexpensive pots and pans, are already induction-compatible and old-fashioned cast iron cookware works very well with induction already. If induction stoves are planned, it is recommended to provide residents with a simple fridge magnet to test their existing cookware. If the magnet sticks to the bottom, it will work on induction! If not, be sure to have a plan for how to supply them with induction-compatible cookware sets.

Heat Pump Clothes Dryers (HPCDs)

- *Energy efficiency benefits:* Heat pump clothes dryers are slightly more efficient than traditional electric resistance models and offer the added benefit of not requiring outdoor venting. This reduces energy usage and costs by eliminating the need to heat or cool air that would otherwise infiltrate through a vent.
- *Reduced fire hazard:* The absence of an exhaust vent eliminates the risk of lint buildup leading to fire hazards.
- *Water drainage:* Moisture captured from the clothes needs to drain either to a sink, drainpipe, or to the clothes washer through a special device.
- *Increased drying time:* HPCDs remove moisture from clothes instead of heating clothes to evaporate the moisture. This results in drying times being slightly increased.

Health & safety

Decarbonization plans are often implemented along with building envelope improvements to reduce air leakage and heat losses. However, sealing and tightening a building's envelope without adequate ventilation can trap moisture and indoor air pollutants, as well as other air-borne health hazards, leading to potential health and structural issues. Accumulated moisture may result in mold growth and deterioration of materials such as drywall and flooring. Poor indoor air quality can exacerbate respiratory conditions like asthma or lead to acute illnesses.

To mitigate these risks, mechanical ventilation must be incorporated if not already present. Ventilation solutions may include spot systems, such as bathroom or kitchen exhaust fans, preferably with timers, or whole-building systems designed to maintain healthy air exchanges throughout the property. Be sure to include these elements in your HVAC system upgrade planning, as applicable.

2D. Incorporate Supporting Elements

Up to this point, the focus has been on the technical aspects of your decarbonization plan. Before moving into financial planning, it's important to conduct a comprehensive review of related activities and expenses that may impact both the financial and technical components of the plan. These related items may include:

Staff responsibilities

Building decarbonization requires time, specialized skills, and dedicated personnel. Ensuring that your team has the capacity to manage decarbonization-related tasks effectively is essential for successfully maintaining, implementing, and reporting on the plan.

- **Plan and Project Management:** A decarbonization plan that spans multiple years is not a one-time effort. As conditions evolve, the plan must be periodically reassessed and updated to remain effective.
- **Mandated Compliance Reporting:** Energy codes and building performance standards require the submission of plan documentation and regular compliance reporting.

If your current staffing does not include personnel with the capacity and expertise to manage these responsibilities, the cost of hiring additional staff or a consultant should be incorporated into your financial analysis and plan timeline.

Staff and resident engagement and education

As stated earlier in the Guide, equitable building decarbonization involves engaging those impacted by the plan and providing opportunities for them to be involved in the decision-making process. Open, transparent communication and targeted education are key to ensuring equity throughout the process. Both the time and cost associated with engagement and education efforts, especially with residents and facility staff, should be factored into the plan.

Alternative housing for residents

Depending on the decarbonization measures being implemented, alternative housing may be necessary to protect resident health and safety and minimize disruptions that could affect satisfaction and retention. Evaluate at what point(s) in your plan's implementation you may need to provide alternative housing and incorporate the associated time and costs into the planning process.

Note: These topics are explored in greater detail in the subsequent sections of this guide.

2E. Develop Financial Plan

Once you have laid the technical groundwork and incorporated supporting elements, the next step is to evaluate and plan for the financial components of your decarbonization efforts. Effective financial planning should account for:

- Available capital resources, both internal and external
- Capital planning cycles and funding timelines
- Investment decision points
- Expected return on investment

- Cost of noncompliance (fines or penalties for not achieving regulatory mandates)

This phase will likely involve engaging a new group of stakeholders with financial expertise. However, including facilities and operations staff in the process can help streamline approvals and promote alignment between technical and financial priorities.

Methodology

Because building decarbonization involves numerous dynamic factors, a **life-cycle cost analysis**, which accounts for time-sensitive variables such as inflation, energy price fluctuations, and financing rates, is recommended over a simple payback analysis. A life-cycle cost analysis should be performed on the various packages or combinations of decarbonization measures being considered so that the packages can be compared against one another.

Life-Cycle Cost (LCC) Analysis

The process for conducting a life-cycle cost analysis includes:

- Estimating all relevant expenses, including installation, operational, and financing costs, as well as projected savings from energy and maintenance improvements for each package of decarbonization measures, along with avoided penalties for noncompliance.
- Distributing revenues from cost savings and both upfront and ongoing expenses across defined time periods to calculate cash flows.
- Applying escalation rates to revenues and costs expected to increase over the analysis period (e.g., utility rates).
- Using a discount rate to calculate the net present value (NPV) of each package, enabling a more accurate comparison of long-term financial impacts.

An example LCC analysis can be found in Appendix A

Interpreting LCC analysis results

The goal is to find a set of decarbonization measures where the LCC analysis produces more favorable results than the business-as-usual case. However, this may not be the result of the first scenario run through the LCC analysis. Using an LCC analysis tool, like DOE's BLCC5 Program, will enable you to run alternative scenarios that combine different sets of decarbonization measures and/or vary the implementation timeline.

It is important to closely examine both the positive and negative cash flows associated with each phase of a decarbonization project. Although a particular overall financial outcome may appear favorable, certain phases of implementation could require expenditures that exceed the operational budget. These potential shortfalls may necessitate additional capital acquisition, which would then affect the life-cycle cost of the measures.

2F. Evaluate Feasibility

At each stage of the process, technical and financial assessments have helped evaluate the feasibility of individual components of the decarbonization plan. Now is the time to bring those pieces together and assess the plan's viability as a whole. This step should include reconvening with stakeholders for a candid and transparent discussion—not only about the financial costs, but also the individual and collective impacts on residents, maintenance staff, property managers, and others affected by implementation and outcomes. It’s equally important to consider the expected benefits and what will be required to fully realize them.

2G. Create Implementation Timeline

An implementation timeline serves as a roadmap to guide you on your decarbonization journey. Developing a timeline results in sequential steps that align the measures identified in the GHG emissions reduction audit within a realistic timeline that considers everything you’ve thought about thus far—including enabling actions, replacement needs, investment decision points, scales of efficiency, regulatory compliance deadlines, and whether you’re pursuing full or partial decarbonization for your building.

The timeline should be flexible yet provide a clear picture of what steps are needed to prepare the building for necessary upgrades—and at what milestones. This will ensure that you’re prepared to make the right investments before any external factors or emergencies, such as an equipment failure, force you to make an immediate decision.

An example implementation timeline for a hypothetical building with aging equipment is provided in Appendix B.

2H. Educate Staff, Residents, and Leadership Team

Timing

Although this subsection of the guide may be listed as the last step of developing the decarbonization plan, it’s actually an ongoing step throughout its development that will take different forms at different points. It is essential to engage staff and residents—or at least a truly representative subset—throughout the planning process. Collaborative development, or co-production, of the plan not only provides valuable insights the planners might otherwise not obtain, but also builds a foundation of transparency, trust, and a shared sense of ownership.

Ongoing engagement can take many forms, and those forms can change as a plan is developed. Common engagement strategies include:

- *Working groups:* Small, focused teams that provide input and feedback.
- *Advisory councils:* Representative bodies that help guide decision-making and ensure diverse perspectives are considered.
- *Town halls:* Open forums for sharing updates, addressing concerns, and fostering transparency.
- *Educational workshops:* Informational sessions designed to build understanding of decarbonization goals, technologies, and impacts.
- *Flash polls:* Quick surveys on specific topics to get input as planners are making choices that affect stakeholders or stakeholder groups; these can be done digitally, in person, or on paper.

Broad audience education

Once the decarbonization plan is finalized, it should serve as a central resource for communicating its goals, process, and anticipated outcomes to staff and residents who were not involved in its development. It's important to recognize that different audiences—such as property managers, maintenance staff, residents, owners, and investors—have distinct priorities and perspectives. Adapting your messaging so that it responds to each group's interests and concerns will enhance their understanding, foster positive engagement, and support successful implementation.

Although much of the plan's core content will remain consistent across audiences, the specific ways in which it affects each group will require role-specific messaging to ensure relevance and clarity.

Maintenance staff

As previously noted, maintenance staff are key stakeholders in the building decarbonization process. It is essential to keep them informed and actively engaged throughout each phase. Given the potential changes to building systems, their roles and toolsets may shift significantly after implementing decarbonization measures. Conducting proactive assessments of their skills and knowledge, along with providing targeted training as needed, is critical to ensuring they are well-equipped—and feel confident—to operate and maintain new technologies effectively.

While some training will depend on the specific equipment and materials selected, many foundational topics can be addressed well before retrofits begin. Use available resources to educate staff on decarbonization strategies and benefits, the process for evaluating, planning, and implementing decarbonization measures, and the basics of emerging technologies such as air-source heat pumps, heat pump water heaters, and advanced ventilation systems. To ensure training is both effective and efficient, begin by assessing staff's current knowledge and skills. This will help tailor the depth and scope of training to meet actual needs and avoid alienating them by covering material they already understand.

Some resources for this level of training are:

- ASHRAE's (American Society of Heating, Refrigerating and Cooling Engineers) Introduction to Building Decarbonization course
- Building Operator Certification Training Courses
- Smart Buildings Center's Qualified Energy Manager Training

Once specific equipment models have been selected, staff can enroll in training and/or certifications that are geared towards those models. The best resources for training about specific equipment models are the equipment manufacturers and distributors.

Some training may be free, whereas others may require a sizable investment of time and money, so it's a good idea to evaluate a number of different options to find those that offer quality training that meets the needs of your individual staff. Some considerations for evaluating training options are:

- Time – class time and any out-of-classroom expectations
- Cost – sessions and materials
- Timeline (current openings or wait list)
- Virtual vs. in-person
- Alignment with staff availability
    - Location of in-person
    - Transportation options
    - Conflict with personal commitments such as child- or eldercare
- Hands-on versus theoretical

Residents

Many of the topics that should be communicated to residents are outlined in Section 1 of this guide—including what building decarbonization means, the expected benefits, how residents will be involved in the process, and how implementation may affect them.

Multifamily residents typically view the building through a different lens than property owners or managers. For residents, the building is not just a structure, it's their home and community. For owners and managers, it may be viewed primarily as an investment.

Neither perspective is wrong, but understanding this distinction is essential for effective communication. The more you can connect the information you provide to the residents' lived experiences, the more likely they are to understand and engage with the process.

Additionally, although complying with state and local mandates may be a key motivator for owners and managers, residents are more likely to be concerned with affordability, comfort, health, and safety. Therefore, messaging for residents should center these priorities. Use language that is friendly, clear, and free of technical jargon to ensure accessibility and build trust.

Because residents may prefer different methods of receiving information, using a variety of communication channels and formats will help ensure your information is received. Common approaches include:

- Educational workshops
- Fact sheets
- Videos

Whenever possible, translate communications into the languages spoken by residents and account for the communications needs of residents with disabilities to ensure accessibility, inclusivity, and effective engagement.

Executive team

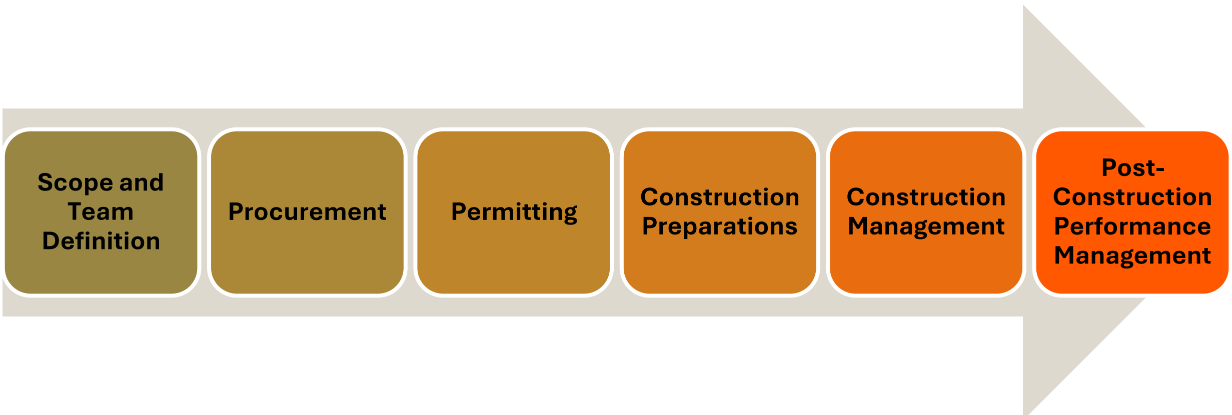
The executive team's primary concerns typically center on maintaining the value of their investment and ensuring compliance with state and local mandates. Therefore, communications should focus on these priorities. Because time is a limited resource for busy executives, messaging should be concise, direct, and results-oriented. Use numbers and visual aids—such as charts, graphs, and tables—to clearly and efficiently convey key information.

Step 3. Implement Decarbonization Plan

The pace at which you move into the implementation phase will depend on several factors, including financing, contractor and equipment availability, staff capacity, seasonal restrictions on certain equipment replacements, and any health and safety remediation requirements. The scope of implementation will also vary based on the number of buildings involved and the specific measures outlined in your decarbonization plan. For example, whether you are undertaking upgrades in a single building or installing heat pumps across multiple properties.

The following sections of this guide outline steps that apply to projects of varying sizes and timelines, while also highlighting special considerations for unique circumstances.

The implementation process generally follows these steps.



3A. Assemble Project Team

Forming the appropriate team for each implementation project is essential to ensure the necessary expertise, capacity, and coordination are in place to successfully carry out the work. For substantial rehabilitation projects—particularly those involving structural upgrades or installing complex systems—a comprehensive design team is typically required. This may include architects and engineers, as well as relevant internal staff.

For smaller or more straightforward projects, a leaner team composed of internal staff and a qualified contractor may be sufficient.

Additional team members to consider include:

- **Owner's Representative**: Especially valuable for larger projects, this role helps manage coordination among all parties involved in the project and ensures that project goals and expected outcomes are achieved.
- **Commissioning (Cx) Agent or Third-Party Verifier**: A commissioning agent assesses system performance after retrofits are installed to confirm optimal operation. A third-party verifier provides an added layer of assurance by verifying that the envelope and structural components have been installed correctly.

Strong coordination and thorough planning during the pre-retrofit phase can significantly reduce both time and costs during implementation. Take the time to engage stakeholders in detailed discussions around project scope, design, and execution planning to ensure alignment and avoid delays.

3B. Procure the Work

Including one or more contractors during the design phase is highly advantageous, as their expertise can help validate the feasibility of your plans and streamline decision-making. In some cases, this means the procurement process may already be underway. Regardless of when contractors are engaged, selecting the right team is critical to the success of your decarbonization project. Even if you have established relationships with HVAC, electrical, or general contractors, it is essential to confirm that they possess the appropriate skills, certifications, and experience to execute your specific scope of work effectively.

Contractor qualifications

When reviewing RFQs and RFPs and speaking with contractors about their qualifications to perform decarbonization work, certain credentials and skill sets are important, depending on the specific trade.

All trades

- Current and valid trade licensing
- Formal trade education from an accredited institution
- BPI (Building Performance Institute) certification for building shell and weatherization (preferred)
- Demonstrated experience installing and servicing heat pumps and/or heat pump hot water heaters
- Demonstrated experience working in multifamily buildings

General contractor

- Proven experience managing, coordinating, and scheduling across trades, owners, and stakeholders
- Established project management and quality assurance systems
- Strong communication and interpersonal skills
- Demonstrated ability to diplomatically manage conflict and maintain productive relationships with building staff, subcontractors, and residents

HVAC

- Heat Pump certifications - all manufacturers a plus, but manufacturer of selected equipment should be considered as a minimum requirement
- Manual J & Load calculator training - ACCA or equal

Electrical

- Proven expertise in upgrading electrical service panels and evaluating future service capacity needs

The State of Washington maintains a Qualified Contractor Network of contractors authorized by the state to perform work on the Inflation Reduction Act's Home Energy Rebate projects. Those applying for the rebates will be given access to the "Find a Contractor" directory through the rebate administrator's website after receiving rebate approval.

Bid documents

If you are soliciting bids, clearly defining the scope and technical requirements in a bid document is essential. This ensures that prospective contractors fully understand the work to be performed and are appropriately qualified to meet project expectations. For smaller projects, a Request for Quote (RFQ)—which emphasizes organizational experience and background—may be sufficient. For larger or more complex projects, a Request for Proposal (RFP) that outlines detailed technical and execution requirements will help you gather comprehensive information and select the most qualified firm for the job.

Contract

Once the team is selected, the contracting process begins. The contract should include typical provisions for a contract, defining the scope of work for each team, the expected timeline, and the expected budget, payment amount, and terms.

You can include your decarbonization goals and measurement and verification (M&V)[12] requirements in the contract, too. In fact, as an owner, you can add incentives or penalties for meeting M&V requirements to your procurement contract.

The M&V process is detailed in Section 3F of the Guide.

Resources

Building Innovation Hub's Service Procurement Guide

- Step 5. Bid the Job
- Step 6. Select the Right Vendor

3C. Obtain Permits

The requirements for a permit will vary depending on the jurisdiction in which the property resides. Therefore, we recommend you consult your local jurisdictions online permitting resources or reach out to the permitting department directly. However, some best practices apply regardless of the jurisdiction.

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[12] The process of using measurements to reliably verify the performance of building upgrades.

- **Start the permitting process early** and build extra time into your project schedule to accommodate potential delays or additional reviews.
- **Identify all required permits** for your project and understand the specific requirements for each. Some permits may require a preliminary assessment or pre-submittal conference before you can apply.
- **Prepare complete and accurate documentation** to avoid processing delays. Ensure all required materials are gathered and formatted correctly—whether digital or paper.
- **Reach out to the permitting department whenever clarification is needed**, especially if requirements or next steps are unclear.

3D. Prepare for Retrofits

Data collection

To effectively compare pre-retrofit and post-retrofit energy consumption and costs, it is essential to collect baseline data before any decarbonization work begins. This step is typically addressed through compliance with energy benchmarking requirements. However, if benchmarking has not yet been conducted on the building, it is critical to begin data collection immediately. Gathering at least 12 months of historical energy usage data allows for a comprehensive analysis of building performance across all four seasons, providing a reliable foundation for evaluating the impact of decarbonization measures.

Retrofit-specific planning efficiencies

Multi-family decarbonization retrofits typically take 8-10 weeks, from project initiation to completion. This does not include equipment procurement timelines, administrative costs, or permit approvals, which can sometimes be lengthy. Total project timelines can extend further due to unforeseen issues, material delays, market conditions, and field barriers.

The following retrofit-planning efficiencies help projects make progress and limit the number of delays.

- **Coordinate with the contractor on order of operations** to allow for reasonable livable conditions or relocation, if needed.
- **Arrange for the contractor to bulk order equipment, if possible.** One challenge of decarbonization is high upfront costs associated with purchasing and installing equipment. Bulk ordering equipment reduces equipment costs, expedites project schedules, and minimizes potential delays. Limitations associated with this strategy include contractor cashflow and warehouse space, and aligning multiple projects in the pipeline for specific equipment.

- **Utilize over-the-counter permitting when applicable**. Projects having to go through a full-permit review process can take substantial time and require additional planning and design aspects. Over-the-counter permitting is a more time efficient process and can be used in some situations.

Alternative housing for residents

Creating a general plan for alternative housing for residents while the building is being retrofitted was part of developing the decarbonization plan. However, once you're ready to begin decarbonizing your building, you'll need to develop a specific accommodations plan and share it with residents well in advance of the first day of construction.

Some accommodations details may already be outlined in lease agreements. However, when they are not, the following factors regarding alternative housing should be considered:

- Timely notice of relocation and return
- Written notifications in residents' preferred languages
- Reimbursement of moving expenses and any damage to personal property by relocation personnel
- Providing comparable space and amenities
- Proximity to current residence and access to public transportation.

3E. Manage Retrofits

Ensuring quality installation

Ensuring quality installation starts before you retrofit your building by clearly defining scope and requirements and hiring qualified contractors and consultants, as discussed in previous sections of this guide. While the building is being retrofitted, it is important to have someone monitoring the installation who is familiar with the project details, code requirements, equipment specifications, proper construction practices, and the expected outcomes.

Specific considerations

Insulation: If walls are being opened up for insulation, make sure proper installation is verified before the drywall is put back up

Air sealing: A blower door test can be performed before retrofits are complete to determine whether air leaks still exist

Ensuring proper operations & maintenance (O&M) documentation

Ensuring the operations and maintenance requirements for the building's upgrades are clearly documented as part of the decarbonization project is essential for two key reasons. First, the WA Clean Buildings Performance Standard mandates submission of an operations and maintenance plan by July 1, 2027, for multifamily buildings larger than 20,000 square feet. Second, facilities and maintenance staff will need detailed guidance on how to operate and maintain new equipment to achieve designated performance goals and remain in compliance with building performance standards. It is critical to clearly establish who is responsible for producing this documentation, specify what information is to be included, and set clear timelines for when the documentation will be completed.

3F. Post-installation Tasks

Measurement & verification

As mentioned previously, a measurement and verification (M&V) plan should be created and communicated to contractors prior to retrofitting the building, and even as early as in the bid documents. After retrofits are complete, the M&V plan should be implemented.

It is best to have a commissioning (Cx) agent, or another third-party verifier, conduct the M&V plan so there are no conflicts of interest. A third-party verifier, or Cx agent, is paid separately from the design and retrofit teams so their measurements are accountable directly to the owner.

Documentation and processing for financial incentives

When decarbonization measures that are covered by financial incentives are completed, be sure to submit the necessary paperwork in time for any incentive program deadlines. Contractors who are familiar with the incentive program can help complete and submit the required documentation to the appropriate processing entity (the incentive provider itself or a third-party program implementer).

Warranty registration

Ensure that any new equipment with a warranty has been registered through the manufacturer's website, ideally within a week of installation.

Monitoring

Explore ways to monitor the building's performance outside of benchmarking. Some common monitoring tools available are:

- Building Management Systems (BMS): Comprehensive platforms that integrate and control multiple building systems like HVAC, lighting, and security.

- Data Loggers: Devices that collect and record data on environmental and energy conditions. Most models offer the ability to transmit data to a computer for further analysis.
- Building diagnostic equipment: Specialized tools for specific measurements like air leakage and heat flow.

Equipment-specific training

- *Maintenance staff:* If maintenance staff did not receive training on newly installed equipment before it went in, it is essential to schedule training sessions as soon as possible. Proper training ensures that staff are equipped to operate, maintain, and troubleshoot new systems effectively, which is critical for achieving the intended performance and longevity of decarbonization measures. Training should be tailored to the specific models installed and may include manufacturer-led sessions, certifications, or hands-on workshops.

- *Residents:* In parallel, it's important to engage residents regarding any new equipment installed in their units or shared spaces. Clear communication about how the equipment works, and any adjustments in daily habits or usage patterns that may be needed, will help ensure the systems function as intended. For example, residents may need guidance on operating heat pump thermostats, using induction cooktops, or maintaining proper ventilation. Providing user-friendly instructions, demonstrations, and translated materials as necessary can support successful adoption and maximize the benefits of the upgrades.

Section 4: Utility Rates and Allowances

The utility bill savings that building owners and residents may realize from installing upgraded equipment depend not only on the performance of the new equipment and systems, but also on the utility rates and utility allowance policies set by external agencies. Although these rate structures and allowance methodologies are largely outside the direct control of owners, there is still meaningful room for flexibility. By exploring alternative utility allowance calculation methods, and understanding available rate options or discount programs, owners can help ensure that post-retrofit utility costs are accurately reflected and that potential savings are maximized for both the property and its residents.

Rates

Both Seattle City Light (SCL) and Puget Sound Energy (PSE) currently only offer a flat electricity rate for multifamily properties with four or more residential units. However, for two- to three-unit properties equipped with smart meters at the individual unit level, a time-of-use (TOU) rate is available through SCL. PSE offers a TOU rate for residential customers (currently on a Schedule 7 rate). TOU rates allow residents to benefit from lower electricity costs during off-peak hours—such as early mornings, evenings, overnight periods, and weekends—potentially reducing overall energy expenses for both residents and building owners.

Beyond lowering utility bills, TOU rates can enhance the performance of onsite solar and battery storage systems as well as centralized domestic hot water and space heating systems designed for thermal storage. By encouraging reduced energy usage during peak daytime hours, TOU pricing enables more energy to be stored and used during off-peak periods, improving cost efficiency and supporting broader decarbonization goals.

In addition, both SCL and PSE offer discount programs for customers who meet income eligibility requirements.

- Seattle City Light's Utility Discount Program: https://www.seattle.gov/human-services/services-and-programs/utility-discount-program. Consult this map to determine if your property is within the Seattle City Light service territory.
- PSE's Bill Discount Rate: https://www.pse.com/en/account-and-billing/assistance-programs/bill-discount-rate

Building owners can help their residents manage energy costs by raising awareness of the various rates and programs offered by the utility(s) serving the property.

Impact on Utility Allowances

For subsidized multifamily properties, it is important that utility allowances reflect actual utility costs post-retrofit. Outside of the utility allowances published by your local public housing authority, the Washington State Housing Finance Commission (WSHFC) offers several alternative methods for calculating utility allowances, providing flexibility to choose the approach that best reflects post-retrofit utility costs for residents. However, for all but three of the methods included in the WSHFC guidance, prior approval from the Commission is required.

Section 5: Compliance with WA State and Seattle Mandates

Energy Codes

Washington State Energy Code (for buildings outside the City of Seattle)

The Washington State Energy Code (WAC 51-11C/R) dictates the performance of new buildings and certain renovations to existing buildings. Chapter 5 of the code contains specific requirements and exemptions for additions, alterations, repairs, and changes of occupancy or use-type of existing buildings. Routine maintenance, repairs to existing building components, and replacement of existing systems are generally exempt from these requirements if the repairs or replacements do not increase the building's projected energy consumption.

The code contains specific performance requirements for all building systems that impact energy consumption, including envelope components, HVAC, lighting, water heating, pumps, controls for these systems, and other miscellaneous building systems. It provides multiple compliance pathways outlined below.

Note: An update to the current Washington State Energy Code (2024) is expected in the near future. We recommend you consult the current version of Chapter 5 to ensure you are referencing the latest requirements.

Category	Pathway	Description
Prescriptive		Building system is designed to meet or exceed a specified performance metrics. For new buildings and additions, additional energy measure credits must be selected from a menu of increased performance specifications above the minimum requirements. The prescriptive compliance pathway is an all-electric code that permits no fossil-fueled building systems. If fossil-fueled building systems are installed, a separate fossil fuel compliance path must be followed which requires additional energy measure credits to be selected.
Performance	Total building	Building design must be modeled with software that meets the ASHRAE 90.1 Appendix G performance standards.

		The annual energy performance as modeled must exceed the baseline design by a factor dependent on the building type.
	Outcome-based energy budget	Requires buildings to perform whole-building energy modeling to demonstrate projected energy consumption below established Energy Use Intensity (EUI) targets for the proposed design. Once the building is constructed, the building must document one year of net energy use below an energy budget within 3 years after occupancy and every 5 years thereafter through actual consumption records. Also requires that the building be designed to offset all estimated energy needs through renewable energy generation, with at least 40% generated on-site.

Seattle Energy Code (2021)

Buildings located within the city limits of Seattle must comply with the Seattle Energy Code (2021). This code largely mirrors the State energy code, with various amendments to establish higher energy-efficiency standards for properties in the City of Seattle. The compliance paths for the Seattle Energy Code vary from the WA energy code as follows:

- **Prescriptive Pathway:** stricter requirements
- **Total Building Performance Path:** no variance from state code
- **Outcome-Based Energy Budget Path:** not available; replaced by Target Performance Path
- **Target Performance Path (Seattle only):** specifies the use of ENERGY STAR® Portfolio Manager for demonstration of actual energy use and fines levied for non-compliance depending on the percentage difference between the target performance and the documented performance.

Section 5 of the Seattle Energy Code (2021) includes targeted provisions to promote decarbonization in existing buildings. In most cases, any modification or replacement of fossil-fueled heating systems requires installing electrically powered heat pumps as the primary heating source. The existing fossil-fuel system may remain only as a backup for extreme cold conditions. Additionally, buildings that retain any fossil-fueled systems must develop a schematic-level design plan outlining a pathway for full future decarbonization. The buildings listed below are exempt from the Seattle Energy Code's requirement to modify or replace fossil-fueled systems with electric systems when the fossil-fueled systems fail but **must still submit a Future Decarbonization Plan**:

- Affordable Housing
- Group I-1, I-2, and I-3 occupancies (Institutional)
- Buildings with more than 50 percent of conditioned floor area occupied by organizations recognized as nonprofit by the state of Washington or by federal tax law
- Buildings with no more than 20,000 square feet of conditioned floor area

Building Performance Standards

Washington State Clean Building Performance Standard (WA CBPS)

The Washington State Clean Building Performance Standard (WA CBPS) is a state-wide standard to reduce energy use in large buildings, which was created by the 2019 Washington Clean Buildings Act. The standard was expanded and augmented in 2022 and 2023. Reporting deadlines range from June 1, 2026, to June 1, 2028, depending on building size and occupancy type. *Note: federally owned buildings and buildings owned by federally recognized tribes are exempt from the standard.*

WA CBPS Program compliance is broken down into two tiers:

Program Element	Tier 1	Tier 2
Building Size	Nonresidential buildings >50,000 sq ft	Residential buildings >20,000 sq ft, and nonresidential buildings >20,000 and <50,001 sq ft
Includes multifamily residential?	No	Yes, all multifamily residential buildings >20,000 sq ft
Required activities	Benchmarking, energy management plan (EMP), operations and maintenance (O&M) program, and meeting performance metrics (energy use intensity)	Benchmarking, energy management plan (EMP), and operations and maintenance (O&M) program; **meeting performance metrics not yet required but may be added at a future date**
Compliance deadline	June 1, 2026, for buildings >220,000 sq ft June 1, 2027, for buildings >90,000 and <220,001 sq ft	July 1, 2027, for all Tier 2 buildings, but can begin reporting as early as July 1, 2025

Program Element	Tier 1	Tier 2
	June 1, 2028, for buildings >50,000 and <90,001 sq ft	

Source: https://deptofcommerce.app.box.com/s/gtgnjoolbj0bshdzdr7482phqo7phnda

Requirements for multifamily buildings

- **Benchmarking** by measuring and tracking energy use in a building over time
- Implementing an **operations and maintenance program**
- Creating an **energy management plan**

Seattle Building Emissions Performance Standard (BEPS)

Seattle's Building Emissions Performance Standard, which applies to multifamily and commercial buildings greater than 20,000 square feet within the city's limits, is focused on reducing greenhouse gas emissions; therefore, it uses a Greenhouse Gas Intensity Target (GHGIT) instead of an energy usage intensity (EUI) target like the state standard does. Building owners must identify property-specific greenhouse gas intensity targets based on the mix of activities within a building and implement measures to meet those targets if the building's greenhouse gas intensity doesn't already meet it. Buildings with fossil-fueled systems will have much higher greenhouse gas intensities than similar buildings that are all- or nearly all-electric, so owners of those buildings are thus likely to need to implement more decarbonization measures to reduce the building's greenhouse gas intensity to meet its GHGIT.

OSE Director's Rule 2025-01 was released in December 2025. **Buildings in Seattle must still comply with the WA CBPS.**

BEPS Compliance Timeline by Building Size

Building Size (SF)	Benchmarking Verification and GHG Report	Meet GHGI Target, Benchmarking Verification, and GHG Report			
≥ 220,001	2027	2031	2036	2041	2046
90,001 – 220,000	2027	2032	2037	2042	2047
50,001 – 90,000	2028	2033	2038	2043	2048
30,001 – 50,000	2029	2034	2039	2044	2049
20,001 – 30,000	2030	2035	2040	2045	2050
Building portfolios, district campus, and connected buildings	2028	2033	2038	2043	2048

Requirements

The compliance steps for Seattle BEPS include **Benchmarking Verification**, submitting a **Greenhouse Gas (GHG) Report**, and meeting a **GHGI Target.**

- **Benchmarking Verification:** A qualified person must verify the benchmarking data for the building's energy and greenhouse gas emissions that has previously been submitted for annual Seattle energy benchmarking under SMC 22.920 to ensure the data is accurate and up to date, and submit a benchmarking verification report. This includes steps such as confirming energy sources, meters, property uses, and floor area are correct in ENERGY STAR Portfolio Manager. Buildings confirmed as all-electric may be exempt from the GHG Report and the GHGI target requirements.
- **Greenhouse Gas (GHG) Report:** For this step, a qualified person must document current greenhouse gas emissions intensity (GHGI), the building's estimated GHGIT, and the building's equipment, and create an outline of actions needed to achieve the GHGIT. They must also indicate any exemptions, extensions and alternative compliance paths that may be used and submit any required eligibility forms. All reports will be submitted using a portal provided by OSE.
- **Meet GHGI Targets:** If needed to meet upcoming targets, upgrades must be completed before the building's next compliance deadlines (starting in 2031 for the largest multifamily buildings, unless approved for an extension or alternative compliance). Thus, for a building ≥220,001 SF, this would mean that upgrades should be completed by the end of 2030 so the reduced emissions can be verified in the benchmarking data by its October 1, 2031, compliance deadline. Starting in 2046 and through 2050 depending on building size, multifamily buildings must achieve net-zero emissions.

Flexibility options to meet BEPS GHGIT: Low-income housing and low-rent housing multifamily buildings are eligible for an extension of the 2031-2036 GHGIT compliance deadline (see box below), and may apply for other extensions as well. In addition, BEPS offers several alternative compliance pathways for flexibility, especially for buildings with hardships or extenuating circumstances, and for portfolios of buildings.

For further information on the Seattle Building Emissions Performance Standard, please visit the Office of Sustainability and Environment's BEPS website.

WA and City of Seattle BPS Compliance Timelines, Compared

Multifamily buildings greater than 20,000 square feet must adhere to the following deadlines.

Location	WA CBPS		City of Seattle BEPS	
	Reporting	Energy Performance Target	Benchmarking Verification & GHG Report	First Emissions Performance Target
Within Seattle city limits	7/1/2027	Not currently required	Starting 10/1/2027 (>90,001 SF)	Starting 10/1/2031 (≥220,001 SF) (10/1/36 for low-income housing with approved extension)

Buildings Eligible for Extension from Meeting 2031-2035 Seattle BEPS GHGIT

- *Low-income housing:* multifamily buildings that meet low-income housing definition.
- *Human services uses*: a covered building with >50% occupancy by human service uses.
- *Low-rent housing*: Multifamily buildings not meeting low-income housing definition where contract rent and utility allowance meet requirements published by Office of Housing.
- *Low-income housing with pre-established refinancing date conflict*: Multifamily buildings that meet low-income housing definition and had a pre-established financing date that will not occur until after 2036-2040 (extension applies to 2036-2040 GHGIT).
- *High rental vacancy rate*: covered buildings with a rental vacancy rate ≥35% during a consecutive 12-month period within the 36 months preceding the compliance date (extension may apply to any compliance interval).

Details on how to apply and additional extensions can be found in the **OSE Director's Rule 2025-01**, Section 14.

Outside Seattle city limits			N/A	N/A

Compliance Assistance Resources

Building owners can get help understanding the Washington Clean Building Performance Standard (WA CBPS) and the Seattle Building Emissions Performance Standard (BEPS) from a variety of sources. Many are free! Other resources can help you better understand your building, such as tool lending libraries and utility labs, and obtaining that understanding is an important step towards planning for your building's decarbonization.

- Seattle Office of Sustainability & Environment's Building Emissions Navigator program: small-group coaching cohorts for owners with buildings in the City of Seattle that need compliance assistance with Seattle BEPS and how it intersects with WA CBPS (free)
- Puget Sound Energy's Clean Buildings Accelerator: small group coaching cohorts providing PSE customers with compliance assistance for WA CBPS (free) (for owners with buildings outside the City of Seattle)
- Snohomish PUD's Clean Buildings Accelerator: small-group coaching cohorts for SnoPUD customers providing compliance assistance for WA CBPS (free)
- Seattle City Light's Lab: educational webinars on energy efficiency, building systems, code compliance, and more; links to many other resources like case studies and articles; consultations on emerging technologies (free)
- WA Department of Commerce Support and Resources: office hours, trainings, tailored support for WA CBPS from Climate Fellows (free)
- Smart Buildings Center's Clean Building Performance Standard Helpdesk: assistance via one-on-one appointments, virtual meetings or a simple phone-call to help with WA CBPS questions (free; sponsored by WA Department of Commerce and local utilities)
- Smart Buildings Center's Tool Lending Library: a lending "library" of diagnostic tools available to building owners, managers, and energy service professionals in Washington State and Oregon, for short-term data collection on energy-using equipment and systems (free)
- Smart Buildings Center's Technical Webinar Series: live and recorded webinars on a variety of topics related to building operations, energy use, emissions reduction, and regulatory compliance (fees for registration)

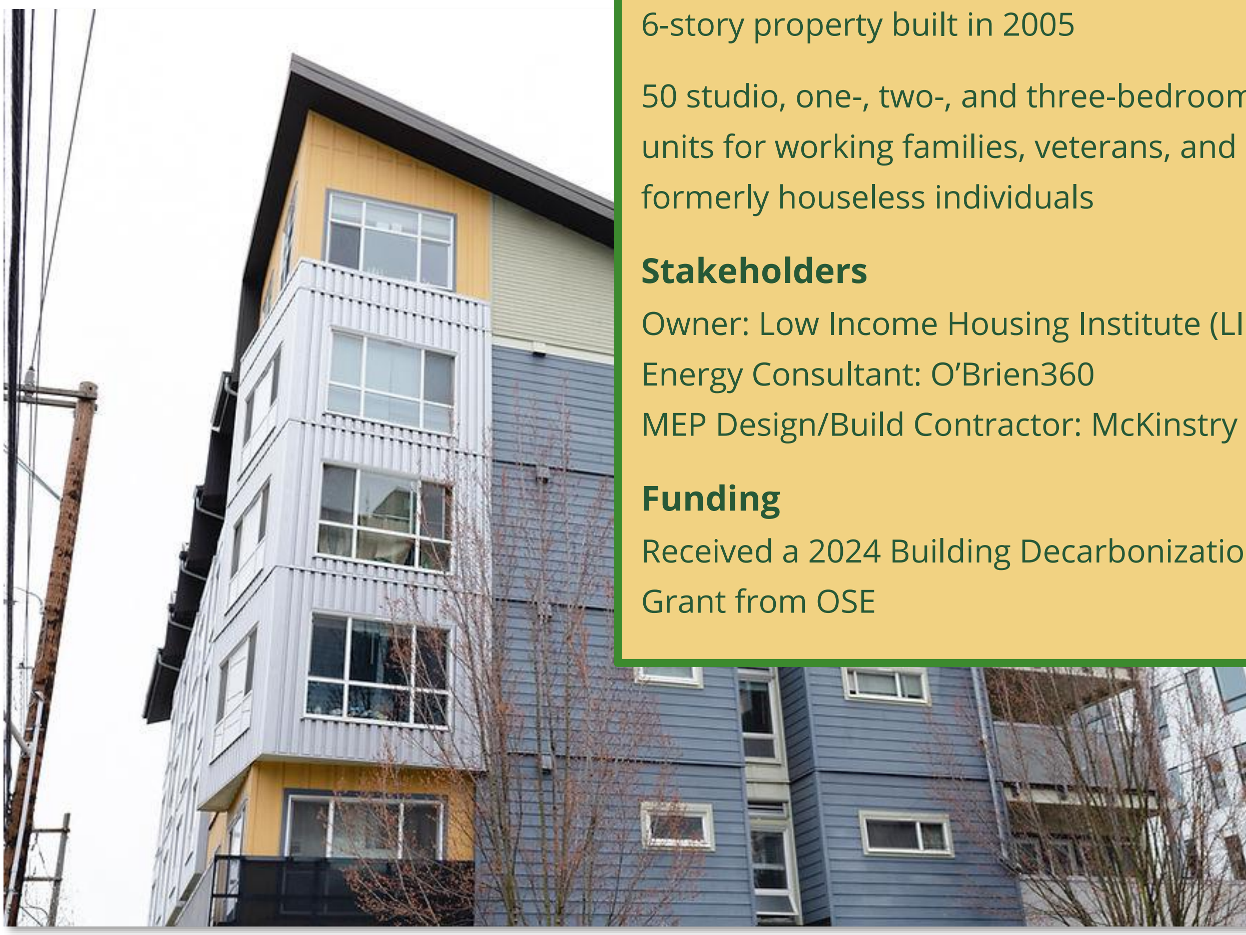
Section 6: Case Studies

The following pages present two detailed case studies that illustrate a range of approaches to multifamily building retrofits. Each example highlights different combinations of decarbonization strategies, partnerships, technical solutions, financing considerations, and implementation challenges. Together, they demonstrate how building owners and their project teams can tailor retrofit pathways to meet regulatory requirements, improve building performance, and enhance resident comfort and safety—while navigating the unique conditions, constraints, and opportunities present in each property.

In addition, the City of Seattle's OSE has compiled case studies and other guidance on decarbonization and will continue to add case studies based on the Building Decarbonization Grants that OSE awards. Links to OSE's materials are available on its Resources web page.

Denny Park

230 8th Avenue N



Property

6-story property built in 2005

50 studio, one-, two-, and three-bedroom units for working families, veterans, and formerly houseless individuals

Stakeholders

Owner: Low Income Housing Institute (LIHI)
Energy Consultant: O'Brien360
MEP Design/Build Contractor: McKinstry

Funding

Received a 2024 Building Decarbonization Grant from OSE

Project Overview

LIHI's Denny Park apartments decarbonization plan and implementation supports future compliance with the City of Seattle's Building Emissions Performance Standard (BEPS). It was funded in part by the City Office of Sustainability & Environment's 2024 Building Decarbonization Grant program.

The project is currently in the pre-construction phase with the following scope defined:

- Conversion from gas central hot water space heating to in-unit electric resistance.
- Replacement of corridor gas-fueled hot water space heating with electric heat pumps
- Installation of heat pump plus energy-recovery ventilation in the common room
- Replacement of gas dryers with electric models

- Upgrade of common area and in-unit lighting[13]
- Replacement of whole-unit exhaust fans with more energy efficient versions[13]
- Addition of electric heat pump to existing gas hot water heating system

Project Approach

LIHI approached this decarbonization project—and its goal of meeting BEPS and energy code requirements—by partnering with O'Brien360 and McKinstry to complete a feasibility study that would define the proposed scope of work along with budgetary pricing.

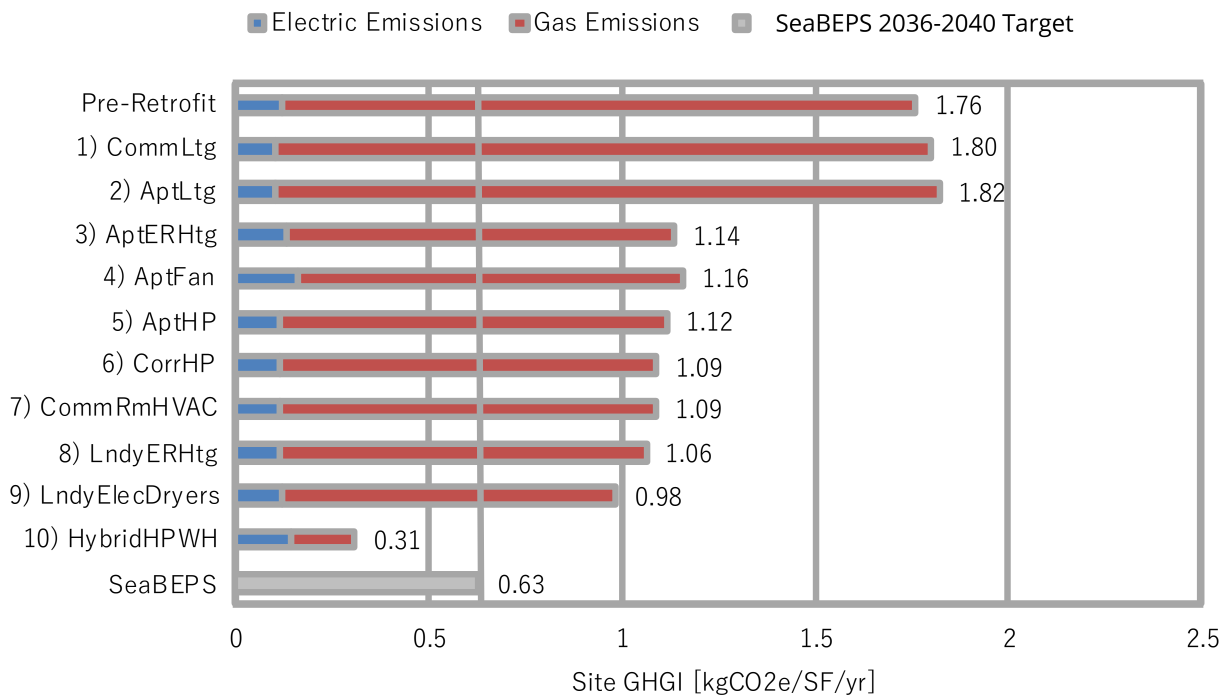
Before developing permit plans, the project team engaged with the Seattle Department of Construction and Inspections (SDCI) to review their concept plan and confirm the project was not a substantial alteration, as well as to approve alternate ways of complying with the Seattle Energy Code. This early collaboration led to customized solutions that satisfied both Energy Code compliance and the budget limitations for the project.

McKinstry is now tasked to produce detailed mechanical, electrical, and plumbing plans, along with a firm installation price. The design/build approach can provide advantages over the traditional design/bid/build method, including improved coordination, clearer scope, and reduced project risk, However, it does require the property owner to relinquish more control of the project to the design/build firm.

Projected Results

The design team utilized whole-building energy modeling software to project the energy savings and emissions reduction of the measures to be included in the scope. On the next page is a chart of the modeled emissions estimates which demonstrates that the combined measures will bring the property into compliance with the 2036-2040 GHGIT for multifamily buildings in Seattle BEPS.

[13] Lighting and exhaust fan upgrades aren't decarbonization measures on their own, but they can free up electrical capacity for electrifying fossil-fueled equipment.


Electric Emissions
Gas Emissions
SeaBEPS 2036-2040 Target
Pre-Retrofit
1) CommLtg
2) AptLtg
3) AptERHtg
4) AptFan
5) AptHP
6) CorrHP
7) CommRmHVAC
8) LndyERHtg
9) LndyElecDryers
10) HybridHPWH
SeaBEPS
1.76
1.80
1.82
1.14
1.16
1.12
1.09
1.09
1.06
0.98
0.31
0.63
0
0.5
1
1.5
2
2.5
Site GHGI [kgCO2e/SF/yr]

Bayview Tower

2614 4th Ave

Property

13-story property built in 1976

100 one-bedroom units servings senior and disabled residents

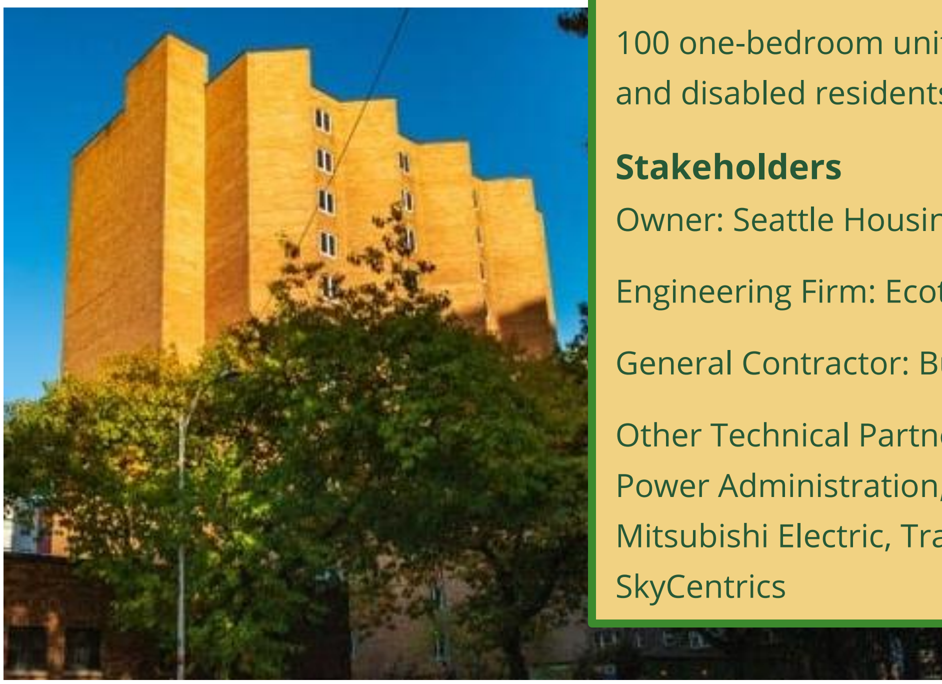
Stakeholders

Owner: Seattle Housing Authority

Engineering Firm: Ecotope, Inc.

General Contractor: Burton Construction

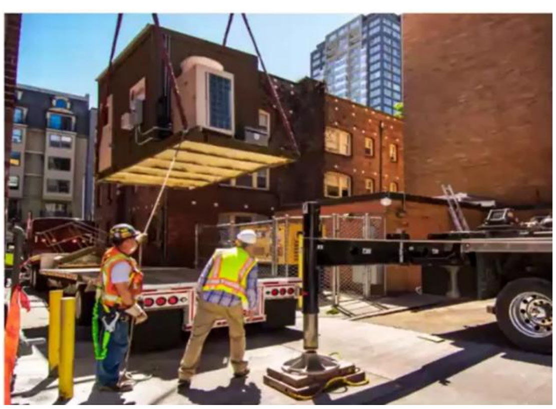
Other Technical Partners: Bonneville Power Administration, Seattle City Light, Mitsubishi Electric, Trane US, Steffes, SkyCentrics



Source: https://digitaledition.pmmag.com/pme-september-2022/feature-3/

Project Overview

Although not a decarbonization project, the Bayview Tower effort showcases a successful retrofit of a centralized heat-pump hot-water system that repurposed existing equipment, incorporated emerging technologies, and applied innovative engineering solutions to overcome complex challenges. Given the widespread use of gas-fueled hot-water systems in the Seattle area, this project highlights a forward-looking approach to efficient water-heating technology. The renovation focused primarily on upgrading the central electric-resistance water-heating system and replacing the electric-resistance heating systems serving the common corridors.

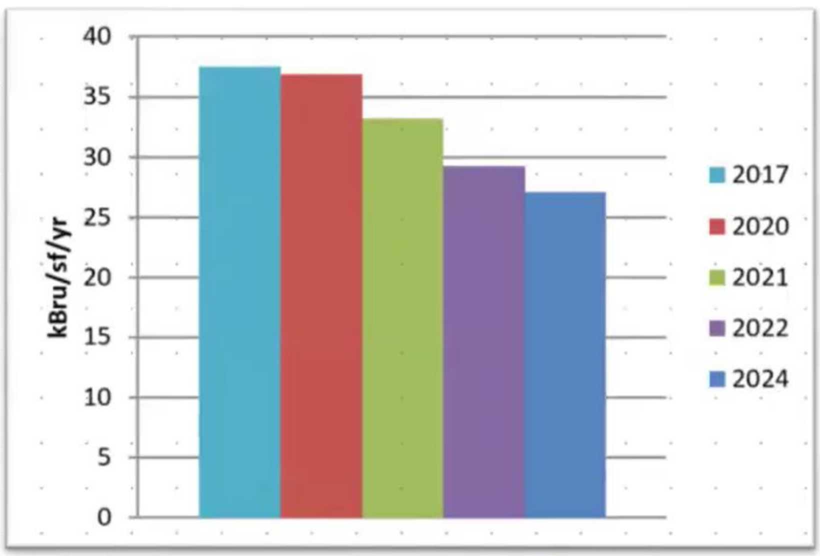


Project Approach

Water Heating

The existing electric central water-heating system was replaced with a central heat-pump water heater. Multiple technical partners collaborated to develop an installation approach that simplified the process and minimized disruptions to residents' hot-water access. The new equipment was preassembled on a platform, which was then lifted onto the roof next to the room housing the original system. After piping was connected between the old and new systems, the team simply switched off the existing equipment and activated the heat pump, resulting in only a few hours of hot-water downtime for residents.

Beyond the efficiency gains from the new equipment, additional energy and cost savings were achieved by repurposing the original system's storage tanks and adding new controls. The combination of the new equipment and the controls has reduced energy usage for Bayview Tower's water heating between 50 to 70%.



Corridor Heating

The existing electric resistance heating system serving the common corridors was replaced with a heat recovery system that captures heat from the units' bathroom exhaust—heat previously vented outdoors. The heat-recovery system utilized the existing partitions in Bayview Tower's ventilation shafts, which already separated kitchen exhaust—containing potential contaminants—from the cleaner bathroom exhaust. In the new configuration, the bathroom exhaust was routed through a heat-recovery system that transfers the captured heat to the ventilation air for common corridors. Additional efficiency was achieved by installing variable-speed drives on the existing rooftop exhaust fans. These drives adjust fan operation based on the volume of exhaust moving through the system, reducing energy use while maintaining proper ventilation.

Results

The new systems' usage and costs have been monitored since their installation in the summer of 2022, and the results show substantial improvement. The bar chart below illustrates the reduction in site EUI through 2024

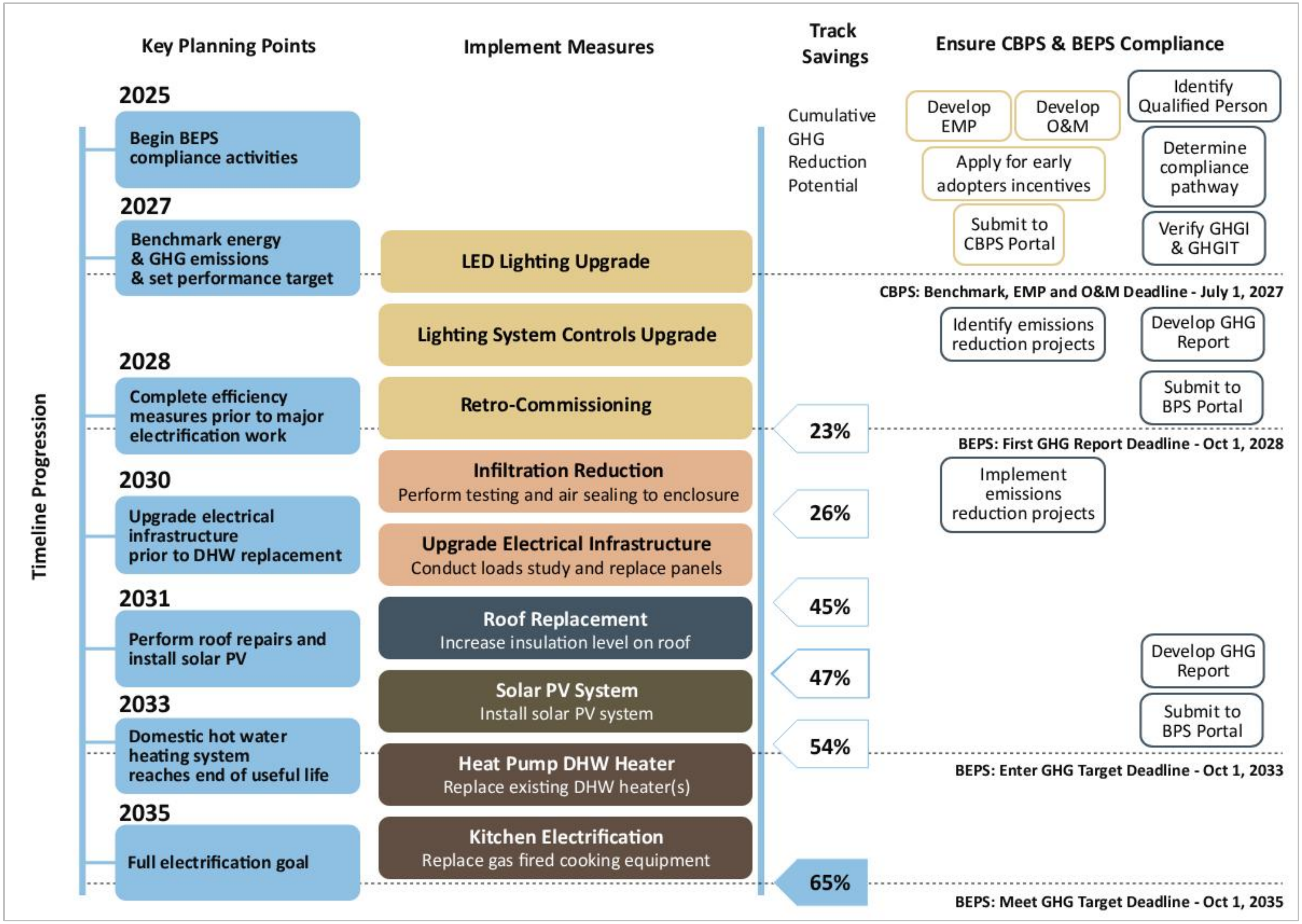
APPENDIX A

Sample Lifecyle Cost Analysis

Year			0	1	2	3	4	5	6	7	8	9	10
Business Case													
BRIDGE LOAN													
Bridge Loan Amount	$		$1,645,600										
Loan Fees	$		($16,456)										
Construction loan payments	$			($848,759)	($848,759)	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost of Capital			$1,629,144	($848,759)	($848,759)	$0	$0	$0	$0	$0	$0	$0	$0
TAX CREDITS													
Federal ITC	$	Year 1		$177,600									
Total Tax Benefits				$177,600	$0	$0	$0	$0	$0	$0	$0	$0	$0
INCENTIVES													
SRECs	$			($476)	($476)	($476)	($476)	($476)	$0	$0	$0	$0	$0
HEAR Rebates	$			$1,268,000									
HER Rebates	$			$200,000									
Utility Incentives	$			$200,000									
Other Program Incentives	$			$25,000									
Total Incentive Payments				$1,692,524	($476)	($476)	($476)	($476)	$0	$0	$0	$0	$0
GRANTS													
Restricted Grant, non-federal	$		$300,000										
Restricted Grant, federal	$		$200,000										
Non-restricted Grant			$0										
Total Cost of Capital			$500,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
ENERGY SAVINGS													
Electricity Savings	$	$ Annual		$85,612	$88,180	$90,826	$93,551	$96,357	$99,248	$102,225	$105,292	$108,451	$111,704
Gas Savings	$	$ Annual		$207,000	$217,350	$228,218	$239,628	$251,610	$264,190	$277,400	$291,270	$305,833	$321,125
Demand Charge Savings	$	Estimated		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Revenue				$292,612	$305,530	$319,043	$333,179	$347,967	$363,438	$379,625	$396,562	$414,284	$432,829
OPERATING EXPENSES		$/kW/Yr											
Fixed O&M Expense	$	$10.40		($2,000)	($2,000)	($2,000)	($100)	($102)	($104)	($106)	($108)	($110)	($113)
Insurance	$	$3.40		($12)	($12)	($12)	($13)	($13)	($13)	($13)	($14)	($14)	($14)
Project Administration	$	$5.20		($18)	($19)	($19)	($19)	($20)	($20)	($20)	($21)	($21)	($22)
Total Operating Expense				($2,030)	($2,031)	($2,031)	($132)	($135)	($137)	($140)	($143)	($146)	($149)
CASHFLOW													
Net Benefits (Costs)	$		($3,071,856)	$1,311,948	($545,735)	$316,536	$332,571	$347,357	$363,301	$379,485	$396,419	$414,138	$432,681
Cumulative Cashflow	$		($3,071,856)	($1,759,908)	($2,305,643)	($1,989,106)	($1,656,535)	($1,309,178)	($945,878)	($566,393)	($169,974)	$244,165	$676,845
Payback Calculation		Years	**8.4**	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.4	0.0
Internal Rate of Return													
Internal Net Benefits (Costs less loans	$		($5,201,000)	$2,160,706	$303,024	$316,536	$332,571	$347,357	$363,301	$379,485	$396,419	$414,138	$432,681
Internal Cumulative Cashflow	$		($5,201,000)	($3,040,294)	($2,737,270)	($2,420,733)	($2,088,162)	($1,740,805)	($1,377,505)	($998,020)	($601,601)	($187,462)	$245,218

APPENDIX B

Sample Decarbonization Timeline



APPENDIX C

Sample Decarbonization Assessment Report

The sample decarbonization assessment report on the following pages is from the Building Energy Exchange's Roadmap for Multifamily Affordable Housing, which is based on typical property typologies in New York that are evaluating decarbonization to comply with New York building performance standards. Although the geographic location and specifics of the building performance standards are different, the report provides an excellent example of the type of information that a GHG Emissions Reduction Audit can provide.

typology: post-1980, mid-rise, senior rental housing

baseline building conditions

This post-1980s mid-rise building has a typical brick masonry assembly with minimal detailing and no interior insulation and utilizes natural gas for heating plus thru-wall A/Cs for cooling, making it a strong candidate for insulated over-cladding and unitized thru-wall heat pumps.

low carbon retrofit package

Low Carbon improvements include new efficient hydronic boilers, an electric heat pump DHW system, solar PV, efficient lighting fixtures and appliances. Envelope upgrades include new roof insulation, windows, air sealing measures, and optional above grade wall R-15 EIFS over-cladding. **GHG savings for this scope of work are based on the 2030 emissions factor.**

GHG savings

RELATIVE TO BASELINE BUILDING AND BASED ON THE 2030 EMISSIONS FACTOR

no carbon retrofit package

No Carbon improvements include all 2030 measures plus additional upgrades which may supersede some 2030 measures. Improvements include energy recovery ventilation plus electrification of heating, cooking, and clothes drying resulting in whole building electrification. Envelope upgrades include new high performance windows and optional above grade wall R-15 EIFS over-cladding. **GHG savings for this scope of work are based on the 2050 emissions factor.**

GHG savings

RELATIVE TO BASELINE BUILDING AND BASED ON THE 2050 EMISSIONS FACTOR

BUILDING SYSTEM	% OF GHG EMISSIONS	SYSTEM COMPONENTS	DESCRIPTION	ENERGY CONSERVATION MEASURES (ECMs) (low carbon)	ESTIMATED COST/DU*	GHG savings (2030)	ENERGY CONSERVATION MEASURES (ECMs) (no carbon)	ESTIMATED COST/DU*	ESTIMATED TOTAL COST/DU*	GHG savings (2050)
envelope	n/a	Roof Insulation	Concrete deck, no insulation	■ R-38 above deck	$2,550	19%			$2,550	0% **/****
		Windows/Glazing	Estimated to be U = 0.8	■ New aluminum, double pane, low-e, argon filled, double hung	$3,500		■ New high performance, uPVC, thermally broken, casement	$4,500	$4,500	
		Air Sealing & Weatherization	Unknown	■ Door & window weatherstripping	$1,000				$1,000	
		Above Grade Walls	Uninsulated brick wall assembly	+ Optional R-15 EIFS over-cladding	$10,000		+ Optional R-15 EIFS over-cladding	$10,000	$10,000	
heating	49%	Heating	Conventional hydronic boilers with Aquastat and baseboards	■ New conventional hydronic boilers with TRVs or zone valves ■ Heat Timer boiler controls with indoor temp feedback ■ Real Time Energy Management (RTEM)	$5,450 $350 $3,600	5% +12% WITH R-15 EIFS OVER-CLADDING	■ Packaged cold-climate heat pump (PTHP) T	$9,350	$9,350 $3,600	52% **/**** +0% **/**** WITH R-15 EIFS OVER-CLADDING
cooling		Cooling	Thru-wall ACs	■ New thru-wall ENERGY STAR ACs	$2,000		(see above) PTHPs also provide cooling			
		Pumps	(2) 3HP single speed pumps	■ NEMA Premium pumps with VFDs	$250					
		Pipe Insulation	Some pipe insulation	■ New pipe insulation	$300					
ventilation		Ventilation	Common Area: passive In-unit Bath: registers only In-unit Kitchen: passive via window	■ Direct drive, variable speed EC motor central exhaust fans with timers & CAR dampers	$1,600		■ Central ERVs serving corridors ⚡ T ■ Central ERVs serving apartments ⚡ T	$4,700	$4,700 (see above)	
		Ductwork	In-unit: leaky	■ Clean & seal ducts; conduct testing, adjusting, & balancing	(see above)					
domestic hot water	26%	DHW	Heating hydronic boilers with Aquastat and small storage tank	■ Central air source heat pump (ASHP) with storage ⚡ T	$8,050	23%	No additional recommended measures		$8,050	30%***
		Plumbing Fixtures	Standard flow fixtures	■ Low flow fixtures (WaterSense where applicable)	$600				$600	
lighting	9%	Common Area	Predominately 4' T12	■ LEDs with occupancy/vacancy sensors	$800	1%	No additional recommended measures		$800	5%***
		Exterior	High wattage metal halide	■ LEDs with photocells & timeclock	(see above)				(see above)	
		In-unit	T12 & incandescent	■ LEDs	$1,000				$1,000	
appliances	16%	Appliances	Non-ENERGY STAR refrigerators Gas stoves	■ ENERGY STAR refrigerators	$1,350	1%	■ Electric stoves ⚡ T	$950	$2,300	13%
		Central Laundry	(1) Non-ENERGY STAR washer (3) ENERGY STAR washers (3) Gas dryers	■ (4) ENERGY STAR washers	$0 (per equipment lease agreement)		■ (3) Heat pump dryers ⚡ T	$0	$0 (per equipment lease agreement)	
renewables		None		■ 62kW ballasted rooftop solar system	$2,750	4%	No additional recommended measures		$2,750	0%
			ASSOCIATED UPGRADES	⚡ electrical service and distribution upgrades T structural/finish upgrades including dunnage, patching, & sealing	$3,200 $10		⚡ electrical service and distribution upgrade T structural/finish upgrades including dunnage, patching, & sealing	$6,400 $4,950	$9,600 $4,950	
				2030 Emissions Factor The 2030 emissions factor reflects an electric grid powered 70% by renewable energy. ESTIMATED TOTAL COST/DU	$38,360	53%	2050 Emissions Factor The 2050 emissions factor reflects a zero-emissions electric grid powered 100% by renewable energy. ESTIMATED TOTAL COST/DU		$56,050	100%
				ESTIMATED TOTAL COST/DU WITH R-15 EIFS OVER-CLADDING	$48,360	65%	ESTIMATED TOTAL COST/DU WITH R-15 EIFS OVER-CLADDING		$66,050	100%

* Rough order of magnitude estimated costs based on current information at the time of publication that include material, labor, and mark-up. For more information, see the *Decarbonization Roadmap for Multifamily Affordable Housing Best Practices Manual*.

** Due to the interactivity of the energy model, the GHG savings for envelope are attributed to the HVAC category for the 2050 scope.

*** Fully electrified systems in 2030 show a GHG savings increase in 2050 because of New York's electrical grid transitioning to more clean energy sources.

**** GHG savings from envelope upgrades fall to zero once all related building systems are electrified and the electric grid is fully decarbonized. However, improvements to the building envelope will reduce the need for heating and cooling, which saves energy and minimizes operating costs.

1 calculate → **2 compare** → **3 develop** → **4 implement**

1 calculate
carbon emissions

Calculate the building's annual estimated GHG emissions using the BE-Ex Carbon Calculator: www.be-exchange.org/calculator

2 compare
to the LL97 emissions limits

Compare the building's current calculated GHG emissions with LL97 limits and determine what reduction is required for compliance.

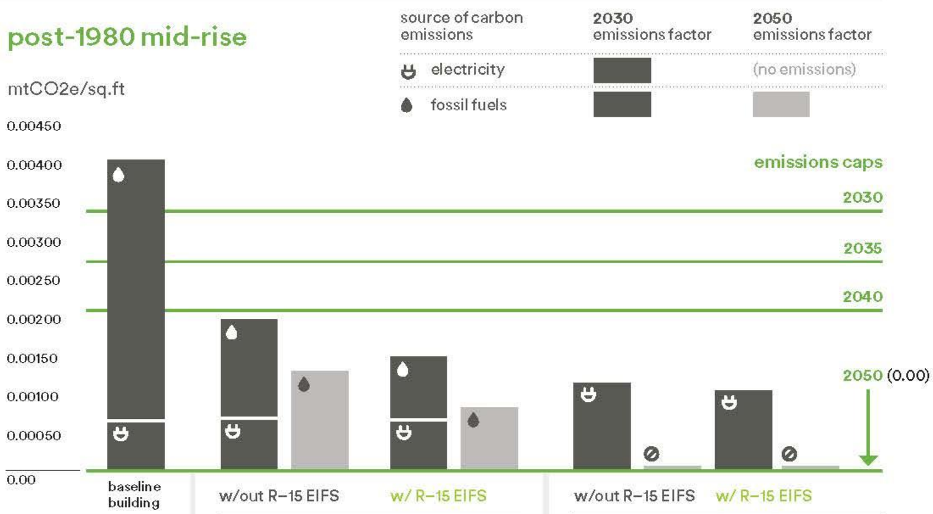
3 develop
a retrofit master plan

Develop a scope of energy conservation measures (ECMs) that are selected and phased to align with building operational and system needs, and financing cycles.

4 implement
building decarbonization measures

carbon emissions intensity: post-1980 mid-rise

The following graph illustrates the carbon emissions intensity associated with the *Low Carbon* and *No Carbon* retrofit packages outlined on the previous pages.



first year estimated savings ($/DU)	Low Carbon Retrofit Package: w/out R-15 EIFS	Low Carbon Retrofit Package: w/ R-15 EIFS	No Carbon Retrofit Package: w/out R-15 EIFS	No Carbon Retrofit Package: w/ R-15 EIFS
owners	$320	$400	$95	$200
tenants	$10	$50	$0	$10

Emissions Factors

Each scope of work is evaluated against the 2030 and 2050 emissions factors as defined under LL97:

- The 2030 emissions factor reflects an electric grid powered 70% by renewable energy.
- The 2050 emissions factor reflects a zero emissions electric grid powered 100% by renewable energy.

The *Baseline Building* shows emissions from the existing building conditions based on the 2030 emissions factor.

Emissions per Fuel Type

The graph distinguishes between the carbon emissions associated with each fuel type: electricity or fossil fuels. In 2050, when the electric grid is powered by 100% renewable energy sources, the emissions from electric equipment will be zero. The *No Carbon* scopes have zero emissions as a result.

Emissions Caps

The graph includes carbon emissions caps for the LL97 reporting periods. Note the emissions cap for 2050 is at zero.

When the emissions associated with a scope of work exceeds a specific emissions cap, the building may be subject to financial penalties.

key takeaway

Simple low-rise buildings can be a good fit for RetrofitNY-type projects, but the high costs are an impediment; whereas the *Low Carbon* retrofit package would comply with LL97 2030 emissions limits. Adding PTHPs into existing AC sleeves, while retaining the existing gas/hydronic heating system, can provide cooling to vulnerable seniors while enabling a future cost-effective phase-out of fossil-fuels when the building is overclad and/or the boiler is converted to a heat pump.