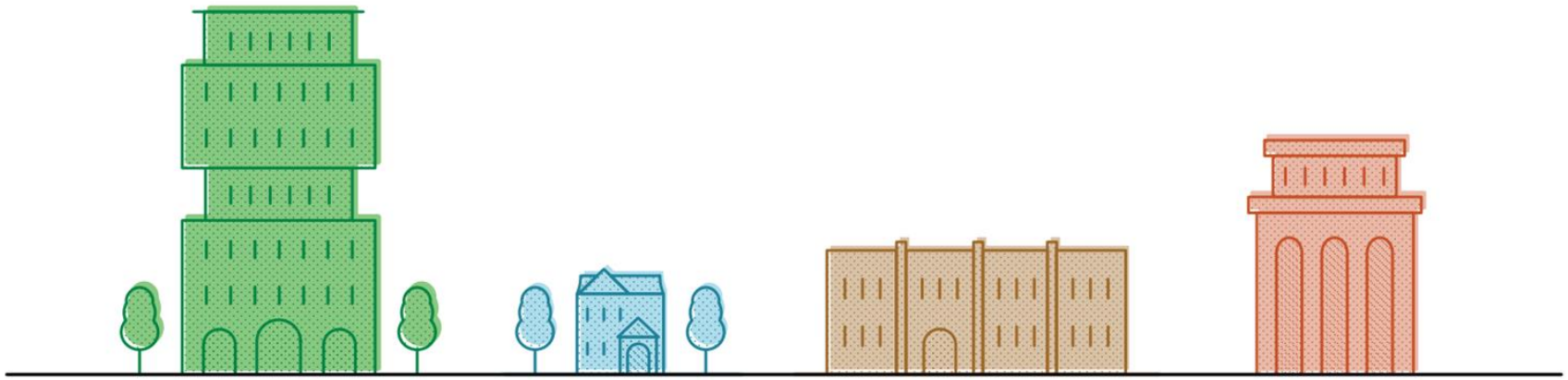
Net Zero Building Retrofit Guides

When to Implement Measures Guide

Guide for Single Family Homes

Guide for Commercial and Multi-Unit Residential Buildings



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When to Implement Measures Guide for **Single Family Homes**

When to Implement Measures Guide – *Single Family Home*

This tool identifies and recommends retrofit measures to be completed prior, with, or after a selected net zero retrofit measure for a single family home.

Contents

When to Implement Measures Guide – *Single Family Home*

Building Envelope Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **EnerGuide Evaluation or Home Inspection**: Review current conditions and identify elements that impact energy use and performance, equipment conditions, and possible retrofit measures, including walls, windows, insulation, and roofing systems, to identify deficiencies and opportunities for improvement. • **Building Envelope Audit**: Conduct blower door test and/or a thermographic inspection to assess air leakage, insulation effectiveness, and thermal bridging.	• **High-Performance Windows**: Replace existing windows with high-performance windows to reduce heat loss, such as triple-pane glazing with low-E coatings to improve thermal performance and minimize solar heat gain. • **Insulation Upgrade**: Improve or replace insulation in walls, roofs, attics, or foundations to enhance thermal performance, energy efficiency and overall comfort. • **Airtightness**: Complete air sealing to prevent drafts and ensure all gaps and cracks are properly sealed, to maximize effectiveness of the retrofit.	• **Heating and Cooling System Measures**: Plan for heating and cooling retrofits once energy use is reduced from building envelope retrofits. • **Renewable Energy Sources**: Install solar PV and/or energy storage to reduce demand on electrical grid after roof upgrades.

When to Implement Measures Guide – *Single Family Home*

HVAC Systems – Heating Systems Measures -

Complete *prior:*	Complete *with:*	Complete *after:*
• **EnerGuide Evaluation or Home Inspection**: Review current conditions and identify elements that impact energy use and performance, equipment conditions, and possible retrofit measures. • **Building Envelope Measures**: Improve the building's energy efficiency and reduce heating energy needs. – Insulation – High Performance Windows – Air Sealing • **Evaluate Electrical Capacity**: Check if the building requires electrical capacity upgrades to support the new system.	• **Domestic Hot Water**: Evaluate if the domestic hot water system can be upgraded alongside the heating system. • **Cooling and Air Conditioning**: Assess whether cooling systems, such as air conditioning, can be integrated with the heating system measures. Systems like air source and ground source heat pumps can often provide both heating and cooling from a single unit. • **Energy Recovery Ventilator (ERV)**: Install to reduce overall heating and cooling demands. • **Tracking and Smart Controls**: Track the performance of the heating system and integrate the controls into a home automation system.	• **Renewable Energy Sources**: Install solar PV and/or energy storage to reduce demand on electrical grid.

When to Implement Measures Guide – *Single Family Home*

HVAC Systems – Cooling Systems Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **EnerGuide Evaluation or Home Inspection**: Review current conditions and identify elements that impact energy use and performance, equipment conditions, and possible retrofit measures. • **Building Envelope Measures**: Improve the building's energy efficiency and reduce heating energy needs. – Insulation – High Performance Windows – Air Sealing • **Evaluate Electrical Capacity**: Check if the building requires electrical capacity upgrades to support the new system.	• **Energy Recovery Ventilator (ERV)**: Install to reduce overall heating and cooling demands. • **Heating System Measures**: Assess whether the building heating systems can be integrated with the cooling measures. Systems like air source and ground source heat pumps can often provide both heating and cooling from a single unit. • **Tracking and Smart Controls**: To track the performance of the cooling system and integrate the controls into a home automation system.	• **Renewable Energy Sources**: Install solar PV and/or energy storage to reduce demand on electrical grid.

When to Implement Measures Guide – *Single Family Home*

HVAC Systems – Ventilation Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **EnerGuide Evaluation or Home Inspection**: Review current conditions and identify elements that impact energy use and performance, equipment conditions, and possible retrofit measures. • **Conduct an Air Audit**: Identify areas for improvement in terms of airflow, air quality, and energy efficiency. • **Building Envelope Measures**: Improve the building's energy efficiency and reduce heating energy needs. – Insulation – High Performance Windows – Air Sealing	• **Exhaust Fans**: Integrate or upgrade in bathrooms and kitchens to ensure proper ventilation and air quality. • **Energy Recovery Ventilators (ERV)**: Install to reduce overall heating and cooling demands. • **Heating and Cooling System Retrofits**: Plan ventilation upgrades as part of end-of-life for HVAC equipment since ventilation system measures may require HVAC system modifications.	• **Commissioning**: Test and balance the system to ensure it operates as intended. This step ensures that energy efficiency and air quality goals are met.

When to Implement Measures Guide – *Single Family Home*

Domestic Hot Water Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **EnerGuide Evaluation or Home Inspection**: Review current conditions and identify elements that impact energy use and performance, equipment conditions, and possible retrofit measures. • **Evaluate Electrical Capacity**: Check if the building requires electrical capacity upgrades to support the new system. Electrical capacity upgrades are potentially required only in homes 30 years and older.	• **Heating System Measures**: Assess whether the building heating systems can be integrated with the domestic hot water. Systems like air source and ground source heat pumps can often provide space heating and domestic hot water heating. • **Tracking and Smart Controls**: Track the performance of the domestic hot water system and integrate the controls into a home automation system. • **Renewable Energy Generation and Storage**: Pair your domestic hot water systems with renewable energy sources like solar thermal and add thermal storage tanks to helps to store extra heat for later use.	• *No specific retrofits following domestic hot water measures are suggested. Continue with your roadmap to net zero as planned.*

When to Implement Measures Guide – *Single Family Home*

Smart Homes and Appliances Measures

Complete *prior:*	Complete *with:*	Complete *after:*
Note: Smart home technologies and appliances can be stand-alone measures that are implemented at any time, piece by piece, or all at once. • **EnerGuide Evaluation or Home Inspection**: Review current conditions and identify elements that impact energy use and performance, equipment conditions, and possible retrofit measures. Evaluate if your building has existing HVAC, lighting, or security systems that can be integrated into a smart home system. • **Heating and Cooling System Measures**: Consider upgrading heating, cooling, and ventilation systems to reduce energy and enable compatibility with smart home controls.	• **Programmable or Smart Thermostats**: Install a programmable or smart thermostat that can be automatically adjust based on schedule, temperature occupancy, weather, and energy usage patterns. • **Lighting**: Integrate lighting to smart homes systems to automatically adjust lighting based on occupancy and daylight.	*No specific measures following as smart home systems and appliances measures as they function as stand-alone measures. Continue with your roadmap to net zero as planned.*

When to Implement Measures Guide – *Single Family Home*

Lighting and Lighting Controls Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **EnerGuide Evaluation or Home Inspection**: Review current conditions and identify elements that impact energy use and performance, equipment conditions, and possible retrofit measures. Evaluate your current lighting systems, including fixtures and controls.	• **Smart Homes Technologies**: Integrate new lighting controls with smart homes systems or standalone controls as needed to maximize energy efficiency, reduce costs, and improve occupant comfort.	*No specific measures following Lighting measures are suggested. Continue with your roadmap to net zero as planned.*

When to Implement Measures Guide – *Single Family Home*

Renewable Energy Generation and Storage Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **EnerGuide Evaluation or Home Inspection**: Review current conditions and identify elements that impact energy use and performance, equipment conditions, and possible retrofit measures. • **Evaluate Electrical Equipment**: Check if the building requires electrical equipment upgrades to support a renewable generation system. • **Heating and Cooling System Measures**: Electrify heating, cooling and ventilation systems prior to installing renewable energy generation systems to correctly size the renewable system. • **Lighting**: Upgrade lighting to reduce energy use prior to installing renewable energy generation systems.	• **Solar PV**: Install rooftop solar photovoltaic panels to reduce utility energy costs and increase resiliency. • **Solar Thermal**: Consider a solar thermal system for high hot water demands, such as heating swimming pools. • **Battery Storage**: Determine if the renewable energy systems are likely to produce excess energy beyond the buildings consumption and are likely to require batteries for energy storage. • **Power Management System**: Ensure the system is designed to efficiently switch between solar power, battery storage, and the electrical grid to meet your home's energy requirements. Integrate the system with the smart home system for optimized controls and efficiency.	• *No specific measures following renewable energy generation and storage measures are suggested. Continue with your roadmap to net zero as planned.*

When to Implement Measures Guide for **Commercial & Multi-Unit Residential**

When to Implement Measures Guide – *Commercial and Multi-Unit Residential Buildings*

This tool identifies and recommends retrofit measures to be completed prior, with, or after a selected net zero retrofit measure for commercial and multi-unit residential buildings.

Contents

When to Implement Measures Guide – *Commercial and Multi-Unit Residential Buildings*

Building Envelope Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **Building Envelope Assessment**: Conduct a building envelope assessment to evaluate the current condition of walls, windows, insulation, and roofing systems, including identifying deficiencies, determining material ages, and identifying opportunities for improvement. Conduct blower door test and/or a thermographic inspection to assess air leakage, insulation effectiveness, and thermal bridging. • **Energy and GHG Audit**: Conduct an audit to identify energy end uses, peak loads, GHG emissions, energy efficiency improvements, and possible retrofit measures.	• **High-Performance Windows**: Replace existing windows with high-performance windows to reduce heat loss, such as triple-pane glazing with low-E coatings to improve thermal performance and minimize solar heat gain. • **Insulation Upgrade**: Improve or replace insulation in walls, roofs, or foundations to enhance thermal performance, energy efficiency and overall comfort. • **Airtightness**: Complete air sealing to prevent drafts and ensure all gaps and cracks are properly sealed, to maximize effectiveness of the retrofit.	• **Heating and Cooling System Measures**: Plan for heating and cooling retrofits once energy use is reduced from building envelope retrofits. • **Renewable energy sources**: Install solar PV and/or energy storage to reduce demand on electrical grid after roof upgrades.

When to Implement Measures Guide – *Commercial and Multi-Unit Residential Buildings*

HVAC Systems – Heating Systems Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **Building Condition Assessment**: Conduct a building condition assessment to evaluate the current condition of equipment. • **Energy and GHG Audit**: Conduct an audit to identify energy end uses, peak loads, GHG emissions, energy efficiency improvements, and possible retrofit measures. • **Building Envelope Measures**: Improve the building's energy efficiency and reduce heating energy needs, including insulation, high performance windows, and air sealing measures. • **Evaluate Electrical Capacity**: Check if the building requires electrical capacity upgrades to support the new system. • **Building Automation System**: Install or upgrade a building automation system to optimize heating system scheduling, setpoints, and controls for improved efficiency and performance.	• **Domestic Hot Water**: Evaluate if the domestic hot water system can be upgraded alongside the heating system. • **Cooling and Air Conditioning**: Assess whether cooling systems can be integrated with the heating system measures. Systems like air source and ground source heat pumps can often provide both heating and cooling from a single unit. • **Energy Recovery Ventilator (ERV)**: Install to reduce overall heating and cooling demands. • **Sub Metering**: Install sub-metering on the heating equipment to track the performance of the heating system and integrate the controls into a building automation system.	• **Commissioning**: Test and balance the system to ensure it operates as intended. • **Renewable energy sources**: Install solar PV and/or energy storage to reduce demand on electrical grid.

When to Implement Measures Guide – *Commercial and Multi-Unit Residential Buildings*

HVAC Systems – Cooling Systems Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **Building Condition Assessment**: Conduct a building condition assessment to evaluate the current condition of equipment. • **Energy and GHG Audit**: Conduct an audit to identify energy end uses, peak loads, GHG emissions, energy efficiency improvements, and possible retrofit measures. • **Building Envelope Measures**: Improve the building's energy efficiency and reduce cooling energy needs, including insulation, high performance windows, and air sealing measures. • **Evaluate Electrical Capacity**: Check if the building requires electrical capacity upgrades to support the new system. • **Building Automation System**: Install or upgrade a building automation system to optimize cooling system scheduling, setpoints, and controls for improved efficiency and performance.	• **Energy Recovery Ventilator (ERV)**: Install to reduce overall heating and cooling demands. • **Heating System Measures**: Assess whether the building heating systems can be integrated with the cooling measures. Systems like air source and ground source heat pumps can often provide both heating and cooling from a single unit. • **Sub Metering**: Install sub-metering on the cooling equipment to track the performance of the cooling system and integrate the controls into a building automation system.	• **Commissioning**: Test and balance the system to ensure it operates as intended. • **Renewable energy sources**: Install solar PV and/or energy storage to reduce demand on electrical grid.

When to Implement Measures Guide – *Commercial and Multi-Unit Residential Buildings*

HVAC Systems – Ventilation Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **Building Condition Assessment**: Conduct a building condition assessment to evaluate the current condition of equipment. • **Energy and GHG Audit**: Conduct an audit to identify energy end uses, peak loads, GHG emissions, energy efficiency improvements, and possible retrofit measures. • **Conduct an Air Audit**: Identify areas for improvement in terms of airflow, air quality, and energy efficiency. • **Building Envelope Measures**: Improve the building's energy efficiency and reduce heating and cooling energy needs, including insulation, high performance windows, and air sealing measures.	• **Energy Recovery Ventilators (ERV)**: Install energy recovery ventilators to reduce overall heating and cooling demands. • **Heating and Cooling System Retrofits**: Plan ventilation upgrades as part of end-of-life for HVAC equipment since ventilation system measures may require HVAC system modifications.	• **Commissioning**: Test and balance the system to ensure it operates as intended. This step ensures that energy efficiency and air quality goals are met.

When to Implement Measures Guide – *Commercial and Multi-Unit Residential Buildings*

Domestic Hot Water Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **Building Condition Assessment**: Conduct a building condition assessment to evaluate the current condition of equipment. • **Energy and GHG Audit**: Conduct an audit to identify energy end uses, peak loads, GHG emissions, energy efficiency improvements, and possible retrofit measures. • **Evaluate Electrical Capacity**: Check if the building requires electrical capacity upgrades to support the new system.	• **Heating System Measures**: Assess whether the building heating systems can be integrated with the domestic hot water. Systems like air source and ground source heat pumps can often provide space heating and domestic hot water heating. • **Sub Metering**: Install sub-metering on the domestic hot water equipment to track the performance of the domestic hot water system and integrate the controls into a building automation system. • **Renewable Energy Generation and Storage**: Pair your domestic hot water systems with renewable energy sources like solar thermal and add thermal storage tanks to helps to store extra heat for later use.	• *No specific retrofits following domestic hot water measures are suggested. Continue with your roadmap to net zero as planned.*

When to Implement Measures Guide – *Commercial and Multi-Unit Residential Buildings*

Building Control and Automation System Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **Building Condition Assessment**: Conduct a building condition assessment to evaluate the current condition of equipment and automation system. • **Energy and GHG Audit**: Conduct an audit to identify energy end uses, peak loads, GHG emissions, energy efficiency improvements, and possible retrofit measures. Evaluate if the building has existing HVAC, lighting, or security controls and systems that can be integrated into a building automation system.	• **Integrate Existing Systems**: Integrate the building's existing HVAC, lighting, security, and plumbing systems with the building automation system to centralize control and monitoring and automate these systems using sensors and software.	• **Heating and Cooling System Measures:** Upgrade the heating, cooling, and ventilation systems to reduce energy and enable compatibility with the building automation system. • **Lighting:** Upgrade lighting fixtures and controls to integrate with the building automation system to automatically adjust lighting based on occupancy and daylight. • **Domestic Hot Water**: Upgrade the domestic hot water system to integrate controls with the building automation system to monitor real-time hot water demand and actively optimize efficiency.

When to Implement Measures Guide – *Commercial and Multi-Unit Residential Buildings*

Lighting and Lighting Controls Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **Building Condition Assessment**: Conduct a building condition assessment to evaluate the current condition of equipment. • **Energy and GHG Audit**: Conduct an audit to identify energy end uses, peak loads, GHG emissions, energy efficiency improvements, and possible retrofit measures.	• **Sub Metering**: Install sub-metering on the lighting equipment to track the performance of the lighting system and integrate the controls into a building automation system.	*No specific measures following Lighting measures are suggested. Continue with your roadmap to net zero as planned.*

When to Implement Measures Guide – *Commercial and Multi-Unit Residential Buildings*

Renewable Energy Generation and Storage Measures

Complete *prior:*	Complete *with:*	Complete *after:*
• **Building Condition Assessment**: Conduct a building condition assessment to evaluate the current condition of equipment. • **Energy and GHG Audit**: Conduct an audit to identify energy end uses, peak loads, GHG emissions, energy efficiency improvements, and possible retrofit measures. • **Evaluate Electrical Equipment**: Check if the building requires electrical equipment upgrades to support a renewable generation system. • **Heating and Cooling System Measures**: Electrify heating, cooling and ventilation systems prior to installing renewable energy generation systems to correctly size the renewable system. • **Lighting**: Upgrade lighting to reduce energy use prior to installing renewable energy generation systems.	• **Solar PV**: Install rooftop solar photovoltaic panels to reduce utility energy costs and increase resiliency. • **Solar Thermal**: Consider a solar thermal system for high hot water demands. • **Battery Storage**: Determine if the renewable energy systems are likely to produce excess energy beyond the buildings consumption and are likely to require batteries for energy storage. • **Power Management System**: Ensure the system is designed to efficiently switch between solar power, battery storage, and the electrical grid to meet your building's energy requirements. Integrate the system with the building automation system for optimized controls and efficiency.	• *No specific measures following renewable energy generation and storage measures are suggested. Continue with your roadmap to net zero as planned.*