Title

Framework for Greenhouse Gas Emissions Reduction Planning: Building Portfolios

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U.S. DEPARTMENT OF ENERGY

Framework for Greenhouse Gas Emissions Reduction Planning: Building Portfolios

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Introduction

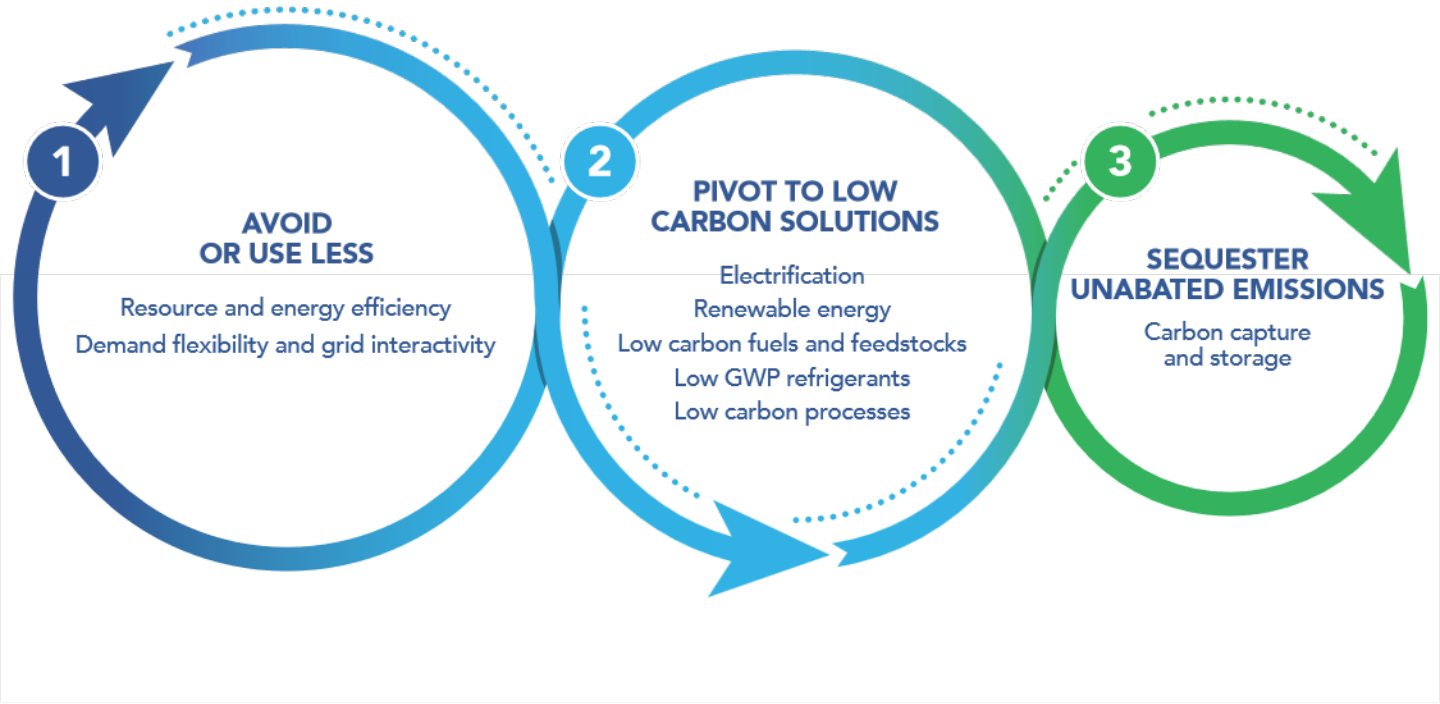
PURPOSE

The goal of this framework for greenhouse gas (GHG) emissions reduction planning (ERP) is to provide guidance to organizations seeking to reduce GHG emissions for their building portfolios and vehicle fleets. The process described in this framework helps organizations develop an actionable plan that prioritizes emissions reduction measures, identifies solutions, and lays out a phased pathway to achieve deep emissions reductions. The plan aims to result in the achievement of Scope 1 and 2 GHG emissions reduction targets, in alignment with goals set within the U.S. Department of Energy's (DOE's) Better Climate Challenge, as well as longer term emissions reduction goals.

As depicted in FIGURE 1, this guidance encourages organizations to prioritize measures that use less energy or avoid emissions, then transition to low carbon energy sources and low global warming potential (GWP) refrigerants, with the goal of reducing emissions without the use of carbon offsets. The scope of the plan will include both near-term actions and a transition to low- to no-carbon operations in the longer term. Near-term strategies such as electrification-readiness efforts will prepare organizations for deep emissions reduction projects across their portfolio as the electric grid decarbonizes over the next few decades. The planning horizon for the ERP is 10–20 years, depending on an organization's goals. The framework lays the groundwork for applying technical strategies to reduce on-site emissions across a portfolio.

The framework applies to commercial, multifamily, or institutional organizations that are developing an emissions reduction plan for their portfolio of buildings and fleets. Stakeholders include building owners, property managers, sustainability and energy teams, and facilities engineers. While this guidance was developed through the Better Climate Challenge, and therefore focuses on Scope 1 and 2 GHG emissions, the principles apply across all building portfolio decarbonization efforts.

FIGURE 1. Prioritization of GHG Measures



HOW CAN THIS FRAMEWORK BE USED?

The output of this framework is a GHG Emissions Reduction Plan that communicates an organization's strategy for achieving GHG emissions reductions targets. The framework was developed in coordination with industry design and operations professionals and owner representatives to document the emerging industry practice of portfolio-level emissions reduction planning. While the framework outlines methods and processes based on that collaboration, "best practices" will evolve over time as the practice matures. Consider the following strategies when using this framework:

- Organizations are encouraged to take actions such as pilots or "low-hanging-fruit" projects to reduce GHG emissions throughout the planning process, even before the plan is fully documented.
- The milestones outlined in this framework (FIGURE 2) are designed to be flexible and do not need to be completed in sequential order.
- The methods to achieve each milestone in the framework may vary; this document is not meant to be prescriptive.
- The final ERP deliverable may not be a single document. The ERP may be part of a larger climate strategy, and details such as building-level plans may be housed outside of the ERP.
- This framework can be used to support the development of the scope of work for external consultants (as needed) or guide the process for in-house development, depending on staff expertise and capacity.
- The framework can be used in conjunction with tools that support the development and execution of the emissions reduction plan. Potential tools include environmental, social and governance (ESG) tools for GHG inventory development and reporting, software that identify emissions reduction opportunities through automated data analysis, project tracking and capital planning tools, and ongoing commissioning tools such as energy management and information systems (EMIS).

WHY DEVELOP A GHG EMISSIONS REDUCTION PLAN?

There are many benefits to developing and documenting an Emissions Reduction Plan that outlines how an organization is going to achieve its GHG emissions reduction targets. The Emissions Reduction Plan is the necessary step to define how to meet the targets across the portfolio. Emissions Reduction Plan benefits include the following:

- Offering stakeholders (e.g., executive leadership, employees, building occupants) confidence that the organization has identified and secured the resources (financial and personnel) needed to turn their ambitious targets into action.
- Preparing an organization to meet regulatory and reporting requirements and avoid potential financial penalties from state, local, or other GHG policies and programs.
- Supporting analysis of multiple scenarios to identify the preferred strategies to pursue.
- Aligning decarbonization ambitions with the operational actions needed to achieve them (i.e., capital planning processes, maintenance/replacement decisions).
- Reducing the chance of decisions resulting in assets that lock in carbon emissions for the foreseeable future by integrating decarbonization principles throughout all organizational practices.
- Supporting organizations in staying on track to achieve long-term emissions reductions even if there is staff turnover, since the emissions reduction plans have been defined and documented.

A GHG Emissions Reduction Plan translates targets into action and ensures staff at all levels of the organization have access to the resources needed to achieve deep GHG reductions within the desired time frame.

FIGURE 2. Framework for Greenhouse Gas Emissions Reduction Planning

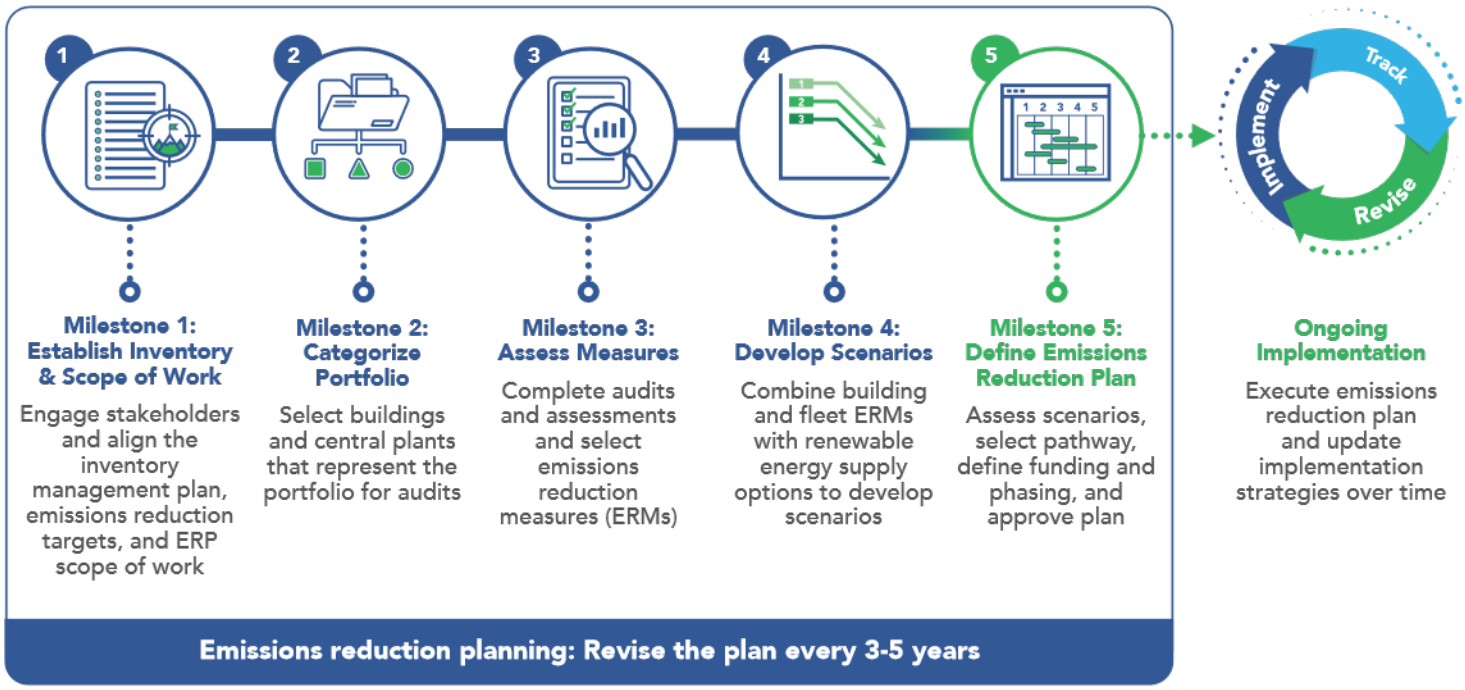


FIGURE 2 illustrates the five milestones in DOE's *Framework for Greenhouse Gas Emissions Reduction Planning*. This framework describes the steps to achieve each milestone, but they do not necessarily need to be completed in sequential order. The goal of this framework is to move an organization from targets to a plan that sets owners up for a successful implementation process that achieves deep GHG reduction goals.

While some organizations have established high-level plans for reducing GHG emissions, these plans generally differ from an ERP in some key ways, as summarized in FIGURE 3. High-level plans, often called *Climate Action Plans* (CAP) or *Sustainability Plans*, do not have a formal or standardized definition. However, they tend to provide a broad overview of the organization's plan to reduce emissions and explain why they are making such a commitment. As such, they focus more on GHG emissions target setting, stakeholder engagement, and broad strategies to reduce emissions.

As defined by this framework, an ERP extends past this broad overview by concretely laying out how an organization will meet its emissions reductions targets. Importantly, discrete strategies are scaled across the organization's portfolio of buildings and fleets of vehicles. An ERP is also deeply informed by strategic building audits and portfolio-level scenarios that consider different pathways to reduce emissions. In contrast, a high-level plan such as a CAP may not be informed by building audits. Finally, an ERP lays out an approach for emission reduction projects, when the projects will be completed, and how they will be financed. Given this context, high-level plans such as CAPs vary greatly in content. Thus, they may include content also found in ERPs and can serve as a starting point for developing an ERP.

FIGURE 3. Comparison of an Emissions Reduction Plan with Other Plans

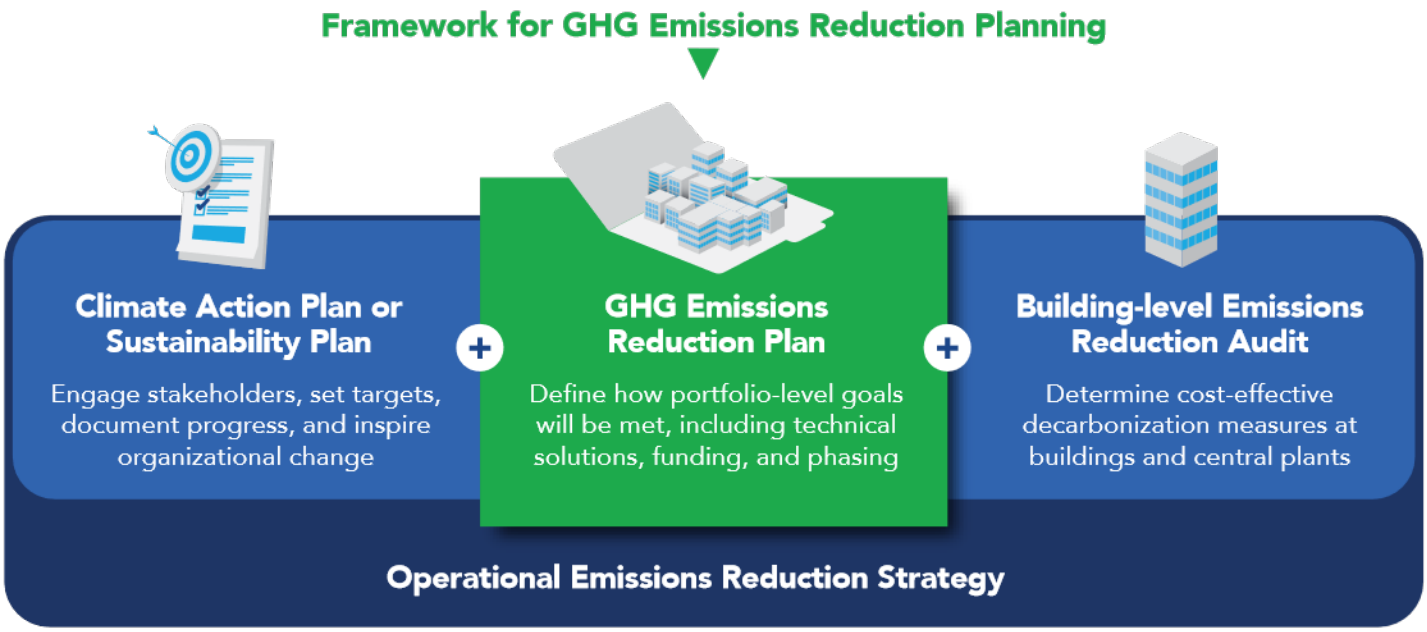


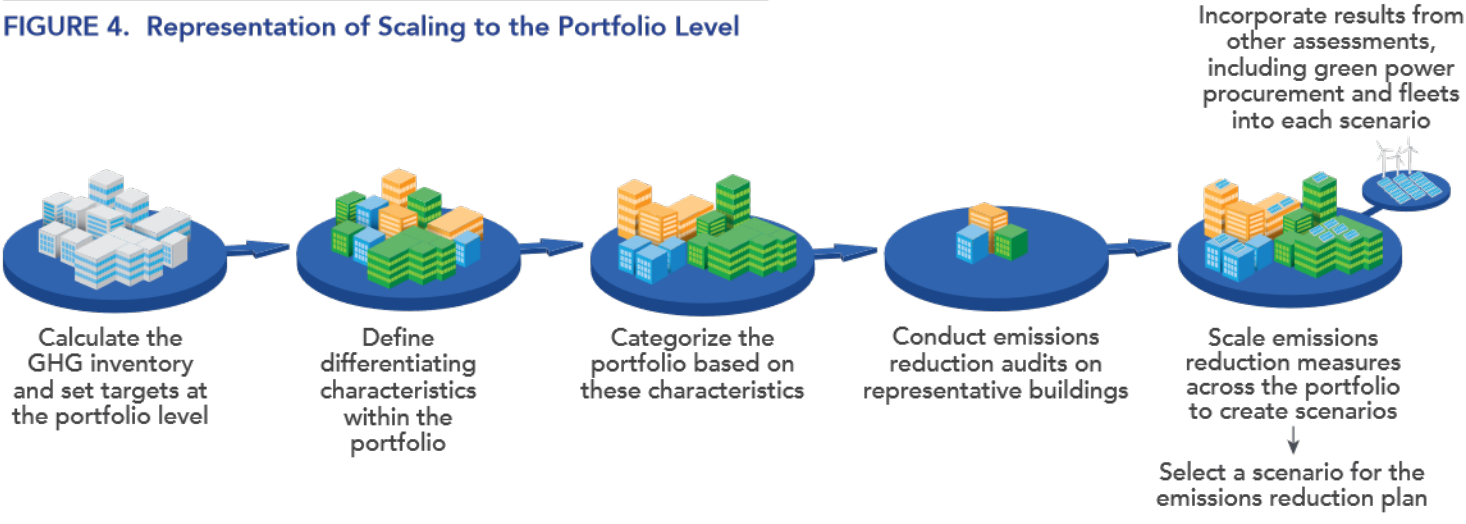
FIGURE 3 compares the Emission Reduction Plan with other types of plans. An Emissions Reduction Plan is more specific than the typical Climate Action Plan and has a broader scope than a building-level emissions reduction audit. The ERP is a concrete plan for reducing emissions, informed by audits of select buildings that can represent the entire portfolio. The time horizon for an ERP is 10–20 years.

HOW DOES THE EMISSIONS REDUCTION PLANNING FRAMEWORK HELP?

The framework guides organizations to systematically develop and evaluate scenarios at the portfolio level and proactively plan for the resources needed to complete actions in their buildings. This approach moves organizations from implementing individual ad hoc projects toward a path of transforming and improving their entire portfolio in a holistic and systematic fashion.

FIGURE 4 shows the portfolio scaling process that is described in detail throughout the milestones in this framework. After calculating its GHG inventory and setting portfolio emissions reduction targets, an organization defines characteristics that differentiate its buildings (e.g., HVAC system type and GHG emissions intensity). These characteristics are used to categorize buildings in the portfolio. For example, buildings with packaged rooftop units are in one category, and buildings served by a central HVAC plant are in another category. Next, the organization selects a sample of buildings for decarbonization audits that represent the different categories. The framework refers to these as *representative buildings*. The results from these representative building audits are scaled across similar buildings to estimate emissions reduction impacts and develop potential scenarios at the portfolio level. Additionally, the scenarios are influenced by portfolio-level assessments such as fleet electrification studies, solar opportunity analysis, and utility green power options. After evaluating the scenarios, the organization selects and defines their emissions reduction pathway. As shown previously in FIGURE 2, the framework offers five milestones to help organizations execute this process.

FIGURE 4. Representation of Scaling to the Portfolio Level

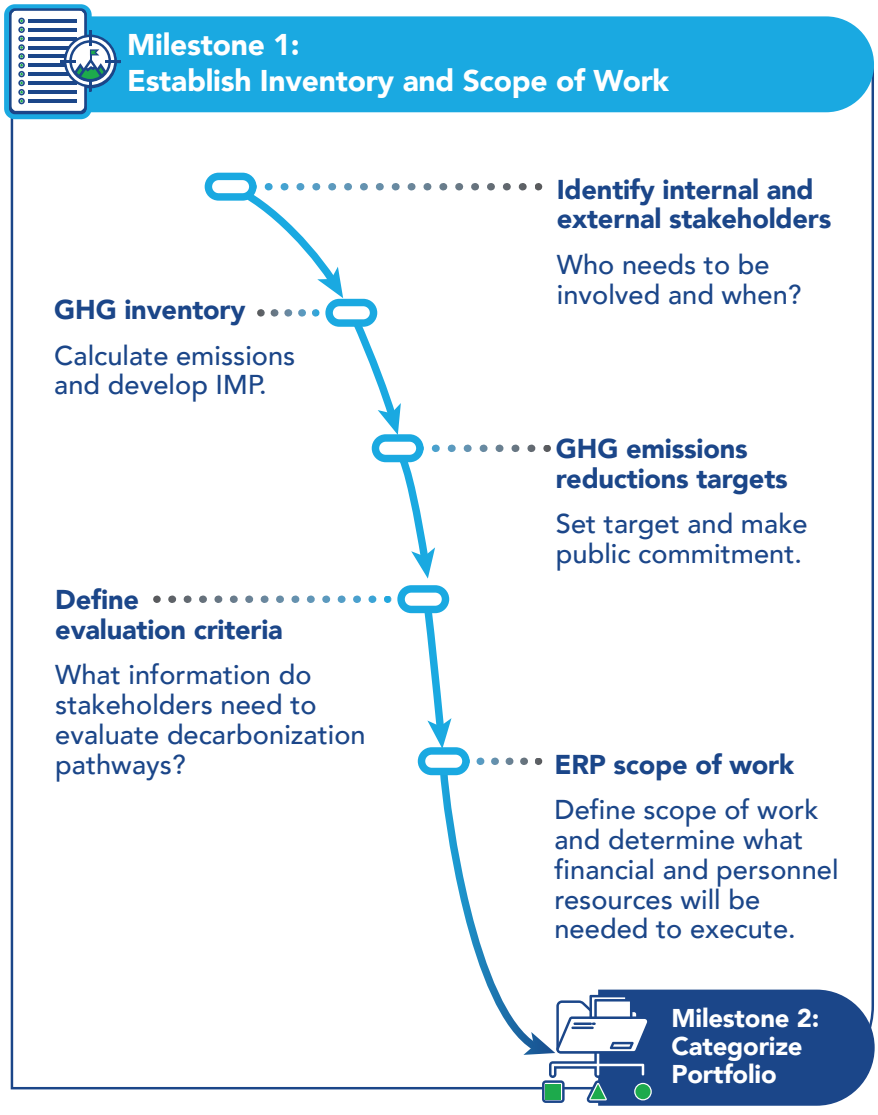


MILESTONE 1: Establish Inventory and Scope of Work

PURPOSE

The purpose of this milestone is to ensure the organization's commitment to developing and implementing an ERP will be successful. This milestone starts with alignment on the GHG inventory management plan (IMP), GHG emissions reduction targets, and ERP scope of work, as outlined in FIGURE 5. Due to the broad involvement required across an organization to enable successful decarbonization, engaging a diverse group of stakeholders across all levels is essential to defining a clear scope of work and forecasting additional financial and personnel resources that may be necessary to develop and implement the ERP. Here, this milestone is covered at a high level, but the resources referenced below provide more detailed guidance.

FIGURE 5. Milestone 1: Establish Inventory and Scope of Work

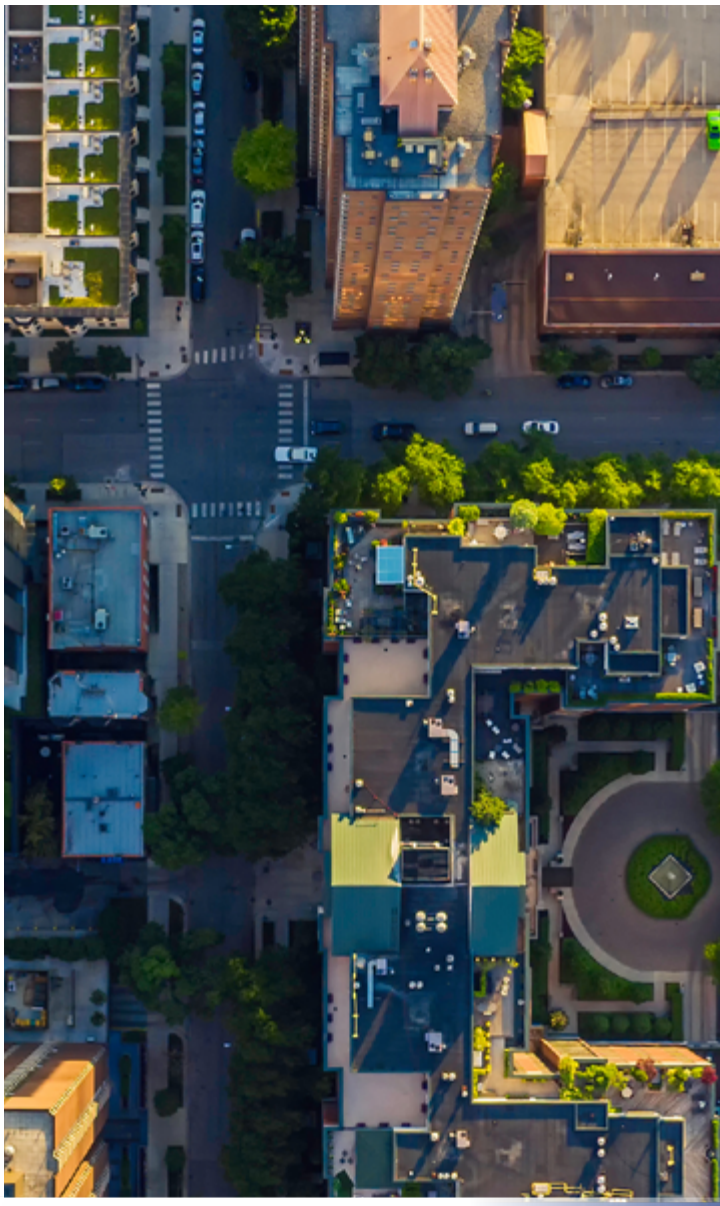


RESOURCES

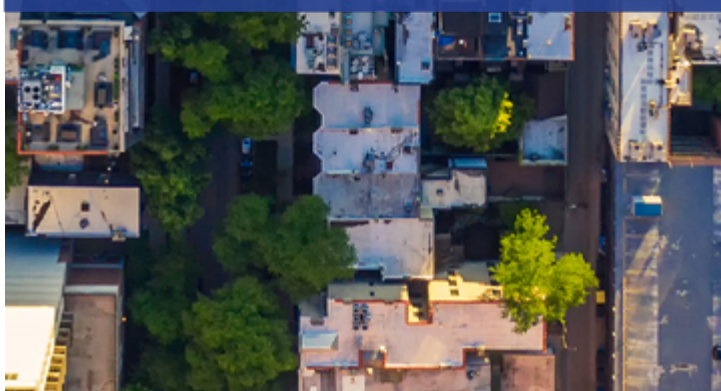
1. Better Buildings guidance on Engaging Stakeholders in Reducing Carbon: This DOE Better Buildings resource hub includes a library of resources on how and when to engage critical stakeholders throughout decarbonization planning and execution.

2. EPA's GHG Inventory Development Process and Guidance (EPA, 2022): This EPA guidance outlines a four-step process for developing a GHG inventory, including an inventory management plan, and setting targets. The guidance is aligned with The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. (World Resource Institute and World Business Council for Sustainable Development, 2004).

3. The National Renewable Energy Laboratory's Greenhouse Gas Emissions Accounting in Buildings (NREL, 2022): This resource provides a high-level overview on GHG emissions accounting and includes information on the differences between commonly-used tools and frameworks that can be used to calculate and report emissions, as well as direction on where to find emission factors.



Organizations do not need to wait until the full ERP is completed to implement projects.



IDENTIFY AND ENGAGE STAKEHOLDERS

When identifying stakeholders to engage, consider who will be needed to support the planning effort (e.g., property managers), who will be needed to approve the Emissions Reduction Plan (e.g., the CFO), and who will be expected to support plan implementation (e.g., project managers). The level of stakeholder engagement may vary at this point depending on roles within the organization, but it is important that those leading the planning and those that will be implementing the plan develop a relationship early on in this process and define future touch points to set the foundation for success. It is also critical to ensure executive leadership is engaged and committed to the emissions reduction targets and the decarbonization pathway documented in the ERP. Leadership can ensure emissions reduction targets are met by clearly communicating their commitment to all levels of the organization. TABLE 1 provides a list of potential stakeholders and examples of their responsibilities in the emissions reduction planning process.

TABLE 1. Potential Stakeholders

Stakeholder Category	Stakeholder Responsibilities
Executive Leadership	Provide resources and support to effectively develop and implement the plan (e.g., CEO, CFO, COO).
Finance	Identify the financial metrics required to assess the business case and provide guidance on potential financing mechanisms.
Property Management, Facilities/Engineering, and Energy Management	Identify operational needs and maintenance concerns, suggest and evaluate technical solutions, and provide building-level information.
Capital Planning, Procurement, and Project Management	Identify workload expectations and opportunities to streamline procurement and project delivery efforts when implementing activities at scale.
ESG/Sustainability	Identify sustainability considerations and expectations, including those beyond operational carbon emissions. Provide input on the risks and opportunities of the GHG Emissions Reduction Plan and review the plan through a lens of ESG regulatory and reporting requirements.
Real Estate and Transaction	Provide insight into the organization's future space needs and incorporate decarbonization requirements into considerations for new construction or acquisitions.
Marketing	Identify ways to communicate efforts and GHG emissions reduction planning status within and beyond the organization.
Occupants and Community Members (external)	Identify ways to address occupant concerns and improve their overall experience through emissions reduction measures. Consider opportunities to collaborate with the broader community on larger scale decarbonization efforts.

ESTABLISH A GREENHOUSE GAS INVENTORY

After identifying stakeholders, the next step is to develop a GHG IMP that leads to a GHG inventory in conformance with the Greenhouse Gas Protocol. While all stakeholders may not need to be involved in developing the details of the IMP, there should be alignment on the organizational and operational boundaries of the GHG inventory and targets. The IMP ensures standardization and repeatability in methods of calculating and reporting GHG emissions year over year by documenting the organization's process for data management, methods to quantify emissions, and methods for auditing and verification. The GHG inventory is calculated based on methodologies detailed in the IMP.

An IMP will cover the organization's methods for reporting Scope 1, 2, and 3 emissions, using the following definitions from the GHG protocol:

- Scope 1 emissions consist of direct GHG emissions from sources controlled or owned by an organization, such as boilers, furnaces, and vehicle fleets.
- Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity, steam, heating, or cooling.
- Scope 3 emissions are defined as other indirect GHG emissions that are the result of an organization's activities but are emitted from sources that are not owned or controlled by the company.

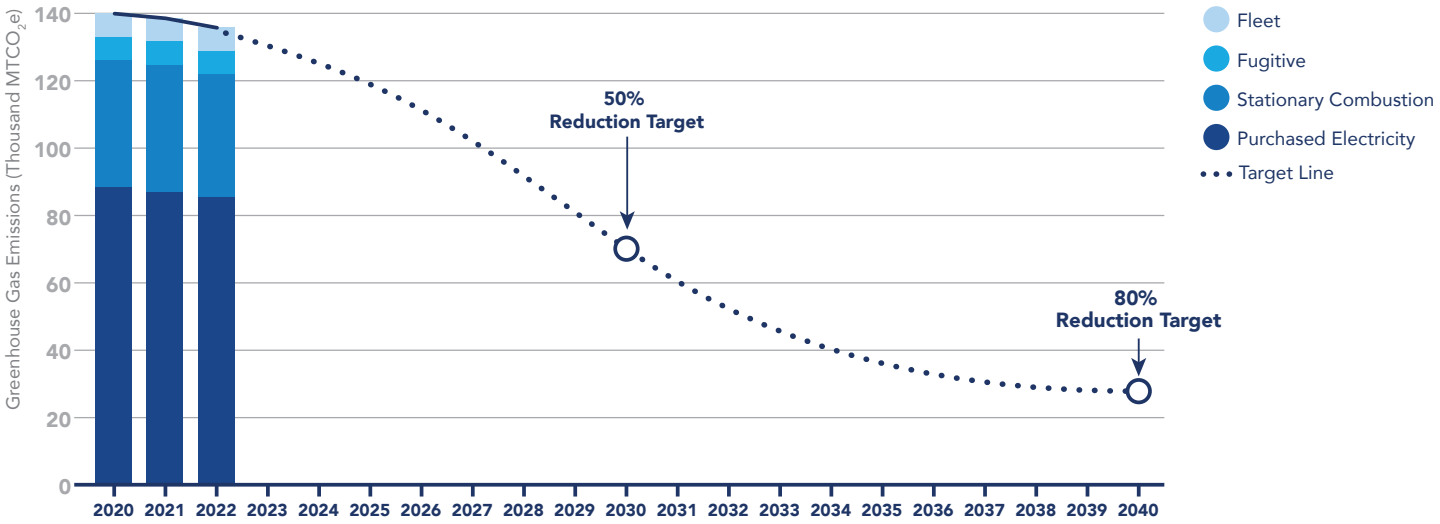
As noted in the introduction, this framework focuses on developing a GHG Emissions Reduction Plan for Scope 1 and Scope 2 emissions. Scope 3 emissions (e.g., other indirect value chain emissions) are not covered in this framework. For organizations with emissions from leased assets (e.g., tenant emissions), emissions can be categorized as direct (Scope 1) emissions or indirect (Scope 2 or 3) emissions, depending on the organizational boundary approach defined in the IMP. Therefore, this framework can support a decarbonization plan for tenant emissions regardless of scope category.

SET GHG EMISSIONS REDUCTION TARGETS

After establishing the GHG inventory, the organization can define the baseline year and timeline for GHG emissions reduction targets. Target setting is typically a percent reduction in GHG emissions compared to a baseline year in a certain time frame for a specific scope (e.g., 50% reduction in Scope 1 and 2 GHG emissions by 2030 from a 2020 baseline). Some organizations may complete portfolio-level analysis prior to publicly announcing reduction targets to increase confidence in their ability to achieve the targets.

Throughout the course of this document, there will be references to an example organization using this framework to develop their ERP. These examples may not apply to each organization but are intended to provide a narrative illustrating one organization's development of an ERP. In this example, the organization has committed to reducing their emissions by 50% by 2030 and has also committed to an 80% reduction by 2040. FIGURE 6 shows three years of the example organization's baseline GHG emissions along with their 50% and 80% reduction targets.

FIGURE 6. Baseline Emissions and Target Reductions



DEFINE THE EVALUATION CRITERIA

Working with stakeholders, organizations can define specific evaluation criteria that will be used to select a decarbonization pathway from potential scenarios. Evaluation criteria may include financials (e.g., lifecycle cost), emissions reduction potential, and other considerations (e.g., occupant benefits). These evaluation criteria are covered in more detail in Milestone 5: Define Emissions Reduction Plan.

In parallel to defining evaluation criteria, stakeholders should identify internal and external strategic opportunities and risks that may impact or improve the organization's ability to develop and achieve the intended outcomes of the ERP and work with stakeholders to implement actions to address these risks.

Example opportunity and risk analysis may include the following:

- Identify tax credits and incentives that can be leveraged for decarbonization projects.
- Review potential risks for increasing GHG emissions due to acquisitions or new construction.
- Identify current and future federal, state, and local legal and regulatory requirements that may apply to the organization's building energy or GHG emissions, and ensure the ERP supports compliance.
- Assess voluntary commitments the organization has made and consider how they may overlap or conflict with planning, data collection, and governance of the ERP.

GHG EMISSIONS REDUCTION PLAN SCOPE OF WORK

Finally, the organization will define the scope of work required to develop the GHG Emissions Reduction Plan and plan for the financial and personnel resources needed to execute this scope of work.

Organizations may have already completed or are in the process of completing various plans, studies, and analyses, and these should be compiled and reviewed for usefulness to reduce the potential for duplicative work. Existing information may include asset management plans, energy or decarbonization audits, district energy studies, benchmarking reports, climate action plans, and strategic energy plans. If previous plans and studies have not been completed, then the scoping process will define which areas to include.

Certain scope of work elements are core to nearly all Emissions Reduction Plans, while other elements may be optional and can be incorporated based on organizational needs, as listed in TABLE 2. Consider whether the elements in TABLE 2 should be included in the plan, at what level of detail, and whether the elements will be delivered internally or externally (e.g., by consultants), and begin planning for how the work will be funded. The purpose of the remaining milestones described in the framework is to outline the steps required to develop an ERP. Appendix A includes descriptions of each scope of work element.

TABLE 2. Elements of an Emissions Reduction Plan Scope of Work

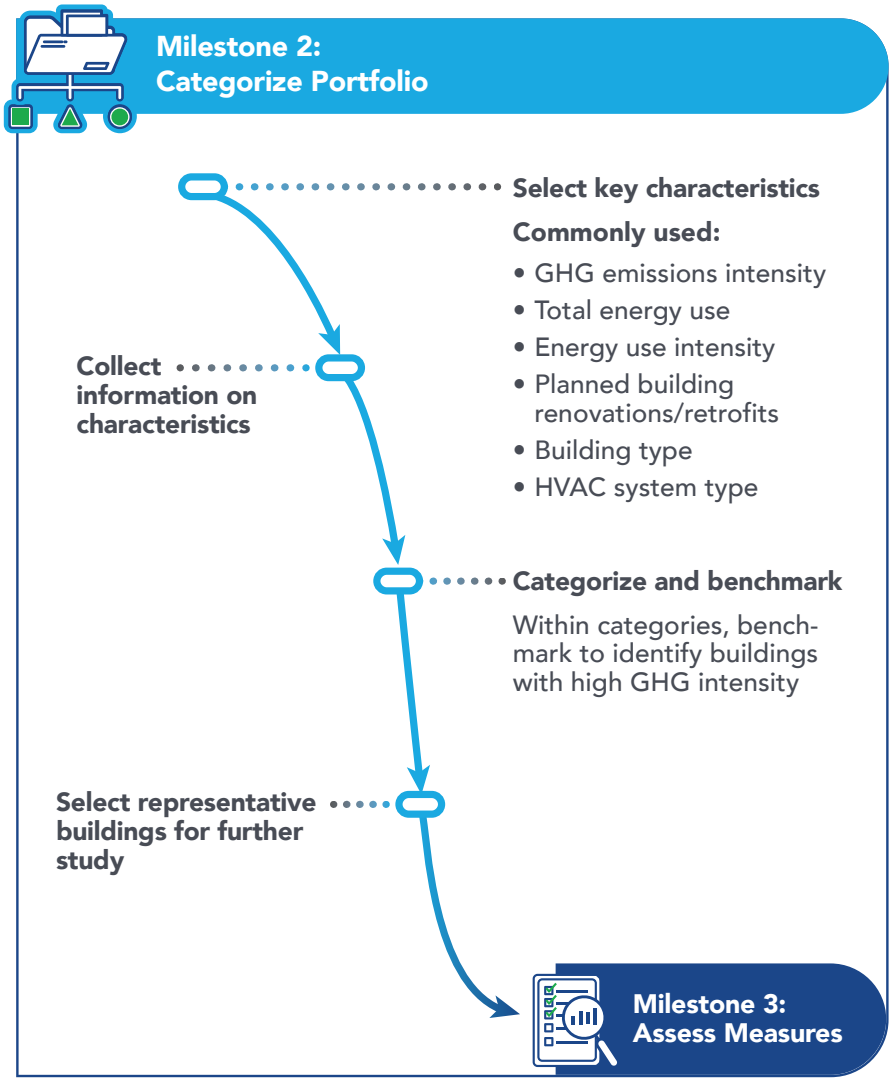
CORE	• Portfolio categorization • Building audits and district energy/central plant studies • Scenario development and assessment • Renewable energy procurement • Retrofit policy or requirements development • Project phasing and prioritization • Fleet emissions reductions
OPTIONAL	• Analysis of potential funding sources • Scope 3 emissions analysis • Stakeholder engagement • Pilot development • Resiliency assessment

MILESTONE 2: Categorize Portfolio

PURPOSE

With ambitious GHG emissions reduction goals, most or all buildings within a portfolio will likely need to implement some level of emissions reduction measures. However, organizations are often challenged with how to understand the magnitude of the emissions reduction opportunities in a large portfolio of buildings without conducting assessments at each building. The purpose of this milestone is to categorize the buildings within the portfolio to identify representative buildings that cover the diversity of building types and systems, as illustrated in FIGURE 7. This milestone begins with defining the key characteristics that differentiate its buildings. Next, uses these characteristics are used to categorize buildings in the portfolio. The organization then selects a sample of buildings for decarbonization audits that represent the different categories. The results from the representative building audits are scaled across similar buildings to estimate emissions reduction impacts and develop potential scenarios at the portfolio level. Vehicle fleets are not covered in this milestone but are addressed in Milestone 3 as a portfolio-wide measure.

FIGURE 7. Milestone 2: Categorize Portfolio



SELECT KEY CHARACTERISTICS

The first step in Milestone 2 is to select the key characteristics that will be used to prioritize and categorize the buildings in the portfolio. When selecting characteristics, consider what differentiates buildings within the portfolio. An organization with similar building types across the country might identify climate zone and energy prices as key characteristics, while an organization with many buildings in one location might identify building type and HVAC system as key characteristics. TABLE 3 lists common building characteristics that can be used to help prioritize and categorize buildings in the portfolio. GHG emissions intensity or site energy use intensity should always be selected as a characteristic. TABLE 4 provides a list of additional characteristics to consider.

TABLE 3. Most Common Building Characteristics Used in Portfolio Categorization

Characteristic	Guidance for Selection of Characteristic
GHG emissions intensity (lbs. CO_2e/ft^2)	Benchmark GHG emissions intensity (GHGI) between similar building types that are different sizes by normalizing across square footage. This information is used to determine which buildings within the same building type have the highest GHG intensity.
Total GHG emissions (tons CO_2e)	Rank buildings by total GHG emissions. This information is used to identify buildings that are the largest contributors to the portfolio's emissions.
Site energy use intensity ($kBtu/ft^2$)	This is used to benchmark energy use at the building so buildings of various sizes can be compared.
Total energy use (kBtu)	Identify buildings that are the largest contributors to the portfolio's energy use.
Planned renovations / equipment end-of-life	Ensure planned investments are designed to be low to no carbon.
Building type	Group similar building types to apply similar strategies.
On-Site Fossil Fuel Combustion (% energy use or $kBtu/ft^2$)	Identify buildings where on-site fossil fuel combustion is a significant contributor to the building's total emissions
HVAC system type	A high-level categorization (e.g., district vs. distributed, hydronic vs. air, fuel type) should be used when there are a range of system types requiring decarbonization strategies.
Climate zone	Different technical approaches may apply based on climate zone (e.g., cold climate heat pumps and envelope measures). Select representative buildings in the range of climate zones in which the portfolio is located.

Note: CO_2e/ft^2 is carbon dioxide equivalent per square foot; $kBtu/ft^2$ is thousands of British thermal units per square foot.

TABLE 4. Additional Building Characteristics Used in Portfolio Categorization

Characteristic	Guidance for Selection of Characteristic
Ownership structure	Ownership/management/lease structures may result in differences in utility payment responsibility, so categorizing by ownership structure can be a useful characteristic.
Disadvantaged Communities	Determine if buildings are located within disadvantaged communities and consider these buildings for investment.
Energy prices	Prioritize buildings with the highest energy prices.
Regulatory drivers	Prioritize locations with building performance standards, benchmarking and decarbonization ordinances, strong building codes, and potential financial penalties or taxes.
Utility grid carbon intensity	Prioritize overall GHG emission reduction efforts in regions with high grid carbon intensity and prioritize electrification in regions with lower grid carbon intensity.
Utility incentives and funding opportunities	Prioritize locations with utility programs and grants that support electrification and building efficiency improvements.

Many organizations find it useful to pair either GHGI and total GHG emissions or EUI and total energy use so that both total emissions and emissions intensity are captured. Though organizations are more familiar with a site's EUI than GHGI, EUI does not adequately capture the difference in emissions intensity between different fuels (such as natural gas and electricity) or the variation in electrical grid carbon intensity between regions. Organizations can apply the same emissions factors used in their GHG inventory to calculate GHG intensity on a building level. However, some organizations may find EUI more readily available at this step of their emissions reduction planning efforts. If EUI or energy use are selected as a characteristic, then an additional characteristic such as on-site fossil fuel combustion should be included to help portfolios target high natural gas-consuming buildings.

Other common characteristics include building type, HVAC system type, and climate zone. These characteristics can be paired to identify solutions appropriate to specific groups of buildings. For example, an organization may look at groups of buildings that have packaged gas-fired units in warm climates and packaged gas-fired units in cold climates to identify appropriate heat pump solutions for both groups of buildings. Additionally, organizations may want to consider groups of buildings with and without planned renovations or major equipment reaching end-of-life. This will ensure that strategies for both situations are identified.

COLLECT INFORMATION ON CHARACTERISTICS

Gather information on the selected characteristics of individual buildings to better understand what differentiates the buildings within the portfolio. Generally, three to five characteristics will be sufficient to categorize a portfolio. The organization may already have information available on some of these characteristics, but others may need to be collected internally or with the support of a consultant. Automated methods can be used to collect some of the characteristics, such as through virtual data-driven audits or automated building-stock analysis, to help speed the process.

CATEGORIZE AND BENCHMARK

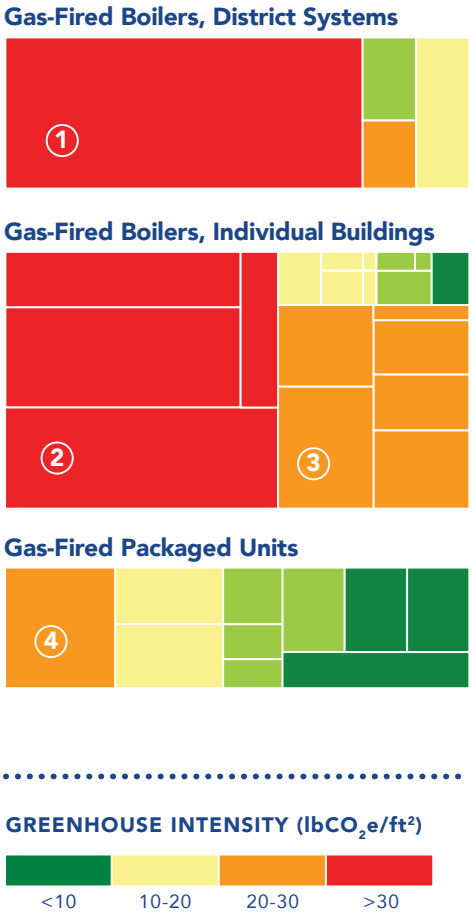
Once characteristic information has been collected, group buildings in the portfolio into different categories for prioritization. This multi-layer approach to categorization helps owners define a subset of buildings that represents the breadth of their portfolio and captures the different emissions reduction strategies that may be applied. Within each category, buildings can be benchmarked using the ENERGY STAR Portfolio Manager (or a similar tool). Other analysis approaches can also provide a high-level identification of emissions reductions opportunities early in the process.

SELECT REPRESENTATIVE BUILDINGS FOR FURTHER STUDY

The number of buildings selected for further study depends on the results of the categorization and the diversity of the building portfolio. Buildings with planned renovations or retrofits represent a prime opportunity to include low-carbon designs into existing efforts and should also be prioritized for emissions reduction audits. Once representative buildings (and central plants) are selected, the next step is to move forward with audits.

FIGURE 8 illustrates the example organization's categorization of a 34-building portfolio with each rectangle representing a single building in the portfolio. This example applies three characteristics: GHG intensity (color), absolute GHG emissions (relative size of rectangle), and heating system type. Four buildings in the portfolio were selected as a representative sample of the system types (indicated by the numbers on the rectangles), focusing on buildings that have both high GHG intensity and high total emissions. The representative sample of four buildings will receive emissions reduction audits, with the results applied across the portfolio for similar system types. Since one of the representative buildings is served by a central plant that serves many other buildings, a district energy decarbonization study also will be conducted.

FIGURE 8. Categorization of Buildings in a Portfolio



MILESTONE 3: Assess Measures

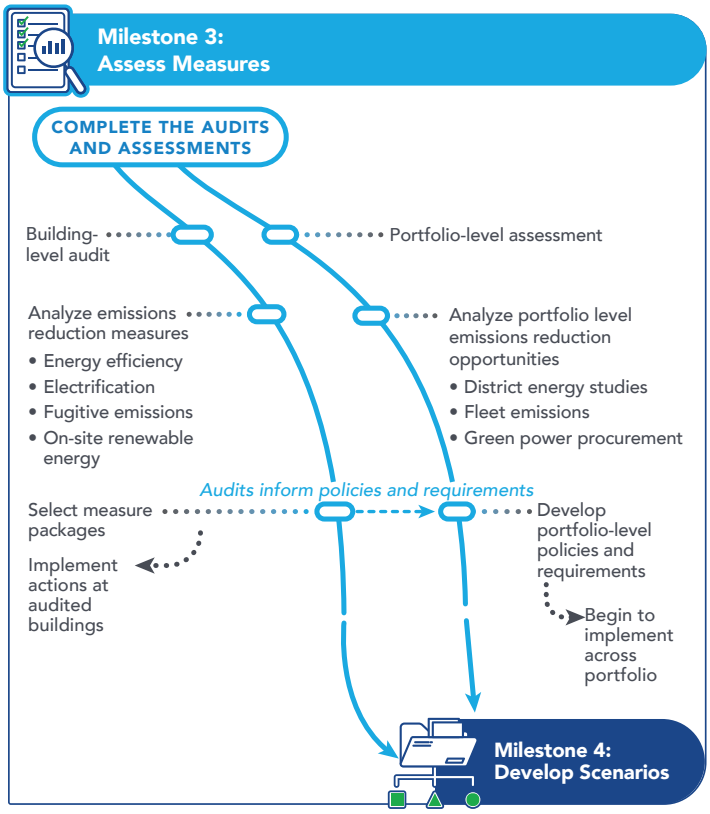
PURPOSE

In this milestone, the organization will move forward with GHG emissions reduction audits on the representative buildings selected in Milestone 2 and assess additional measures at the portfolio level, such as green power procurement. The Emissions Reduction Audits serve three main purposes:

1. Define packages of emissions reduction measures (ERMs) to implement that achieve targets for a building.
2. Define measure packages for each category of buildings in the portfolio to support scaling audit results across the portfolio.
3. Define individual measures to apply through portfolio-wide policies and requirements.

These actions will allow the organization to select ERMs to implement immediately, as well as to define measures for implementation across the portfolio, as shown in FIGURE 9. While emissions reduction audits of representative buildings may not capture unique opportunities at each building in the portfolio, they will identify the appropriate strategies to apply within each building category. Furthermore, the results from these audits can be scaled across the portfolio to estimate emissions reductions as described in Milestone 4. Other approaches might be used when developing emissions reduction estimates (including comparison to benchmarks like ENERGY STAR or automated building-stock analysis). Emissions reduction audits can support these approaches by facilitating rapid implementation of identified emissions reduction opportunities and increasing the accuracy of the analysis.

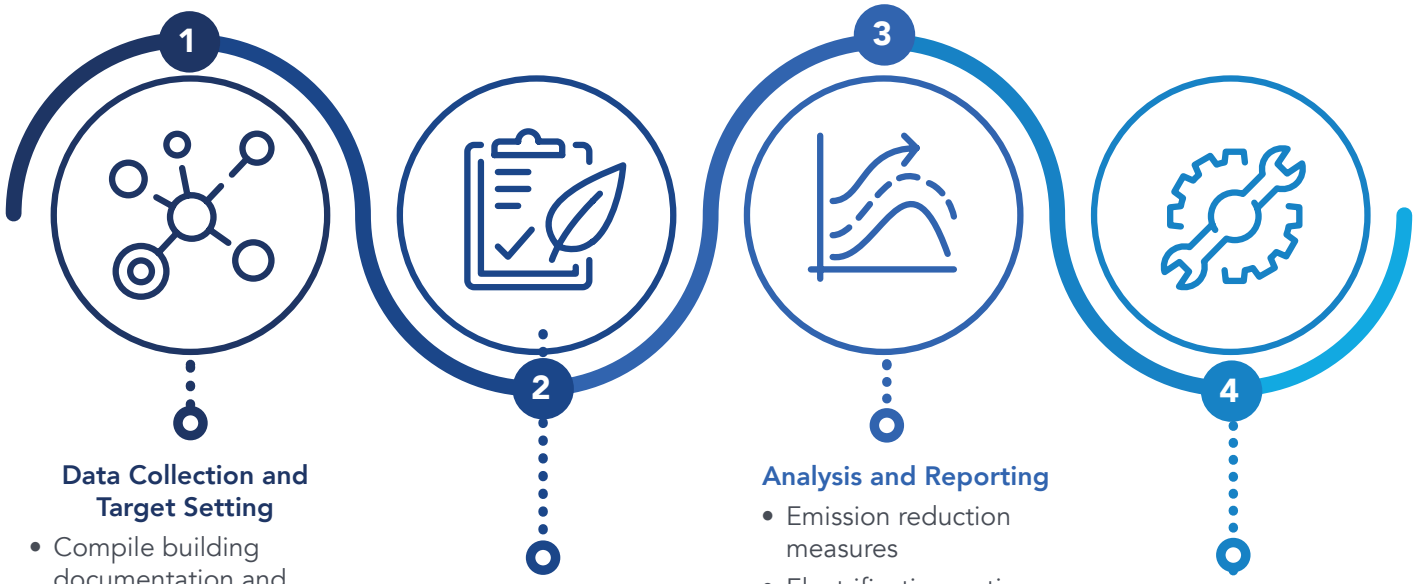
FIGURE 9. Milestone 3: Assess Measures



BUILDING-LEVEL EMISSIONS REDUCTION AUDITS

Prior to completing emissions reduction audits at the representative buildings, the organization first needs to clearly define the scope of the audit. The Better Buildings Initiative has developed the resource, *GHG Emissions Reduction Audit: A Checklist for Owners* (Kramer et al., 2023), which includes guidance and an accompanying checklist that details recommended services and deliverables for a building-level GHG emissions reduction audit for operational Scope 1 and 2 GHG emissions. It is recommended that organizations use this resource to define the scope of work for their audits. The resource defines four main tasks within an emissions reduction audit, as summarized in FIGURE 10. The resource does not recommend exactly how the auditor should execute the tasks, but works in conjunction with audit standards, such as ASHRAE Standard 211, that provide more detailed technical guidance for auditors.

FIGURE 10. Tasks in a GHG Emissions Reduction Audit



1 Data Collection and Target Setting

- Compile building documentation and energy data
- Calculate Scope 1 and 2 emissions
- Building-level GHG Emissions Reduction Targets

2 On-site Inspections

- Existing equipment assessment
- Electrical service capacity
- Combustion equipment inventory
- On-site renewable energy assessment
- Initial Assessment Report

3 Analysis and Reporting

- Emission reduction measures
- Electrification options
- On-site renewable energy analysis
- Low-emissions measure packages
- Emissions reduction audit report

4 Selection and Implementation by Owner

- Evaluate scenarios and select strategy
- Develop scope and solicit bids for work
- Commission systems and monitor performance

Optional Audit Scope

- Electrical panel load study
- Existing building commissioning or monitoring-based commissioning
- Energy storage assessment
- Demand management and load flexibility assessment
- EV charging assessment

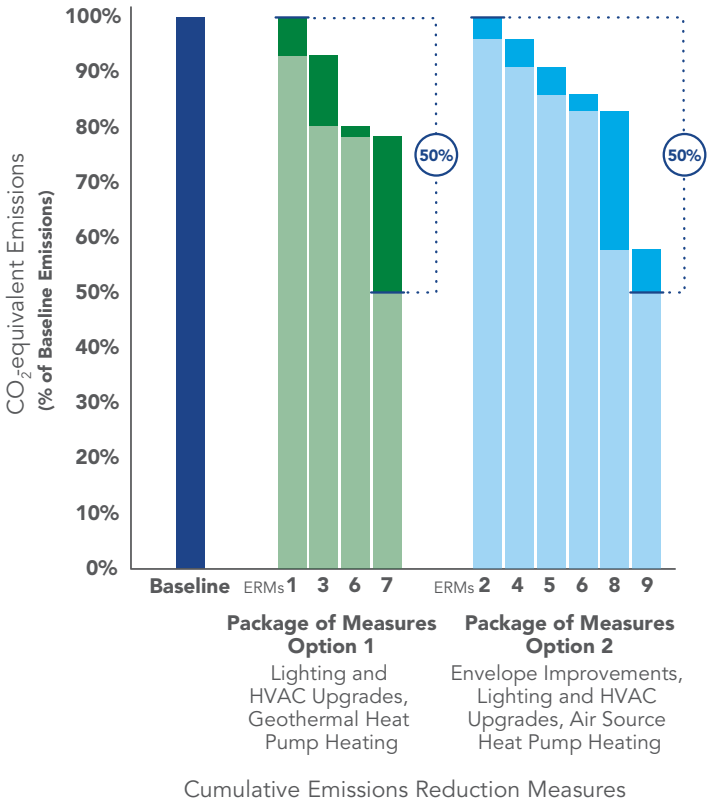
GHG Emissions Reduction Audit: A Checklist for Owners (Kramer et al., 2023)

The emissions reduction audit results in the following types of measures that are combined into packages of measures that meet the building's GHG reduction target:

- Energy efficiency
- Electrification (e.g., using heat pumps rather than electric resistance heating)
- Fugitive emissions (e.g., mitigating refrigerant leaks; use of low-GWP refrigerants)
- On-site renewable energy

FIGURE 11 is an example of two building-level measure packages that achieve 50% emissions reduction. Each measure package considers interactive effects of the measures to produce a cumulative level of emissions reduction, and the options are assessed against an owner's needs and funding.

FIGURE 11. Building-level Measure Packages



Based on the emissions reduction audits, one or more packages of measures are determined. These measure packages may align with building types, system types, or another key characteristic of the portfolio. These measure packages will be inputs into Milestone 4: Develop Scenarios.

PORTFOLIO-LEVEL ASSESSMENTS

In addition to building-level audits, an organization may complete assessments to define measures that apply to multiple buildings or the entire portfolio. Portfolio-level measures for green power procurement, central plants, and vehicle fleet electrification studies emissions are described in more detail in this section due to the importance of these measures.

Further, building audits and portfolio assessments will result in measures that can be implemented as standard practice across the portfolio. TABLE 5 contains examples of portfolio-level practices to be considered.

Building audits and portfolio assessments will result in measures that can be implemented as standard practice across the portfolio.

TABLE 5. Portfolio-level Policies and Requirements

Policy/Requirement	Description
Renovation/refresh requirements	Renovation and refresh requirements that incorporate energy efficiency, deep retrofits, and electrification. For example, include LED lighting and advanced lighting control into organizational guidelines.
Equipment purchasing and upgrade requirements	Performance standards that promote efficiency and limit the installation of new fossil fuel combustion equipment whenever feasible
Operations and maintenance (O&M) practices	Requirements for building operations with a decarbonization focus for internal O&M staff and external contractors
New construction design specifications	Design specifications that minimize or eliminate emissions generated from new construction, such as energy use or GHG intensity targets, a net zero energy target, and all-electric buildings.
Building automation system upgrades	Common sequences and setpoints for building automation systems (BAS) and a plan to modernize the BAS
Energy management and information systems (EMIS)	Requirements for tracking, visualizing, and analyzing energy, carbon, and BAS data from disparate sources
Grid integration	Policies that promote responsiveness to electric grid conditions, including demand response and energy storage measures
Low global warming potential (GWP) refrigerants	Policies to monitor refrigerant use, identify leaks, and phase-in low-GWP refrigerants
Vehicle purchasing requirements	Requirements for electric or alternative fuel vehicles based on review of organizational needs
Staffing	Staffing policies to effectively implement the ERP, including energy management, sustainability, facilities, and procurement
On-site solar screening	Screening for on-site solar opportunities through a portfolio-level review
Green lease policy	Organizational policies for green leases (new and renewals) that align financial benefits of sustainability initiatives to both parties
Training policies	Ensuring that current personnel have ongoing training to maintain and enable further GHG emissions reductions

District Energy Studies

For buildings served by central plants, a central plant or district energy decarbonization study will be needed, in parallel to building level audits, to identify ways to holistically reduce emissions and minimize total implementation cost. A district energy study can identify potential decarbonization pathways, including centralized heat pumps or an ambient loop with heat pumps at each building. Alignment on a district energy strategy prepares organizations to properly phase decarbonization efforts and avoid investing in future stranded assets.

Green Power Procurement

The emissions reduction audits include on-site energy supply options at the building level, however, on-site solar screening can also be completed at the portfolio-level to determine opportunities for solar based on a remote assessment using facility location and satellite imagery.

Additionally, off-site green power options tend to be addressed through an organization's centralized energy purchasing. Green power may represent a large piece of the emissions reduction strategy for portfolios with buildings that have significant demand relative to on-site solar potential (such as data centers and larger buildings in dense urban environments). Renewable energy assets generate both the electricity itself and the environmental attributes, which is represented through renewable energy certificates (RECs). An organization must retain these environmental attributes for the green power to reduce the organization's emissions. Off-site energy supply options include the following:

- Green power purchases through the utility (or community choice aggregators in some areas)
- Physical power purchase agreements (PPAs) in which an organization purchases electricity and associated RECs from a renewable generator on the same power market
- Financial (or virtual) PPAs in which an organization purchases electricity and associated RECs from a renewable generator. The electricity is then sold on the power market without being delivered to the organization (which can still retain the RECs).
- RECs in which the organization procures the environmental attributes of the renewable generation

Consider instituting organizational requirements for off-site renewable energy, including supporting new project development (additionality), prioritization of local generation assets, and incorporation of energy storage in tandem. Organizations may also consider a holistic approach to supporting the transition to a 100% carbon-free grid, including 24/7 hourly matching of electricity. For additional information on green power procurement, refer to the Environmental Protection Agency's Green Power Markets resources.

Long-term scenario planning may incorporate electric grid emissions rate projections as utilities make progress in adding low-carbon generation to their portfolios. Projections for electrical grid carbon intensity can be obtained from public sources or sometimes from the local utilities. Reviewing scenarios with more conservative estimates of grid carbon intensity, or even no change from current emissions, will help determine the extent of emissions reduction impact if electric grid emissions do not improve as projected.

Fleet Emissions

For some organizations, the mobile combustion emissions from vehicle fleets can represent a meaningful portion of their overall emissions and therefore should be assessed in parallel to building-related portfolio-level measures. When considering opportunities to reduce GHG emissions from vehicle fleets, a needs assessment can help to right-size and optimize the fleet. For example, assess current vehicle utilization and determine key data points such as trip length and purpose to determine if electric vehicles could be an appropriate solution at this time or in the future. Consider the following when assessing vehicle fleets:

- Near-term and long-term organizational needs for vehicles
- Vehicle purchasing policies
- The implementation of electric or alternative fuels, such as green hydrogen
- Idle-reduction measures
- Fuel economy improvements
- Infrastructure needed to support these vehicles, such as electric vehicle charging equipment
- Emerging transportation technologies, such as vehicle-to-building/vehicle-to-grid technology

For detailed resources and support, refer to the DOE's Vehicle Technologies Office, Clean Cities Coalition Network.

For some organizations, the mobile combustion emissions from vehicle fleets can represent a meaningful portion of their overall emissions.

IMPLEMENT EMISSIONS REDUCTION MEASURES

In addition to assessing which measures should be inputs into scenario development, emissions reduction audits can be used to identify projects for immediate implementation. Organizations do not need to wait until the full ERP is completed to implement projects but should review the audit results and assess whether the recommended projects generally align with the direction of the ERP. Organizations should be empowered to act on the audit results through initial projects and pilots.

Selected portfolio-level measures and the building-level measure packages are inputs into Milestone 4: Develop Scenarios.

MILESTONE 4: Develop Scenarios

PURPOSE

After assessing measures in Milestone 3, an organization can now identify how these measures may be combined, scaled, and phased across their building portfolio to create scenarios that achieve their emissions reduction targets. By developing and analyzing multiple scenarios, an organization can compare the costs and benefits of each scenario and select a decarbonization pathway that best meets their needs.

The inputs to scenario development are summarized in FIGURE 12, and the scenario development approach is illustrated by the example in FIGURE 13. Following the example, the scenario development inputs and process are described.

To develop multiple scenarios and evaluate their alignment with the organization's needs, different technical strategies can be tested such as the level of energy efficiency, electrification, and reliance on renewables. The example in this milestone illustrates four scenarios.

FIGURE 12. Milestone 4: Develop Scenarios

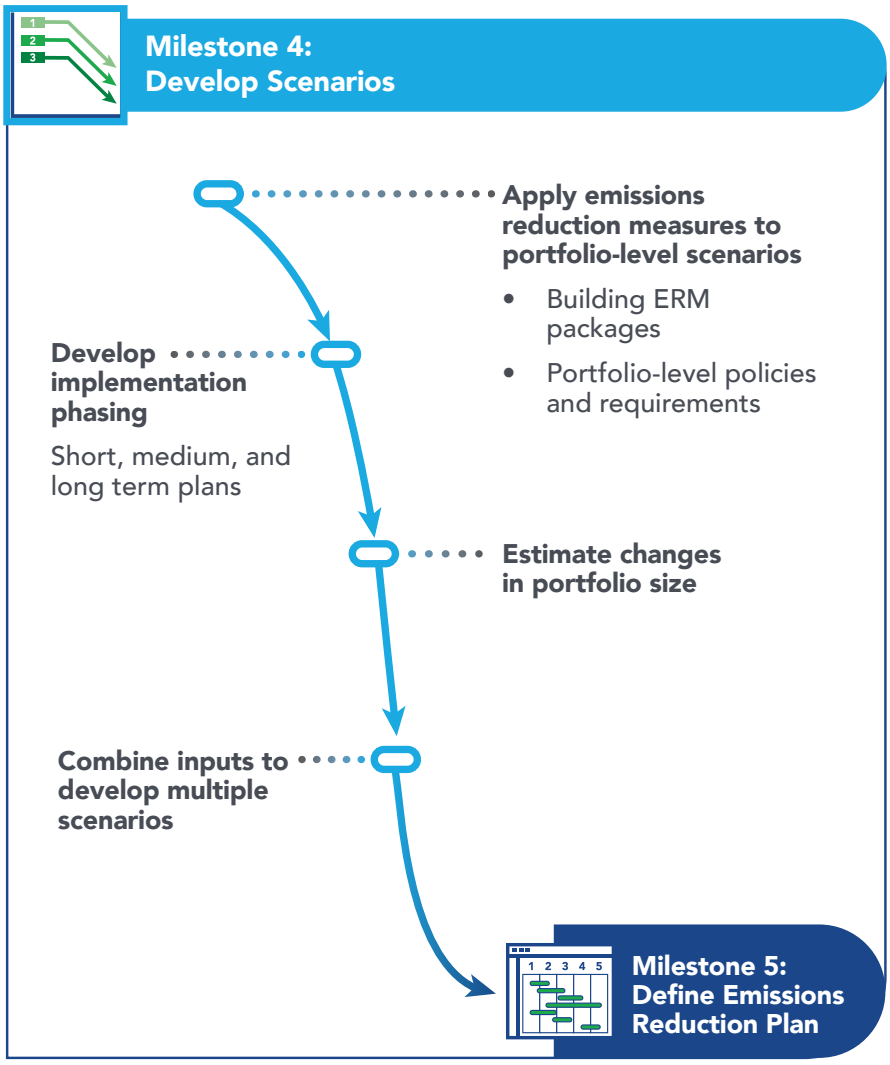
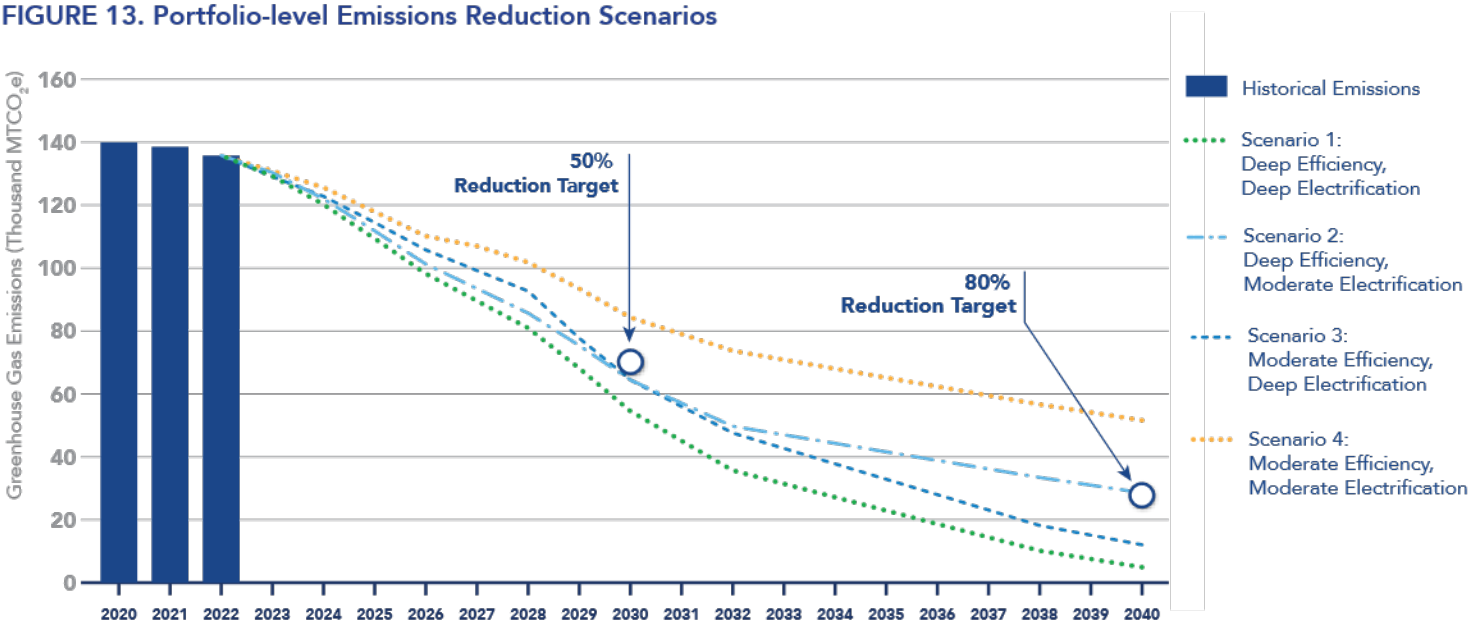


FIGURE 13. Portfolio-level Emissions Reduction Scenarios



EXAMPLE SCENARIO ANALYSIS

For the example organization, four scenarios were developed to assess the implications of applying different levels of energy efficiency and electrification measures. FIGURE 13 illustrates the differences in emissions reductions over a 20 year time horizon for each of these scenarios. This analysis should be included in the organization's final emissions reduction plan to document how they arrived at their selected emissions reduction pathway.

The portfolio-level emissions reduction scenarios shown in FIGURE 13 are described below.

SCENARIO 1: Deep Efficiency, Deep Electrification maximizes the energy efficiency opportunities across the portfolio and electrifies the vast majority of fossil fuel combustion systems. The deep efficiency allows for smaller electrified HVAC systems and allows a substantial amount of portfolio's electricity requirements to be served by on-site solar, minimizing the need for off-site renewable procurement. Scenario 1 meets both the organization's 2030 and 2040 goals.

SCENARIO 2: Deep Efficiency, Moderate Electrification maximizes the energy efficiency opportunities across the portfolio but retains a larger portion of the fossil fuel combustion systems. This results in a lower capital cost than Scenario 1 but leaves a significant natural gas load that cannot be directly supplied by on-site or off-site renewable production. Scenario 2 meets the both 50% reduction target and 80% reduction target, but with a minimal safety margin.

SCENARIO 3: Moderate Efficiency, Deep Electrification includes rapid-payback portfolio-wide measures and incremental efficiency improvements, but not the more involved envelope improvement measures applied in the Deep Efficiency scenarios. While this approach lowers the capital cost of efficiency improvements, it leads to larger electrified systems (including increased electrical service in several cases) and requires a significant amount of off-site renewable energy to be procured. Scenario 3 meets both the 2030 and 2040 goals.

SCENARIO 4: Moderate Efficiency, Moderate Electrification includes the same efficiency measures as Scenario 3 but only electrifies a smaller portion of the portfolio's fossil fuel combustion assets. This leaves a significant amount of Scope 1 emissions that cannot be mitigated through on-site or off-site renewable energy. In the example in FIGURE 13, the scenario does not meet either the 2030 or 2040 emissions reduction targets and is removed from further consideration.

SCENARIO DEVELOPMENT INPUTS

Inputs to scenarios include building-level measure packages and portfolio-level polices (both defined in Milestone 3), as well as how measures are phased over time and estimated changes to the portfolio size. Organizations can consider other inputs to their scenarios depending on specific needs. Most importantly, organizations should align their scenarios with capital planning, reinvestment, major equipment end-of-life, or deferred maintenance planning timelines.

Apply ERMs to the Portfolio

The results of the building-level audits should be extrapolated during this phase to estimate impacts across the portfolio. While specific plans and designs may not be created for each individual building during this milestone, the strategies identified during the representative audits can set the general approach to be applied within building categories. The expected savings (energy consumption, GHG emissions, and operating costs) from the building-level measure packages can be used to project savings at buildings within the same category. Portfolio-level assessments can then be layered into savings projections.

Develop Implementation Phasing

One of the most important variables in GHG emissions reduction planning is how quickly measures will be implemented across the portfolio. Aggressive decarbonization efforts generally require expedited upgrades and replacement of systems before the end of the equipment's useful life. These early replacement efforts should be directed toward electrification of natural gas or district heating systems. Alternatively, an owner may focus decarbonization projects to coincide with their existing building upgrade plans and refresh cycles. A third option—the least aggressive timing—is to implement electrification-ready upgrades, then plan to replace the equipment at the end of its useful life.

Without pre-planning, owners are faced with replacing equipment upon failure, which poses challenges for implementing emissions reduction projects due to the urgency of the replacement schedule. Moreover, relatively recently purchased equipment may not reach end-of-life before 2050 or another critical date established in emissions reduction target-setting. Pre-planning and portfolio-level policies will ensure that the low-emission, best option retrofits are most likely to be chosen by staff.

In many cases, emissions reductions measures can provide other benefits (such as reduced operating costs). Expedited implementation can enable organizations to capture these benefits sooner and demonstrate their climate commitment with action.

Estimate Changes in Portfolio Size

The amount of growth or contraction of the portfolio floor area is another key input into the emission reduction scenario analysis. Building acquisitions or sales and new construction plans will impact portfolio-level emission reduction estimates. Potential changes in building use (such as conversion from an office to a lab) can alter emissions and provide an opportunity to incorporate decarbonization into associated renovations.

Energy efficiency and decarbonization practices for new construction will also affect the emissions impact of portfolio changes. Consider developing net zero energy and all-electric specifications for new construction to avoid the need to mitigate these emissions again in the future. It is typically more cost-effective to reduce a building's emissions during design and construction than after it is built. Ensure capital planning departments are properly incentivized to incorporate and retain decarbonization components in the design and construction of new facilities.

Pre-planning and portfolio-level policies will ensure that the low-emission, best option retrofits are most likely to be chosen by staff.

COMBINE INPUTS TO DEVELOP MULTIPLE SCENARIOS

To develop one or more scenarios that achieve deep emissions reduction, the previously described scenario inputs can be combined and phased. There are different technical approaches to scaling the results from the representative building audits to the broader portfolio. The scaling should generally identify which measures (or measure packages) are related to specific categories and apply emissions projects appropriately. This process could include scaling using building area and energy use intensities, regression analysis, automated building-stock analysis, or other approaches. Local emissions factors should be used for portfolios that extend beyond one physical location.

Emissions reduction estimates may be scaled through category-specific measures or portfolio-level measures. The following examples illustrate these concepts:

- **Scaling category-specific measures:** An organization could audit representative buildings with gas-fired packaged rooftop units in both moderate and cold climates to identify the appropriate set of retrofits for each climate. The anticipated emissions reduction from heating electrification would scale up with the quantity of existing natural gas combustion systems, with systems that include backup heat and significant envelope improvement measures applied to the cold climate category.
- **Scaling portfolio-level measures:** Portfolio-level lighting emissions reductions can be scaled to the floor area that has not yet been modernized.

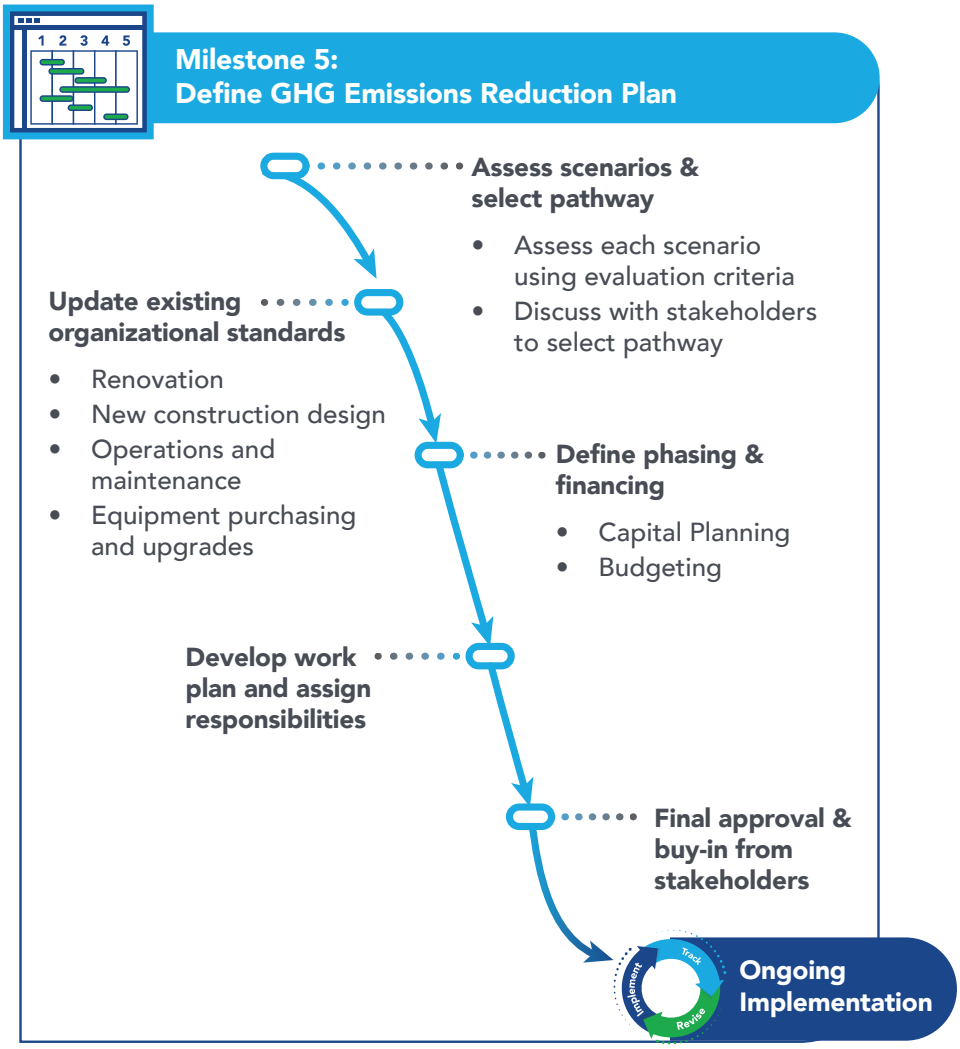
There will likely be more than one viable technical approach to decarbonization, and the scenario development process allows for a life cycle cost comparison. For example, full electrification or hybrid gas/electric systems designs can be compared. Similarly, deeper energy efficiency measures will require smaller renewable energy requirements. If the scenarios do not meet the emission reduction targets, then more aggressive strategies should be evaluated.

MILESTONE 5:
Define GHG Emissions Reduction Plan

PURPOSE

A complete Emissions Reduction Plan defines how the emissions reduction targets will be met, providing clarity and detail on next steps, including project phasing and financing, with buy-in from stakeholders (FIGURE 14). The final ERP deliverable may not be a single document, and organizations may house things such as building-level plans elsewhere. The plan will be updated periodically based on changing external trends and technologies, and it is intended to be utilized as a living document to guide decarbonization. The completed ERP should meet each of the requirements defined in the scope of work (Milestone 1).

FIGURE 14. Milestone 5: Define GHG Emissions Reduction Plan



ASSESS SCENARIOS AND SELECT PATHWAYS

After developing multiple emissions reduction scenarios, an organization will assess which scenario best meets its organizational needs and defines a final emissions reduction pathway. The evaluation criteria defined in the Emissions Reduction Plan scope of work are applied at this phase to determine the relative merits of each scenario (see examples in TABLE 6).

Some organizations may want to assign weights and scores, while others may want to use a more qualitative assessment. FIGURE 15 on the next page illustrates how the example organization qualitatively assessed scenarios using their chosen evaluation criteria. Selecting a pathway is a critical step in the development of a GHG Emissions Reduction Plan. Stakeholders should be engaged to ensure organizational clarity on the direction and speed of decarbonization. During this step, it may be helpful to remind stakeholders that the organization has already committed to emissions reduction targets, and that this evaluation should focus on identifying the best pathway for the organization to meet its target.

TABLE 6. Evaluation Criteria

Evaluation Criteria	Description
Economic Evaluation	Assess the comparative economic performance between scenarios, taking into consideration the financial criteria used in the organization (lifecycle cost, net present value, return on investment, simple payback).
Emissions Reductions	Compare the emissions reduction potential of each scenario, including the certainty of meeting emissions reduction targets.
Operational Impacts	Assess the comparative impact to facilities operations, including maintainability, disruption, and system complexity.
Occupant Benefits	Identify whether certain scenarios may provide additional benefits to building occupants, including health and wellness.
Resilience	Assess which scenarios will best position the organization to support occupants, business services, and assets during extreme events.
Risk Management	Identify how each scenario will address the regulatory and financial risks from performance standards, carbon charges, and supply disruptions.
Equity	Assess the equity impacts of each scenario, identifying opportunities to align investment decisions in ways that strengthen environmental justice.

FIGURE 15. Applying Evaluation Criteria to Scenarios

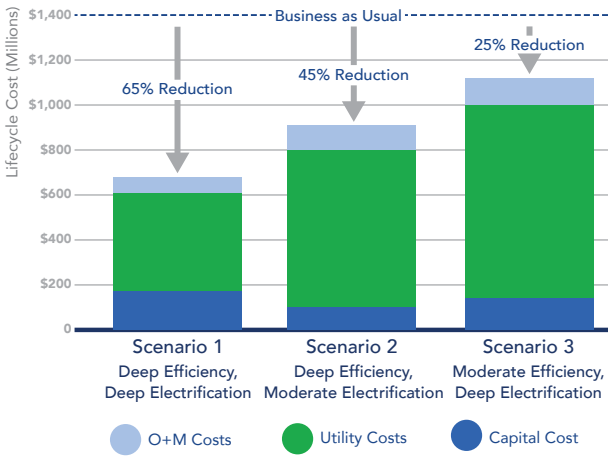
Evaluation Criteria	SCENARIOS: Deep Efficiency, Deep Electrification	SCENARIOS: Deep Efficiency, Moderate Electrification	SCENARIOS: Moderate Efficiency, Deep Electrification	NOTES
Lifecycle Cost	●	◒	○	Deep efficiency scenarios reduce operating costs, and full electrification allows for more cost to be offset by on-site solar.
Capital Cost	○	●	◒	Full electrification has a higher capital cost, but pairing it with deep efficiency measures mitigates some of these costs. Moderate efficiency requires more solar/storage to meet goals.
Emissions Reductions	●	◒	◒	Partial electrification reduces the ability to displace emissions with on-site and off-site renewables and lowers benefit of a Greening Grid.
Occupant Benefits	●	●	◒	Deep efficiency options improve thermal comfort and occupant well-being.
Risk	●	○	◒	Deep efficiency/moderate electrification has a small margin of safety for achieving the 80% reduction target and leaves regulatory risk due to continued reliance on natural gas

○ Fair ◒ Good ● Best

In the example in FIGURE 15, an organization is using a qualitative assessment of equally weighted criteria to compare three different scenarios. These scenarios vary based on the depth of the energy efficiency and electrification upgrades. Based on the comparative strength of the Deep Efficiency, Deep Electrification scenario, it is selected for implementation. To address the higher capital cost of this scenario, the organization will identify financing sources to reduce or eliminate the need for upfront expenses.

Lifecycle cost analysis can help organizations evaluate the long-term implications of their emission reduction investments. FIGURE 16 illustrates how different scenarios can be compared from a lifecycle cost perspective, with higher upfront investments leading to lower long-term operational costs. In this example, the Deep Efficiency, Deep Electrification scenario has the lowest lifecycle cost among the competing scenarios and the business as usual case. The energy savings from the deeper efficiency paired with the ability to source a higher portion of their buildings' energy from on-site solar significantly reduces the ongoing utility costs. Operations and maintenance costs are also lower in this scenario due to reduced HVAC system size and avoidance of fossil fuel-based backup heating systems.

FIGURE 16. Lifecycle Cost (30 years) by Emissions Reduction Scenario



DEFINE PHASING AND FINANCING

As a part of the plan, it is important to formalize the phasing for implementing building-level and portfolio-level emission reduction measures. In parallel, work with capital planning groups to ensure that decarbonization is fully integrated and budgeted. It may be helpful to break phasing into short-term, mid-term, and long-term categories. Projects might be prioritized into these time frames based on renovations, anticipated equipment end-of-life, or potential for emissions reductions.

Short-term projects may have additional detail, with building-level budgets and design and construction timelines, while long-term projects convey the magnitude of funding needed and align the organization on the appropriate level of investment for each infrastructure system. For example, if an organization identifies the need to transition from steam to medium-temperature hot water distribution as a long-term measure, it might narrow investments into the existing steam infrastructure to safety-related improvements while preparing individual buildings served by the district system for the transition in the short term and mid term. This reduces the risk of investing in future stranded assets.

There are a variety of potential financing sources that can allow an organization to fund projects without upfront costs. The Better Buildings Financing Navigator is an online tool that can help organizations find financing solutions for decarbonization projects. In many cases, the reductions in operational costs from decarbonization can exceed the payment toward the project's implementation, resulting in positive cash flow from the onset of the project. Organizations should identify which financing approaches meet the requirements of the organization and include financing decisions in the ERP.

DEVELOP A WORK PLAN

Develop a work plan with a timeline that defines the implementation, with additional detail for the immediate next steps. Identify who will be responsible for implementing each component of the plan and consider whether additional staff will be needed to ensure a timely and successful implementation. Consider delegating authority to specific departments for project execution, while providing high-level guidance on policies, requirements, and acceptable technologies.

There will likely be updates required to existing policies (or new ones created). Portfolio-level policies and requirements were introduced in TABLE 5. These policies are critical for implementation because they touch the entire portfolio of buildings and avoid "reinventing the wheel" at each site.

FINAL LEADERSHIP APPROVAL OF GHG EMISSIONS REDUCTION PLAN

Throughout the emission reduction plan development process, stakeholders will have been engaged in various aspects of the planning. Review the final plan with stakeholders, emphasizing the organization's existing commitments, and get final approval and buy-in from leadership at the executive level. Revise as needed to address concerns and ensure alignment going forward.

The output resulting from working through the milestones in this *Framework for Greenhouse Gas Emissions Reduction Planning* is a written plan with stakeholder approval that is ready to implement. An example outline of an ERP that contains the core elements is included in Appendix B.

Organizations often prioritize and phase their emission reduction efforts based on renovation schedules, anticipated equipment end-of-life, and potential for emissions reductions.

A visualization of an organization's selected emissions reduction pathway is an important tool when communicating with stakeholders. FIGURE 17 shows how the example organization's selected pathway combines energy efficiency, electrification, renewable energy, and fugitive emissions management measures. The scenario also includes the emissions reduction impact as the electrical grid becomes less carbon intensive ("greening of the grid").

Emissions reduction estimates should be based on specific solutions identified during plan development. While high-level estimates may be appropriate in early development, the emissions reduction estimates in the complete plan should be based on specific solutions identified during the ERP process. For example, the energy efficiency wedge in FIGURE 17 should be built up from the solutions identified in Milestone 3: Assess Measures and applied across the portfolio rather than using a high-level assumption of percent improvement per year.

FIGURE 17. Selected Pathway to Meeting GHG Emissions Reduction Targets

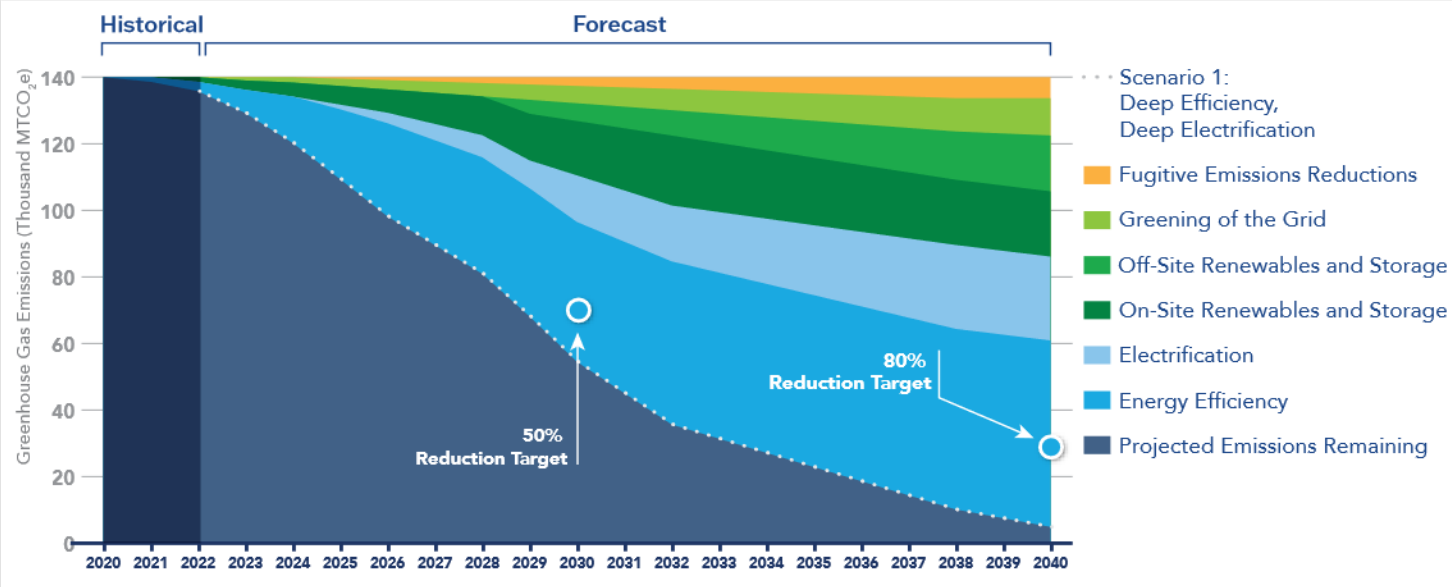
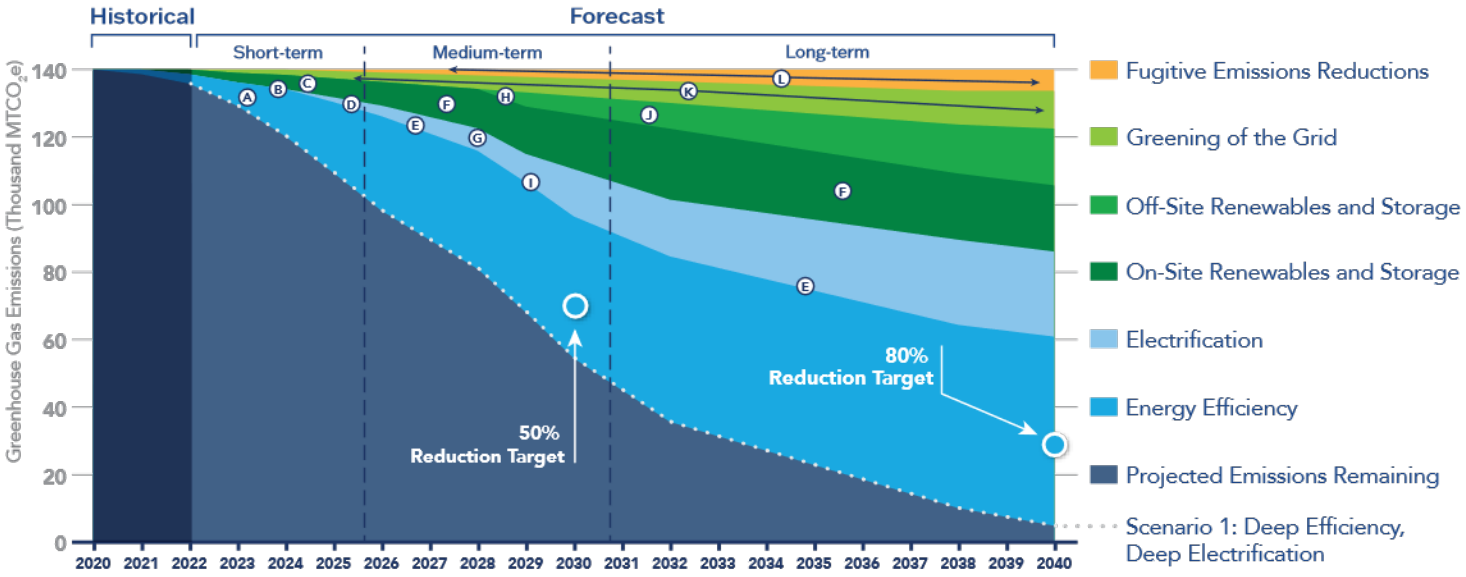


FIGURE 18 provides the story behind the selected pathway, annotated with footnotes to communicate details on the specific strategies selected. With a plan in place, it is time to publicize the plan and begin implementation. When sharing the plan, consider which elements of the plan should remain internal, and which can be publicized externally. Organizations can show leadership by publicizing not just their emissions reduction goals, but also sharing how they intend to meet their commitment. This can serve as a model for other organizations that are working to develop their own emissions reduction plan.

FIGURE 18. Selected Pathway with Phasing Annotations



A. Implement portfolio-wide lighting and controls measures
B. Implement deep energy efficiency and electrification projects in pilot buildings
C. Install initial on-site solar arrays and energy storage
D. Implement electrification readiness plans to avoid installing new fossil fuel combustion equipment
E. Implement next round of deep energy efficiency and electrification projects
F. Continue to install on-site solar and storage, striving for net zero energy on buildings with efficiency and electrification upgrades
G. Complete fleet electrification
H. Pilot off-site renewable energy projects
I. Upgrade and electrify central plant at headquarters
J. Procure additional off-site wind and solar PPAs to serve buildings with limited on-site solar potential
K. Estimate reduced emissions from increased renewables on the grid, amplified by shift from natural gas to electricity
L. Select low GWP refrigerant during electrification upgrades and as drop in replacements when feasible

Implement the Plan

The GHG Emissions Reduction Plan is meant to be an actionable, living document that is revisited and updated periodically to reflect changes to emissions reduction strategies, technological advances (or reduction in cost), and the pace of implementation. The plan documents the commitment and next steps from all stakeholders involved and can be used as an accountability tool. To further engrain a commitment to emissions reduction throughout the organization, tools like 50001 Ready Navigator can be used in conjunction with the ERP to establish an organizational structure with clear roles and responsibilities that will lead to successful emissions reduction implementation across the portfolio of buildings.

At this point in the process, considerable time will have been invested in creating an actionable Emissions Reduction Plan. A wise way to protect that investment is to install an energy management and information system (EMIS) to help track energy and emissions reduction progress and identify performance issues (Kramer et al., 2020). A performance tracking system can give owners and operators an on-demand view into emissions reduction progress. With a robust system in place to evaluate emissions reduction progress, organizations are poised to identify what's working, revise the plan when necessary, recognize ongoing achievements, and transparently share their results.

An Emissions Reduction Plan begins and ends with implementation in mind. The plan ensures that the organization is aligned on the solutions to pursue, the phasing of these solutions, and the resources needed to implement them.

Appendix A: Emissions Reduction Plan Scope of Work

TABLE A1. Core Elements in the Emissions Reduction Plan Scope of Work

Scope of Work Element	ERP Milestone	Description	Considerations
Portfolio Categorization	Milestone 2	Categorize buildings based on diverse characteristics and identify representative buildings to select for further study.	What level of detail is currently available for building-level characteristics? Which internal or external partner would best collect this information?
Building Audits	Compare the emissions reduction potential of each scenario, including the certainty of meeting emissions reduction targets.	Identify decarbonization solutions that can be implemented within representative buildings and applied across the entire portfolio.	Will these be conducted by the same entity developing the overall Emissions Reduction Plan? Would separate entities be contracted in different regions?
District Energy/ Central Plant Study	Milestone 3 (as applicable)	Identify solutions to decarbonize district energy systems and central plants.	How will this study be coordinated with building-level audits (buildings served by the central plant)?
Scenario Development	Milestone 4	Develop scenarios that will achieve organizational emissions reduction targets.	How will the building-level audits be applied across the portfolio?
Economic Analysis	Milestone 4	Analyze the economic impact of the proposed scenarios over time.	What level of cost-estimating fidelity is required? What financial indicators are required (e.g., simple payback or net present value)?
Renewable Procurement Strategy	Milestone 4	Assess various renewable energy procurement options, both on and off site.	Does the organization already have policies on renewable energy procurement? Or does this need to be developed?
Fleet	Milestone 5	Identify solutions to reduce fleet emissions, including electric vehicle charging.	How much do fleet emissions contribute to the organization's overall GHG emissions?
Scenario Assessment and Selection	Milestone 5	Assess each scenario based on organizational evaluation criteria; support scenario selection.	What level of information will need to be provided to stakeholders to select an emissions reduction pathway?
Financing Support	Milestone 5	Identify sources of financing the project implementation.	Does the organization need to identify sources of financing for project implementation? Should this encompass the entire plan or individual projects?
Phasing and Prioritization	Milestone 5	Develop phasing and prioritization for projects in more detail, including enabling steps for electrification.	Should this be provided in greater detail at the organizational level? Or will guidance be provided to departments or regions to develop their own detailed implementation timeline?
Review and Update Portfolio-level Practices	Milestone 5	Review and make recommendations to update various organizational practices to better facilitate decarbonization.	Which practices and requirements have not been recently updated to incorporate decarbonization? Which should be created?

Appendix A: Emissions Reduction Plan Scope of Work (continued)

TABLE A2. Optional Elements in the Emissions Reduction Plan Scope of Work

Scope of Work Element	ERP Milestone	Description	Considerations
Pilot Development	Milestones 3–5	Support development and assessment of pilot projects to encourage broader adoption.	Does the organization need validation of pilot project results to move forward on implementation?
Tenant Emissions	All Milestones	Assess approaches and emissions reduction estimates related to tenant emissions, which can be a significant component of certain organization's overall emissions.	Does the organization include tenant emissions (often considered Scope 3) in their emissions reduction targets? Would supporting tenants in their emissions reductions efforts and addressing the split-incentive yield benefits to both the owner and tenant?
Scope 3 Emissions	All Milestones	Include other Scope 3 emissions, such as commuting, business travel, purchasing, and embodied carbon.	Does the organization have emissions reduction targets that include Scope 3 emissions? Would it be better to address these emissions in a separate effort? (Note that this may depend on the category of Scope 3 emissions.)
Increased Engagement	All Milestones	Provide broader engagement within the organization and community to build support for the organization's decarbonization effort.	What level of engagement is required for the Emissions Reduction Plan to move forward? Is the development of the plan an opportunity to educate the broader organization or community?
Resiliency	All Milestones	Assess potential impacts from climate change and identify solutions to improve resiliency.	Has a climate risk assessment already been performed? Does resiliency need to be a separate item or should it be considered throughout the plan development?

Appendix B: Example Outline for an Emissions Reduction Plan

TABLE B1 is an outline of a completed Emissions Reduction Plan, including the core elements. There may be additional elements included in the final plan. For additional elements to add to the outline, refer to TABLE A2. Optional Elements in the Emissions Reduction Plan Scope of Work.

TABLE B1: Emissions Reduction Plan Deliverable Outline

Introduction	
GHG Inventory	▸ Overview of the historical and current GHG emissions ▸ Definition of organizational and operational boundaries of reporting inventory
Emissions Reduction Targets	▸ Definition of GHG targets, scope of targets, and explanation of scope (i.e., what is included and excluded from the target)
Purpose	▸ Discuss why this plan is necessary and the role it will play in meeting the defined targets. ▸ Acknowledge stakeholders involved in the development of the plan.
Planning Approach	
Portfolio Categorization	▸ Overview of how the portfolio was categorized based on differentiating characteristics ▸ Outline of the representative buildings that were selected for emissions reduction audits
Building-level Measure Packages	▸ Summary of building level measure packages from building emission reduction audits
Portfolio-level Measures	▸ Summary of measures that will be implemented across all buildings in the portfolio, regardless of portfolio category
Emissions Reduction Pathway	
Scenario Assessment	▸ Outline of the strategies used to develop scenarios ▸ Outline of scenarios studied
Emissions Reduction Pathway	▸ Evaluation criteria used to select scenario as the proposed emissions reduction pathway ▸ Description of the selected scenario and how this pathway meets the GHG emissions reduction targets
Implementation	
Roles and Responsibilities	▸ Discuss how organizational policies and requirements have been developed or updated in order to support the ERP implementation. ▸ Assign ownership of plan components to specific stakeholders.
Phasing and Prioritization	▸ Discuss how measures will be implemented (i.e., consultants, integrated into current planning). ▸ Timeline and phasing of implementation of building-level and portfolio-level measures
Financing	▸ Outline of financing approach and sources
Next Steps	▸ Define how often the plan will be assessed and updated as conditions change in the organization and as technology costs and savings change.

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